The Translation of Metaphors in Popular Science from English into Arabic in the domain of Astronomy and Astrophysics

By

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Declaration of originality

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Abstract

Popular science articles are nowadays a key component of the scientific writing landscape: science is popularised through a recontextualization of a primary scientific discourse to fit the knowledge and expectations of a broader audience, but then disseminated further through translation. This recontextualization is often achieved using metaphors to help the non-expert reader to access complex and abstract scientific concepts based on shared author-reader experiences, which are, however, not necessarily shared with the new target-culture audience, potentially endangering cross-linguistic communication of the scientific content.

This thesis aims to investigate metaphors in American popular science articles dealing with astronomy and astrophysics published in Scientific American and their Arabic translations published in Majallat-Al-Oloom. The thesis focuses more particularly on metaphors fulfilling a pedagogical role which are embedded in culture specific domains. Although English is argued to be the global lingual franca of the sciences nowadays, the use of culture specific metaphors might raise difficulties in disseminating the scientific content in English and in its translations.

The field of astronomy and astrophysics has been chosen because of the complex and often abstract nature of its concepts that requires an appropriate discourse strategy to bring abstract concepts closer to the general reader’s understanding. It is also a domain that is visible in the public understanding of the sciences through its large diffusion. In this scientific communication metaphor fulfils not only a terminological function but is also used as a pedagogical tool to achieve popularisation. Despite its role in disseminating scientific content, metaphor in the discourse of astronomy and astrophysics has remained so far unexplored from both metaphor studies and translation perspectives.

To achieve these aims, a multidimensional framework combining a conceptual approach with linguistic and functional elements was devised to capture the complexity of metaphor from a translation perspective, especially between languages of differing diffusion where English is a global lingua franca. A bilingual corpus was compiled (circa 150,000 words) and analysed quantitatively and qualitatively. The updated version of the metaphor identification procedure (MIPVU) was further adapted to allow the identification of the linguistic metaphors and their functions. The methodology also accounted for how the conceptual metaphors are implied from the linguistic data, a step that is often unaccounted for in the literature.

The study shows that linguistic metaphors used in the source texts fulfil mainly a pedagogical function and are often embedded in culture-specific domains, presenting challenges for translation.

A wide range of strategies was identified in the translation of these metaphors, where the same conceptual metaphor is often reproduced in the target text by combining many strategies (couplets). This results in new metaphors in the target system that are argued to achieve a dual purpose: they facilitate access to scientific concepts communicated in the source text by unpacking the metaphorical images for a new audience; and they contribute to the enrichment of the target-language system.
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Abbreviations and conventions

A&A Astronomy and Astrophysics
BNC British National Corpus
BT Back translation
CCA Contemporary Corpus of Arabic
CDA Critical Discourse Analysis
CM Conceptual metaphor
CMT Conceptual Metaphor Theory
COCA Contemporary Corpus of American English
COD Concise Oxford Dictionary
CTH Conceptual Translation Hypotheses
DDA Dynamic Discourse Approach
DGAA Dictionary of Geophysics, Astrophysics, and Astronomy
DMC Different Mapping Condition
MED MacMillan English Dictionary for Advanced Learners
MEDA MacMillan English Dictionary for Advanced Learners of American English
Mflag Metaphor flag or signal
MIP Metaphor Identification Procedure
MIPVU Metaphor Identification Procedure Vrije University
MRW Metaphor related word
MSA Modern Standard Arabic
SC Source culture
SL Source Language
SMC Similar Mapping Condition

ST Source Text

TC Target culture

TL Target language

TT Target text

Through this work, the following typographic conventions are used:

SMALL CAPITALS Conceptual metaphors, e.g. IDEAS ARE BUILDINGS

“” Single inverted comma: linguistic metaphors.

In addition, the following conventions are used:

Examples from the A&A corpus are referenced using file code in Sketch Engine. The full list of file codes and their corresponding references are provided in appendices 1 and 2.

Red font is used for metaphors discussed only in an example. If the example contains other metaphors that are not discussed, these are not highlighted.

The transliteration of few Arabic terms/names occurring in the thesis is done following the guidelines provided in Habash et al., (2007).

Underline for metaphor signals in an example.
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Chapter 1. Introduction

The conceptual theory of metaphor has moved the role of metaphors from being a mere ornament of literary texts into a more central role where metaphors are not only used in literary texts but in scientific and specialised texts alike (Bicchieri 1988; Leatherdale 1974). The new role of metaphor as central to the cognition followed the advent of cognitive linguistics and mainly with the seminal work of Lakoff and Johnson (1980)—*Metaphors We Live By*—a conceptual role of metaphor was proposed. Metaphors were no longer seen as a decorative device but as a cognitive tool that brings unknown concepts closer to our understanding by means of a comparison (“mapping” in cognitive linguistics terminology) between two domains, the “target domain” which is usually more abstract one the “source domain” which, is usually more concrete. Conceptual metaphors can be traced in discourse through the linguistic expressions or vehicles that express them. Furthermore, the relevance of metaphors in science has now been demonstrated by a multitude of studies (e.g., Baake 2003; Bailer-Jones 2000; 2002; Boyd 1993; Bradie 1999; Brown 2003). Science plays a central role in the development of modern societies, and scientific institutions put considerable effort into disseminating scientific knowledge not only through popularisation in publications and broadcasting but also through translation, which plays a key role in knowledge transfer. However, the role of metaphor in the different popular science genres is still under-investigated in both Metaphor Studies and Translation Studies. This thesis proposes to bridge this gap by focusing on how metaphors are used and translated in the specific genre of popular science articles dealing with astronomy and astrophysics.

1.1 Background

Metaphors have long been studied from a translation perspective from the point of view of translatability/untranslatability (e.g. Dagut 1976; Van den Broeck 1981) or from a prescriptive perspective such as the recommended procedures for metaphor translation (Newmark, 1980; 1988). These perspectives offer a narrow scope for metaphor translation analysis that could benefit from the insights of the conceptual theory of metaphor. A number of researchers (e.g. Al-Harrasi 2001; Al-Hasnawi 2007; Rodriguez Marquez 2010; Rojo and Ibarretxe-Antunano 2013; Schäffner 2004) have integrated the conceptual metaphor theory into Translation Studies, offering new perspectives on the study of metaphor in translation and mainly shifting the focus from the linguistic to the conceptual
level of metaphors. Many theoretical and methodological frames have been developed (Herrmann 2013; Papadoudi 2010; 2014; Rodriguez Marquez 2010; Shuttleworth 2011, 2013, Alshunnag, 2016) to study metaphors from a conceptual perspective.

In the conceptual theory of metaphor, the overarching concept is that of a conceptual metaphor where a link (the ‘mapping’) is created between the abstract knowledge referred to as the ‘target domain’ and the more concrete experience referred to as the ‘source domain’ as will be explained in detail in Chapter 5. The linguistic metaphors are seen as the realisations of this underlying conceptual level. For instance, the word “process” is a linguistic metaphor commonly used to describe the activities going in the brain. This linguistic metaphor is underlined by the conceptual metaphor the BRAIN IS A COMUTER.

However, by placing the focus on the conceptual level, the cultural and textual problems that might arise from the use of metaphors in a special context such as popular science texts which have a pedagogical purpose risk being neglected.

Additionally, most of the current frameworks proposed so far are typology-based. For instance, Shuttleworth (2011, 2013, 2016) and Alshunnag (2016) both approach conceptual metaphors using the typology proposed by Lakoff and Johnson (1980) where metaphors are classified into ontological, orientational and structural metaphors. Alshunnag goes even further by calling these types “metaphors functions” (Alsunnag 2016:35)

Other researchers such as Manfredi (2014,) who also argue to apply a conceptual framework to their analysis, uses typology-based approaches such as the systematic functional approach were metaphors are classified into grammatical and lexical metaphors. In a more recent work, Manfredi (2017) applied a conceptual approach to metaphor where she was seeking conceptual equivalence between the metaphors identified in the TT and the ST starting with the identification of the metaphors in the TT. However, the researcher does not specify how she identified the linguistic metaphors in her corpus neither how she related them to the proposed conceptual metaphors. This latter is a problem that is often neglected in metaphor studies where the underlying conceptual metaphors are presented as a given as flagged out by Deignan (2017).

The framework of the current study proposes to analyse metaphors from a functional perspective where the concept of function is closely related to the notion of the genre. The
developed framework is based on recent studies where metaphor is seen as a recontextualization strategy to fit the purposes of different audiences as Caballero (2013) puts it in her introduction to the Special issue of *Metaphor and Symbol* on metaphor and genre.

Studying metaphor from the perspective of the genre allows to draw on the benefits of the conceptual approach without losing sight of the textual dimension of the metaphor. Both issues are relevant to Translation Studies. Whether a metaphor is translated or not does not necessarily depend on its type (ontological, directional and orientational) but more on its function and how it relates to the construction of meaning within the text.

Hence, the present study aims to contribute to both Metaphor Studies and Translation Studies by investigating linguistic metaphors and their underlying conceptual metaphors in the genre- of popular science dealing with the subject of Astronomy and Astrophysics (A&A) in both American English source texts and Arabic translated texts through the lenses of a multidimensional approach combining the cognitive, linguistic, textual dimension without occulting the cultural specificity of metaphors. This study focuses on analysing the genre-related functions of metaphors in the original English-language articles in a first place and endeavours to shed light on how these metaphors are dealt with in the translated texts.

The terms “Astronomy” and “Astrophysics” are used in this study together to refer to the scientific field that deals with the age of the universe, the movement and behaviour of cosmic bodies (including stars, planets, black holes, and galaxies) and the physical laws that rule the universe. As Maoz (2016: 01) points out, “Astronomy” and “Astrophysics” are used nowadays interchangeably and often together as in, for example, the journal of *Astronomy and Astrophysics (A&A)* which defines its scope of study as including ‘all aspects of astronomy and astrophysics (theoretical, observational, and instrumental)’ (see the journal website at http://www.aanda.org). This scientific field has been chosen as it visible in the media due to its wide popularisation. In addition, it ties with various other scientific disciplines such as physics, mathematics, biology and can be seen as a representative field *par excellence*. It is also a scientific field where metaphors play an important role not only in explaining scientific concepts but also in creating them, or as Happel (2002:34) puts it:
Language by physicists about the universe as a whole is highly metaphoric. In fact, the possibility of speaking about the universe as an entire unit is itself problematic, even metaphoric in physics. Physical discussion of origins and conclusions give the cosmos a narrative structure with its own implicit plot, agents, complication and denouement. Physics and astrophysics, despite their explanatory mathematics, emerge from rhetoric and use metaphor-driven models to communicate their insights to appropriate audiences (Happel:2002:34).

Despite the centrality of metaphors in the discourse of astrophysics and astronomy, it has, to date, received little interest in both discourse studies and metaphor studies.

1.2 General issues peculiar to translation into Arabic

This study aims also to account for the conceptual, linguistic and cultural differences and/or similarities in the use of metaphor in popular science texts between English as a global lingua franca in which both science and its popularisation are widely disseminated, and Arabic, which is distant from English not only culturally and linguistically but also technologically and scientifically. The role Arabic translation has played in the development of the sciences in Europe is undeniable (Al-Khalili 2010; Montgomery 2000, Salama-Carr 1990, 2009). In modern times, the translation movement from European languages, mainly from French as a global lingua franca into Arabic, at the beginning of the 19th century, is thought to play a similar role in the development of the sciences in the Arab-speaking world (Salama-Carr 2009).

In addition to the general issues raised by any act of translation, there are certain issues which are inherent in and peculiar to translation from English into Arabic. Some of these issues are problematic particularly with respect to metaphor identification in the Arabic data. Highlighted below are some of these issues that will provide a basis for, later clarification, some decisions regarding the methodology and even the interpretation of the results of the data analysis.

One of the main issues related to Arabic is the coexistence of different forms, a standard form known as *Fusha* (formal Arabic) as well as different regional varieties often referred to pejoratively as ‘colloquial’ *ammeya* (vulgar, popular). These colloquial varieties of Arabic are used to fulfil communication purposes in daily life while *fusha*, the archaic form of Arabic or the language of the Book (with capital ‘b’ in reference to the Holy Quran)
Arkoun (1975), is confined to the circles of schools and is used in formal written communication (Bassiouney 2009; Holes 2004).

Holes (2004) argues that the main difference between the varieties of colloquial Arabic and *fusha* is the variety of accents. However, in reality, not only the accent differs but also the vocabulary and syntax (Bassiouney 2009). It can be argued that literate Arabic speakers perform an ongoing process of translation between colloquial spoken Arabic and *fusha*.

Since the methodology adopted in this study relies on the use of up-to-date corpus-based dictionaries in both the SL and TL, the status of these dictionaries in Arabic needs to be addressed in relation to the issue of the development of the language because it has some influence on methodological choices, as will be seen later in Chapter 6. There is a general agreement regarding the lack of up-to-date general and specialised dictionaries in Arabic, nowadays (Mazaud 2004). This situation can be explained by the status and the development of Modern Standard Arabic which has been influenced by other languages via translation. As a result, archaic Arabic, which is the language of the Quran and classical literature, is barely accessible to Arabic speakers nowadays unless accompanied by an interpretation and heavy annotations. Another problem related to the development of MSA is that it has undergone morphological and lexical changes which are not reflected in the language dictionaries. Arabic-language dictionaries which are still edited nowadays are those of the 7th (13th CE) and 8th (14th CE) centuries Hijri such as *Lissan Al Arab* (literally ‘Arab’s tongue’) (Ibn Manzur 1968) written in the 7th century Hijri, now in its 22nd edition. These dictionaries and other Arabic-language dictionaries such as *القاموس المحيط* (Al Kamus-Al Muhit) (literally ‘The Comprehensive Dictionary’) (Al-Fayruz Abadi, 1999) that, dates from the 7th century Hijri (1300CE), are searchable online through websites such as http://www.baheth.info/all.jsp?term. However, these resources prove to be unreliable to identify the basic meaning of words because the new editions are not updated and do not contain all entries for modern and contemporary words or their meaning.

There are also several dictionaries known as “modern” or “contemporary” on the market today such as *المنجد في اللغة العربية المعاصرة* (literally ‘The Helper: Dictionary of Contemporary Arabic’) which, is in its 2nd edition (Naama, 2001). However, it is a ‘recycled’ version of *Lissan Al Arab* and is organised in a similar way following the alphabetic order of the triadic roots (from where most Arab lexemes are supposed to derive). Despite effort to
modernise the dictionary, it contains a number of ‘obsolete’ words and a limited number of ‘modern’ words.

To illustrate this problem, a search on the word ترجمة (‘translation’) in Lissan Al Arab dictionary\(^1\) reveals that the term appears under the triadic root رجم from which is derived the verb رجم meaning ‘to kill’, ‘to chase away’ and ‘throw stones on someone or something’, and the verb تراجح meaning ‘throw stones at each other’ and figuratively ‘insult’ each other. In the third position, comes the headword ترجم (translate) meaning ‘explain’ and ‘translate.’ It is worth noting that the word ترجمة (‘translation’), which has been in use in the Arabic language for centuries, is not listed in the المندج في اللغة العربية المعاصرة (‘The Helper: Dictionary of Contemporary Arabic’). This situation amplifies the unreliability of modern as well as old dictionaries to accurately reflect the development of Arabic as used, nowadays, in education and written communication, including translations.

A lack of reliable specialised dictionaries makes translation a challenging activity. This is further evidenced by the fact that numerous terms used by translators do not exist in the available dictionaries especially A&A scientific terms. Translators face tasks such as filling terminological gaps. Izwaini (2010), for instance, in a study of the vocabulary of Information Technology (IT) in English and its translation into Arabic and Swedish, found that in order to address the lack of terminology in the specialised field of IT, translators resort primarily to literal rendition which sometimes results in odd or opaque translations. However, literal translation used as a translation strategy is also a way of creating new lexical units and new collocations in Arabic. While new words and collocations introduced into the language via translation are in wide use in everyday language, they remain absent from language dictionaries.

Another issue related to terminology is the lack of standardisation which results in the creation and the spread of multiple terms referring to the same concepts. These terms are not always well defined and may refer to obscure concepts. Dourari (2006), for instance, in a study of the translation of Semiotics texts translated into Arabic, argues that translation is often reduced to the creation of lists of terms that refer to imprecise concepts whose epistemological origins are blurred (Dourari 2006: 84). The issue of metalanguage in

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\(^1\) Searchable online from http://www.baheth.info/all.jsp?term=ترجمة [Last accessed 06/10/2016.]
Modern Arabic dictionaries has also been flagged by Shayakhmetov (2015) who advocates that one way of addressing the precision of terms and their meaning is the development of bilingual dictionaries (2015). With this regard, it is worth noting that there have been some lexicographic developments aiming to address both the issue of the content of the dictionaries and the standardisation of the terms (Benzahra, 2012). These efforts include the creation of corpus-based bilingual dictionaries such as the *Oxford Arabic Dictionary* (Arts, *et al.*, 2014). This bilingual dictionary can be used to search for conventionalised metaphors called in this study “generic metaphors”.

These examples show some of the problems that arise when dealing with English into Arabic translation that range from the lack of terminology, the lack of standardisation and extends to the lack of metalanguage and concepts to which the terms refer. The multiplicity of translators’ footnotes in the corpus of the present study may be considered as a translation strategy used to deal with this terminological issue. The translation of metaphors, specifically, is highly challenging because metaphor fulfils a cognitive role serving not only to create terminology but also to explain scientific phenomena by mapping abstract domains into more concrete ones.

It is worth mentioning that there is a continuous effort from different standardisation organisations to produce unified terminology, especially in the technical fields. ZarZar (2017) argues that one of the concrete steps towards addressing the unification of terminology is the project ARABTERM. This is a joint project launched in 2008 by the Arab League Educational, Cultural and Scientific Organisation (ALESCO) in collaboration with the German Federal Ministry of Economic Cooperation and Development (BMZ) (ibid. 45). The main goal of this project is to issue a unified terminology dictionary and to make is accessible online to the users.

These translation problems specific to the English-Arabic pair of languages that, as will be seen in Chapter 6, have required the adaptation of the linguistic metaphor identification procedure in the Arabic subcorpus. These issues related to the development of the Arabic language are also kept in mind while interpreting the results of the corpus analysis as will be seen in Chapter 8.

The next section outlines the research questions that will be answered through this study and describes the corpus that will be analysed to answer the research questions.
1.3 Research questions

This study aims to explore the role of metaphors and their translations in the dissemination of the scientific knowledge in the field of astronomy and astrophysics in a global context where English is argued to be a global lingua franca of scientific communication.

To answer this question, the following subquestions are answered:

✓ What are the linguistic metaphors used in popular science articles of Astronomy and Astrophysics (A&A), what functions do they fulfil and to what extent are they signalled?
✓ What are the source domains in which these linguistic metaphors are embedded and what are the conceptual metaphors related to them?
✓ How are these conceptual and linguistic metaphors addressed in translation?

To answer these questions, a parallel bilingual corpus which is genre-specific and subject-specific. It is composed of English original articles about Astronomy and Astrophysics from the popular science magazine *Scientific American* and their Arabic translations in *Majallat-Al-Oloom* (The Magazine of Sciences).

1.4 Motivation for the study

Despite current growing interest in research on metaphor in scientific translation (Shuttleworth (2017), the genre of popular science articles has attracted little interest, particularly in the domain of A&A from a subject and genre perspectives. These perspectives, however, have been shown in some research to shed a different light on the functions of metaphor in popular science texts and are thought to be determinant in how metaphor is translated. Papadoudi (2010, 2014), for instance, focused on the analysis of metaphors in a parallel bilingual corpus of popular technology articles between Greek and English. Elsewhere, Samaniego Fernandez (2002, 2011, 2013a, 2013b) focused on the analysis of economic metaphors between Spanish and English in a corpus of economics newspaper articles from a conceptual point of view; Shuttleworth (2011, 2013 2017)
conducted a genre-specific research on metaphor translation between different languages: English, French, Spanish, Russian, and Chinese in *Scientific American* articles. However, his research focused mainly on metaphors related to neurobiology and biotechnology, leaving the “metaphorical potential” for other disciplines such as Cosmology and Physics (both branches of Astronomy and Astrophysics) “untapped” (Shuttleworth, 2013: 117).

The present study aims to bring new insight into both Metaphor Studies and Translation Studies by enriching current Metaphor Studies with an analysis of a scientific domain that has been so far under-researched i.e. Astronomy and Astrophysics. It also proposes an enhanced methodological framework for the analysis of metaphors in English and Arabic that tackles not only issues of linguistic metaphor identification but also the underlying conceptual metaphor identification. It also aims to contribute to the development of our knowledge of Modern Standard Arabic use in sciences bearing in mind the key role of metaphor as a powerful tool in explaining scientific concepts and the role of translation in disseminating knowledge.

### 1.5 Structure of the thesis

This thesis is structured as follows.

Following the current chapter, which provides a background to the study states the research questions, motivation of the study and outlines the structure of thesis, Chapter two provides historical background to the issue of scientific popularisation to bring to light certain misconceptions regarding the function of popular science texts and how they relate to specialised scientific texts. This is important because popular science texts are often seen as a mere simplification of primary scientific texts (Meyer, 2003). Therefore, this chapter sets the scene for the following chapter, where the relevance of metaphor in shaping the discourse in popular science articles is explained.

Chapter three deals with the role of metaphors in specialised and popular science texts. This chapter provides an overview of different categorizations of scientific metaphors and discusses these categories/functions in their relation to each scientific genre (mainly the function of metaphor in popular science texts vs the function of metaphor in specialised texts or general language use texts). It also deals with an important feature of metaphor use: which is metaphor signalling.
Chapter four reviews metaphor translation from linguistic and cognitive perspectives. This chapter is broken into five parts: the first section reviews linguistic approaches to metaphor in translation and outlines shortfalls of this approach. The second section reviews conceptual approaches to metaphor and assesses the value of each for metaphor translation. The third section reviews the issue of metaphor translation in scientific texts. The fourth section provides an assessment of the interaction between linguistic and conceptual approaches to metaphor translation and provides a general framework upon which the analysis of the corpus compiled for the purposes of this study is conducted.

Chapter five provides a justification for the methodology used in this study and further defines key concepts of the conceptual metaphor theory. This chapter focuses on methods for linguistic metaphor identification in original English texts (the English subcorpus) and the translated texts (Arabic subcorpus). The chapter is divided into four main parts: the first section further explores the conceptual approach to metaphor introduced in chapter four by presenting the key concepts of the Conceptual Metaphor Theory (CMT). Through this exploration, the limitations of CMT as a framework to tackle metaphor in translation are highlighted. The second, third and fourth sections present different approaches to metaphor developed in response to the limitations of CMT. First, the discourse-analysis approach, which returns the focus to the linguistic level in the study of metaphor, is examined. Second, the corpus approach, which responds to methodological limitations of CMT, is presented. Third, procedures for metaphor identification—the acknowledged first step in working towards a conceptual analysis—are described. These approaches are introduced, in this chapter, as a necessary basis for the methodology developed in chapter six.

Chapter six describes the proposed methodological framework to analyse metaphor in translation. It is divided into three main parts. The first part describes the corpus design and corpus processing tools. The second part describes the method for the identification of linguistic metaphors and their functions in the English and Arabic subcorpora. The third part describes how conceptual metaphors are inferred from linguistic data. This latter question has been often neglected in metaphor research.

Chapter seven is the first of two results chapters. It presents the quantitative and qualitative analysis of the English subcorpus and is composed of two main sections. The first section presents the numerical findings related to the metaphor functions identified in this study,
generic metaphors, terminological metaphors and pedagogical metaphors, used in the English subcorpus, as well as to the source domains underlying them and their distribution across metaphor functions. Given that pedagogical metaphors prevail in the English corpus, they were retained for further analysis with a focus on culture-specific ones. The culture-specificity of metaphors is introduced, in this chapter, as a filter to narrow down the focus of the research given the additional translation challenge that arises when the source text metaphors are culture-specific. This is the case, for instance, for sports and food metaphors. In addition, metaphor signalling in the A&A English subcorpus is discussed and will be returned to later in chapter eight to unveil any shift in the signalling pattern in the TT. The second section of chapter seven has a narrower focus. Metaphors fulfilling a pedagogical function, mainly those embedded in culture-specific source domains, are further analysed given their potential for the study of metaphor translation.

Chapter eight deals with the analysis of culture-specific metaphors in the Arabic translation subcorpus and proposes a refined framework for metaphor translation analysis. In this chapter, all examples of Arabic translations were back translated into English literally.

Chapter nine summarises the findings and presents a reviewed methodological and analytical framework for metaphor translation. It also highlights limitations of the current study and outlines future research work.
Chapter 2. Popularisation: background and definitions

In the present context, popularisation as a social practice aims at disseminating science and technology to members of society, outside the relevant discourse community, to enhance public understanding of science and increase social, economic and scientific progress (Graham et al., 2006). Popularisation takes different forms and uses different media. Documentaries, TV shows, museums, popular science magazines and newspapers are some of the many ways of disseminating science to a non-specialist audience. This chapter provides the historical background for popularisation in Section 2.1, reviews definitions of popularisation in Section 2.2, and introduces different genres of scientific writing with a focus on popular science articles published in popular science magazines in Section 2.3. The last Section 2.4 provides a summary of the key points reviewed in this chapter.

2.1 Historical background

The emergence of popular science as a distinct form of scientific literacy is relatively recent. The separation between science as a normative and institutionalised activity and its other forms (mainly popular science and science fiction) emerged only in the first half of the 20th century (Beer 1990, 1999; Barton 1998; Bensaude-Vincent 2001; 2009; Secord 2004). The emergence of popular science writing is regarded as a “legitimate” reaction to the highly-specialised language of science which is inaccessible, or accessible with difficulty, to those who do not belong to the same scientific community (the general public or those belonging to another scientific community such as scientists from other domains). This inaccessibility of scientific writing to those who are out of the scientific circle is what has come to be metaphorically described as a “gap” between science and society (Bensaude-Vincent 2001, 2009). The role of popular science is to “bridge” this gap by adapting the content and the form of scientific writings to meet the needs and expectations of different audiences.

The twentieth century was marked by an accentuation of the popularisation phenomenon and more importantly, by its institutionalisation. Since then, several institutions have emerged to frame this popularisation activity. In the UK, for instance, the Committee on Public Understanding of Science (CoPUS) was founded in 1985 by the British Association for the Advancement of Science and the Royal Society. This body (CoPUS) aims to make scientific advancement more accessible to the public (Miller and Mollen 2000).
It is worth mentioning that different terms coexist to refer to the ‘transformative act of making science accessible’ (Fuller 1998: 36), named here ‘popularisation’ or ‘popular science’. In the UK, the term “popular science” is used with “science popularisation” and “science communication”. It generally refers to the public means of science dissemination such as television broadcasting and popular science books. The term “public understanding of science”, is in use in both UK and USA. The term “scientific literacy”, however, is more specific to the American context and the term “public awareness of science (PAS)”, also used in the UK, is more specific to the Canadian context. (DeBoer 2000; Gregory and Miller 1998; Laugksch 2000; Miller 2001, 2003). There is also a more recent coinage to refer to the act of making science accessible which is “Public Engagement with Science and Technology (PEST)” (Pitrelli 2003; Trench 2008). This term encompasses both aspects of science: theory and application.

These different terms denote a change in the perception of scientific communication. Scientific popularisation was often perceived as a unidirectional model of science communication where a scientist or a scientific authority (a scientific institution, for instance) addresses an audience described as “passive” (Bensaude-Vincent, 2001) or as “deficient” (Cloître and Shinn 1985; Hilgartner 1990). In this model, the audience is assumed to have little or no scientific knowledge and no ability to understand science. This unidirectional model was challenged, and an alternative bidirectional model of scientific communication was presented. In this bidirectional model, the notion of “general public” is replaced by that of a “citizen” who is not only capable of understanding science but is also taking part in the debate about science (Trench, 2008), hence the notion of “public engagement”.

2.2 Popularisation: definition or definitions

From a discourse analysis perspective, popular science is often seen as a simplification of a primary scientific discourse (Myers 2003) or a reformulation of scientific discourse (Jacobi 1999). Such views do not take into account the complex nature of the writing process where the primary scientific material is reshaped to serve different communicative purposes and is addressed to a different audience. Calsamiglia and Ferrero (2003), for instance, have investigated different strategies used to communicate among experts on one side, and between experts and non-experts on the other side. They argue that popularisation
discourse is tailored to meet the communicative goals of this type of discourse. Fuller (1998) expresses the complex process of popularisation in terms of translation where translation is defined as “the process of negotiating a bridge between distinct registers. Registers are contextually (socially and historically) specific ways of speaking” (1998:36 emphasis added). Fuller (ibid.) explains that “in the transformative act of making science accessible, a process of recontextualization occurs where science is repackaged to fit the discursive configurations of more overtly social and political texts” (emphasis added). This connection between popular science writing and translation seems highly relevant as popular science writing can be seen as a kind of intralingual translation in the sense that it is a complex operation of meaning transfer by recontextualization and adaptation to the particular needs of a different readership. This “recontextualization” is achieved by different rhetorical strategies, including explanation, metaphor and analogy. The current study focuses on metaphor and analogy (the definition of metaphor within this study encompasses analogy as will be seen later) as particular cases of recontextualization in popular science articles.

In order to understand the changes that take place during the recontextualization process, it is necessary to review the forms or genres of scientific communication. The next section offers a review of the main representative genres of written science communication with a particular focus on popular science articles.

2.3 Scientific writing genres

This section aims at describing how popular science articles differ from other scientific genres such as textbooks and research articles. Broadly speaking, scientific communication can be divided into three types: communication among scientists, communication of science to the general public (popularisation), and communication of science within educational institutions (educational communication) (Goldman and Bisanz 2002). Each of these scientific communication types, represented by a particular genre, is described below.

2.3.1 Purposes of scientific communication

Scientific communication cannot be seen as a single set of texts since different texts can be grouped together according to their form and function. The genre is considered in this study
in terms of the functions, social and cultural practices and communicative purposes it achieves (Ravid and Tolchinsky 2002).

Goldman and Bisanz (2002: 22) argue that each community shapes the genres it uses to communicate. Popular science articles, as a means of disseminating knowledge, are, according to the two authors, largely shaped by the media and the publishing industry. Goldman and Bisanz (2002: 25) categorise scientific texts into three main categories.

First, genres of communication among scientists that include research articles among others. Then, genres of communication between experts and non-experts aiming at popularising scientific information. This category includes but is not limited to fiction, reference books (e.g. encyclopaedias, almanacks), feature articles, special informational websites on science topics (e.g. National Geographic). The third category is what Godman and Bisanz (2002) call “formal education”. It includes different genres such as textbooks, laboratory workbooks, training manuals and other related genres. Research articles, popular science articles and textbooks are considered as prototypical for each group of scientific communication. They differ in function, the level of expertise of authors, targeted audience and purposes to be achieved.

Research articles are often considered as a primary source of scientific knowledge from which all other genres derive (Baram-Tsabari and Yarden, 2005; Swales, 1995; Yarden 2009). This conceptualisation of research articles as source text implies that all other forms of scientific writing and genres are a sort of intralingual translations. From a translation perspective, it can be said that little research has been conducted in this area (see Göpferich 2007; Zethsen 2009).

Relying on the notion of genre, in its broad definition as a transfer between registers (Bhatia 1993/2014; Biber and Conrad 2009; Martin and Rose 2003, 2008), the notion of intralingual translation where popular science articles are seen as recontextualization seems to become more and more accepted (See for instance Deignan et al., 2013 and Semino 2008)

It is worth noting that “translation” is often used in the literature to define popular science texts (Baram-Tsabari and Yarden 2005; Fuller 1998; Swales 1995; Yarden 2009).
However, such a definition uses “translation” rather as a metaphor than a proper act of intralingual translation as put forwards by Elshakry (2008: 702):

Antipositivists and later historians and sociologists of science have similarly developed working metaphors for the “translations” that occur in the contact zones between scientific theories and experimental practices or between things and concepts. For the antipositivists, theories of pidginization or creolization between contact languages offered metaphors for the process of translating between the language and practice of theory and experimentation across disciplinary cultures. For these later historians and sociologists of science, the “vocabulary of translation” is applied to a sociology of scientific knowledge and to the kinds of displacements and transformations that are said to occur in the material-semiotic network that binds together actors, interests, and objects in the social construction of science (Elshakry, 2008:702).

Interestingly, the metaphor of translation is exploited in a way that indicates that each form is a different genre since it involves different “actors”, “interests”, and “objects”. Each of these parameters can be used to compare popular science texts and research science texts from the point of view of translation proper. Although the intralingual dimension of translation lies beyond the scope of this study, it deserves further investigation as it can help to understand the function and organisation of popular science texts. This, in turn, can lead to a better “interlingual” translation. In addition, it can help a better understanding of popular science texts. It is a common agreement between translation theorists and practitioners that understanding is the first stage in the process of translation.

In the following section, the main discursive features of the three representative genres of scientific writing (research articles, textbooks and popular science articles) are described as a first step towards identifying protentional similarities and differences in the use of metaphors in each of these genres. This will help better understand the focus of the current study on the use of the metaphor in the genre of popular science articles.

2.3.2 Research articles

A number of studies on scientific genres have focused on research articles (Bazerman 1988; Myers 1989, 1990, 1991; Swales 1990, 2004) and textbooks (Eggins and Martin 1997; Hyland and Hamp-Lyons 2002; Hyland 2004; Penney et al., 2003; Swales 1995). Fewer have looked at popular science articles as compared to the two other forms of scientific writing (Nwogu 1991; Parkinson 2000, 2002; Parkinson and Adendorff 2004, 2005).
Research articles are a central genre in scientific communication as they are a means of introducing new knowledge. They are a persuasive argument addressed to the scientific community that is either involved in the ongoing research (same scientific community) or has an interest in it (scientists from other related disciplines) (Goldman and Bisanz 2002). The readership of research articles has an evaluative attitude toward the method and findings of the research article, and tends to attribute credits to researchers and distinguishes new knowledge from old knowledge. Research articles serve as a primary source of knowledge that can be recontextualised to become accessible to other audiences. For instance, Sharma and Anderson (2009) examine how research articles are transformed not to say translated into educational texts. They found out that research articles are characterised by four distinguishing features: “concealment of rhetoric”, use of grammatical metaphors, empirical evidence as a rhetoric tool, and a double-edged addressivity (2009:1260). Unexpectedly, while undergoing recontextualization and transformation, features (01) (concealment of rhetoric) and (02) (grammatical metaphor) remain unchanged whereas feature (03) (empirical evidence) plays a less important role in textbooks and feature (04) (addressivity) changes; while in expert-to-expert communication, both addresser and addressee are considered equal, in expert-to-non-expert communication. Students in the case of textbooks are considered inferior. This case seems to be a well-documented one about the translation between different genres. However, Sharma and Anderson (2009) do not report how these features unfold at the discourse level.

Parkinson and Adendorff (2005) have conducted a comparative study of the three representative genres of scientific writing which are research articles, popular science articles and textbooks and established that the main differences between the three genres lie in the following features:

- “Representation of human participants in the texts
- Use of passivation and nominalisation
- Evaluation in the texts, including use of attitudinal lexis
- Hedging and tentative language (Parkinson and Adendorff 2005:284)

The use of figurative language is not mentioned in any of these studies unless considered as part of what Parkinson and Adendorff, (2005:284) call “tentative language”.

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However, the centrality of figurative language in studies of each of these genres is more recent. In a special issue of *Metaphor and Symbol* dedicated to metaphor in and across genres, Caballero(2013a) outlines the relevance of the study of metaphors in the genre as follows:

A shared assumption is that a genre approach to metaphor helps understand people’s use of metaphor as closely related to the topic, participants, rhetorical goals and prototypical text formats involved in verbal interaction—some of the basic factors shaping genre. Most interestingly, by focusing on the rhetorical use of metaphor in and across genres, the discussion throughout this issue presents metaphor as something that can be expanded, changed, and re-used in agreement with changes in the genre contexts where it is used. The title “Metaphor in and Across Genres” points to people’s use of metaphorical language as a discourse strategy as well as to the “malleability” of certain metaphors when relocated or reused in various genres—a quality that underlies the health, longevity, and expansion of the metaphors thus used (Caballero:2013a:1).

The notion of genre is further exploited (see Deignan *et al.*, 2013, Semino 2008) to understand the role of metaphor in the three different genres reviewed here using the notion of “recontextualization”. Deignan *et al.*, (2013:99) argue that metaphors are often used first in specialised articles, then “taken up as pedagogical tools” when communicated to a broader audience. The researchers also argue that use of figurative language is “more frequent and more varied” (2013:111) in popular science articles compared to specialised articles.

2.3.3 **Textbooks**

As mentioned above, textbooks have attracted great interest in studies about scientific genres. Textbooks are mainly addressed to students. They are seen as a novice audience, who unlike the audience of research articles, take most of the facts presented as accepted (Swales 1995). Goldman and Bisanz (2002: 40) point out that “textbooks present information but overlook the important explanatory function of science”. Several recent studies have dealt with the role of metaphor in science learning and understanding, where metaphor is seen as an effective explanatory tool (Cameron 2002, 2003).

2.3.4 **Popular science articles**

Science is reported in the media by science journalists and scientists themselves. Scientists contest the way the media report science news for several reasons, but mainly because the media emphasise the “sensationalization” of scientific events and discoveries. Such a focus
affects the accuracy of information and leads to misreporting scientific results and findings. It has been argued that such a biased reporting of science can mislead the general public and generate negative feelings and actions/reactions toward scientific issues (Maillé et al., 2009).

Maillé et al., (2009) report that journalistic reports of science are characterised by inaccuracy in reporting scientific cases. This is thought to be engendered by the time constraints media journalists face. According to Maillé et al., (2009), in media reports of science, journalists omit methodology, which is considered as a central part of scientific research by scientists and hence, is a source of disappointment and disapproval not to say condemnation of the way the media report scientific issues. Nowadays, science journalists are increasingly aware of challenges that arise when reporting science in media, and how it can mislead public opinion about different scientific issues. In an interview\(^2\), Ben Goldacre, a qualified medical doctor and reporter for the Guardian, talks about sensationalised reporting of science and gives an example of how journalists misrepresent science by manipulating data in order to write their stories. Another example is a study conducted by Social Market Foundation (SMF), about the reasons that led to the reduction of MMR vaccines being administered. Ann Rossister, director of SMF, is quoted saying:

> The public’s inherent mistrust of government and its motives is exacerbated by the media’s sensationalist treatment of scientific stories (…) such misreporting can have fatal consequences: in 1998, the Daily Mail devoted some 700 stories to MMR creating the erroneous impression that the vaccine was dangerous. Following this, the number of people being inoculated against MMR fell by 20%, increasing the danger of these life-threatening diseases (BBC, 2006).\(^3\)

These examples demonstrate that the task of writing science for a general audience can be a real challenge and can sometimes have negative consequences. However, the role of media in popularising science cannot always be perceived negatively. Miller (2009) argues that the media report not only scientific knowledge that is validated by the scientific community but also presents new discoveries and new knowledge that may be still in

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\(^2\) The full video is available at [http://www.knowtex.com/posts/sensationalised-science-reporting_3729/comments](http://www.knowtex.com/posts/sensationalised-science-reporting_3729/comments) [Last accessed 22/10/2014].

debate in scientific circles. In the case of controversial issues such as genetically modified molecules and the effect of greenhouse gases, popular science articles can become an arena for scientific debate where both scientists and public interact. Calsamiglia and Van Dijk (2004) explore the role media in broadcasting a new image of science where “old” knowledge interact with “new” knowledge. The two others investigate various discursive strategies implemented to make specialised knowledge accessible to public taking into consideration the constraint of the newspaper as a medium. They have identified various strategies of explanation, among which metaphor (2004:370).

In addition to media articles about science, there is another kind of reporting science to a general audience, which is popular science magazines. Magazines such as *Scientific American* are devoted to scientific issues and target an “educated readership with an interest in science” (Olohan: 2016:174). Some scholars such as Rey (2000, 2007) and Rey and Tricás (2006) argue that the targeted audience has more than interest in science and is more an audience with some level of specialisation. Rey (2007), for instance, argues that *Scientific American* magazine belongs to what she calls “articles de semi-vulgarisation” that are midway between research articles and media articles about science. However, the view where popular science articles are seen as written by scientists addressing a heterogeneous audience of non-specialist readers is generally accepted. By “non-specialised reader”, it is meant, readers who are not specialists in the field being popularised. Specialists from other fields other than the one being popularised can also be included in this description.

Compared to media articles about science, popular science articles published in magazines can be said to be more reliable regarding their contents. This might be because they address an audience with a certain level of scientific awareness. It can also be argued that journalists and scientists publishing in magazines do not have to contend with the time and the space constraints as journalists when publishing in newspapers, as the magazines are published periodically and not daily. Their content is also devoted to scientific issues and not ‘diluted’ in a mass of other news.

Yarden (2009) compares scientific texts to popular science texts and educational texts (textbooks) and argues that while scientific texts are primarily expository and
argumentative, popular science texts are hybrid: expository, narrative and argumentative at the same time.

In the case of Astronomy and Astrophysics, there are few reports in the media about current research in this field apart from the news related to particular events. The way in which Astronomy and Astrophysics are popularised by researchers working in the field is either in the form of popular astronomy books or science fiction novels or magazines such as *Scientific American* that is translated into several languages. Astronomy & Astrophysics as a field is also argued to have a special role in the public communication of science as it acts as a “science catcher” (Madsen, 2003). It attracts the interest of large audiences as it is linked to different scientific disciplines: mathematics, physics, chemistry, geology, atmosphere sciences and biology and different technological applications like optics and remote sensing. Astronomy & Astrophysics is also linked to the humanities; its subject is shared with philosophy and religion. It is also the subject of interest of some pseudo-sciences (astrology is an example). Fiction, which has space and the universe as its subject, is also used successfully as a means of science communication (Madsen and West 2000).

It is also worth mentioning that the dissemination of astronomy and astrophysics as well as other scientific fields is done in a global context where English is not only the global lingual lingua franca of science communication but is also adopted as a global corporate lingua franca (Blenkinsopp and Shademan Pajouh, 2010). Scientific content is first produced in English and then disseminated into other languages mainly via translation (Mary Snell-Hornby, 2000; O’hagan and Ashworth, 2002).

Few researchers have highlighted the role of similes and metaphors in popular science articles, especially in highly abstract scientific fields such as A&A despite the key role they play in explaining scientific concepts as will be seen in the next chapter.

2.4 Conclusion

Popularisation can be defined as a kind of intralingual translation in the sense that it is a complex operation of meaning transfer by recontextualization and adaptation to the needs of the readership. The literature shows divergent views concerning the readership of popular science articles in general and *Scientific American* magazine in particular. In the current research, the audience targeted by the popular science articles is regarded as a non-
specialised one. This definition is in line with the objectives stated in both *Scientific American* and its Arabic translation.

Popular science articles differ from research articles and textbooks in the purposes to be achieved and targeted audience. Regarded as such, popular science articles can be considered a kind of intralingual translation where the research article is the source text, and the popular science text is the target text. This can literally be the case for popular science articles published in the media as there is an identifiable ST.

Each genre has a different function and is oriented towards a different audience: Research articles are written by scientists and are addressed to the specialised scientific community in order to demonstrate a new scientific issue. The scientific research is both expository and argumentative. Textbooks address science students. The main function of textbooks is informative. Popular science articles are written either by scientific journalists or scientists. They are addressed to a heterogeneous audience that can encompass interested scientists from other scientific fields in addition to non-specialised readers. Popular science articles are hybrid: expository, narrative, argumentative and explanatory at the same time. The next chapter shows how metaphor, which is regarded as an important feature in scientific writing, is used in both specialised and popular science texts.
Chapter 3. Metaphor in science and popular science genres

Metaphor is studied here from a conceptual metaphor theory point of view and is broadly defined following Lakoff and Johnson (1980) as a cross-domain mapping. This definition encompasses also what is traditionally referred to as “analogies”. Metaphor and metonymy (in CMT, metonymy differs from metaphor as it involves a mapping within the domain rather than across domains) are seen as the “two major modes by which people conceptualize their experience” (Gibbs, 1994:13). Metaphor is the focus of the current study as the main representation of figurative language, a term that is rather “problematic” as Deignan et al. (2013:10) points out because “it does not capture a homogenous and clearly defined subset of uses of language, or ways of processing language” (ibid.). Metaphor is central to scientific communication because it is widely used explanatory procedure, as reported in various studies about biology, which is one of the scientific fields that have known a profusion of studies on metaphor in popular science (Brunette and Caignon 2004; Calsamiglia and Van Dijk 2004; Ceccarelli 2004; Christidou et al., 2004; Knudsen 2003, 2005; Kua et al., 2004; Larson et al., 2005; Liakopoulos 2002; Nelkin 1994, 2001; Pramling and Säljö, 2007; Williams Camus, 2009). The current chapter outlines the role of metaphors in scientific discourse and the metaphor functions in the different scientific writing genres. Section 3.1 summarises the contradictory views related to the use of metaphors in scientific discourse. Section 3.2 deals in detail with the two main categories/functions of metaphor in science which are the theory-constitutive and the pedagogical metaphors. Section 3.3 further details the different metaphor functions from a genre perspective. Section 3.4 presents the issue of metaphor signalling which is salient to the analysis of metaphors in popular science articles and their translations. The last Section 3.5 summarises the key points dealt with in this chapter.

3.1 Should a scientist abstain from metaphor?

The positivist view of scientific discourse posits that scientific language is exclusively literal and that the use of any rhetorical device can generate confusion and ambiguity. This position vis-à-vis the use of tropes in science is explicitly expressed by Bishop Barkeley who argues that a “philosopher should abstain from metaphor” (reported in Bicchieri 1988:
Hence, the title of the article by Bicchieri (1988), namely ‘Should a scientist abstain from metaphor’. The article provides a condensed review of the role of metaphor in scientific thinking through analysis of a corpus of economics texts. The author criticises the positivist view of scientific language and argues that tropes, especially metaphors are valid scientific instruments in the generation of new knowledge. Hence, instead of being a hindrance, Bicchieri (1988) argues that a metaphor is an important tool for the development of scientific thinking because as Gaudin (1993: 152) formulates it: “[La métaphore] facilite la construction du concept en ce qu’elle fournit par analogie un support imaginative qui la rattache à un circuit conceptuel déjà frayé.”

[Metaphor facilitates the construction of a concept in the sense that it provides a means of imagining that concept through analogy with another concept already existing.]

According to Hausman (1989), the positivist view relies on the Aristotelian definition of metaphor as a deviation from literal language. The recognition of metaphor and analogy as constituents of scientific theories is a consequence of the development of metaphor theories that moved gradually from the comparison theory represented by Aristotle to the interactive theory presented by Black (1993) with a new postulation that similarity is rather created by the metaphor and not anterior to it (Hausman 1989). Black (1993: 27) holds that the metaphor cannot be simplified into an implicit comparison as postulated by the comparison view. He further argues that it could not also be seen as “replacing some set of literal sentences” (ibid.) as held by the substitution view. Instead, metaphor reveals new entailments between “the main subject” and the “secondary subject” leading to “creating similarity” (ibid.) Black (1993:28) argues that metaphor works by projecting some “associated implications” of the secondary subject upon the primary subject. The two subjects (the primary and the secondary) are said to interact in the following way:

(a) The presence of the primary subject incites the hearer to select some of the secondary subject’s properties; and (b) invites him to construct a parallel implication-complex that can fit the primary subject; and (c) reciprocity introduces parallel changes in the secondary subject. (Black 1993: 28)

Black (1993:21) holds that his interest is directed towards the “cognitive aspects” of certain metaphors. Black’s view has implications for the way metaphor is thought to contribute to
the creation of theories and scientific models. In an earlier work, Black (1962) explicitly states that:

> Perhaps every science must start with metaphor and end with algebra, and perhaps without the metaphor there would never have been any algebra. (Black 1962:242)

Black has not only provided arguments for the relevance of metaphor in science but also posited some cognitive principles for the study of metaphor. His terminology is quite similar to the terminology adopted by Lakoff and Johnson (1980/2008) in their seminal work *Metaphors we live by*. The terms “principal subject” and “secondary subject” can be likened to the terms “target domain” and “source domain”. The term “projection” is somehow equivalent to the term “mapping” in the conceptual theory of metaphor, to which we return in Chapter 5. The conceptual theory of metaphor can, therefore, be seen as a development of Black’s interactive view. Both, the interactive view and the conceptual theory of metaphor are built upon the same postulate of “partial mapping” between the source and the target domains, what Black (1993: 28) calls “associated implications” between the primary and the secondary subjects.

### 3.2 Metaphor functions or metaphor categories

Metaphor function has been linked to text genres in various studies (Musolff 2010; 2016; Musolff and Zinken 2009). Charteris-Black (2004), for instance, investigated the ideological function of metaphor in political speeches where the ideological function features as key. Metaphor use in different scientific genres (research articles, educational texts, popular science texts) has also been explored (Boyd 1993; Baake 2003; Brunette and Caignon 2004; Cameron and Stelma 2004; Semino 2008; Herrmann 2013; Deignan Littlemore and Semino 2013). Cameron and Deignan (2004), for instance, explored the use of metaphors in what they call “educational discourse” that includes popular science texts and classroom conversations and argue that educational metaphors fulfil four different functions: explanatory function, illustrating function, summarising function and an argument/convincing function.

A wider range of metaphor functions has also been identified by Goatly (2011) who lists thirteen metaphor functions in discourse. Goatly (ibid.), however, does not specify in his study whether the different metaphor functions are linked to specific genres.
This variety of metaphor functions is often presented in the literature as metaphor “categories”. Boyd (1993), for instance, claims that there are two main categories of metaphor in scientific discourse: theory-constitutive metaphors and exegetical metaphors.

The notion of categories is criticised, namely by Semino (2008:134), who suggests that Boyd’s distinction does not capture two different categories of metaphor, but rather two different functions a metaphor can perform when used in particular scientific texts and genres.

Boyd’s metaphors categories, or rather functions are explained, in some detail, in what follows as they represent the two key functions of metaphor in specialised scientific articles and popular science articles. As will be seen later in this chapter, the core difference in the use of these two functions between the two genres of research articles and popular science articles resides in the dominance of one or the other function in each genre rather than in the exclusion of one or the other function.

3.2.1 Theory-constitutive metaphor

By theory-constitutive metaphor, Boyd (1993) means metaphors that are inherent to a particular scientific theory or model. He argues that such metaphors are theory-constitutive because they cannot be replaced by a literal expression. A number of theories are built upon such metaphors. For instance, the ‘string theory’ in A&A is built upon the ‘string’ metaphor. Strings are thought to be the tiniest elements of the universe; they derive their name from an analogy with the strings of musical instruments. ‘Strings’ are thought to vibrate and oscillate in the way a stringed instrument does. Boyd (1993) holds that metaphor is not only used to coin new words to denominate newly discovered entities but it actually constitutes theories and creates new knowledge by creating new similarities.

A number of theories are built upon metaphors; the ‘code’ and the ‘translation’ metaphors in genetics are other examples of metaphorical scientific models (Brunette and Caignon 2004). The use of metaphor is seen by Baake (2003) as a characteristic of the early stages of a scientific theory. Such a metaphor may disappear later when knowledge about the phenomenon is developed enough to be described in a literal way, which means in a more objective and neutral way (Baake 2003; Bailer-Jones 2000, 2002; Bicchieri 1988; Hoffman 1980; Knudsen 2003; Oliveira 2009). This idea is consistent with the claim about the role
of metaphor in science. Baake (2003:56) considers metaphor as ‘one of the several tools for producing theory, along with mathematics, empirical research, and intuition’. Baake (2003) refers to the relation between the scientific discovery and the creation of knowledge, but questions whether science discovers intrinsic facts about the world or whether, through the process of scientific discourse, it creates those facts. He holds that knowledge creation is a process whereby discovery (the act of observation) occurs concurrently with creation (the act of reflection upon what is observed). As noted above for Boyd (1993), Baake (2003) supports the theory-constitutive role of metaphor in science and the contribution of metaphor to knowledge production.

However, the metaphor does not always play a positive role, according to some studies. It happens that when theories develop, metaphors that constitute them may become irrelevant; this is the case, for instance, of the ‘code’ metaphor in genetics. Knudsen (2003) argues that despite the fact that the ‘code’ metaphor was found to be inaccurate because it was associated with the wrong chemical entity, it is still pervasive in genetics where it is no more seen as a metaphor but as a conventionalised term. Despite the role of metaphor in explaining abstract notions to learners mainly in education institutions (Garland and Ratay 2007), there are few studies about the role of metaphors in the field of Astronomy and Astrophysics characterised by its complexity and level of abstraction as claimed by McCool (2008:14) in the following statement:

> Effective science communication requires a return to the mind of a beginner. This is a critical detail to remember because astronomy is, above all else, a remarkably complex subject. Since astronomy is initially a study of the abstract, observations of mysterious targets in the archives of time, we slowly forget our initial self. Novelty gives way to expertise. The problem is that effective astronomy communication requires a kind of scientific translation, a process made possible only by understanding the novice stargazer. And one of the best ways to accomplish this goal is communicating through analogy and metaphor (McCool, 2008:14).

To back up his strong claim, McCool (2008, 2009) reviews some popular metaphors in Astronomy And Astrophysics such as Kepler's metaphor of ‘the music spheres’ and argues that metaphor and analogy can be “vehicles” that help us to “grasp difficult astronomical concepts” (2008:15).

Boyd contrasts the theory-constitutive metaphor with pedagogical or exegetical metaphor, which is used for explanation and illustration. In contrast with the theory-constitutive
metaphors, Boyd (1993) argues that pedagogical metaphors can be replaced by literal expressions.

3.2.2 Pedagogical or exegetical metaphors

A pedagogical metaphor, as its name indicates, is widely used in texts for educational purposes such as textbooks or in particular contexts such as classrooms (Cameron 2002, 2003) or popular science texts (Semino 2008, 2011, Deignan et al., 2013). However, this type of metaphor can also be found in scientific texts such as research articles as explanation procedures are not confined to popular science texts. As noted, Boyd holds that such metaphors can be replaced by literal expressions:

Certain metaphors, which might be plausibly termed exegetical or pedagogical metaphors, play a role in the teaching or explication of theories which already admit of entirely adequate nonmetaphorical (or, at any rate, less metaphorical) formulations (Boyd 1993: 485).

Because the concept of ‘pedagogical metaphors’ is central to the present study, it is further detailed in the next section where metaphor function is explained in relation to the concept of ‘genre’.

3.3 Metaphor and scientific genres

Recent studies of metaphor tend to consider metaphor as genre-related (Caballero 2013a, 2003b; Deignan et al., 2013; Porto and Romano 2013; Semino 2008, 2011; Wee 2005).

Deignan et al., (2013), for instance, argue that using a framework based on what they consider as established notions which are ‘genre’ and ‘register’ “enable researchers to determine commonalities and differences, and ultimately establish more accurately how these co-occur with particular patterns of metaphor use” (2013:51).

In the same line, Wee (2005) claims that the notion of genre allows accounting for differences and similarities where, he maintains, the metaphor is a form of what he calls “recontextualization” and that recontextualization is constrained by the genre or what he calls “activity type” (2005:219).
Wee (2005) proposes that metaphor is a recontextualization because it transfers meaning from one context (source domain) to another (target domain). This section scrutinises the role of metaphor in popular science articles from this point of view.

Within this perspective, the two categories of theory constitutive metaphors and pedagogical metaphors discussed in the previous sections are seen rather as functions than as categories. While Boyd (1993) considers that the status of metaphor as theory-constitutive or pedagogical is inherent to the linguistic expression independently from its context, Knudsen (2003) argues that a metaphor can be theory-constitutive or pedagogical or both according to the context and to the genre where it is used. Rather than being a category, it is a function a metaphor fulfils in context or in a particular genre (Semino 2008). Knudsen (2003) categorises metaphors according to the genre where they are used. She compares how metaphors are used in biology in two different genres: specialised articles and popular science articles. Knudsen’s main argument is that metaphors used in research articles designate established scientific context and are, hence, no longer seen as metaphoric by scientists who use them when they address other scientists. She terms this kind of metaphor ‘close metaphor’ because its meaning is established and is not open to interpretation or explanation. These ‘close metaphors’ are theory-constitutive metaphors in Boyd terminology. When these same metaphors are used in popular science articles, authors tend to explain them to the reader who may not be aware of their established meaning as concepts of the scientific field. They are hence, ‘opened’. This ‘opening’ is done either by signalling them typographically as metaphors (‘the use of the metaphor between inverted commas for instance) or by providing an explanation, often using another metaphor. The following two examples are both taken from Knudsen (2003) to illustrate the use of the ‘translation’ metaphor in a research article published in Science and a popular science article published in Scientific American magazine. The first example is from a research article; the second example is from a popular science article.

If similar mispairing occurred during translation, messenger RNA containing 7-methylguanine would code as if contained adenine in place of the methylated base (Wilhelm and Ludlum, 1966: 1043 quoted in Knudsen, 2003:1254, emphasis is the author’s)

In this example, the linguistic metaphors ‘translation’, ‘messenger’ and ‘code’ feature in the research article without any signalling or explanation. In terms of Knudsen, they are ‘closed metaphors’.
The genetic code is not the message itself but the “dictionary” used by the cell to translate from the four-letter language of nucleic acid to the 20-letter language of protein. The machinery of the cell can translate in one direction only: from nucleic acid to protein but not from protein to nucleic acid. (Nirenberg, 1963, 56 quoted in Knudsen 2003, 1256, emphasis is her, quotes in original)

In this example, the linguistic metaphor ‘code’ is explained by another metaphor “the dictionary” (ibid.). This metaphor is typologically signalled using inverted commas (which is one of the metaphor signals listed in Goatly’s as will be seen in Section 3.3. Furthermore, the linguistic metaphor ‘translation’ is also explained by making the source language and the target language explicit. The cell translates from the language of nucleic acid, which is a four-letter language, into a language of protein which is a 20-letter language. The linguistic metaphor ‘translation’ is extended and used to provide more information: the machine translation of the cell is unidirectional as it can only transform the nucleic acid into a protein and not the other way around (from a protein into a nucleic acid). It should also be noted that the metaphor expression “translate” is no longer signalled after its first use. Knudsen (2003) argues that once a metaphor is explained in a popular science article, it tends to “close” again as it is not signalled or explained again as the text unfolds (ibid.).

Knudsen (2003) provides a useful distinction between the use of metaphor in both scientific articles and popular science ones. Accordingly, she argues that the same metaphor fulfils a different function when used in different genres. Regarding the statistical differences in the use of metaphor between the two genres of research articles and popular science articles, she finds that 90% of metaphors used in both genres are theory-constitutive metaphors. She concludes that none of the metaphors used in popular science articles is original, and they have all been recycled from specialised articles. If this is the case for biology texts, it does not seem to be the case for Astronomy and Astrophysics texts as will be shown later in Chapter 7.

Knudsen’s findings are partially supported by the findings of Skorczynska Sznajder and Deignan (2006). The two researchers conducted a comparative study of the use of metaphors in research articles and popular science articles in the field of economics. Relying on Henderson’s (1986) typology of metaphors in economic texts, the two researchers classified the metaphors according to their genre specificity into two categories: “generic” or “genre specific”. A metaphor is regarded as ‘generic’ when it belongs to the common stock of the language. This category encompasses conventional
metaphors, the meaning of which is listed in a general dictionary of the English language. The ‘genre specific’ metaphors, they go on to argue, serves three functions: “filling lexical gaps”, “illustration” and “modelling”. Illustrating metaphors have a primarily decorative or illustrative purpose while modelling metaphors are used to “extend economic thought” (Skorczynska Sznajder and Deignan 2006: 96). In order to classify a metaphor as filling lexical gaps or catachresis metaphor, illustrating or modelling metaphor, the linguistic metaphor is searched in a specialised dictionary. If the metaphor is found in the specialised dictionary, then it is categorised as either filling a lexical gap or a modelling metaphor. If the linguistic metaphor is not found in a specialised dictionary and is not found in a general-language dictionary, it is classified as an illustrating metaphor.

The modelling function in Skorczynska Sznajder and Deignan (2006) appears to correspond to what Boyd’s calls “pre-theoretical metaphors”. According to Boyd (ibid.), pre-theoretical metaphors are those which are used to describe a new scientific theory. After the theory is tested, the metaphor, he claims, can be validated and then become a theory-constitutive metaphor. If not, the metaphor would be abandoned or may stay in use for pedagogical purposes and becomes an exegetical metaphor. Pre-theoretical metaphors and constitutive metaphors differ from term coinage because they do not only create a term for a theory, they are often part of the conceptualisation of the theory (Oliveira, 2009). In addition, metaphor-driven models are an important part in communicating scientific content to differ audiences as highlighted by Happel (2002:34). In other terms, the theory would not have existed outside the metaphor. As Happel (1995).

Before discussing the findings of Skorczynska Sznajder and Deignan (2006), it may be useful to point out that there are a plethora of different terms used to refer to the different functions of metaphor in scientific writings. Some of the different terms overlap as summed up in Table 3.1 below.

<table>
<thead>
<tr>
<th>Author(s)</th>
<th>Metaphor category/function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boyd (1993)</td>
<td>Theory constitutive, Pedagogical or exegetical, Pre-theoretical metaphors</td>
</tr>
</tbody>
</table>

Table 3.1 Metaphor categories/functions used in the different reviewed studies
Knudsen (2003) claims that metaphors in research articles fulfil a cognitive role and are hence theory-constitutive or in her terms ‘closed metaphors’. When the same metaphor is used in popular science texts, it is either signalled or explained, which she terms ‘opened metaphors’. In this case, a metaphor fulfils pedagogical purposes. Once a metaphor is explained, it is ‘closed’ again, meaning that it is reused without explanation or signalling.

For Knudsen, any metaphor that occurs in a popular science text is necessarily linked to a theory-constitutive metaphor already established in the field. Consequently, these metaphors are not taken as a novel but rather as a recycled form of metaphors already used in research articles. The study of Skorczynska Sznajder and Deignan (2006) invalidates this last assumption about the novelty of pedagogical metaphors. The co-authors acknowledge that popular science texts use pedagogical metaphors that are often novel and not necessarily linked to theory-constitutive ones. In Skorczynska Sznajder and Deignan (2006): ‘modelling metaphors’ and ‘metaphors used to fill in terminological gaps’ or what can be called ‘catachresis metaphors’ are used in the sense of theory-constitutive metaphor. Modelling metaphors cannot be distinguished from catachresis metaphors because they are two faces of the same coin: they refer to both, the concept or the scientific model, and, at the same time, provide the ‘linguistic expression’ or ‘term’ to refer to the concept also called the denominative function (See Oliveira, 2009)

This review shows that there is often an amalgamation between metaphor functions and metaphor categories. More importantly, metaphor functions seem not to be mutually exclusive: Knudsen (2003) and Semino (2008) argue that the same metaphor can fulfil different functions.

<table>
<thead>
<tr>
<th></th>
<th>Closed metaphors</th>
<th>Opened metaphors/closed metaphor</th>
<th>Metaphors for filling terminological gaps (catachresis metaphors)</th>
<th>Illustrating metaphors</th>
<th>Modelling metaphors</th>
<th>generic metaphors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sckorynscka and Deignan (2006)</td>
<td>Metaphors for filling terminological gaps (catachresis metaphors)</td>
<td>Illustrating metaphors</td>
<td>Modelling metaphors</td>
<td>generic metaphors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cameron (2002, 2003)</td>
<td>Educational metaphor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Since this study aims to investigate metaphors in popular science texts of Astronomy and Astrophysics, we adopted the notion of metaphor functions from a genre perspective. Following Skorsynska and Deignan’s study (2006), it is agreed that metaphors belonging to the common stock of language are not genre specific. They are labelled ‘generic metaphors’ in the current study. This label indicates more a category than a function.

Generic metaphors are identified, as will be seen later in Chapter 6, using a general English-language dictionary. These metaphors (excluded from the study in Skorsynska and Deignan, 2006) might feature in popular science texts for different reasons: for instance, to appeal to the reader’s attention as pointed out by Scarpa (2002).

The two other genre-specific metaphor functions in Skorsynska and Deignan (2006)—namely, the function of “filling a lexical gap” and the function of “modelling” (theory-constitutive in Boyd’s terms)—are grouped here under the same label “terminological metaphors” because, as explained above, these two functions are two sides of the same coin.

The third metaphor type/function is “pedagogical”. The pedagogical metaphor function in the current study encompasses a wider range of functional variety than the “illustrating metaphor” in Skorsynska and Deignan (2006). In addition to their illustrating role, pedagogical metaphors provide an explanation and can also, as Cameron and Low (2004) point out, serve to summarise opinions or to convince and to argue. As said earlier, metaphor functions are not mutually exclusive, and it is accepted that the same metaphor has the potential to fulfil one or more of these functions.

The distinction established, in this study, between the three functions (generic, pedagogical and terminological) is valid, as far as it allows us to shed light on conceptual metaphors used in English popular science articles on A&A characterised by the complex and often abstract nature of their concepts. This task is thought to be accomplished mainly by pedagogical metaphors that are dominant in the A&A bilingual corpus as will be seen later in Chapter 7. From a translation perspective, pedagogical metaphors can be highly challenging, particularly if they are embedded in specific cultural domains that are not shared between the readership of the source English texts and the readership of the target Arabic texts.
This section has reviewed different functions of metaphors from a genre perspective. It has also hinted at the importance of metaphor signalling which according to Knudsen (2003) is a means to reopen “closed metaphors” when they are recontextualized in popular science articles. The next section provides more details on metaphor signalling and explains why it is a relevant parameter in the present study.

### 3.4 Metaphor signalling

A number of researchers advocate that “metaphor signals” also called “metaphor markers” (Goatly, 2011), “metaphor tuning devices” (Cameron, 2002; 2003), or “metaphor flags” (Steen et al., 2010a; 2010b, 2010c), are linked to metaphor function in the (con)text (Goatly, 1997; Knudsen, 2003; 2005; Skorczynska Sznajder and Piqué, 2005; Skorczynska Sznajder and Deignan, 2006; Skorczynska Sznajder, 2010). Metaphor signals are defined as devices which can be used to identify metaphors in texts (Goatly 1997). Table 3.2 below summarises metaphor signals (what Goatly calls “markers”) and their categories.

**Table 3.2** Goatly’s categorization of metaphor signals (markers) (1997:174-5)

<table>
<thead>
<tr>
<th>Marker category</th>
<th>Metaphorical markers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Explicit markers</td>
<td>metaphor-ically, figurative-ly, Trope</td>
</tr>
<tr>
<td>2. Intensifiers</td>
<td>literally, really, actually, in fact, simply, fairly, just, absolutely, fully, completely, quite, thoroughly, utterly, veritable, regular</td>
</tr>
<tr>
<td>3. Hedges and downtoners</td>
<td>in a /one way, a bit of, half-, practically, almost, not exactly, not so much, as, if not</td>
</tr>
<tr>
<td>4. Semantic metalanguage</td>
<td>in both/more than one sense/s, mean-(ing), import</td>
</tr>
<tr>
<td>5. Mimetic terms</td>
<td>image, likeness, picture, parody, caricature, model, plan, effigy, imitation, artificial, mock</td>
</tr>
<tr>
<td>6. Symbolism terms</td>
<td>symbol(-ic/-ically), sign, type, token, instance, example</td>
</tr>
<tr>
<td>7. Superordinate terms</td>
<td>(some) (curious, strange, odd, peculiar, special) sort of, kind of</td>
</tr>
<tr>
<td>8. Copular similes</td>
<td>like, as</td>
</tr>
<tr>
<td>9. Precision similes and other comparisons</td>
<td>material verb + like x, the y of a x, y’s x; noun-adj, the x equivalent of</td>
</tr>
<tr>
<td>10. Clausal similes</td>
<td>as if, as though</td>
</tr>
<tr>
<td>11. Perceptual processes</td>
<td>seemed, sounded, looked, felt, tasted, + like/as though/as if</td>
</tr>
<tr>
<td>12. Misperception terms</td>
<td>delusion, illusion, hallucination, mirage, phantom, fantasy, unreal</td>
</tr>
<tr>
<td>13. Cognitive processes</td>
<td>believe, think, regard, unbelievable, incredible</td>
</tr>
<tr>
<td>14. Verbal processes</td>
<td>say, call, refer to, swear</td>
</tr>
<tr>
<td>15. So to speak</td>
<td>“ ” ! White space</td>
</tr>
<tr>
<td>16. Orthography</td>
<td>“ ” ! White space</td>
</tr>
</tbody>
</table>
As Table 3.2 shows, Goatly has proposed 20 categories of metaphors’ signals. Some of them can be used with non-metaphorical words as well as metaphorical ones. This is mainly the case for category 13, i.e. “cognitive processes” expressed by verbs such as believe, think, regard and adjectives such as unbelievable and incredible. This is also the case for category 14 “verbal processes” and category 16 “orthographical marker” such as white space. Skorczynska Sznajder and Piqué (2005) have used Goatly’s (1997/2011) categories to identify metaphors in two corpora: business research articles and business periodical articles and found that the use of the signals allows the identification of a large number of metaphors in the corpus. However, some signals such as the “orthographic markers” (category 16) are difficult to use as means of metaphor automatic identification in electronic corpora. This is because they may be used in the text to fulfil other purposes than metaphor signalling. Other signals among which: “such”, and “as”, “the intensifiers” or “verbal processes” are used with literal and non-literal words and hence, cannot be used for an automatic search for metaphors without a case by case verification. The analysis of the corpus compiled for the purposes of this study takes metaphor signals into consideration because of the role they play in popular science texts. In addition, some metaphor identifiers can be used in an automatic search in corpora (Philip 2008; Skorczynska Sznajder and Piqué 2005).

From a translation point of view, signalling pattern can differ between the ST and TT. No research has been carried so far to analyse the possible shifts in metaphor signalling patterns between original and translated texts with the exception of Papadoudi (2014:46) who reports a more frequent use of metaphor signals in the TT compared to the ST. The researcher (2014:47) argues that metaphor signalling can be seen as an instance of a translation universal known as “explicitation” or to indicate the translator is not comfortable in transferring certain metaphors into the TT.
Given the cultural gap between English and Arabic, metaphor signalling is expected to expand in the TT as means of explicitating metaphors that, otherwise, cannot be easily understood by the TT reader. To verify this hypothesis, metaphor signalling patterns in the ST and TT are discussed in some details in Chapters 7 and 8.

3.5 Conclusion

This chapter has provided a review of different views regarding metaphor use in scientific texts. The two main functions found to occur in popular science texts are the terminological function (theory-constitutive in Boyd’s terms) and pedagogical (or “exegetical metaphors” in Boyd’s terms). Other metaphors belonging to the common stock of language (termed “generic metaphors”) are also found to be used in scientific texts but are thought to be non-genre and might feature in these texts as cohesive devices or to appeal to the reader’s attention.

Furthermore, the metaphor function depends on the genre and the context where it is used. Terminological metaphors, as argued by Knudsen (2003, 2005), are recontextualised and become pedagogical metaphors when used in popular science texts. The recontextualization of metaphors is often done by introducing a metaphor signal which means that signalling is an important feature of metaphor use in popular science articles.

We have seen so far that the genre of popular science articles aims at communicating scientific knowledge to heterogeneous audiences that range from specialists from other disciplines to non-specialised readers. This act of communication is achieved by recontextualizing primary research articles to suit expectations of a heterogeneous audience. In this process of recontextualization, metaphors play a key role as a means of explaining specialised terms. Three functions are found to coexist in the genre of popular science articles. These are generic metaphors, terminological metaphors and pedagogical metaphors.

In the next chapter, this research is taken a step forwards by reviewing how metaphors have been dealt with from a translation perspective. The aim of the next chapter is to assess different metaphor translation theories in order to set up the theoretical framework for metaphor analysis in the specific context of popular science articles.
Chapter 4. Review of approaches to metaphor translation

Translation Studies have traditionally considered metaphor from the perspective of translatability/untranslatability and have focused on metaphor as a rhetoric device or a ‘deviation’ from the literal meaning (Dagut 1976; Newmark 1980). With the developments of metaphor studies in cognitive linguistics, translation scholars became interested in the potential implications cognitive linguistics may have for Translation Studies (Al-Harrasi 2001; Charteris-Black and Ennis 2001; Schäffner 2004; Štambuk 1998; Tabakowska 1993; Temmerman 2000; 2002; Vandaele and Lubin, 2005; Vandaele et al., 2006). A review of the cognitive approaches to metaphor translation was recently subject to a volume of Applications of Cognitive Linguistics dedicated to the theoretical models and applications of cognitive linguistics to translation (Rojo and Ibarretxe-Antunano 2013b).

This chapter aims to review the main theories of metaphor and their implications for approaches to translating metaphor in order to prepare the framework for the metaphor analysis in the current study. The contribution of CMT cannot be fully comprehended if the linguistic approaches to metaphor are not acknowledged in the first place. Hence, the linguistic approach to metaphor and its implications for metaphor translation research is reviewed in Section 4.1. This is followed by a review of the cognitive approach to metaphor translation in Section 4.2. In this section, four main models of metaphor translation which are based on CMT are presented. Each of these models has provided elements for the conceptual approach to metaphor translation. The translation of metaphors in scientific texts is key in the current study where the metaphor is approached from a genre perspective. Hence, approaches to metaphor translation in scientific texts are reviewed separately in Section 4.3. The translation patterns that emerge from the literature review are discussed and summarised in Section 4.4. These emerging patterns are used as a starting point for the analysis of metaphors in the A&A corpus. The main points discussed in this chapter are summarised in Section 4.6.

4.1 Linguistic approaches to metaphor translation

This section reviews linguistic approaches to metaphor and their implications for metaphor translation. It is divided into three parts: the first part (4.1.1) provides a background for linguistic approaches to metaphor; the second part (4.1.2) discusses implications of these
approaches for metaphor translation, and the last part (4.1.3) summarises the main arguments presented in this section.

4.1.1 Background

The linguistic approaches to metaphor are based on objectivist philosophical assumptions that the mind and language are literal and not figurative. The reality is conceived as external and independent of the mind (Kövecses 2005). The mind is thought to reflect reality objectively through the mental representations that are stored in mind (Kövecses 2005: 09). The metaphor is hence unwanted as it obstructs an objective construction of reality. It is therefore banned by some from scientific language (e.g. Bicchieri 1988: 293).

These assumptions are found in the Aristotelian approach to metaphor which sees metaphor as a deviation from literal language and a particular way of seeing an external resemblance between things. However, this resemblance cannot be seen by everybody and metaphor is, therefore, a “mark of genius” rather than a cognitive aspect of the human brain (Black 1993).

Black (1993) divides metaphor theories that developed from Aristotle’s view into three main theories: substitution theory, comparison theory, and interaction theory.

Way (1991: 23) defines the substitution theory as “any view which holds that a metaphorical expression is used in place of an equivalent literal expression and is, therefore, completely replaceable by its literal counterpart”. Metaphor, as an implicit comparison, is a special case of metaphor as substitution, in which the literal equivalent to the metaphor is held to be a comparison or a statement of similarity (Black 1993).

Black’s (1993) interactive view holds that rather than relying on pre-existing similarities, metaphor creates new ones. Thus, metaphor cannot be replaced by the literal meaning. Black’s view of metaphor is close to the cognitive-linguistic approach as it gives central importance to a metaphor for meaning and cognition.

Before Black, Richards (1936) rejected the Aristotelian assumptions about metaphor as a deviation from literal meaning and its restriction to poetics and literature. Richards argued in favour of the prevalence of metaphor in speech. He also defined metaphors in terms of interaction between two thoughts:
The traditional theory noticed only a few of the modes of metaphor; and limited its application of the term *metaphor* to a few of them only. *And it made metaphor seem to be a verbal matter, a shifting and displacement of words, whereas fundamentally it is a borrowing and intercourse of thoughts,* a transaction between contexts. *Thought is metaphoric,* and proceeds by comparison, and the metaphors of language derive therefrom (Richards 1936: 94. Emphasis added)

Richards brought new insights to metaphor studies by considering metaphor as a matter of thought and not only as a matter of language. Richards’ view can, therefore, be considered as the precursor for the conceptual metaphor theory that developed later.

### 4.1.2 Implications of traditional views of metaphor for Translation Studies

In Translation Studies, the metaphor has been dealt with from the point of view of translatability and untranslatability as noted above. Dagut (1976: 28), for example, argues that the translatability or untranslatability of metaphor is ruled by “the extent to which the cultural experience and associations it draws are shared by the speakers of the particular TL”. Dagut distinguishes between three cases of metaphor translation:

- Novel metaphors which, he argues, are untranslatable;
- Translatable metaphors which Dagut describes as “ephemeral”: this category includes conventional metaphors that have lost their metaphoric origins and are no longer perceived as metaphors by the language users;
- New metaphors that enter in use by the language speakers and hence lose their novelty and uniqueness (stock metaphors).

Dagut’s study focuses on distinguishing metaphor from polysemy and idioms. He argues that metaphor is a ‘special’ case of language and culture; he measures its translatability by the degree of the shared ground between cultural experience and semantic associations. Despite the distinction Dagut (1976) makes between the categories of metaphors, he focuses only on the translation of the novel ones. In addition, there seems to be no practical implication for the distinction between the two last categories (“ephemeral” and “stock” metaphors) as both categories refer to metaphors that became part of the common language.

Nevertheless, it is thought here that the commonness of ephemeral and new metaphors does not deprive them of the semantic and cultural content that may give rise to the same translation problems as those arising from the translation of novel metaphors.
Like Dagut (1976), several other scholars have focused on the translatability/untranslatability of metaphors giving particular attention to novel metaphors.

Van den Broeck (1981: 78), for example, states that:

With regard to the use and function of metaphors a traditional typology of texts will be of little use. The only plausible distinction seems to be that between creative and non-creative language use, in that in the former metaphor as such is functionally relevant, whereas in the latter it is most likely not to be. (Van den Broeck, 1981: 78).

Van den Broeck (1981) proposes the following typology for metaphor translation:

1. Translation “sensu stricto” if the “vehicle” and “tenor” correspond between SL and TL;
2. The substitution of the vehicle of SL by a different one in the TL;
3. The deletion of metaphor in the TL and its replacement by a paraphrase.

Van den Broeck argues that the solution chosen to render a metaphor depends on the genre of the text in which it is used. For example, literary texts are said to use creative metaphors which, in his opinion, pose translation problems. However, he argues that scientific texts do not pose any problem in terms of “rendering them metaphorically or non-metaphorically” (ibid.:78). The reason for this, according to Van Den Broeck, is that scientific metaphors are universal.

Van Den Broek (ibid.) is one of the first translation scholars to investigate how metaphors are translated in scientific texts and to link the metaphor function to the genre where it is used. He also challenged the issue of untranslatability by proposing alternative solutions to the ‘untranslatable’ metaphors as Dagut calls them. The metaphor translation solutions proposed by Van Den Broek (ibid.) include the substitution of a metaphor by a non-metaphorical word or expression. This solution is found to feature in other metaphor Translation Studies such as Rodriguez Marquez (2010) and Papadoudi (2010, 2014), and also features in the present study as will be seen later in Chapter 8.

Van den Broeck’s list of metaphor translation procedure is further extended by Newmark (1988) who focuses on providing a classification of metaphor types and procedures for metaphor translation from a prescriptive perspective. Newmark defines metaphor as a “resemblance, a common semantic area between two more or less similar things—the image
and the object” (1988:104). He refers to the concept or the mental image as the “image”, which he defines in terms of “the picture conjured up by the metaphor, which may be universal (a ‘glassy’ stare), cultural (a ‘beery’ face), or individual (a ‘papery’ cheek)” (emphasis added). Newmark (ibid. 105) refers to the linguistic metaphor as the “metaphor” “which may be one-word, or “extended over any stretch of language from collocation to the whole text”.

Newmark’s distinction between the “image” i.e. ‘the picture conjured by the metaphor’, which may be universal, cultural or individual, and the ‘object’ i.e. what is described or qualified by a metaphor’ (Newmark 1988:105), is similar to the distinction between the conceptual and the linguistic levels in the conceptual approach to metaphor. Newmark also raises the problem of the delimitation of the boundaries of the linguistic metaphor: what is a metaphor? Is it one word, multiple words or does it extend beyond? However, his view differs from the conceptual view in that he deems it necessary to go through the literal meaning in order to understand the metaphor which can be the basic meaning but does not go beyond. The identification of the basic meaning, however, is only to first step in the analysis of metaphors from a conceptual theory perspective.

Newmark distinguishes clearly between the concept and the linguistic expression but concentrates his attention on the linguistic level. He proposes seven types of metaphors: dead, stock, clichés, standard metaphors, adopted metaphors, recent metaphors and original metaphors. However, he does not provide a way to distinguish between these metaphor types. Some of these types overlap; for instance, there is no clear distinction between dead and stock metaphors or between recent and original metaphors.

Newmark also proposes different procedures to translate metaphors which are:

1. Reproducing the same image in the TL;

2. Replacing the image in the SL with a standard TL image which does not clash with the TL culture, what Newmark (1988) also calls “cultural equivalence”;

3. Translating metaphor by simile, retaining the image;

4. Translating metaphor (or simile) by simile plus sense;

5. Converting metaphor to sense;

6. Deletion, if the metaphor is redundant;

7. Using the same metaphor combined with sense, in order to enforce the image.
Procedures 4 and 7, which are a combination of two solutions, show how metaphor can be problematic in translation. The analysis of the A&A corpus as will be seen in Chapter 8, shows that combining two procedures to translate a metaphor is one of the strategies identified in the A&A corpus to render linguistic metaphors from English into Arabic. Newmark (1988:91) calls this procedure a “couplet” and defines it as a combination of two translation procedures (i.e. strategies) or more. He argues that this solution is “particularly common for cultural words if transference (loan) is combined with a functional or a cultural equivalent” (ibid.).

The couplet seems to be a pragmatic solution in order to transfer the metaphor and its functions into the TT and to attune the reader and help him/her to understand the metaphor, particularly if the metaphor is culturally-bound as will be seen later in Chapter 8.

Despite this detailed description of metaphor translation procedures, Newmark’s metaphor types/categories seem to be an unnecessary extension of the Van den Broeck’s categorization because ‘dead’, ‘clichés’ and ‘standard’ metaphors can all be classified as conventionalised metaphors in the sense that their meaning can be, more or less, found in general language dictionaries.

In addition, procedure 3 also presents some interest: by transforming the metaphor into a simile, the metaphor keeps its power as a conceptual and pervasive tool and becomes easier to grasp by the reader through the introduction of a simile device. This can be considered as a translation strategy where a metaphor signal is used in the TT as means of explicitation as seen in Section 3.4 and as will be discussed later in the analysis of the Arabic translation sub-corpus.

Furthermore, Newmark has raised an important issue which is metaphor identification. In this regard, he offers to use the truth condition principle to identify a metaphor. By the truth condition, Newmark proposes that “whenever a sentence is “grammatical” but does not appear to make sense, you have to test its apparently nonsensical element for a possible metaphorical meaning.” (1988: 106). Newmark’s “truth condition” is quite similar to the “incongruence principle” applied by the Pragglejaz group (Crisp et al., 2007) in their Metaphor Identification Procedure (MIP) to be discussed later in Chapter 5.

Newmark’s (19981) contribution to metaphor translation analysis is undeniable despite criticism as outlined above.
Other scholars such as Toury (1995) argue that the linguistic approaches described so far are all oriented towards the source text. He argues that a target text-oriented approach reveals other strategies for dealing with metaphors.

In Toury (1995)’s opinion, the source text-oriented approaches can be summarised as follows;

- metaphor into ‘same’ metaphor;
- metaphor into ‘different’ metaphor;
- metaphor into non-metaphor, meaning the translation of a metaphor by a non-metaphor;
- metaphor into 0 metaphor which means suppression of the metaphor from the target text

In addition, by looking from a target text perspective, two other strategies can be added (Toury 1995: 83):

- non-metaphor into a metaphor
- Nil into a metaphor.

In both cases, a metaphor occurs in the target text where no metaphor is used in the source text. The difference between the two cases is that in the latter case there is no linguistic motivation in the source text that may justify this addition.

Contrary to the previously mentioned studies where the choice of a metaphor translation strategy may be motivated by the nature/function of the metaphor (novel or conventional, for instance), Toury (1995:84) argues that the translation procedure adopted is justified by the norms prevailing in the target text rather than by the nature of metaphor in the source text in accordance with his framework of Descriptive Translation Studies (DTS):

[...] it seems reasonable to assume that the use of the metaphors in a target text is reduced, even so much as blocked on occasion, by certain target norms, and not by anything in the nature of the (source) metaphors, the texts they are incorporated in, or the discrepancy between the target and source languages

[...] (Toury, 1995:84. Emphasis in the original)

Toury (ibid.) adds a new dimension to metaphor translation studies which is the study of metaphor from both perspectives: a source-text oriented perspective and a target-text oriented perspective. This approach allows the identification of a new aspect of metaphor translation, which is the translation of non-metaphors into metaphors. However, it seems
to be hard to find a concrete way to distinguish between the cases where the addition is motivated and the cases where it is not motivated. The target-text oriented perspective will be important for the analysis of the Arabic subcorpus as will be seen later in Chapter 8.

4.1.3 Conclusion

The different studies reviewed in this section point out the complexity of the translation of metaphors. This complexity is due to the differences in languages and cultures. Newmark (1988) provides a detailed description of the cultural differences that make of metaphor translation a problematic issue and raises methodological issues related to metaphor delimitation and identification. In contrast to the studies by Dagut and Van Den Broeck studies, Newmark distinguishes between the conceptual and the linguistic levels of a metaphor. However, he then focuses only on the linguistic level of the metaphor. These translation approaches to metaphor are characterised by the following:

a. a failure to provide a clear definition of what metaphor is and a methodology for metaphor identification;

b. a failure to provide an explanation as to why metaphor is pervasive not only in literary discourse but also in pragmatic texts and everyday language;

c. the studies discussed here focus on isolated metaphorical expressions without seeking any relationship between the metaphors that are used within the same context or text or any correlation with other metaphors that may reveal their connection at a higher level, which is that of thought and cognition.

This last point is addressed by Stienstra (1993: 2016) who criticises translation scholars for restricting their attention to individual metaphors from the point of view of translatability and untranslatability or the barriers that may hinder the transfer of the metaphors into the target text, rather than showing awareness of the role of metaphorical concepts in texts.

This question about the role of metaphorical concepts is at the heart of the conceptual approach to metaphors that has brought metaphor to a more central position in thought in addition to its role in language. The following section provides a review of the main cognitive models of metaphor translation. The definition of the key concepts of the conceptual approach to metaphors is returned to with some detail in Chapter 5.
4.2 Cognitive approaches to metaphor translation

This section provides an overview of some studies that report on the implications of the conceptual metaphor for Translation Studies. The four studies reviewed in this Chapter are considered as key studies that shifted the focus in translation studies form the linguistic into the conceptual level. Hiraga’s model reviewed in Section 4.2.1 although it does not focus on translation, is the first model that presents a detailed account of intercultural differences in conceptual metaphors. Mandelblit cognitive translation hypotheses presented in Section 4.2.2 are the first attempt to apply the conceptual metaphor theory to the interpreting process. Section 4.2.3 Schöffner’s cognitive model of metaphor translation presented in Section 4.2.3 is seen by different researchers are the first clear formation of a conceptual approach to translation studies (Samaniego Fernandez, 2013). Maalej cognitive model of metaphor translation presented in Section 4.2.4 is reviewed here as it one of the early studies where the conceptual metaphor theory was applied in translation between English and Arabic which are the languages scrutinised in this dissertation.

4.2.1 Hiraga’s comparative model

Hiraga (1991) compares conceptual metaphors in English and Japanese. He comes to the conclusion that the two languages present similarities and differences in conceptual and linguistic metaphors. He claims that the differences can be explained by the cultural variations between these two unrelated cultures. Hiraga (1991) proposes the following model of conceptual metaphors between English and Japanese.

1. Similar conceptual metaphors and similar linguistic metaphors. An example of this is the conceptual metaphor TIME IS MONEY which is common in both cultures;
2. Similar conceptual metaphors and different linguistic metaphors. In this case, the two languages use the same conceptual metaphor, but the linguistic metaphor that embodies it in the TT differs from the one used in the ST. Hiraga (1991:153) argues that life is conceived in both languages as a sport (LIFE IS A SPORT). However, while American English uses a linguistic metaphor from the source domain BASEBALL embodied by the linguistic metaphor ‘right of the bat’, Japanese uses a linguistic metaphor that embodies the source domain SUMO which is a popular sport in Japan;
3. Different conceptual metaphors and the same linguistic metaphors. By this combination, Hiraga refers to similar linguistic expressions which have different meanings. He illustrates this case with the conceptual metaphor SOFT IS BAD realised in
English through the use of the word “soft” in examples such as ‘he is a soft man’ whereas this same expression in Japanese is the realisation of another concept SOFT IS GOOD. In other words, a soft man in English can be interpreted as easy to influence or impose upon whereas, in Japanese, Hiraga says it means “a man of flexible thinking” (1991:159);

4. Different conceptual metaphors and different linguistic metaphors. The two cultures have different conceptions and different expressions to talk about the same idea. Hiraga (1991:160) gives the example of IDEAS ARE IN THE MIND in English vs. IDEAS ARE IN HARA (belly) in Japanese. However, both source domains “mind” and “hara” are conceived as containers, and thus both English and Japanese conceptual metaphors can be subcategories of a hypernymic conceptual metaphor IDEAS ARE IN CONTAINERS. It can be then classified under the second model which is ‘similar conceptual metaphors and different linguistic expressions’. Both English and Chinese use the same concept of ‘container’ and different expressions. English uses the expression ‘mind’, Japanese uses the expression ‘hara’ (belly). Arabic uses another linguistic expression which is the ‘heart’. An example of this is found in the Quran in Surat 22(verse 46) cited below.

أَفَلْمَ يَسِيرُوا فِي الأَرْضِ فَتَكُونَ لَهُمْ قُلُوبٌ يَعْقِلُونَ بِهَا أَوْ آذَانٌ يَسْمَعُونَ بِهَا فَإِنَّهَا لَا تَعْمَى الأَبْصَارُ وَلَكِن تَعْمَى القُلُوبُ الَتِي فِي الصُّدُورِ

What, have they not journeyed in the land so they have hearts to understand with or ears to hear with? It is not the eyes that are blind, but blind are the hearts within the breasts (Arberry, 1964:338).

It seems that all three languages share the conceptual metaphor IDEAS ARE IN CONTAINERS based on the source domain CONTAINER and use different subdomains. English uses MIND as a container, Japanese uses the HARA as a container and Arabic uses both MIND and HEART as containers.

Hiraga’s model has been a starting point “for other Translation Studies such as Mandelblit (1995) who proposes similar hypotheses. While Hiraga focuses only on the similarities and the differences between cultures, Mandelblit (1995) focuses on the implications of these similarities and differences for the translation process.

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5 Among various English translations of Qur’an, Arberry’s translation was chosen as it is renowned for its high quality. (See Khaleel, 2005).
4.2.2 Mandelbit’s Cognitive Translation Hypotheses

Mandelblit (1995: 483) argues that the difficulty in metaphor translation “resides in the use of different metaphorical mappings between the source language (SL) and the target language (TL) to express the same idea”. As such, translation would involve not only a transfer process from one language to another but also a transfer from one way of conceptualising the world into another. The researcher formulates (1993: 491) what she calls the “Cognitive Translation Hypotheses” (CTH). The term “mappings”, in CMT, refers to the nature of the links between the metaphor source and target domains as will be seen in more details in Chapter 5.

According to Mandelblit (1995), there are two possible hypotheses.

The first hypothesis—Similar Mapping Condition (SMC)—assumes that the linguistic metaphors in the source and target texts are based on the same metaphorical mapping. In this case, she claims, the translation is straightforward and problem free.

The second hypothesis—Different Mapping Condition (DMC)—implies not only that different linguistic metaphors are used between the source and the target languages but also different underlying conceptual metaphors. In this case, Mandelblit (ibid.) suggests the translation is problematic and requires more time to be solved compared to metaphors of the first hypothesis. Mandelblit (ibid.) based her findings on the measurement of the time translators need to translate metaphors from each of the four hypotheses.

Mandelblit (1995) framework has served as the basis for many other studies about the cognitive effort in translating metaphors such as the works carried out within the framework of the project Capturing Translation Processes (CPT) (Massey, 2016, Massey and Ehrensberger-Dow (2017). Within this project, the translation process was analysed by using biometrics technologies such as eye-trackers and key-stroke logging software to analyse the cognitive load encountered by trainee translators and professional translators while translating texts where metaphors are used.

Mandelblit’s (ibid.) and the more recent applications of her approach are process-oriented and does not fully account for the implications of the cognitive approach to metaphor translation as a product. However, it provides further evidence pointing towards the additional challenges metaphors pose in the translation activity.
The following two studies, Schäffner (2004) and Maalej (2008), describe the implications of the cognitive approach for the translation product and try to outline some metaphor translation patterns.

4.2.3 Schäffner’s cognitive approach to the translation of political texts

Schäffner (2004: 1267) compares political German source texts and English target texts from a cognitive perspective and identifies the following translation patterns. (All cited examples here are from Schäffner’s study. They all concern Helmut Kohl’s discourse about the friendship between Germany and USA.)

1. A conceptual metaphor is identical in the source text (ST), and the target text (TT) (what Schäffner refers to as macro level) but the linguistic expression (the micro level is Schäffner’s terms) is not the same. This is, for instance, the case where the German expression “Brücke über den Atlantik” (transatlantic bridge) used to describe the German-USA friendship is rendered by “transatlantic friendship” in the target English text.

2. Structural components of the base conceptual schema in the ST are replaced in the TT by expressions that make entailments explicit. In the following example:

   Unser Ziel, Herr Präsident, ist es, den Bau des Hauses Europa zu vollenden. Dabei wollen wir, daß unsere amerikanischen Freunde in diesem Haus auf Dauer ihre feste Wohnung haben. (literally: [. . .] We want our American friends to have a permanent apartment in this house.)

   Translated as follows:

   Our goal is to complete the construction of the European house—with a permanent right of residence for our American friends—and enable the family of European nations to live together side by side in lasting peace.

   ‘Haus’, and ‘ferse Wohnung’ are linguistic metaphors embodying the conceptual metaphor EUROPE IS A HOUSE. The same conceptual and linguistic metaphor is used in the target language, but the linguistic metaphor makes the entailments more explicit and extended by providing additional information (‘and enable the family of European nations to live together side by side in lasting peace’).

3. A metaphor is more elaborate in the TT compared to the ST. Schäffner (2004: 1265) argues that the metaphor POLITICS IS MOVEMENT ALONG A PATH TOWARDS A
DESTINATION is common to both German and English political texts. However, English uses a more elaborate linguistic expression. She gives the following example:

There is still a long way to go to achieve this. - Bis dahin ist es noch ein weiter Weg. (1994 PES Manifesto; literally: It is still a long way towards there.)

4. ST and TT employ different metaphorical expressions which can be combined under the same abstract conceptual metaphor. For example; the German word ‘Dach’ (roof) is translated into English by ‘umbrella’. Both linguistic metaphors can be linked to the same conceptual metaphor BEING PROTECTED IS BEING UNDER A COVER.

5. The expression in the TT reflects a different aspect of the conceptual metaphor. Schäffner (2004:1266) illustrates this case with the following example:

We must act as one on the international scene.

Translated into French as

Nous devons parler d’une seule voix sur la scène internationale.

(1999 EPP Manifesto) (Literally, we should talk with the same voice at the international scene). (my translation)

Both German and French use the conceptual metaphor EUROPE IS A PERSON. However, where English highlights the “theatre” aspect through the use of the expression ‘act’, French highlights the ‘voice’ aspect. Both ‘act’ and ‘voice’ are instantiations of the same underlying conceptual metaphor, but their entailment differs.

Schäffner’s (2004) translation patterns can be considered as an elaboration of Hiraga’s model and Mandelblit’s hypotheses. She focuses on both similarities and differences at the conceptual and linguistic levels revealing new patterns in metaphor translation. In her identified patterns, Schäffner points out at the highlighting/hiding issue in conceptual theory. While conceptual theorists argue in favour of a partial mapping between the source and the target domain, this cross-linguistic study reveals that the different languages may use the same conceptual metaphors but build on different mappings between the source and the target domain as shown in the actor/voice example in Schäffner’s study (ibid.). Hence, the partial nature of the mapping is a relevant concept to explore in translation.
4.2.4 Maalej’s Cognitive model for translating metaphor

Maalej (2008) focuses on the translation of metaphors between English and Arabic which he considers as ‘unrelated cultures’. He explains that the difficulty in translating metaphors between Arabic and English arises because the two languages belong to “remotely unrelated cultures that show more dissimilarities than commonalities”. Maalej’s (2008:67) cognitive model for translating metaphor consists of three steps:

1. Unpacking the source language (SL)/ the source culture (SC) linguistics into their conceptual counterparts;
2. Comparing cultures using Hiraga’s comparative culture model;
3. Repacking the metaphor into the target language (TL) and TC (target culture).

By “repacking” Maalej (2008) means the re-expression of the SL/SC into its equivalent TL/TC metaphor on the basis of “knowledge of how the categories are both packed and structured”. This knowledge is according to Maalej (2008:63) “embedded in a pattern of cultural beliefs and practices”. Hence the cultural aspect of metaphor and “the distance that separates the cultural background of the source text and target audience in terms of time and place” (Snell-Hornby 1988/1995: 41 cited by Maleej 2008:63) determines how it is translated.

Maalej provides a model for metaphor translation based on the general process of translation. It encompasses three steps: firstly, understanding (“unpacking” in Maalej’s terms); secondly, comparing metaphors used in the source and target languages by applying Hiraga’s comparative model and Mandelblit’s hypotheses; thirdly, rewriting (in Maalej’s model, “repacking”) in the target language. In order to find out whether English and Tunisian Arabic share the same conceptualisations, he analysed a corpus of a Tunisian Arabic play حديث الليل (night’s talk) by Taoukif Jabari⁶ and Maalej English translation. In order to check similarities and differences of conceptual metaphors, he adopts a literal translation of metaphors. If the literal translation makes sense, he interprets this as evidence of a shared conceptualisation between English and Tunisian Arabic. If the translation does not make sense or sounds odd, shocking or unintelligible to English speakers, then the researcher concludes that the two languages use different conceptualisations (Maalej, 2008:69).

⁶ Maalej explains his choice of a play as a corpus by the lack of naturally occurring corpora and argues that the play is “a sort of compromise between popular literature and the vernacular” (2008:68).
Maalej (ibid.) finds that there are more differences than similarities between English and Tunisian Arabic and argues that these differences might render the translation problematic. However, his findings cannot be generalised to translation from Arabic into English as they are limited to a short satirical novel. Maalej (ibid.) identified the following conceptual metaphor in his analysis:

**NON-COMMERCIAL ENTITIES ARE COMMODITIES**

**THINKING IS A DISEASE**

**THINKING IS AN ILLEGAL ACTIVITY**

**INEDIBLE ENTITIES ARE FOOD.**

It can be said that the text chosen by Maleej (ibid.) is of culture-specificity as it describes two levels of the Tunisian context: the social level and the political level. A less culture-specific text might have shown fewer disparities between the two languages/cultures. As it will be seen later in Chapter 8, the analysis of the A&A corpus points in a different direction: culture-specific metaphors used in the A&A English subcorpus are often reproduced using similar conceptual and linguistic metaphors in the Arabic translations for reasons that will be discussed in Chapter 8.

This section has reviewed selected approaches to metaphor translation from a cognitive perspective. Hiraga’s comparative model provides a basis for comparison of conceptual and linguistic metaphors between different languages and cultures. His first translation strategy where the same conceptual and linguistic metaphors are used in both the ST and TT is similar to what Van den Broeck calls “translation sensu stricto”. Mandelblit’s (1995) translation hypotheses are based on Hiraga’s model. She provides that difficulty in metaphor translation arises only when the two languages (the source and the target languages) use different conceptual metaphors. Maalej study seems to corroborate this view as he shows that the conceptual and linguistic metaphors peculiar to the Tunisian social and political situation are not shared between Tunisian Arabic and English.

Before summarising all the identified patterns for metaphor translation (Section 4.5), it is necessary to pause to look at studies that focus on metaphor translation in scientific genres. The review of metaphor translation in different scientific genres in the next Section 4.4 aims to establish whether metaphor translation strategies used in scientific texts are specific to the scientific genres or are the same as the ones identified earlier in this chapter.
4.3 The conceptual approach to metaphor translation and the notion of culture

Before moving into a review of metaphor translation in scientific texts, it is necessary here to introduce the notion of culture as this concept will be used later in the thesis to narrow down the focus of the thesis to the generally agreed culture specific source domains.

From a translation perspective, Newmark (1988: 103) defines culture in opposition to universal where universal means “general aspects of nature and humans and their physical and mental activities; numbers and dimensions” and culture is “a way of life and its manifestations peculiar to one speech community”. In his definition of culture, Newmark includes the following:

1. Ecology: animals, plants, local winds, etc.;
2. Material culture (artefacts): such as food and clothes;
3. Social culture: work and leisure;
4. Organization, customs and ideas such as politics and religion;
5. Gestures and habits.

Similarly Katan (1999) defines culture “in terms of a shared mental model or map of the world”. This shared mental model is a “system of congruent and interrelated beliefs, values, strategies and cognitive environments which guide the shared basis of the behaviour” (Katan 1999:26).

In this regard, source domains such as SPORTS instantiated by linguistic metaphors such as ‘baseball’ and ‘poker’ or FOOD instantiated by linguistic metaphors such as ‘pancakes’ or ‘cupcakes’ in the A&A corpus are seen as elements of the American cultural model.

The cultural differences between English and Arabic which are the languages investigated in this study also encompass the dimension of power and language inequalities. This concept is relevant when studying the translation of scientific texts between English, the global lingua franca of modern times (House, 2013; Montgomery 2013) or as Hiarvard (2010:76) metaphorically puts it “English is the “protocol” for oral and written communication across national frontiers”. In this global context, English is found to be the most used language to reach the global market and to communicate in the digital era (Schaffner, 1999:95). It is also found to influence other languages via translation (Godev,
Arabic, like some other languages relies on translation as means of knowledge transfer (Salama-Carr, 2015).

Bearing in mind the issue of translation and globalisation, it is worth mentioning that it is not argued here that the cultural artefacts might be unknown in the target language/culture, but that specific entailments related to them might not be necessarily known to the reader of the TT. For instance, the game of poker might be known outside the American culture but certain specificities of the game such as the name of the hands “royal flash hand”, “three of a kind” might be an issue in translating culture specific metaphors as the entailments between the source domains and target domains of these metaphors might not be easily accessible to the TT reader.

4.4 Translation of metaphors in scientific texts

Scientific discourse, in general, has attracted less attention from translation scholars compared to other forms of writing namely literary texts (Olohan and Salama-Carr, 2011). It is, hence, not surprising that the study of metaphors in scientific texts has also been subject to little research. The metaphor is thought to play an important role in literary texts whereas metaphor in scientific texts was neglected for the reasons summarised by Boase-Beier (2006) as follows:

> Because non-literary texts do not require the translator to worry about aspects of style such as repetition, metre and the like, there is unlikely to be any reason to change metaphors in translation and so the risk of losing an important conceptual metaphor is negligible. (Boase-Beier 2006: 100)

Despite the common assumption that the loss of a conceptual metaphor in a scientific text is negligible, as claimed by Boase-Beier (ibid.), the conceptual metaphor is found to play an important role in conveying scientific ideas, which indeed makes it a relevant problem from a translation perspective. For example, Fuertes-Olivera And Pizarro-Sánchez (2002) conducted a study on the translation of metaphors of inflation in specialised business texts translated from Spanish into English. Their study focuses on terminological metaphors. The authors adopt Indurkhya’s (1992) categorisation of metaphors into generic metaphors, similarity-based metaphors and similarity-creating metaphors. Generic metaphors are used
in the sense of conventional metaphors. However, the distinction between ‘similarity-based’ and ‘similarity-creating’ metaphors is not clear. Indurkhya (ibid.: 2) argues that in a ‘similarity-based metaphor’, the reader is invited to compare between the source and the target domains. However, in a ‘similarity-creating metaphor’, there is no prior similarity between the source and the target when the metaphor is first encountered, but then the similarity is created in the consciousness of the reader. Indurkhya’s category of “similarity-creating metaphor” is similar to Black’s interactive view of metaphor. Black (1993) also argues that the similarity is created by the metaphor, an opinion to which Gentner et al. (2001) also adhere. While Fuertes-Olivera and Pizarro-Sánchez (2002) argue that this distinction is important for the analysis of metaphorical concepts, they do not provide any systematic way to categorise metaphors into ‘similarity-creating’ or ‘similarity based’. From a translation point of view, Fuertes-Olivera and Pizarro-Sánchez (2002) find that there are more similarities than differences in the translation of English terminological metaphors of inflation into Spanish in their data. The authors point out that this results mainly from a literal translation of the business terms of inflation. The literal translation, as the authors express it, leads to the creation of ‘similarity creating metaphors’ in Spanish because several metaphors which are conventional metaphors in English become a novel and creative ones when translated literally into Spanish. In this regard, Fuertes-Olivera and Pizarro-Sánchez (ibid.) hold that a literal translation of metaphors in specialised texts is a way of producing ‘similarity-creating metaphors’ and ‘a common method of spreading technological know-how, scientific knowledge, and terminology’ (2002:64).

Despite the importance given to the role of metaphor in creating terminology on one side and explaining scientific concepts on the other side, little interest has been shown in the translation of metaphors in popular science texts. Translation adds another level of difficulty and complexity to the study of metaphor, as translation itself is a transfer of meaning from one domain into another. Hence, it too can be expressed in terms of recontextualization. Unlike the translation of metaphors in literary texts that have known a profusion of studies (Alvarez, 1993), the translation of metaphors in popular science articles, although it is not completely new, is still under-researched (Rey, 2000; 2007; Rey and Tricás, 2006).

Rey (2007) draws attention to the particular issue of cultural elements in popular science and how it is important from a translation perspective as will be seen later in Chapters 7
and 8 where the focus of the current study is narrowed down to culture-specific metaphors fulfilling a pedagogical function. The researcher reports that cultural elements, which are often embodied in linguistic metaphors, fulfil two main functions:

[...]d’une part, assurer la transmission de contenus scientifiques (fonction cognitive-référentielle) et d’autre part attirer et retenir l’attention du lecteur (fonction interactive) (Rey, 2007:135).

[...]on one side, they insure the transmission of scientific content (cognitive-referential function; on the other side, they draw and keep the reader’s attention (interactive function)].

Rey reports that, often, these cultural references are not shared between two cultures or languages. She further argues that their literal transfer cannot fulfil the aims they are used for in the target language and are hence found to be “adapted”. Rey (ibid) suggests that “adaptation” as a translation strategy that focuses on the reader of the target text and aims to add or delete culture-specific elements in the target text in order to produce the same effect on the reader is appropriate in the translation of the genre of popular science articles. This is because the primary function of this genre is to transmit scientific knowledge to a specific readership which cannot access it without the mediation of cultural and historical referents.

Rey (2007) points out that cultural referents that fulfil a cognitive function are transferred into the target text while those fulfilling an interactive function are either deleted or replaced by other cultural elements from the target language.

Harvey (1998) adopts a similar functional approach. She argues that a conventional metaphor in the ST can be deleted in the target text with a negligible effect (Harvey, 1998:284); on the other hand, metaphors with a cognitive function are compensated for if they could not be systematically reproduced in the TT (1998:278–279). The adaptation strategy proposed by Rey (2007) is one way of achieving compensation.

Papadoudi (2010), who conducted research on the translation of metaphors in popular technology from English to Greek, has contributed to the extension of the identified translation strategies by the identification of two more strategies, which are: the elaboration of the metaphor in the TT and a shift in the sub-metaphor category in the TT.

Metaphor translation strategies identified by Papadoudi’s (2010:279) are as follows:

(1) Metaphors common to the ST and TT;
(2) Metaphors elaborated in the TT;
(3) The shift of sub-metaphor category in the TT;
(4) The shift of metaphor category in the TT;
(5) The literal rendition of metaphors in the TT;
(6) The omission of metaphors in the TT;
(7) No translation provided in the TT;
(8) The addition of metaphorical expressions in the TT.

Strategies 3 and 4 are formulated as a result of the researcher’s categorisation of the metaphors into categories and subcategories and can be related to pattern 4 in Schäffner’s (2004) identified patterns (the ST and TT employ different metaphorical expressions which can be combined under the same abstract conceptual metaphor). The researcher also takes into consideration Toury’s categorization of a target text-oriented strategy which is the rendition of a non-metaphoric statement in the source text by a metaphor in the target text (strategy 8).

Strategies (2), (3) and (4) can also be seen as compensatory strategies for metaphors that cannot be “systematically reproduced” in the TT, perhaps given their level of cultural specificity.

This section has outlined the identification of translation strategies that seem to be relevant to scientific genres. These are recapped below.

The first strategy is a similarity creating metaphor which results from a literal translation. Although this strategy can be said to be the same as the use of the same linguistic and conceptual metaphor strategy (Hiraga 1991, Maalej 2008, Mandelblit, 1995), it differs in the fact that the similarity is not the result of a common conceptualisation between the source and the target languages but results from the translation process (the literal rendition). This distinction is an important one as will be seen later in Chapter 8.

The second strategy is specific to linguistic metaphors embedded in cultural source domains. As Rey (2000, 2007) argues, culture-specific metaphors from the source text are adapted to the target text culture. This means that culture-specific metaphors from the source text are replaced by culture-specific metaphors from the target language/culture in
the target text. Rey (2000, 2007) argues that adaptation and suppression are the main strategies for dealing with culture-specific elements in popular science articles. As will be seen later in Chapter 8, the analysis of the A&A corpus shows a different trend for the translation of culture-specific metaphors.

Linguistic metaphors are found to be extended in the TT as evidenced by Papadoudi who also found that a shift is possible not only between conceptual domains as argued by Hiraga (1991) but also between conceptual subdomains.

Now that we have discussed the different translation strategies for metaphor translation from different perspectives and in relation, specifically, to the translation of scientific and popular science texts, a summary of the identified strategies is provided in the following section and will be used as a starting point for the analysis of the translation A&A subcorpus in Chapter 8.

4.5 Summary of translation strategies for dealing with metaphor identified in the literature

The review of the different approaches to metaphor translation has led to the identification of four possible scenarios for dealing with conceptual and linguistic metaphors from a translation perspective. These scenarios are:

- The conceptual and the linguistic metaphors are retained in the TT. This is achieved by one of the following measures:
  a. Use of the same conceptual and linguistic metaphor in the ST and TT;
  b. Use of a conceptual and linguistic metaphor in the ST and TT with an extension (elaboration) of the linguistic metaphor in the TT to simulate the ST concept;
  c. Use of same conceptual metaphor but using a different linguistic metaphor.

- The conceptual metaphor in the TT is different from the conceptual metaphor in the ST. This is done by any of the following:
  a. Use of same conceptual metaphor but using a linguistic metaphor that highlights a different mapping between the source and target domains in the TT;
b. Use of the same conceptual metaphor and a different linguistic metaphor;

c. Use of a different conceptual metaphor and same linguistic metaphor;

d. Use of a different linguistic metaphor and different linguistic metaphor.

- The conceptual metaphor is not transferred into the TT. This results from the following:

a. Omission of the metaphor in the TT while the context where it occurs is preserved;

b. None translation of the metaphor in the TT. This strategy is distinguished from the previous one by the deletion of the context where the metaphor occurs, i.e. deletion of either the sentence or the whole paragraph containing the metaphor.

- A conceptual metaphor is added in the TT. This is done by one of the following:

a. Nil into a metaphor

b. Transferring a literal expression into a metaphor

These strategies were taken as a starting point for the preliminary analysis of a sample of the A&A corpus in Merakchi and Rogers (2013) where culture-specific metaphors were specifically investigated. A summary of these strategies is presented in Table 4.1 below.

<table>
<thead>
<tr>
<th>Translation strategy</th>
<th>Conceptual metaphor in TT</th>
<th>Linguistic metaphor in TT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Same as ST</td>
<td>Same as ST</td>
</tr>
<tr>
<td>2</td>
<td>Same as ST</td>
<td>Semantically related to ST</td>
</tr>
<tr>
<td>3</td>
<td>Same as ST</td>
<td>Different from ST</td>
</tr>
<tr>
<td>4</td>
<td>Different from ST</td>
<td>Different from ST</td>
</tr>
<tr>
<td>5</td>
<td>CM replaced by non-metaphor</td>
<td>No MLE</td>
</tr>
<tr>
<td>6</td>
<td>CM passage omitted</td>
<td>Passage omitted; MLE omitted</td>
</tr>
<tr>
<td>7</td>
<td>CM used where none in ST</td>
<td>MLE used where none in ST</td>
</tr>
</tbody>
</table>

Note: MLE metaphorical linguistic expression used as a synonym of LM (linguistic metaphor) in the present study.

In addition to these strategies, this study allowed the identification of the couplet as a recurrent strategy to render culture-specific metaphors in the A&A corpus. The full
analysis of the A&A corpus has led to an extension of some of the strategies identified in this pilot study; and the identification of new strategies as will be seen in Chapter 8.

4.6 Conclusion

This chapter has reviewed both linguistic and cognitive approaches to metaphor translation and outlined the translation strategies for dealing with metaphor translation in general and specifically in scientific writing genres.

The review has also revealed that a combination of both a linguistic approach and a conceptual approach to metaphor are necessary for a comprehensive framework for metaphor analysis. The metaphor translation strategies summarised in Section 4.3 combines both the linguistic and the conceptual levels.

The next chapter provides a justification to the methodological framework by detailing some of the key concepts of CMT and discussing its major developments that aim to address the methodological shortages.
Chapter 5. Metaphor analysis: A multidimensional framework

It has been established in the previous chapter that a metaphor analysis framework can account for both the linguistic and the conceptual dimension.

This chapter aims to describe in some depth the key concepts of the Conceptual Metaphor Theory (CMT) which are relevant to the analysis of metaphor in translation. These concepts such as “source domain”, “target domain” and “mapping” were briefly introduced in the previous chapter. Given that these are key terms often used later in the analysis of the A&A corpus compiled for the purposes of this study, it was deemed necessary to further explain them. It will be pointed out to the relevance of the concepts and approaches discussed to translation where relevant. In addition, this chapter provides a review of three main approaches that developed to address the methodological shortages of CMT and prepares the ground for the development of the methodology used in this current study described in Chapter 6.

This chapter is divided into five sections. Section 5.1 introduces the key concepts of CMT and the need to integrate them into a larger approach to cover all three dimensions of metaphor translation analysis: cultural, linguistic and conceptual. Section 5.2 introduces the two discourse approaches to metaphors that developed in response to what is viewed as an excessive focus on the conceptual dimension of the metaphor. Both discourse approaches, Critical Discourse Analysis and Discourse Dynamic Approach, bring the focus back to the linguistic dimension as the only valid way to access the conceptual level. Section 5.3 highlights the contribution of corpus-based approaches to both metaphor and translation studies as a powerful methodological tool to back up conceptual and linguistic analysis of metaphor in translation. Section 5.4 deals with the issue of linguistic metaphor identification that has been neglected by CMT. How linguistic metaphors are identified is the first step towards the identification of metaphor functions and underlying conceptual metaphors that will be further developed in Chapter 6. Section 5.5 provides a summary of the key points discussed in the current chapter.

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5.1 Conceptual Metaphor Theory (CMT)

Kövecses, (2006) claims that CMT implies a set of philosophical shifts from the traditional objectivist assumptions that thought is essentially literal and independent of the body into experientialist assumptions that the mind reflects the reality through the human being (notably the body). Within this approach, the mind is believed not an independent entity but as created through physical experiences. One of the most important implications of this position is that thought is not mainly literal but both literal and metaphorical.

Seen from a CMT point of view, the metaphor is no longer a figurative device, but a conceptual device realised through a linguistic expression (Lakoff and Johnson, 1980).

This section defines the main concepts of CMT that are used for the metaphor analysis in the current study. The first concept is the mapping between the source and the target domains discussed in Section 5.1.1. The second concept to be discussed is the “partial nature of the mapping” in Section 5.1.2. The third concept to be discussed is the culture-specificity of metaphors in Section 5.1.3. The last section (5.1.4) highlights why CMT alone is not sufficient as a framework for metaphor translation analysis and presents another framework that can be seen as developments of CMT.

5.1.1 Mapping between the source and the target domain

In CMT, metaphors are defined in terms of mappings between a source and a target domain. The source domain is referred to as ‘tenor’ in some studies, and the target domain is referred to as the ‘vehicle’ (Cameron 2003). The source domain is generally more concrete and physical and the target domain more abstract. By “mapping” is understood a set of correspondences between a source and a target domain (Kövecses 2010a; Lakoff 1993; Lakoff and Johnson 1980/2008).

A common example of a conceptual metaphor is LIFE IS A JOURNEY. In this conceptual metaphor, JOURNEY is the source domain and refers to a more concrete experience whereas LIFE which is the target domain is more abstract. In English, this metaphor is linguistically realised through different linguistic metaphors such as those listed by Kövecses (2010a: 2) (in italics in the examples below).

1. He’s without direction in life.
2. I’m *where I want to be* in life.

3. I’m *at a crossroads* in my life.

4. She’ll *go places* in life.

5. He’s never *let* anyone *get in his way*.

6. She’s *gone through* a lot in life.

In these metaphors, the source and the target domains are brought together by a set of mappings which Kövecses (ibid.) summarises as follows:

- Have a beginning and an end;
- Both can be pleasant or unpleasant
- Both have a direction/direction which can change (at the crossroad for example);
- Both can be short or long;
- Both imply changes in places and positions;
- In both, hindrances and problems can be faced;

In these examples, our understanding of life (abstract, target domain) is organised in terms of our understanding of a journey (concrete source domain). The meaning of life is understood in terms of the direction (example 1), if we are stuck at some point in our lives, we are in a situation similar to being ‘at crossroads’ (example 3). If our lives have been eventful then we have gone through a lot (example 6) as in a journey full of stops and steps.

### 5.1.2 Partial nature of the mapping

The nature of relationship between the source and target domains generally referred to as “mapping” is of interest. When two domains are brought together by means of a metaphor, only some aspects of both domains are highlighted while others are not. In the conceptual metaphor *THEORIES ARE BUILDINGS* aspects such as the strength and foundations of buildings are prominent while other aspects such as colour, windows, etc. remain in the background. This focus on some similarities between the source and target domains rather than others is known as the partial nature of mapping (Evans 2006; Kövecses 2010a).

Similarly, the conceptual metaphor *LIFE IS A JOURNEY* discussed above highlights certain mappings such as the destination, the difficulties, the uncertainties but hide others such as
the means of transport for instance. The partial nature of the mapping means that not all features applying to the source domain apply to the target domain.

5.1.3 Universal metaphors vs. Culture-specific metaphors
Since metaphor is not basically in language but in thought according to Lakoff and Johnson (1980), the problem of translation is no more located at the linguistic level but is shifted to the conceptual level (Schäffner 2004). From a CMT perspective, equivalence in translation is no more investigated at the linguistic level only but at a conceptual level. Hence, if the ST and TT use different linguistic expressions for instance and both are the realisation of the same conceptual metaphor in the ST and TT, then it is deemed that the conceptual equivalence is achieved (Schaffner, 2004). Metaphor is partially based on a human condition (bodily experience, sensorimotor experience). Grady (1999) argues that there are some fundamental metaphors which are closely linked to bodily experience and therefore are shared by human beings of different languages or cultures. He calls this kind of metaphor “primary metaphor”.

Primarily metaphors include orientational metaphors such as MORE IS UP; LESS IS DOWN. Grady argues that this conceptualisation of the ‘up’ and ‘down’ is linked to our sensation of gravity and hence is shared by people regardless of their culture or language. Therefore, Grady considers this metaphor as “universal”.

Kövecses (2006: 156-7) argues that there is a large number of universal metaphors in addition to “primary metaphors”. By universal, Kövecses (ibid.) refers to metaphors shared between different languages and cultures. According to him, various conceptual metaphors related to emotions such as love, anger, and happiness, for example, are universal. This view is based on the interaction between the emotions and the body. It is claimed that when a human being is exposed to a strong emotion such as love or anger, the body increases in temperature; the body is perceived as a container whose inside matter is becoming hotter as the emotion increases. These physical and physiological reactions explain a multitude of conceptual metaphors such as the one illustrated in Kövecses (2005: 39-40): AN ANGRY PERSON IS A PRESSURIZED CONTAINER. This conceptual metaphor is realised in English through linguistic metaphors (in italics) in expressions such as: “you make my blood boil”, “he blew his top”, “when I told him, he just exploded”. Kövecses reports that
this conceptual metaphor exists in several other related and unrelated cultures including Chinese and Hungarian.

However, arguing that the expression of emotions is universal should be approached with caution. Arabic for instance, uses a different set of mappings for anger where an angry person is rather a heated container instead of a pressurised one. Expressions of anger such as "يشتاط غضبا" (he is burning of anger) or "الشرر يتطاير من عينيه" (his eyes are throwing sparks, and "غلت مراجله" (his cauldrons are boiling) are common.

Kövecses (2005) holds that the term ‘cultural variation’ is problematic because the cultural variation does not exist between different cultures only but also within the same cultural systems. Distinguishing between different dimensions of culture, Kövecses (ibid.111) lists seven types: the social dimension that encompasses gender differences; the ethnic dimension; the regional dimension; the style dimension; the religious dimension; the diachronic dimension and the development dimension. He acknowledges that the frontiers between these dimensions are movable and the “the dimensions along which metaphors vary merge in most cases” (ibid.).

Cross-cultural variation according to Kövecses (2010b: 207) manifests itself through the change between the generic level and the specific ones in addition to the use of “a set of different source domains for a particular target domain, or conversely, where a culture uses a particular source domain for conceptualising a set of different target domains” (Kövecses 2010b:207). This cross-cultural variation of metaphor is seen as a major source of difficulty in translation as argued by Kövecses (2014:31). Hence, the special focus it receives in this study, as will be seen later in Chapter 7 and Chapter 8.

On the other hand, culture as an anthropological concept is seen as outdated because the anthropological assumption that it is based on is no more valid. Dourari (2002), for example, argues that the anthropological concepts of “culture” and “cross-culture” that prevail in the human sciences are based on the false assumption that cultures are distinct and opposable systems that are separated by a huge gap that needs to be bridged. He argues that this conception of culture underestimates the standardisation of cultures induced by history, economic exchanges and globalisation. Similarly, Asad (2010) questions the anthropological notion of “cultural translation”. Because disparities and variations can be
found even within systems that are recognised as “cultural systems” such as the so called “Judeo-Christian culture” as opposed to the “Arabo-Islamic culture” (see Arkoun, 1993).

These seemingly opposed views of culture and culture variation can be seen as a warning of the complexity of cultural issues and their different definitions within different disciplines (postcolonial studies, sociology, ethnography, and translation) and approaches (diachronic or synchronic approaches).

5.1.4 Shortcomings of CMT

It is undeniable that CMT has brought insight to metaphor studies and to metaphor translation. However, many scholars such as Deignan (2008b), for instance, have criticised it for prioritising the conceptual level of metaphor to the detriment of the linguistic one and for lacking methodological tools to back up the theory. The main criticisms of Conceptual Metaphor Theory are summarised in the following:

1. Prioritising thought over language: The cognitive approach to metaphor derives its main arguments from linguistic data despite the assumption that metaphor is primarily a conceptual tool that is realised through linguistic metaphors (Deignan 2008a; 2008b; 2009; 2010);

2. The way data is collected and analysed is questioned. The linguistic data that are used to support CMT are generally separate sentences or short paragraphs that lack context for interpretation and can be seen as invented data (Deignan 2008b). In order to remedy this issue, a number of linguists such as Deignan (2008a, 2008b; 2009, 2010) advocate the use of corpus-based approaches to give more consistency to their findings through large corpora which are researched and concordanced to explore pre-existing claims. For example, Deignan (2008b) reports that the conceptual metaphor ARGUMENT IS WAR can be researched in a corpus by concordancing lexical items of this metaphor linguistic expressions such as ‘attack’ and ‘defend’. She found that the linguistic evidence supports the claim that the target domain ARGUMENT is structured in terms of the source domain WAR. However, the corpus demonstrates that some linguistic metaphors such as “attack” are not only used in the source domain WAR but in other source domains also such as SPORT, ILLNESS and PHYSICAL VIOLENCE. This means that the same source domain can be mapped onto different target domains;
3. One of the major problems that CMT has neglected is the procedure for metaphor identification. Deignan (2010) argues that conceptual metaphor theory suggests that “metaphor has an identity separable from people and that this identity is permanent and fixed as a shape or appearance of an object would be” (2010:47). Cameron pursues the same argument and contests the way metaphor is conceived in CMT as a “static and pre-existent object in the mind” (2010:85) and argues in favour of a new approach which she calls “a dynamic approach” where metaphorical meaning emerges from the interaction between different discourse participants as will be seen in the next section;

4. Domain delimitation: another methodological problem in CMT is the delimitation of the source and target domains and inferring conceptual metaphors from the linguistic data. Low and Todd (2010) warn against the dangers of overgeneralising on limited linguistic evidence. They also point to the need to establish a consistent procedure for the identification of conceptual metaphors;

5. Conceptual Metaphor Theory focuses more on conventional metaphors rather than on novel or creative metaphors (Cameron and Deignan 2006). This is due mainly to the fact that conventional metaphors explain better the embodiment of conceptual metaphors. The question of the conventionality of metaphors results on two methodological problems: firstly, conventional metaphors are easier to identify as several scholars have dealt with them in different studies. Kövesces (2010), for instance, provides a list of some well-established conventional metaphors. Secondly, from a translation perspective, conventional metaphors are thought to be easier to translate than creative or novel ones (Dagut 1976; Newmark 1988). As seen earlier in Chapter 3, the genre of popular science articles mixes metaphors fulfilling different functions. The main two functions are argued to be the terminological and pedagogical function which coexist with non-genre specific-metaphors termed here generic metaphors which can fulfil various functions. In terms of conventionality/creativity, it is thought that generic and terminological metaphors are more conventional than pedagogical metaphors and hence will pose fewer problems in their translation than pedagogical metaphors, although some conventional metaphors in English as source language may become novel metaphors in the translated texts if there is a terminological gap in the TL or the translator is unaware of the TT term. Finally, a distinction between novel and conventional metaphors cannot be made without a
diachronic study of metaphors as a metaphor can be novel at a certain time and becomes conventional later. In this study, the distinction between conventional and novel metaphors is defined broadly according to the frequency in use of metaphors.

CMT has developed in different ways to overcome these methodological issues summarised in this section. For instance, there are CMT based approaches in discourse analysis (Cameron and Maslen, 2010; Cameron and Low, 1999; Cameron et al., 2009; Charteris-Black, 2004), corpus linguistics (Deignan and Potter, 2004; Deignan 2008a; Deignan, 2008b; Deignan and Semino 2010; Deignan, Littlemore and Semino 2013), and metaphor identification procedures (Crisp et al., 2007; Dorst and Kaal 2012; Steen 2007; Steen et al., 2010a; 2010b; 2010c).

Each of these approaches is reviewed in turn in the following sections starting with the discourse approaches to metaphor analysis in Section 0, moving to the corpus-based approaches in Section 0 and finishing with the metaphor identification procedures in Section 5.4. Each of these approaches has contributed to the elaboration of the methodology applied to the analysis of the A&A corpus in the current study that will be detailed in Chapter 6.

5.2 Discourse approaches to metaphor analysis

Discourse approaches to metaphor encompass two distinct approaches: Critical Discourse Analysis as applied to metaphor by Charteris-Black (2004), and the Dynamic Discourse Approach tailored by Cameron and her team of researchers (Cameron 2003; Cameron and Deignan 2006; Cameron et al., 2009; Cameron and Maslen 2010)

5.2.1 Critical Discourse Analysis of metaphor (CDA)

Critical Discourse Analysis as developed by Charteris-Black (2004) aims to identify the rhetorical motivation and influence of metaphor choice in persuasive language such as political and religious texts (Charteris-Black 2004; 2006). Charteris-Black and Ennis (2001) define metaphor as a linguistic phenomenon where the basic meaning of a word or an expression is incongruent with its contextual meaning (2001:250). Charteris-Black considers that metaphor is primarily linguistic. His approach also differs from the CMT in that metaphor is not considered predetermined by bodily experience only but arises from the intention of the speaker and the goals he/she seeks to achieve (the pragmatic aspect).
One of the limitations of metaphor analysis, when the conceptual approach is isolated from the pragmatic one, is that the only explanation of metaphor motivation is with reference to an underlying experiential basis. This assumes that metaphor use is an unconscious reflex, whereas a pragmatic view argues that speakers use metaphor to persuade by combining the cognitive and linguistic resources at their disposal (Charteris-Black 2004:1).

To identify the goals a speaker aims to achieve when using a metaphor, Critical Discourse Analysis is carried out following three main steps, which are: metaphor identification, explanation and interpretation.

Metaphor identification, as will be seen later in this chapter, is one of the metaphor aspects that is neglected by CMT where the metaphor examples are provided without any reference to the process of their identification as such. Charteris-Black (2004) selects the criterion of the “incongruence” of the lexical unit with its discursive environment as the main clue in metaphor identification. The second step is metaphor interpretation, which involves a categorization of the identified linguistic metaphors according to their conceptual domain. The third step is metaphor explanation that “involves identifying the social agency that is involved in their production and their social role in persuasion” (Charteris-Black 2004:39).

Charteris-Black’s approach to metaphor provides new insights into metaphor studies as it does not see metaphors as separate instances that can be understood out of context but links the use of metaphor to the discursive activity in all its dimensions: linguistic, semantic, pragmatic and conceptual. However, by focusing on “ideological” discourses such as political and religious texts, he sees metaphor as mainly persuasive. Charteris-Black has moved metaphor studies forward by researching the question of metaphor identification and providing methodological insights regarding the use of corpora in metaphor research that was further developed by other researchers, as will be seen later in this chapter.

5.2.2 Discourse Dynamic Approach (DDA) to metaphor

The main difference between Critical Discourse Analysis (CDA) and the Dynamic Discourse Approach (DDA) is that CDA is mainly concerned with political discourse and ideology whilst DDA seeks to explain social behaviours, attitudes and values through the use of metaphor. The Discourse Dynamics Approach assumes that discourse is dynamic, and that metaphor emerges from the interaction of the participants in discourse. DDA is
built partially on CMT. Cameron and Deignan (2006:688) acknowledge that their approach requires the sociocultural and embodied experiential correlation developed within the conceptual metaphor theory but takes metaphor studies forward by including the dynamic aspect of language use at both the individual and social levels.

DDA diverge from CMT mainly in the assumption that metaphor is not static but dynamic. In the sense that its meaning is not stable but develops during discourse interaction (in dialogue, for instance) as Cameron (2009) argues. DDA sees linguistic and cognitive phenomena as processes, flows or movements rather than as objects. DDA was developed mainly to deal with interactions between people in spoken language (Cameron et al., 2009) where metaphor, be it conceptual or linguistic, is claimed to be ‘emergent’ and ‘open to change’ (Cameron et al., 2009: 67).

In addition, Cameron et al. (2009) refer to an important point that is often neglected in CMT which is the context of use. How metaphor is processed and interpreted is largely influenced by the discourse context and participants involved. In addition, DDA links the use of metaphor and its function to the genres where it occurs (for more details on this point, see Semino, 2008). Some traditional CMT scholars such as Kövecses (2010a) have acknowledged the importance of discourse context in studying metaphor.

Furthermore, DDA integrates the notion of “metaphorical shifting”, which is relevant to Translation Studies. When a metaphor is traditionally treated as a single linguistic unit in translation, it can lead to a loss of meaning as the interconnection between the metaphor and its other forms that may appear in the text is not taken into account. The metaphor shifting is also an indicator of the cohesive role of metaphor in discourse. The way metaphor is reused after it is first introduced in the text contributes to the cohesion of the text, as is also argued by Ponterotto (2003). The term “cohesion” is used to refer to the internal textual cohesion or what Kövecses (2010b) also describes as “intertextual metaphorical coherence”. The current study takes partly into account the cohesive nature of metaphors through the analysis of metaphor clusters as will be seen later in Chapter 7 and Chapter 8.

Furthermore, the Dynamic Discourse Approach has tackled the issue of inferring the conceptual metaphors from the linguistic data that is neglected in CMT. Researchers within
CMT have formulated a set of conceptual metaphors some of which have been widely taken up in cognitive studies. Examples include IDEAS ARE BUILDINGS; LOVE IS A JOURNEY; ARGUMENT IS WAR. Linguistic metaphors are gathered and classified according to their source domains, and a generalised conceptual metaphor that encompasses all expressions pertaining to the same domain is formulated. However, as pointed out by Low and Todd (2010:40), researchers do not explain how they generalise upwards from individual linguistic metaphors to a systematic grouping of metaphors. Cameron (2010:91), is also of the view that the idea of connected patterns of metaphor is an important tool for metaphor study. Despite its usefulness in research on metaphor, the grouping and labelling of metaphor groups remain a methodological issue that needs to be dealt with caution. Following Low and Todd’s (2010) guidelines for good practice in metaphor analysis, all decisions made about the choice of underlying systematic metaphors are made explicit, as will be described in the following Chapter 6.

This section has outlined the main contributions of DDA to metaphor studies. In the next section, the corpus based approach to metaphor and translation studies will be discussed.

5.3 Corpus linguistic approaches to metaphor and translation
Corpora are nowadays widely used in both Translation Studies and Metaphor Studies. Their use in each domain has developed separately from each other. This section aims to review the use of corpora in Metaphor Studies and Translation Studies and how they converge to serve the purposes of a study that deals with the translation of metaphors in a genre-specific and subject-specific study. The first part of this section (5.3.1) briefly outlines the main characteristics of corpora in metaphor studies; the second part (5.3.2.) underlines the pragmatic aspects of using corpora in translation studies. The third part (5.3.3) briefly describes the available procedures for searching corpora, their potential and drawbacks.

5.3.1 Corpus approaches to metaphor analysis
The use of corpus techniques in Metaphor Studies has developed as a response to problems with the cognitive approach to linguistic evidence (Deignan 2008b: 151). Deignan (ibid.) argues that from this perspective, metaphor study often relies on decontextualized examples and, as noted earlier, sometimes on invented data. She advocates the use of corpus linguistic techniques to ‘investigate the claims of conceptual metaphor theory
through the examination of naturally-occurring linguistic metaphors’ (ibid.:155). Furthermore, corpus linguistics techniques have revealed aspects of metaphor that remain hidden in cognitive research such as the social, (con)textual, genre-related, cultural, ideological and dynamic dimensions of metaphor (ibid.). Most recent metaphor studies rely either on existing corpora such as the BNC for English, a subsection of corpora such as the BNC Baby or corpora compiled and designed by the researcher. These latter are smaller in size compared to the existing corpora. In Steen et al., (2010b), for example, metaphors are searched in specialised corpora, each of which is intended to be a representative corpus of a genre such as academic writing, pragmatic (newspapers) writing and others. Musolff (2004) reports on his corpus of political texts, and Koller (2004) uses a corpus of business texts to investigate metaphors. Koller and Semino (2009) and Semino and Koller (2009) use a corpus they specifically designed to investigate metaphor in political speeches in German and Italian respectively. Research about metaphor in specific genres is also conducted through corpus techniques. Skorcznska (2005), Scorzynska and Deignan (2006), Deignan et al., (2013), for instance, investigate how metaphors are used in two genres: business academic articles and business popular articles. Caballero (2003; 2013a) investigates metaphor usage in the genre of architecture articles. In addition, there are several corpus-based studies conducted across languages. For instance, Deignan and Potter (2004) investigated metaphorical and metonymical use of the words ‘mouth’, ‘nose’, ‘heart’ and ‘eye’ in English and Italian to test how successful is CMT in explaining these lexis cross-linguistically; Charteris-Black and Ennis (2001), and more recently Muelas Gil (2016) investigated the use of metaphors in English and Spanish financial discourse. Although the above mentioned cross-language studies are not conducted from a translation perspective, they provide evidence of the relevance of a corpus-based approach to a study of metaphor in translation.

5.3.2 Corpus approaches to Translation Studies

A corpus-based approach is widely used nowadays not only in the field of metaphor studies but also in the field of translation studies (Ahmed 2007; Ahmed and Rogers 2001; Baker 1993; 1996; 1998; Bowker 2001; Bowker and Pearson 2002; Braun 2006; Laviosa 1998; 2002; Olohan 2004; Schäffner 1998; Zanettin 2012).
Whilst the use of corpora in linguistics goes back to the 60s (Laviosa 2002: 05), their use in translation studies is more recent. Baker (1993) first underlined the potential of electronic corpora, although manual corpus-based studies predated her proposal, in studying translation emphasising the role of such methods in unveiling the features of translated texts or what she calls “universals of translation” (Baker 1993: 243).

Baker (1996: 176-177) further argues that corpus techniques allow testing of “the kind of distinctive, universal features that have been proposed in the literature but never tested on a large scale such as simplification, explicitation and normalisation.

However, corpus techniques can be used not only in the study of the universals of translation but also to identify other features related to specific translation aspects such as the translation of metaphors and how it can be constrained by the cultural references embedded in them as it is demonstrated in this study.

While the term ‘corpus’ is used traditionally to refer to any collection of texts that are searchable manually, it is now established in corpus-based studies that ‘corpus’ refers to any electronic collection of texts that is searchable by means of special software tools (Deignan, 2005).

There are various types of corpora that can serve different research purposes such as the monolingual/bilingual or multilingual comparable or parallel corpora, general or specialised corpora; unidirectional or bidirectional corpora (see Baker 1993 1996; Bowker and Pearson 2002; Frankenberg-Garcia 2009b; Laviosa 2002; Olohan 2004, Zanettin 2012, 2013). Olohan (2004), for instance, draws the attention to the fact that the definition of each corpus differs slightly from one domain of research to another. In translation studies, ‘comparable corpora’ refer to an electronic collection of texts in different languages which are not translations of each other, whereas ‘parallel’ corpora refer to an electronic collection of texts and their translations (ibid.:24). However, the terms “parallel corpora” and “comparable corpora” are used interchangeably. In the current study, the term “parallel corpus” is used to refer to a collection of electronic texts and their translations.

From the point of view of Descriptive Translation Studies, Olohan (ibid.:10) claims that corpus-based approaches to translation studies can help understand and describe translation profiles and provide some basis to interpret results.
Olohan (ibid.) and other researchers have described different ways for researching corpora in translation research. In the next section, the stress is put on procedures developed specifically to investigate metaphors in different corpora.

5.3.3 Procedures for searching metaphors in corpora

As seen in the previous section, there are different types of corpora that range from general to specific or specialised corpora. Corpora can also be classified as unilingual or multilingual corpora. This section is concerned with the different possibilities of investigating metaphors through corpora.

Stefanowitsch (2006) argues that retrieving conceptual metaphors from any data is a thorny task as “conceptual mappings are not linked to peculiar linguistic forms” (2006:2). He reviews the available strategies for extracting linguistic metaphors from a corpus and classifies them into the following strategies:

1. Searching manually: which limits the research to corpora which have a manageable size for manual searching;

2. Searching electronically for the source-domain vocabulary. In this case, the researcher makes assumptions about potential domains s/he is likely to find in the corpus and then establishes a list of lexical items that will be searched in the corpus;

3. Searching electronically for the target domain vocabulary. In this case, the researcher seeks to establish a keyword list of the target domain investigated and concordance the keywords in the corpus in order to retrieve all instantiations of the searched words;

4. Searching for sentences containing lexical items from both source and target domain;

5. Searching for metaphors using ‘markers of metaphor’ (called here metaphor signals). Stefanowitsch (2006) proposes to use metaphor signals listed by Goatly (1997/2011) to identify and retrieve metaphors automatically from a corpus as seen earlier in Chapter 3;
6. Using annotated corpora. Stefanowitsch (ibid.) reports that few researchers have explored the possibility of annotating corpora for semantic fields. Annotated corpora are claimed to be increasingly available especially for English language (Kimmel 2012).

Stefanowitsch (ibid.) maintains that one or more of these strategies can be combined to investigate corpora. Some researchers use an amalgamation of manual and automatic analysis such as Koller and Semino (2009) and Semino and Koller (2009) who analyse a sample of their corpus manually and then compare the results to a keyword list to find if they are keywords in the whole corpus.

Other researchers such as Philip (2008) proposes an automated procedure, instead of combining a manual and automatic search, applicable to specialised corpora and based on keyword lists and raw frequencies. Philip (2008:91) compares the corpus word frequency list with a reference corpus word frequency list in order to determine the keyword list. Unlike Stefanowitsch (2006), who refers to the use of an existing large corpus as a reference corpus, Philip (2008:100) claims that the use of a smaller reference corpus is more likely to reveal pertinent words in the case of specialised corpora. She further proposes that the list of low-frequency content words (LFCWs) “are where the metaphor vehicles and source domains will be found”. She stresses, however, that this is the case for Italian in particular.

A similar procedure is used by Rodriguez Marquez (2010) in her study of metaphors in financial reports between Mexican Spanish and American English. However, she uses a high-frequency word list instead of a low-frequency word list to search for metaphor candidates in her bidirectional bilingual corpus.

This section has revealed that while corpus techniques offer a high potential for metaphor identification, there are different ways of searching corpora. Each method may lead to different results. It is worth noting that whatever method is chosen, the manual analysis remains ineluctable even in the case of automated research as it is the only way to check the metaphoricity of the metaphor candidates initially identified in the corpus.
This section reviewed different available procedures for searching metaphor in electronic corpora with a focus on specialised corpora. The next section reviews available methods for identifying what counts as a metaphor in the first place.

A number of researchers have proposed ways to define what counts as a metaphor in context. Charteris-Black (2004), for instance, argues that when the meaning of a single word is incongruent with the context, this indicates that the word might be used metaphorically. However, few researchers have proposed a detailed procedure to identify metaphors. The two main procedures available nowadays are the Metaphor Identification Procedure (MIP) and its newest version known as MIPVU. The next section reviews both procedures, highlights the advantages of using the MIPVU over the MIP and more importantly underlines the necessity to adjust the procedure to fit with the requirements of a bilingual corpus of English Arabic texts. The adjustments introduced to the identification method are covered in detail in the methodology chapter.

5.4 Metaphor Identification Methods
This section describes two main metaphor identification procedures concerned with the identification of linguistic metaphors. The first one is known as the Metaphor Identification Procedure (MIP) developed by the Pragglejaz Group. The second one is known as the Metaphor Identification Procedure Vrije University (MIPVU). MIPVI can be seen as an updated version of MIP with a key new feature that recognises cross-domain mapping comparisons (sometimes called “similes” or “analogies”) as metaphors as will be detailed later in Section 5.4.2.

5.4.1 Metaphor Identification Procedure (MIP)
A group of researchers from different disciplines such as linguistics, cognitive linguistics, psycholinguistics, applied linguistics and stylistics, Lynne Cameron, Alan Cienki, Peter Crisp, Alice Deignan, Ray Gibbs, Joe Grady, Zoltan Kövecses, Graham Low, Elena Semino, and Gerard Steen have elaborated a project of metaphor identification procedure (MIP) that was first published in *Metaphor and Symbol* in 2007. This group of researchers has coined the name "Pragglejaz" to refer to the group, the name being composed of the first letters of the researchers’ first names. The aim of the project as stated by the authors (Crisp *et al.*, 2007:02) is to present “an explicit method that can be reliably employed to
identify metaphorically used words in discourse”. MIP seeks to identify the linguistic metaphors as the first step in metaphor research. This step according to Steen (2014) is a crucial one in any research about metaphor. The metaphor identification is not only a methodological issue but underpins the “validity” of the research (Steen: 2014:15).

It worth noting here that MIP and its newer version MIPVU both focus on the linguistic metaphor identification and leave aside the identification of the underlying conceptual metaphor.

The procedure for linguistic metaphor identification proposed by Pragglejaz is composed of four steps which read as follow:

1. Read the entire text/discourse to establish a general understanding of the meaning.
2. Determine the lexical units in the text/discourse.
3. a. For each lexical unit in the text, establish its meaning in context, i.e. how it applies to an entity, relation, or attribute in the situation evoked by the text (contextual meaning). Take into account what comes before and after the lexical unit.
   b. For each lexical unit, determine if it has a more basic contemporary meaning in other contexts than the one in the given context. For our purposes, basic meanings tend to be:
      - more concrete; what they evoke is easier to imagine, see, hear, feel, smell, and taste;
      - related to bodily action;
      - more precise (as opposed to vague);
      - historically older;
   Basic meanings are not necessarily the most frequent meanings of the lexical unit.
   c. If the lexical unit has a more basic current–contemporary meaning in other contexts than the given context, decide whether the contextual meaning contrasts with the basic meaning but can be understood in comparison with it.
4. If yes, mark the lexical unit as metaphorical. (Crisp et al., 2007:3).

This procedure is underpinned by a number of methodological considerations that are discussed in detail by the researchers. The main points are that a linguistic metaphor is an indirect meaning and that it arises when the basic meaning of the lexical unit (the word or a string of words) is incongruent with its discursive meaning (meaning in context). One of the difficulties when applying the procedure is to define what counts as “basic meaning”. In MIP, the researchers define the “basic meaning” as the most concrete meaning of any lexical item and also as the meaning which is historically older. MIP specifies a corpus-based dictionary to establish a word basic meaning which is the MacMillan English Dictionary for Advanced Learners (Rundell 2002).
One of the other methodological issues that are not discussed by the Pragglejaz group is the kind of dictionaries to use when a specialised corpus is analysed. As will be seen later in Chapter 6, the general language dictionary alone would not be enough in the case of a specialised corpus. Other researchers, such as Rodriguez Marquez (2010) who applied the MIP for the analysis of linguistic metaphors in a specialised bilingual American English and Mexican Spanish corpus argues that it is necessary to adapt the dictionary to the language variety and introduce other dictionaries for the analysis of metaphors in other languages such as Mexican Spanish.

Furthermore, Rodriguez Marquez argues that step 2 of the MIP cannot be applied in the case of a large corpus. It is unlikely, according to Rodriguez Marquez, that a single researcher can alone identify all the lexical units of a corpus. The researcher finds that determining the contextual meaning of lexical units in large corpora is also problematic. She, alternatively, proposes to check the metaphoricity of the keywords obtained by using a concordance software (WordSmith 05). However, the use of the keyword list to determine the metaphor candidates limits the identification of the metaphors in a corpus to those which are more frequent, since the principle for a keyword list is the determination of the words in order of frequency.

MIP also limits the identification of metaphors into the indirect meaning and disregards metaphors that as signalled (called ‘direct metaphors’ in what follows) which, as seen in Chapter 3, are particularly important in popular science texts. The introduction of direct metaphors in the metaphor identification procedure is one of the major updates brought to MIP by Steen and his group of researchers working at Vrije University in Amsterdam. The updated version of MIP is called MIPVU (VU for Vrije University in Amsterdam where the researchers who updated the MIP work (Steen et al. 2010a, 2010b, 2010c).

The following section introduces the MIPVU and explains why it is more relevant for researching metaphors in popular science articles.

### 5.4.2 Metaphor Identification Procedure Vrije University (MIPVU)

MIPVU uses a slightly different terminology from MIP. For instance, the expression “Metaphor Related Words” (MRWs) is used to designate a linguistic metaphor (whether it is a single or a multiword) and “metaphor flags” (Mflag) to refer to metaphor signals or
hedges as Goatly (1997) calls them. For the sake of consistency, the words “linguistic metaphors” and “metaphor signals” are used even when the MIPVU is applied. For instance, when the MIPVU advocates to mark a direct metaphor as “MRW, direct” as seen below in the procedure steps, the abbreviation “LM, direct” is used in the present study.

The MIPVU basic procedure is as follows:

1. Find metaphor-related words (MRWs) by examining the texts on a word-by-word basis.
2. When a word is used indirectly and that use may potentially be explained by some form of a cross-domain mapping from a more basic meaning of that word, mark the word as metaphorically used (MRW).
3. When a word is used directly and its use may potentially be explained by some form of cross-domain mapping to a more basic referent or topic in the text, mark the word as direct metaphor (MRW, direct).
4. When words are used for the purpose of lexicogrammatical substitution such as third person pronouns, or when ellipsis occurs where words may be seen as missing, as in some forms of coordination, and when a direct or indirect meaning is conveyed by those substitutions or ellipses that may potentially be explained by some form of cross-domain mapping from a more basic meaning, referent, or topic, insert a code for implicit metaphor (MRW, implicit).
5. When a word functions as a signal that a cross-domain mapping may be at play, mark it as metaphor flag (Mflag).
6. When a word is a new-formation coined, examine the distinct words that are independent parts according to steps 2 through 5. (Steen et al., 2010b 26-27).

MIPVU distinguishes between indirect metaphors (Step 2) and direct metaphors (Step 3). Direct metaphors are those metaphors which are signalled while indirect metaphors are not marked by a “flag” or a “signal”. Another point that MIPVU takes into consideration is the implicit metaphor that occurs when a grammatical substitute or a pronoun is in use (Step 4 of the procedure). These two additional steps make the identification of metaphors more comprehensive. As Steen et al., (2010b:21) puts it, a high-quality metaphor identification is needed for a good quantitative and qualitative analysis. The following example extracted from the A&A English subcorpus which is to be used for the present study illustrates direct and indirect metaphors.
1. Stars **heavier** than the sun **burn** their hydrogen at much faster rates—so fast that even though they begin with more **fuel**, they run out of it sooner. (file4077155)

In this sentence, there are three (03) metaphors, stars and sun are physical objects that have weight and can be compared according to their weight; stars are engines which have fuel that they burn at a certain rate as they can run out of the fuel.

When considering the context which deals with astronomical facts, words like ‘heavier’, ‘burn’ and ‘fuel’ appear to be incongruent because their basic meaning contrasts with the contextual meaning. Here the words ‘heavier’, ‘burn’ and ‘fuel’ are used indirectly.

In the case of direct metaphors, the cross-mapping between the source and the target domain is direct. Example 2 below, which will be returned to in Chapter 6, from the A&A English subcorpus illustrates a direct metaphor.

2. **Suppose** the **odometer** on your car **breaks**. How can you **determine** how far you have driven? If you **know** the **size** of the **gas tank** and the **gas mileage**, it is **easy**: just **divide** the **gas supply** by the **mileage**. The same basic technique applies to stars. The **size** of the **tank** is the **mass** of the star, and the **mileage** is the **nuclear burning rate**. (file4077155)

In this example, there is a cross-domain comparison between determining the age of a star and determining the fuel consumption of a car when the odometer is broken. This cross-domain metaphor is introduced by the metaphor signal ‘suppose’.

MIPVU distinguishes between a simile and direct metaphors in the following way: if the simile expresses a resemblance between two objects belonging to the same source domain, then it is a simile and not a direct metaphor. If the comparison takes place between two different source domains as it is the case in example 2 above, then it is a direct metaphor and not a simile.

### 5.5 Conclusion

The first part of this chapter introduced important concepts of CMT which are relevant to the study of metaphor from a translation point of view. These concepts are the mapping between the source and the target domains of a metaphor, the partial nature of the mapping and the culture-specificity vs. the universality. These are the three main aspects are analysed in detail in Chapter 7 and 8 as they are pertinent to the analysis of metaphor in the ST and to its translation.
The second part of this chapter introduced discourse approaches to metaphor analysis which are one of the three trends developed to tackle the pitfalls of CMT. The discourse analysis approaches (the Critical Discourse Analysis and the Dynamic Discourse Approach) both rebalance the focus on the linguistic and conceptual dimensions. From a translation studies perspective, understanding both dimension can shed light on how metaphor is translated and might help understand the translator’s decision making. Metaphor translation, as will be seen in Chapter 8 dealing with the analysis of the Arabic translated subcorpus, is constrained by the conceptual, textual and to a certain extent cultural dimension. The Dynamic Discourse Analysis in particular has contributed to the elaboration of the methodology as will be seen later in Chapter 6. In addition, it allows to integrate the textual dimension of metaphor into the study, specifically when it comes to analysing metaphors that seem to be connected within the text (extended and clustering metaphors as will be seen in Chapters 7 and 8).

The third part of this chapter introduced a corpus-based approach to metaphor and translation and highlighted the importance of corpora in providing reliable evidence for the interpretation of the results of the analysis and is used as a background for the compilation and design of the A&A corpus as will be shown in Chapter 6.1.

The last part of this chapter discussed the available methods to identify linguistic metaphors. As MIPVU is a development of MIP, it has been chosen as a method for the metaphor identification in the present study. However, it was necessary to adapt and add some steps to fit the purposes of the study as will be detailed in Chapter 6.

Now that we covered the theoretical and methodological backgrounds of the current research, we move towards the description of the design and compilation of the A&A corpus. We then move to describe in detail the methodology to analyse it.
Chapter 6. Methodology

Researching how metaphors are translated in the genre of popular science articles about Astronomy and Astrophysics necessitates a combination of different approaches to consider the three dimensions of the metaphor: the linguistic, the functional and the conceptual dimensions as seen in the previous chapters.

This chapter describes how the different approaches are combined to cover all three dimensions. It is divided into four main sections: Section 6.1 describes the corpus design and the corpus analysis tools. Section 6.3 describes the method for the linguistic metaphors identification in English and Arabic subcorpora. Section 6.4 describes how the underlying conceptual metaphors are inferred from the linguistic data and Section 6.5 summarises the main points discussed in this chapter.

6.1 Corpus design and corpus analysis tools

The corpus compiled for the purposes of this study named the ‘A&A corpus’ (Astronomy and Astrophysics corpus) is a unidirectional parallel genre-specific, subject-specific electronic corpus. The corpus is a parallel one in the sense that it encompasses original texts and their translations (Baker 1993; 1996). It is unidirectional because it encompasses only English original texts translated into Arabic without the reverse direction.

In this section, two main issues are addressed. The first issue relates to the criteria for the corpus design addressed in 6.1.1. The second issue relates to the corpus analysis tools used in corpus compilation and corpus query which is discussed in 6.1.2.

6.1.1 Corpus design

This subsection addresses the features of designing and compiling the A&A bilingual corpus which are: the publication source, the language variety, the authorship, the subject field, the genre, the size and time span, and the corpus annotation.

6.1.1.1 Publication source

The original English articles are published in Scientific American magazine, which has aimed since its foundation in 1845 to achieve a broad dissemination of science⁷.

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⁷ See the presentation of the magazine at https://www.scientificamerican.com/page/about-scientific-american, [Last accessed 21/07/2017].
The Arabic translation of *Scientific American* was initiated by the Kuwait Foundation for the Advancement of Science in 1986 and has similar goals in disseminating scientific knowledge.

It is worth noting that *Scientific American* and its translations into different languages, as Shuttlworth (2017) points out, has served as a corpus to investigate various aspects of translation between different languages such as the study of specialised translation in Bowker and Pearson (2002), glossing in Sharkas (2005; 2011), the role of translators in the written interaction in Min-Hsiu (2013), and metaphors in Shuttleworth (2011; 2013).

### 6.1.1.2 Language variety

The language varieties present in the corpus are American English and Modern Standard Arabic. As already discussed in Chapter 1, the use of English in the sciences is well established (Montgomery, 2000; 2009; 2013) whilst MSA is a form of Arabic that developed after a long period of stagnation and its use in modern sciences is relatively new (Haeri, 2000; Sharkas, 2015). This situation is also reflected in the lack of easily accessible automatic processing tools for the Arabic language. For instance, Sketch Engine corpus tools only integrated Arabic as one of their working languages a few years ago (Kilgarriff *et al.*, 2013; Jakubíček *et al.*, 2013; Arts *et al.*, 2014).

As it will be seen later in Chapter 8, the imbalance in the available resources, namely terminological resources in Arabic might also affect the translation strategies used to transfer the A&A metaphors into Arabic.

### 6.1.1.3 Authorship

The original English texts are written by various authors. All authors of *Scientific American* are well-established experts in the field as acknowledged by the short biography available at the end of each article.

The translator of the Arabic version is often not cited in the Arabic version. When the translator’s name was provided, further information regarding his/her background was gleaned from the publication, the Internet and collected from the magazine through a request sent to the Editor-in-Chief. As a result, it was found out that most of the translators are not linguists but bilingual scientists. For example, Adnan Hamoui, one of the recurrent

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names in the translations holds a DSc in Mathematics (Differential Geometry and General Relativity) from the University of Paris-Sorbonne (1969) as stated in his bibliography available at http://www.iasworld.org/prof-adnan-hamoui/ [Last accessed 09/10/2017].

The fact that most of the translators are experts in the scientific fields, with knowledge of both the original and target languages may give rise to questions when it comes to the interpretation of the results concerning the chosen translation strategies although there is no available corpus of A&A articles translated by translators who received a linguistic/cultural training for comparison. It is assumed here that a linguistic training would raise awareness of issues related to metaphors among other linguistic issues that actors from other disciplines might not necessarily process.

6.1.1.4 Subject field

The A&A corpus is subject specific because all the articles selected belong to the same field which is Astronomy and Astrophysics, one of the many fields (technology, medicine, natural science and so on) popularised within Scientific American magazine.

Scientific American defines its aim and scope as

[the world's premier magazine of scientific discovery and technological innovation for the general public. Readers turn to it for a deep understanding of how science and technology can influence human affairs and illuminate the natural world. Its readers are not primarily scientists; to the extent that they have technical backgrounds, they read Scientific American for information about areas outside their expertise. (https://www.nature.com/scientificamerican/information/aims.htm, last accessed 02/05/2018)].

Scientific American clearly identifies itself as a popular science magazine.

Astronomy and Astrophysics as a field encompasses “all aspects of the study of the universe” (Mitton, 2007). This includes planets, black holes, supernovae, galaxies, stars, cosmic background radiation, Big Bang theory and cosmology which is a branch of astronomy that deals with ‘the origins, properties and evolution of the universe’ (Mitton 2007:75). The full list of corpus texts, their authors and titles can be found in Appendix 1 and 2.

The articles pertaining to the field of Astronomy and Astrophysics were identified using the metadata displayed in the database EBSCO from which the original English articles were retrieved (access granted through the university). The metadata for each article
provides the information related to the title, the author, an abstract of the article, the subject terms, the total word count of the article and the link to the online version of the article. The subject terms were used as means of identification of A&A articles. If any of the subject terms pertaining to A&A were found, then the article was selected. For example, the article entitled *Parallel Universe* has the following subject terms listed in the metadata: ‘cosmology’, ‘cosmic background’, ‘radiation’, ‘galaxies’, ‘planets’. As all these terms pertain to subjects covered by A&A according to Mitton (2007)’s definition of the field, then the article is selected.

Astronomy and Astrophysics (A&A) was chosen as a subject for many reasons: It is a complex subject that deals with the observation of entities such as stars and planets but also with abstract notions such as time, space and gravity. Therefore, metaphors are believed to be a relevant explanatory strategy to communicate those concepts to a non-specialist reader (MacCool 2008, Madsen 2001; Madsen and West 2003). It is also a subject visible in the public understanding of science and well mediatised. More importantly, it has some potential for metaphor translation as there is no study, to my knowledge, that examined how metaphors in this specific domain are translated between English and Arabic. Given the role metaphors play in explaining the concepts of A&A, it might be necessary to transfer them to the TL, but how well do these metaphors travel between these two languages which are linguistically and culturally unrelated?

### 6.1.1.5 Genre-specificity

The corpus is genre-specific. It deals only with articles published in one popular science magazine *Scientific American*, and its published Arabic translation *مجلة العلوم* (*Magazine of Sciences*). Genre-specificity is a relevant criterion in the study of metaphor in use (see (Caballero 2003; 2013a, 2013b; Semino 2008, 2011; Semino *et al.*, 2013) because the use and function of metaphors differ across genres as argued earlier in Chapter 3.3. For example, we can recall that metaphor functions in popular science articles are different from their function in research articles. Genre-specificity is also a relevant criterion from a translation perspective: because metaphor performs various functions in various genres, the role it plays in the text determines to some extent how it is translated.
6.1.1.6 Corpus size and time span

The size of the corpus is a problematic issue that is linked to the representativeness criteria. As pointed out by Bowker and Pearson (2002:46-47), the size of the corpus depends on the needs of the project, the availability of the data and the time allocated for the corpus analysis. In the case of the present study, the corpus is meant to be a representative sample of English into Arabic translation in the genre of popular science articles about A&A. *Scientific American* magazine was chosen as it fulfils a number of these criteria. It is written in English and translated into many languages including MSA. The English version is available electronically upon subscription (taken for one year). The Arabic translations have been available in paper edition since 1986 (date of the first Arabic edition) and electronically (HTML format) from the magazine website ([http://www.oloommagazine.com](http://www.oloommagazine.com)) since 1995. The corpus encompasses only texts available in HTML versions in both languages. This means that only texts published from 1995 onward as they are available electronically in both languages.

An early, but as it proved to be, overambitious aim of the study was to collect all texts published digitally in the field within this magazine. The available online texts were first searched for by scanning every issue and retrieving all articles related to Astronomy and Astrophysics from 1995 up to 2012. The number of texts retrieved totalled 114 original English texts (*circa* 950,000 words) and Arabic translations (*circa* 105,000 words.). Matching the Arabic translations to their English originals was not a straightforward procedure as the English original, and the translations are not published at the same time, and there is a mismatch between the two publications. Not all English articles are translated into Arabic, but when this is the case, they are not always published immediately after the English publication.

The other constraint is that not all the English articles were available electronically in HTML format or text format. Some articles collected directly from the magazine were in unconvertible pdf format due to copyright issues. The number of selected texts was hence reduced to encompass only texts available in HTML or plain text format which can be processed with text-processing tools (such as WordSmith Tools 4, ParaConc and Sketch Engine). The number of available texts in a usable format was, therefore, reduced to 82 in Arabic and 82 in English (*circa* 600 000 words in total).
Initially, 20 texts chosen from different publication years and different authors were manually analysed. (The list of the selected articles and their individual size is found in Appendices 1 and 2). This subsection represents around 25% of the total corpus size.

It was planned to use the results from the manual analysis to retrieve all instantiations of the identified metaphors from the whole corpus automatically following the method advocated by Semino and Koller (2009) and Koller and Semino (2009) where linguistic metaphors are retrieved manually from a subsection of the whole corpus (25%) as a first step. The second step consists of running an automatic concordance of the manually identified metaphors to retrieve all instantiations. However, given the considerable data gleaned from the manual analysis, it was deemed that the 20 texts manually analysed would provide sufficient data to answer the research questions within the time limit of the project.

The size of the current A&A bilingual corpus in number of words is circa 150,000 words. The compiled A&A corpus has the advantage of being an open corpus, and its size can be expanded as the magazine is still published monthly in both English and Arabic. This means that the corpus can be extended in the future to carry further research.

6.1.1.7 Corpus annotation

The A&A English subcorpus was manually annotated for linguistic metaphors, direct metaphors, indirect metaphors and metaphor signals. The identification of the linguistic metaphors in the A&A English and Arabic subcorpora is described in detail in the upcoming Chapter 6.2.

The A&A English and Arabic bilingual corpus design features are summarised in Table 6.1 below.
This first section has provided an overview of the corpus design features. The next section describes in some detail, the corpus analysis tools and the corpus processing.

### 6.1.2 Corpus processing and corpus analysis tools

There are various tools available nowadays for the automatic processing of digital corpora. There is a variety of software tools for studying metaphor in discourse such as Atlas.ti, NVivo, Vis Dis, etc. (for a detailed overview of these applications, see Kimmel, (2012)). For the purposes of this study, two software products were initially chosen: WordSmith tools version 4 (Scott, 2004) and Paraconc version 1 (Barlow, 2008). WordSmith tools were used at an early stage of this research because of their popularity in metaphor studies. Despite the existence of more recent versions, version 4 remains the only version compatible with the Arabic language. Wordsmith tools, however, have limitations when it comes to bilingual or multilingual corpora. The major shortcoming of WordSmith is the alignment option. Although texts can be aligned, there is no way to query the resulting parallel corpus. Paraconc, on the other hand, is designed to work with parallel corpora. It offers both alignment and parallel query search options.

Both WordSmith and Paraconc are computer-based tools and are limited in size and power of data processing. For this reason, a switch was made to a different tool later in the research, namely Sketch Engine. Sketch Engine is a powerful internet-based tool, offering

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**Table 6.1 Summary of design features of the A&A corpus**

<table>
<thead>
<tr>
<th>Design feature</th>
<th>English subcorpus</th>
<th>Arabic subcorpus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Publication source</td>
<td><em>Scientific American</em></td>
<td><em>Majalat al-Oloom</em></td>
</tr>
<tr>
<td>Language</td>
<td>English</td>
<td>Arabic</td>
</tr>
<tr>
<td>Language variety</td>
<td>American (US English)</td>
<td>Modern Standard Arabic (MSA)</td>
</tr>
<tr>
<td>Status</td>
<td>Original</td>
<td>Translation</td>
</tr>
<tr>
<td>Authorship</td>
<td>Experts in the scientific field</td>
<td>Experts in the scientific field</td>
</tr>
<tr>
<td>Subject field</td>
<td>Astronomy and Astrophysics</td>
<td>Astronomy and Astrophysics</td>
</tr>
<tr>
<td>Genre</td>
<td>Article in popular science magazine</td>
<td>Article in popular science magazine</td>
</tr>
<tr>
<td>Size in number of words</td>
<td>75, 124 words</td>
<td>80, 524 words</td>
</tr>
<tr>
<td>Size in number of texts</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Corpus annotation</td>
<td>Manual annotation of linguistic metaphors, direct metaphors, indirect metaphors and metaphor signals.</td>
<td>Not annotated</td>
</tr>
</tbody>
</table>
more space for data storage and an easy way to query the corpus (Arts et al., 2014; Kilgarriff et al., 2004).

Sketch Engine presents the following advantages: its structure is well developed, and it is designed to work with different languages including English and Arabic. The corpus once uploaded into the Sketch Engine software can be tagged for parts of speech (POS) in both languages. Additional tagging options are available. The corpus can be searched for specific annotation/mark-up in both the unilingual corpus and the parallel corpus.

The Sketch Engine tool makes available large corpora such as the TenTen corpora family that are searchable online using Sketch Engine tools. In the present study, we use the Arabic TenTen (arTenTen) corpus as a reference corpus as an alternative to a general language dictionary to help with the identification of linguistic metaphors in the A&A Arabic subcorpus as it will be seen later in 6.2.2.

The decision to switch from the use of WordSmith (Scott, 2004) and Paraconc (Barlow, 2008) was made after experiencing difficulties in aligning and querying the parallel bilingual English-Arabic corpus. Paraconc allows a parallel search for special lexical units. However, it does not allow a search for specific annotated units. Sketch Engine, on the other hand, offers the possibility to search for annotated lexical items using the option ‘corpus query language’ (CQL).

Sketch Engine was launched in 2004 (Kilgarriff et al., 2004) and has been improved over the last 12 years. In what follows, the main functions of Sketch Engine are described.

Arts et al., (2014) report that Sketch Engine is both a tool and a service. It is a tool that offers core functions, some of which are similar to the functions offered by other available tools such as the keyword list and the concordance. In addition, it is an Internet-based service. Users take a subscription (in the case of the present study, a 2-year subscription was taken) and are offered many options: search the corpora available via Sketch Engine such as the BNC, build up new corpora using the WebBootCat tool or upload their own corpora. The latter was chosen for the current study. The A&A corpus texts were first aligned using Trados SDL 2015 software and uploaded in TMX format to the Sketch Engine.
The key functions of Sketch Engine that were used for the analysis of the corpus are:

- **Word Sketch** which is “a one-page summary of a word’s grammatical and collocational behaviour” (Arts et al., 2014:9).

Figure 6.1 below shows a word sketch for the lexical unit ‘universe’ in the A&A English subcorpus. This function offers information related to the use of the word in the A&A English subcorpus such as statistical information (364 occurrences in 75,124, i.e., 4.2 per million). It also summarises all modifiers of the word *universe* and their frequencies (e.g. *early, observable, entire, inflationary*), the verbs, the prepositions and the adjectives with which *universe* collocate. This information is not only useful to the language learner but also to the translator as it is a corpus-based evidence to how words are used in context.
Figure 6.1 Word Sketch for the English word ‘universe’ in the A&A English subcorpus

Concordance: The concordance tool in Sketch Engine is similar to all other concordancers. It provides all occurrences of a word in a specified breadth of context. The results of the concordance can be sorted out in various ways. The search can be conducted by different means: a simple search, for instance, a word, a lemma, a phrase, a character or corpus query language (CQL).

The CQL search is relevant as it allows to retrieve the linguistic metaphors from the bilingual corpus, as a whole or by type (direct, indirect). The linguistic metaphors and the metaphor signals were assigned each a code as specified in Table 6.2 below.
Table 6.2 Special codes used to annotate the corpus

<table>
<thead>
<tr>
<th>CODE</th>
<th>MEANING</th>
</tr>
</thead>
<tbody>
<tr>
<td>MRW</td>
<td>Linguistic metaphors</td>
</tr>
<tr>
<td>FMM</td>
<td>Direct metaphors</td>
</tr>
<tr>
<td>WXF</td>
<td>Indirect metaphors</td>
</tr>
<tr>
<td>Mf</td>
<td>Metaphor signal (metaphor flag)</td>
</tr>
</tbody>
</table>

The code MRW is the abbreviation for metaphor related words which is the term used by Steen et al., (2010b) for linguistic metaphors. FMM is an arbitrary code chosen at an earlier stage to allow a search in Microsoft Word for direct metaphors. The code should not match any recognisable chunk of a word that might be highlighted when using the search function in Word. For the same reason, indirect metaphors were annotated using the code “WXF”. The code “Mf” is the abbreviation used by Steen et al., (2010b) for metaphor flag, the term they use for metaphor signal.

The CQL function allows the user to query the corpus using one of these annotations. For instance, conducting a search for all direct metaphors is done by typing the command `<FMM/>` in Table 6.2 below.

Figure 6.2. CQL for direct metaphors in the A&A English corpus

For a detailed description of the CQL function in Sketch Engine and the underlying computational model, refer to Jakubiček, Kilgarriff et al., (2013).
All queries except for the CQL can be carried out on both monolingual and parallel corpora in Sketch Engine. The CQL query, however, is not available for parallel corpora with customised markup uploaded to the Sketch Engine as TMX files. The Sketch Engine support team was contacted and then agreed to fix the problem manually in the A&A corpus as a one-off task. This function is used to retrieve all the linguistic metaphors from the A&A parallel corpus at go. Figure 6.3 shows a sample of the results of a search for direct metaphors in the English A&A corpus and Figure 6.4 shows a sample of the CQL search in the parallel A&A corpus.

It is worth noting here that the alignment is an important step in building the parallel corpus. Following Frankenberg-Garcia (2009b), the alignment was done at the ST sentence level. Whenever the ST sentence corresponded to less or more than one sentence in the TT, the TT sentences were merged together or split to match the original sentence. However, unlike Frankenberg-Garcia (2009b) who used a blank space to match sentences that are not translated into the TT, the same ST sentence was copied into the TT whenever a sentence is not translated into the TT to ensure it was imported into the translation memory. This was done to keep a record of instances where whole passages containing a metaphor are deleted in the TT because the alignment function in Trados SDL does not import segments with no matching translations into the translation memory.
Figure 6.3 Sample of the results of the CQL for annotated direct metaphors in the English A&A corpus

Figure 6.4 Sample of the results of the CQL for linguistic metaphors in the A&A parallel corpus

Word list and keyword list:

As its name indicates, this function produces a list of words in the corpus. It can be either simple (all words and their frequencies) or a keyword list. The keyword list can be obtained by selecting the desired reference corpus. Sketch Engine offers a wide list to choose from (BNC, COCA, Europal, TenTen, etc.). The word list can be obtained for words, lemmas, collocates (n-grams to be specified), and terms.
Sketch Engine offers other functions which are not discussed here as they are not relevant to this study, namely the thesaurus and sketch difference options which are of interest to lexicographers (Arts et al., 2014; Kilgarriff et al., 2004).

This section has covered the main questions related to the design of the corpus and the analysis tools as well as the different query types used to search for linguistic metaphors in the A&A English subcorpus and the A&A bilingual corpus. The next section describes the method used in the present study to identify linguistic metaphors in English, then in Arabic.

6.2 Identification of linguistic metaphors in the corpus

The metaphor identification method applied to the current A&A bilingual corpus is an adaptation of the Metaphor Identification Procedure Vrije University (MIPVU) (Steen et al., 2010a, 2010b, 2010c), which is itself an update of the metaphor identification procedure (MIP) developed by the Pragglejaz Group (Crisp et al., 2007) as seen earlier in Chapter 5.4.2.

Unlike a number of recent research where the MIP was applied for the identification procedure (Shuttleworth, 2013; Alshunng, 2016), the MIPU was chosen for the identification of linguistic metaphors as it allows to integrate what it is often called “analogies” in the study. Analogies have been found to be a feature of scientific writing (Calsamiglia, 2003; Calsamiglia and Van Dijk, 2004; Gentner, 1982; Hermann, 2013) but have been often studied separately from metaphors. Gentner et al., (2001) are the first researchers, to my knowledge, to draw similarities in the use of the metaphors and analogies in scientific writing. The MIPVU has been elaborated to respond to the need to provide a global framework where both analogies and metaphors are scrutinised together, not only because they seem to fulfil similar functions but also because under the CMT, they can be seen together as a mapping between two domains.

This study, hence, can be seen as a first attempt to look at metaphors and analogies together in popular science articles from a metaphor study and a translation perspectives and capture how they contribute to the dissemination of scientific content.

However, some adjustments of the MIPVU were necessary in order to fit the purposes of this multilingual study.
The MIPVU only provides guidelines on how metaphor candidates are identified and does not offer any other guidelines for the identification of their function or the conceptual metaphor underlying them. For these reasons, MIPVU was adapted to fit the requirements of the present study and overcome the challenges encountered when identifying metaphors in the Arabic data.

It is worth mentioning, at this stage, that MIPVU, like MIP, was developed initially to work with English and cannot necessarily be applied straightforwardly to other languages; hence, it cannot be applicable to a translation corpus without additional steps and adjustments.

This section is in two parts. The first part deals with the methodology for identification of linguistic metaphors and their functions in the A&A English subcorpus. The second part deals with adjustments introduced to allow identification of linguistic metaphors in the Arabic subcorpus.

As explained in the previous chapter, some important components of the identification method rely on the characteristics of English. When applied to other languages, such as Arabic, the procedure has required some adaptation. For example, what general-language dictionary to use to define basic meanings. One of the points that need to be discussed when the procedure is applied to Arabic is the choice of a dictionary to define the basic meaning of words. A number of Arabic language dictionaries are available, but it can be argued that they are not updated as regularly as their English counterparts (Mazaud 2004) as already mentioned in Chapter1.

The issue of how conceptual metaphors are inferred from the linguistic data is discussed later in 6.3.

6.2.1 Identification of linguistic metaphors in the A&A English subcorpus

This section describes the steps undertaken for the identification of the linguistic metaphors in the A&A English subcorpus.

Step 1. Establishing a general understanding of the meaning from texts metadata and the list of keywords.

As seen in the previous chapter, the Praglejazz group advocates “Read[ing] the entire text-discourse to establish a general understanding of the meaning” (Crisp et al., 2007: 03).
However, this step is possible only where the corpus size is manageable. In addition, it is useful when a heterogeneous corpus is used (different subjects for example). For subject-specific corpora such as the A&A corpus, metadata previously collected for individual texts combined with the list of the target domains words (which is the list of the keywords) can be used to establish the contextual meaning albeit the whole corpus, in the present case, was read entirely for a different purpose.

The metadata in the present study is collected from a research data basis available online which is EBSCO, to which the university subscribes. Each title of the twenty texts of the A&A English subcorpus was searched for in the database. The records generated by the search of the database were saved to an Excel sheet. Table 6.3 below is an example of the metadata collected for one of the twenty texts.

<table>
<thead>
<tr>
<th><strong>Table 6.3 Record 1: Metadata for the article ‘Parallel Universe’ from EBSCO host research databases</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Title:</strong></td>
</tr>
<tr>
<td><strong>Authors:</strong></td>
</tr>
<tr>
<td><strong>Source:</strong></td>
</tr>
<tr>
<td><strong>Scientific American; Document Type:</strong></td>
</tr>
<tr>
<td><strong>Subject Terms:</strong></td>
</tr>
<tr>
<td><strong>Abstract:</strong></td>
</tr>
<tr>
<td><strong>Full-Text Word Count:</strong></td>
</tr>
<tr>
<td><strong>ISSN:</strong></td>
</tr>
<tr>
<td><strong>Accession Number:</strong></td>
</tr>
<tr>
<td><strong>Persistent link to this record (Permalink):</strong></td>
</tr>
<tr>
<td><strong>Database:</strong></td>
</tr>
</tbody>
</table>
The subject terms and the abstract provide sufficient information to set up the general meaning of the text. In the case shown in Table 6.3 above, the topic can be identified as a search for parallel universes. Most of the subject terms provided by the record are found in the list of the key terms in Table 6.4 below generated using the Sketch Engine word-list compilation tool. Combining metadata with a keyword list is a time-efficient method to establish the general meaning and the general context for the metaphor identification.
<table>
<thead>
<tr>
<th>words</th>
<th>A&amp;A Corpus</th>
<th></th>
<th>English Web 2013 (enTenTen13)</th>
<th></th>
<th>Score(10)</th>
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<tbody>
<tr>
<td></td>
<td>Freq</td>
<td>Freq/mill*</td>
<td>Freq_</td>
<td>Freq /mill</td>
<td></td>
</tr>
<tr>
<td>universe</td>
<td>328</td>
<td>3876.3</td>
<td>583499</td>
<td>25.7</td>
<td>145.4</td>
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<td>2895.4</td>
<td>870382</td>
<td>38.3</td>
<td>73.7</td>
</tr>
<tr>
<td>black hole*</td>
<td>200</td>
<td>2363.6</td>
<td>3083276</td>
<td>135.7</td>
<td>17.3</td>
</tr>
<tr>
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<td>174</td>
<td>2056.3</td>
<td>53388</td>
<td>2.3</td>
<td>614.3</td>
</tr>
<tr>
<td>star</td>
<td>162</td>
<td>1914.5</td>
<td>1061478</td>
<td>46.7</td>
<td>40.2</td>
</tr>
<tr>
<td>planet</td>
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<td>1820</td>
<td>822055</td>
<td>36.2</td>
<td>49</td>
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<tr>
<td>dark matter</td>
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<td>1820</td>
<td>3873892</td>
<td>170.4</td>
<td>10.6</td>
</tr>
<tr>
<td>particles</td>
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<td>1678.2</td>
<td>247175</td>
<td>10.9</td>
<td>141.4</td>
</tr>
<tr>
<td>galaxy</td>
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<td>109089</td>
<td>4.8</td>
<td>277.3</td>
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<td>61.2</td>
<td>25.1</td>
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<tr>
<td>planets</td>
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<td>169168</td>
<td>7.4</td>
<td>165.3</td>
</tr>
<tr>
<td>solar system</td>
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<td>1323.6</td>
<td>883692</td>
<td>38.9</td>
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<tr>
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</tr>
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<td>7.3</td>
</tr>
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<td>17621</td>
<td>0.8</td>
<td>666.3</td>
</tr>
<tr>
<td>cosmic</td>
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<td>1181.8</td>
<td>97358</td>
<td>4.3</td>
<td>223.9</td>
</tr>
<tr>
<td>inflation</td>
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<td>1158.2</td>
<td>343352</td>
<td>15.1</td>
<td>72</td>
</tr>
<tr>
<td>gravity</td>
<td>92</td>
<td>1087.3</td>
<td>217359</td>
<td>9.6</td>
<td>103</td>
</tr>
<tr>
<td>radiation</td>
<td>91</td>
<td>1075.4</td>
<td>355277</td>
<td>15.6</td>
<td>64.7</td>
</tr>
</tbody>
</table>

The compiled list of target domain words as well as the metadata collected made it relatively easy to spot potential metaphor candidates while reading the texts as words belonging to different knowledge domain would appear incongruent. Incongruency, as

---

9 A frequency of an item normalised per million. If a token has normalised frequency per million 10, it means that in a corpus with million tokens this token would have a frequency of 10. From The Sketch Engine Glossary [online]. Available from https://www.sketchengine.co.uk/user-guide/glossary/?letter=F [Last accessed 23/09/2016].

10 Keyness score: in Sketch Engine, the keyness score, here score, is calculated by dividing the normalised per million frequency word in the focus corpus, here the A&A corpus + n=1 which is the default value by the normalised frequency word in the reference corpus. N is the simple Maths parameter. (see Statistics used in the Sketch Engine, Lexical computing Ltd. July 22, 201 online documents https://www.sketchengine.co.uk/documentation/statistics-used-in-sketch-engine/. [Last accessed 23/09/2016]. For further details on the statistical significance of keywords in comparable corpora, See (Kilgarrif 2012).
already claimed by Charteris-Black (2004), indicates that a word might be used metaphorically.

**Step 2: Determining lexical units**

For the present study, the possible metaphoricity of grammatical words was discarded as it has little or no influence in the analysis of linguistic metaphors fulfilling genre-specific functions and how they are transferred from English into Arabic. In addition, content words are more likely to reveal significant features in the use of metaphors in a specialised corpus, as also argued by Philip (2010).

In addition, the following rules were followed when deciding on what counts as lexical units:

1. As the corpus has been compiled in Sketch Engine, it has been automatically tagged for part of speech (POS). Therefore, following Steen et al. (2010b:27), words with a separate tag are considered as a lexical unit. It is worth mentioning that Steen et al. (ibid.) used a subsection of the BNC for their study. In the case of the Pragglejaz group (Crisp et al.,2007), the corpus was annotated manually for POS.

2. Both MIP (Crisp et al.,2007) and MIPVU Steen et al., (2010b) consider polywords as single lexical units. The same rule was applied to the current study.

3. MIP (Crisp et al.,2007) and MIPVU (Steen et al.,2010b) alike treat phrasal verbs as single lexical units. The same rule is followed here. MIPVI, however, applies a different treatment to prepositional verbs, where the preposition is considered as a separate lexical unit from the verb. In the present study, both phrasal verbs and prepositional verbs are treated similarly as also done in MIP. The reason for this choice is, as stated above, grammatical words are discarded in the present study. Additionally, prepositional verbs also found in the language dictionaries with their own entries; The Macmillan English Dictionary for Advanced Learners, for example, does not make a distinction between phrasal and prepositional verbs.

4. Compounds: MIP and MIPVU differ in the treatment of compound nouns. In the case of MIP, the criterion of “decomposability” (Crisp et al., 2007:25-26)
was applied. This means that if a word can be broken into its constituents, each constituent is considered as a separate lexical unit. In the case of MIPVU, compound words which have their own entry in the dictionary are considered as one lexical unit. All other compound nouns are broken down into their constituents.

The MIPVU rule was followed in the current study for the treatment of compound nouns. For example, the compound nouns “sport utility vehicle”, “tag-of-war” and “roller-coaster” are considered each as one (1) lexical unit because each has its own entry in the Macmillan Dictionary.

5. Classical idioms and fixed collocations: both MIP and MIPVU treat idioms and fixed collocations according to the principle of decomposability. Each word in the idiom is considered as a separate lexical unit. The same rule was followed in the present study. For example, in the expression ‘takes the rap for’ in example 1 below from the A&A English subcorpus, the words ‘takes’ and ‘rap’ are counted as two separate lexical units. The lexical unit “rap” is considered as a linguistic metaphor whereas “the” is discarded because it is a grammatical word and “take” is discarded because it is a delexicalized word.

A similar decision was also made when it came to direct metaphors such as the case in example 2 below from the A&A English subcorpus. All content words following the metaphor signal when a direct metaphor is signalled are marked as linguistic metaphors. In example 2, the content words following the metaphor signal ‘suppose’ are counted as linguistic metaphors. These words are: ‘odometer’(f=1), ‘car’(f=1), ‘breaks’(f=2), ‘determine’(f=2), ‘far’ (f=1), ‘have driven’(f=1), ‘know’(f=1), ‘size’ (f=2), ‘gas’(3), ‘tank’(f=2), ‘mileage’(f=3), ‘easy’(f=1), ‘divide’(f=1), ‘supply’(f=1).

1. Black holes of various sizes take the rap for fusillades of radiation and plasma that astronomers observe all over the cosmos (file4081799).

2. Suppose the odometer on your car breaks. How can you determine how far you have driven? If you know the size of the gas tank and the gas mileage, it is easy; just divide the gas supply by the mileage. The same basic technique applies to stars. The size of the tank is the mass of the star, and the mileage is the nuclear burning rate. (file4077155).

Since this study takes into consideration both word types and tokens, in addition to the inventory of word tokens, the different forms of the same lexical unit are aggregated as one
type. For example, the lexical units ‘swing’ (verb, noun), ‘swung’, ‘swings’ and ‘swinging’ count as one type of linguistic metaphor and four tokens (‘swing’ as a verb and ‘swing’ as a noun are both counted as one type).

**Step 3. Determining contextual meaning**

As seen in the previous chapter, both MIP and MIPVU advocate determining if each lexical unit has a more basic meaning than the one given in context (Crisp et al., 2007:03).

The basic meaning can be

- more concrete [what they evoke is easier to imagine, see, hear, feel, smell and taste];
- related to bodily action;
- more precise (as opposed to vague);
- historically older;

Basic meanings are not necessarily the most frequent meanings of the lexical unit (Crisp et al., 2007: 03).

The contextual meaning of a word in a subject-specific corpus is relatively easy to determine because the potential meaning of words is more circumscribed than in general-language texts, including literary texts. In the case of the A&A English subcorpus, words such as ‘stars’, ‘galaxies’, ‘planets’, ‘black holes’, ‘supernovae’ are more likely to be used in their domain specified sense. On the other hand the occurrence of words from other domains such as ‘parents’, ‘siblings’, ‘nursery’, ‘monsters’, ‘voracious’, ‘missiles’, ‘sport utility vehicle’ might indicate they there are not in their basic meaning and are potentially metaphorical.

The basic meaning is determined by the use of a general language dictionary. In the present study, the *Macmillan English Dictionary for Advanced Learners of American English (MEDA) online* (Rundell and Fox, 2002) is used to identify the basic meaning of the words. It is a language variety specific dictionary chosen because the English subcorpus is written in American English. In addition, the *Oxford English Dictionary online (OED)* is used when the MEDA does not provide the older meaning of a word and when the contemporary meaning(s) listed seem to be metaphorically motivated such as the case of ‘black hole’:

**The Macmillan English Dictionary for Advanced Learners of American English**

provides the following definitions of the word:
1. In outer space where the force of gravity is so strong that light and everything else around it is pulled into it.
2. A situation in which large amounts of money are spent without bringing any benefits.
3. A situation in which there is a lot of sadness and very little hope.

Definition (1) provides the specialised meaning of the word whereas (2) and (3) are both conventional metaphorical meanings of the words. Conventional here is used in the sense that the usage of the metaphor has become so frequent that it has an entry in a general language dictionary.

In order to establish a meaning that is historically older as recommended in MIP, the OED is consulted. Continuing our ‘black hole’ example, it provides the following meanings:

1. a. gen. A place of confinement as punishment. In later use, often with allusion to Black Hole of Calcutta at Phrases.
b. Mil. The punishment cell or ‘lock-up’ in a barracks; the guardroom; (also) spec. =Black Hole of Calcutta at Phrases. The official designation until 1868.

2. A deep pool in a river, spec. one at the base of a waterfall.

3. a. A circumscribed region of the sky seemingly devoid of visible stars; =coal sack n. 2.
b. A region of space within which the gravitational field is so strong that no matter or radiation can escape, except perch. by quantum-mechanical tunnelling (cf. Hawking radiation at Hawking n. 2), and which is thought to be due to a very dense, compact mass inside the region. Black holes are thought to be formed when a massive star exhausts its nuclear fuel and collapses under its own gravity. If the star is massive enough it will collapse and produce a singularity (singularity n. 9e). Before this stage is reached, within a certain radius (the event horizon) light itself becomes trapped and the object becomes invisible.

4. A place where items unaccountably disappear without a trace; somewhere or something impenetrable. Also: a place from which communication with the rest of the world is impossible.

The OED provides 4 definitions of the word where definition (3) provides the specialized meaning of the word and (4) a conventional metaphorical meaning. By considering the oldest historical meaning ‘a place of confinement as punishment’ as the basic meaning, it can be established that the specialised use of ‘black hole’ in A&A is metaphorical since there is a mapping between some features of definition (1) in the OED and the specialised definition of the word in A&A.
Step 4. Identifying indirect metaphors

As seen in the previous chapter, if the contextual meaning clashes with the basic meaning of the word, it is marked as metaphorical. This step corresponds to step number 2 in the MIPVU which reads, in a self-explanatory way, as follows:

Step 2: when a word is used indirectly and the use may potentially be explained by some form of cross-domain mapping from a more basic meaning of that word, mark the word as metaphorically used (MRW) (Steen et al., 2010b: 25).

Step 5. Identifying direct metaphors

There are two cases of direct metaphors: direct metaphor introduced by a metaphor signal and direct metaphors that are not signalled.

The identification of direct metaphors is relatively easy compared to indirect metaphors as they are often signalled using one of the metaphor signals from Goatly’s (1997) list as mentioned in Chapter 3. This is the case in the following example from the A&A English subcorpus:

3. The halo of our galaxy lacks gas, so few new stars form there. Like a dying old town emptied of its young, the halo is home only to the elderly (file4077155).

In this example, the copular simile “like” introduces a cross-domain mapping between the halo where few new stars form and an old town lacking young people.

Words following a metaphor signal are not metaphorical themselves, but they relate to a metaphor, and hence, they can be marked as linguistic metaphors. For ease of annotation and analysis, all content words following a metaphor signal are marked as metaphorical in the A&A English subcorpus.

Given the importance of metaphor signalling in specialised texts and especially in the genre of popular science texts as seen in Chapter 3.4, the metaphor signalling in the STs is analysed in detail in Chapter 7.

The second case of direct metaphors is where a cross-domain mapping is present without the use of metaphor signal. This is illustrated in example 4 below from the A&A English subcorpus.
In a live concert, a person with a musically trained ear can easily pick out the Piccolo from the bassoon. Cosmologists do the same thing with the distribution of galaxies. The relative amount of structure on large and small scales is a powerful cosmological probe.

In example 4, there is a comparison between the way cosmologists infer the distribution of galaxies from the large and small scales and the way a person with a good musical ear can distinguish the sound of similar musical instruments such as the piccolo and the bassoon. Although none of the signals from Goatly’s (1997) list is used, there is still a cross-domain comparison that leads to the identification of the content words in the first sentence as direct linguistic metaphors.

**Step 6. Identifying metaphor function**

This step is added to the MIPVU to allow the identification of the metaphor function (generic, pedagogical, terminological).

As seen in Step 3, a general language dictionary is used to identify the basic meaning of the corpus words. To identify the linguistic metaphor function, an additional dictionary is used. This is a specialised dictionary of Astronomy and Astrophysics *Dictionary Of Geophysics, Astrophysics, And Astronomy* (DGAA) (Basu, 2001).

Terminological metaphors are often described as conventional metaphors which have lost their metaphorical motivation (Temmerman 2002). In addition, they are sometimes explained by means of other metaphors in popular science texts, as shown in the following example:

5. Black holes have a bad reputation. In many ways, it is deserved. They are the most efficient engines of destruction known to humanity. Their intense gravity is a one-way ticket to oblivion for anything that strays too close; inside them is undiscovered country from whose bourn no traveler returns.

The terminological metaphor ‘black hole’ is explained using pedagogical metaphors such as ‘reputation’, ‘efficient engine of destruction’, ‘one-way ticket’, and ‘undiscovered country’.

From a translation perspective, distinguishing between the different functions of metaphors (in the present case, generic, terminological and pedagogical) will allow us to shed light on the various problems that may arise when translating each kind of metaphor. The lack of specialised dictionaries and the relatively recent modern use of Arabic in the sciences as argued in Chapter 1.2, could make terminological metaphors, as well as pedagogical
metaphors, a difficult task for the translator. The proposed TL term could then be the result of the creativity of the translator rather than a standardised term that can be gleaned in a dictionary.

The specialised dictionary is used to identify the terminological function in the ST. As a rule of thumb, any metaphorical word or expression that is listed in the specialised dictionary is marked as a terminological metaphor. For example, the linguistic metaphors ‘black hole’, ‘brown dwarf’, ‘Methuselah stars’ are classified as terminological metaphors.

Generic metaphors are those metaphors which metaphorical meaning are listed in the general language dictionary. If the general-language dictionary cites the metaphorical meaning of the headword, then the word is marked as a generic metaphor. For example, the adjective ‘earthshaking’ in the expression ‘earthshaking discovery’ is marked as a generic metaphor because the general-language dictionary provides the metaphorical meaning of headword earthshaking as ‘of great importance’.

All other metaphor candidates that are not listed in the specialised dictionary or whose metaphorical meaning is not listed in the general language dictionary are categorised as pedagogical metaphors.

However, it should be remembered here that, as seen in Chapter 3.2, the metaphor functions are not exclusive of each other. This is because the same linguistic metaphor can fulfil different functions. In the following examples 6 and 7, we can see how the same linguistic metaphor “show” fulfils two different functions in the A&A English subcorpus.

1. 6. The innermost Galilean satellite, Io, stole the show during the two Voyager encounters. (file316170).

7. Starbursts are galactic fireworks shows during which stars form at a frenetic pace. (file316170).

In example 6 above, the linguistic metaphor ‘show’ is identified as a generic metaphor because the expression “steal the show” is a conventional metaphor whose meaning is listed in MEDA. However, the same linguistic metaphor “shows” in example 7 is identified as a pedagogical linguistic metaphor.

In this example, the term ‘starbursts’ is a terminological metaphor. A starburst is defined as a “galaxy undergoing a strong episode of star formation” (Basu 2001). In this example,
This meaning is expressed using a pedagogical metaphor which is the ‘fireworks show’. The word ‘show’ in this example is not used in this basic meaning or its conventional metaphorical meaning. Hence, it is identified as a pedagogical metaphor. For quantification purposes, the linguistic metaphor ‘show’ will be counted as a generic metaphor and will also be counted as a pedagogical metaphor. The frequency distributions of the linguistic metaphors shown later in Chapter 7 indicates how many times this linguistic metaphor is used to fulfil each function.

Now that we have discussed how the metaphor function is identified in the A&A English subcorpus, we move on to describe the two last steps in the metaphor identification procedure which are the identification of implicit metaphors and new combinations of words. Both steps are added by Steen et al., (2010b) to the original metaphor identification procedure (MIP by Crisp et al., 2007) as mentioned earlier in Chapter 5.4.

**Step 7. Identifying implicit metaphors**

Implicit metaphors are defined by Steen et al., (2010b) as any lexico-grammatical substitutes for a direct or an indirect metaphor.

In example 5 above, ‘their’ in the second sentence is a grammatical substitute for the terminological metaphor ‘black holes’. Therefore, it should considered as a terminological metaphor according to the MIPVU procedure. However, since it was decided to discard the grammatical words from the analysis for the purposes of the present study as explained earlier, this step is not included in the identification procedure here.

**Step 8. Identifying newly formed metaphorical words**

The last step of MIPVU deals with newly coined words. As advocated by Steen et al., (2010b), each part of a compound coined word is analysed separately by running steps 2 to 5 in the MIPVU. For the purposes of this study, newly coined words are examined by looking separately at each part of the expression by running all the previous steps excluding Step 6 and 7. Any newly coined formation is considered as a pedagogical metaphor. This is the case for the expression ‘dirty snowball’ in example 8 below from the A&A English subcorpus.
Visitors from the farthest reaches of the solar system, comets consist of a solid nucleus of dust and ice, which has led them to be called "dirty snowballs." Interactions with the sun produce the nebulous coma and one or more tails that smear the comet against the sky.

In example 8 above, the two words ‘dirty’ and ‘snowball’ are used together as a linguistic metaphor to designate the cosmic entity ‘comet’. This newly coined formation is categorised as a pedagogical linguistic metaphor.

It was so far seen how linguistic metaphors and their function are identified in the A&A English subcorpus. It should be mentioned here that the coding of the metaphor was reviewed by the supervisors. When problematic cases were identified, they were sent to established researchers in the field such as Gerald Steen and Dafni Papadoudi who provided feedback on these cases.

In the next section, the steps for the identification of the linguistic metaphors in the Arabic subcorpus are described.

6.2.2 Identification of linguistic metaphors in the A&A Arabic subcorpus

The focus of the current study is on how metaphors are transferred into the TT rather than what metaphors are used in the TT. For this reason, the Arabic-subcorpus is not investigated from scratch to identify linguistic metaphors. Instead, it is researched as part of a parallel corpus where translation solutions are researched for the original English linguistic metaphors. These translation solutions might be a linguistic metaphor, a non-metaphorical expression or no translation might be provided.

In addition, by searching only for a translation solution for a metaphor used in the English subcorpus (unidirectional analysis of the corpus), linguistic metaphors that might be added to the Arabic subcorpus are not systematically identified. Cases of metaphor addition in the Arabic subcorpus reported in this study are only serendipitous cases identified because they occurred in the vicinity of other metaphors in the ST.

Furthermore, linguistic metaphors are not necessarily translated into the same linguistic metaphors. When different expressions from the ST are used in the TT, it is necessary to run an identification procedure to determine whether the equivalent/correspondent expression is metaphorical or not.
The MIPVU procedure, which was already adjusted to fit the purposes of the present study as discussed earlier in this chapter, is further adapted to tackle the specific issues related to Arabic. The major challenge towards the application of the adapted MIPVU to the Arabic subcorpus is the lack of a reliable contemporary dictionary of Modern Standard Arabic, as indicated in Chapter 1.

In the first place, the translation equivalents are retrieved from the parallel corpus by running a parallel query in the A&A English Arabic parallel corpus compiled in Sketch Engine.

Figure 6.5 below shows the results of a parallel query search for the linguistic metaphor ‘cauldron’. As shown in the figure, the translation equivalent مرجّل is highlighted in yellow (in the software) (the translation equivalent is detected automatically and highlighted).

Figure 6.5. Parallel query for the linguistic metaphor ‘cauldron’ in the A&A bilingual parallel corpus

When the same linguistic expression is used in the TT, it is identified as a linguistic metaphor straightforwardly. When a different expression or other expressions are identified along the same linguistic expression in the TT, the metaphor identification procedure described below is applied.

The identification of linguistic metaphors in the Arabic subcorpus encompasses the following steps:

**Step 1. Establishing general meaning from the text’s metadata and list of keywords.**
This step is not necessary for researching linguistic metaphors in the A&A Arabic subcorpus because the Arabic subcorpus is a translation of the English subcorpus. Consequently, the general meaning which was already established when analysing the English subcorpus is considered to be the same.
**Step 2. Determining lexical units**

Determining lexical units in Arabic is a complex issue because Arabic is an agglutinative language. Sketch Engine uses an integrated toolkit for morphological analysis and disambiguation for Arabic that allows to separate agglutinated words which facilitates the search for individual words.

**Step 3. Determining the contextual meaning**

The third step in the procedure for metaphor identification consists of determining the contextual meaning. This is done by contrasting the basic meaning with the given context where the word occurs.

This is the most problematic step to adapt to Arabic because the Arabic language dictionaries available on the market or freely online do not always reflect the language usage. This issue of codification discussed previously in Chapter 1 has required an adaptation of the identification procedure to access the basic meaning. For the purposes of this study, the online Arabic dictionary (https://www.almaany.com) was selected as a general Arabic language dictionary to determine the basic meaning of words.

When a word is not found in the dictionary, it is looked for in a reference corpus which is here the arTenTen as explained earlier in this chapter (6.1.2). In this case, the frequency is used as a criterion for determining the basic meaning in the reference corpus. For instance, the expression ‘قطار الفعائي’ (snake-like train) in example 9 below, used in the TT as an equivalent to the linguistic metaphor ‘roller-coaster’, could not be found in the general Arabic language dictionary.

9.  

<table>
<thead>
<tr>
<th>Language</th>
<th>Text</th>
</tr>
</thead>
<tbody>
<tr>
<td>ST</td>
<td>The dynamics were like the first moments of a roller-coaster ride. The coaster initially climbs slowly along a gentle hill. (file 3142985).</td>
</tr>
<tr>
<td>TT</td>
<td>كان الديناميك يشبه اللحظات الأولى من رحلة في عربة تجري فوق قضبان أفعائيات. في البداية ترتفع العربة ببطء على طول تلة عادية.</td>
</tr>
<tr>
<td>BT</td>
<td>The dynamics resembled the first moments in a trip in a wagon running on snake-like rails [roller-coaster in English in the TT]. At the beginning, the wagon goes up slowly along a normal hill.</td>
</tr>
</tbody>
</table>
In this case, the various instantiations used in the reference corpus, an excerpt of which is shown in Figure 6.6 below, are analysed.

Figure 6.6 Results of the query ‘قطار افعواني’ (snake-like train) in the Arabic reference corpus arTenTen

The expression ‘قطار افعواني’ (snake-like train) occurs 19 times in the arTenTen, the Arabic reference corpus. In most of the cases, it occurs in collocation with one of the following expressions ‘حديقة ملاه’ (attraction park), ‘مدينة ملاه’ (attraction town), ‘ألعاب ترفيهية’ (leisure games), and ‘ترفيه’ (leisure).

Based on the frequent co-occurrence of the expression ‘قطار افعواني’ (snake-like train) with the vocabulary from the attraction parks, it was safe to conclude that the basic meaning of the expression corresponds to the basic meaning of the original English expression ‘roller-coaster’. This is further confirmed by a footnote provided by a translator in the A&A Arabic subcorpus which reads as follows:

Translation note: it [the roller-coaster] is a bending and twisting rail in an attraction park going up and down; on the rails run small wagons people ride for leisure.
The basic meaning of the ‘roller-coaster’ being identified as a bending and twisting waggon and rail in a fair or an attraction park is incongruent with its contextual meaning in example 11 above and so it is metaphorical.

**Step 4. Identifying indirect metaphor**

As a default position, it is assumed that the metaphor is indirect unless Step 5 applies.

**Step 5. Identifying direct metaphor**

If a linguistic metaphor is signalled by one of the metaphor signals provided in the translated list of signals, such as the metaphor signal “يشبه” (similar) in example 9 above, content words occurring after the signal are marked as direct linguistic metaphors. As there is no list of metaphor signals in Arabic, Goatly’s (1997) list was translated (see Appendix 3) and used as an indicative reference. It is not assumed here that the two languages signal metaphor in the same way. Metaphor signals are not systematically analysed in the Arabic suborpus. The analysis is limited to the signals used with a metaphor already identified in the ST as a means to track any shifts in the signalling pattern.

As seen earlier in the MIPVI procedure applied to English (6.1.2), the same rule applies when a cross-domain mapping is identified in the absence of a metaphor signal.

**Step 6. Identifying metaphor functions**

The identification of the metaphor function in the TT is made differently from the metaphor identification in the ST because of the lack of an up-to-date specialised dictionary of Astronomy and Astrophysics. The most recent dictionary that is currently available is مصطلحات الفلك (The Dictionary of Astronomy Terms) (Nabhan 2007) which was first published in 2007. The dictionary was re-issued in 2010 without revisions or additions.

As mentioned earlier, terminological metaphors are seen as a means of filling a lexical gap. This is relevant for Arabic when a terminological metaphor is rendered by a literal translation (loan and transliteration). This procedure is common in the translation of specialised texts from English into Arabic as Izwaini (2010) points out and results in the creation of new terms in the TT whereas the term in the ST is standardised. For this reason,
any linguistic metaphor identified in the ST as terminological is also marked as terminological in the TT.

The absence of a unified codification of the Astronomy and Astrophysics domain is a translation problem that deserves a separate study. Hence, it is not covered by the scope of this study which focuses on pedagogical metaphors.

The identification of generic and pedagogical metaphors is made using a general Arabic dictionary which is Almaany online dictionary, as mentioned in Step 3 of the current section. When the metaphorical meaning of a word is listed in the general-purpose dictionary and is not identified as terminological metaphors (as seen in the previous para), it is marked as a generic metaphor.

Linguistic metaphors that are not identified as terminological and whose meaning is not listed in a general dictionary as categorised as pedagogical. As will be discussed later in Chapter 8.6, this step has important consequences for the interpretation of the results. This is basically because several generic metaphors in the English source text are translated literally into the TT resulting in the creation of novel expressions in the TT which does not have a conventional meaning that is listed in the dictionary. For instance, the linguistic metaphor ‘revolution’, is identified as generic, in the ST in example 10 below and the linguistic metaphor ‘smoking gun’, in example 11, is identified as generic in the ST.

10. Verification of this connection came with another technological revolution: the charge-coupled device CCD (file3340533)

11. The catch is that "there is no smoking gun," as Hallman puts it (file3340187)

The corresponding expressions ثورة to the linguistic metaphor ‘revolution’, in example 10 above is checked in the general language dictionary where its metaphorical meaning is listed. Consequently, it is marked as linguistic metaphor fulfilling the same generic function in the TT.
In example 11, the corresponding expression to the ‘smoking gun’ used in the ST is "البنِّيِّقة التي يتصاعد منها الدخان" (the gun from which the smoke arises) in the TT. This expression is not idiomatic in the TT and is not found in a general language dictionary.

The linguistic metaphor ‘smoking gun’ is an expression from the common stock of the English language that can be rendered using a non-metaphorical expression 'دليل قطعي' (irrefutable evidence). However, in this context, it is translated literally, and the translation is followed by the explanation 'لا وجود لبنِّيِّقة تعطي دخان الدليل' (back translation: there is no gun that gives the evidence of the smoke). After this explanation, when this same metaphor occurs again in the text, it is rendered by the literal translation without further explanation as in this example 12 below. This might be because untrained translators are reluctant to bypass the literal translation. It is worth reminding here that the Arabic translators of *Scientific American*, according to information gleaned from the internet have a scientific profile and do not seem to have received any training or certification as translators.

12. "That would certainly be a smoking gun," he holds (file3340187)

ويعتقد غيولاسي أن هذا سيكون بالتأكيد بمثابة البنِّيِّقة المنشودة التي يتصاعد منها الدخان (file3340212)

No instance of this translation is found in the general Arabic dictionary neither in the reference corpus. Consequently, this linguistic metaphor is identified as a novel pedagogical linguistic metaphor in the TT.

Examples 11 and 12 illustrate a case where the procedure outlined here leads not only to the identification of a different function of the linguistic metaphor in the TT, but also provides evidence that the literal translation results in novel expressions, as will be seen later in Chapter 8.6, even when the same metaphor is conventional in the source language.

**Step 7. Identifying implicit metaphors**

As seen in 6.1.1, the identification of implicit metaphors is made by identifying the lexico-grammatical substitutes of an already identified linguistic metaphor. However, this step is not relevant to the present study because of the focus on content words, as explained before.
Step 8. Identifying newly formed metaphorical words

Newly formed compound expressions are examined by looking separately at each part of the word by taking all the previous steps.

This adapted procedure to identify linguistic metaphors in the Arabic subcorpus can be integrated into the analysis of metaphors in a parallel corpus as well as used independently for the identification of linguistic metaphors in a specialised Arabic corpus.

We have now covered the procedure for the identification of the linguistic metaphors in the A&A English subcorpus and the A&A Arabic subcorpus; we move on the next Chapter 6.3 to describe how the conceptual metaphors are inferred from the linguistic metaphors.

6.3 From linguistic to conceptual metaphors

The identification of linguistic metaphors has been at the centre of various studies namely Crisp, *et al.*, (2007), Steen *et al.*, (2010 a, 2010 b, 2010c). How to move from the linguistic metaphors to the underlying conceptual metaphor is yet another problem that has been under-researched in metaphor studies. In this section, we describe the steps that lead to the identification of the conceptual metaphors underlying linguistic metaphors.

Inferring the conceptual metaphors underlying the linguistic metaphor is language independent as it does not involve linguistic decisions except for step one which consists of identifying the linguistic metaphor. This step has been covered in detail for both English and Arabic as seen earlier in this chapter. The remaining steps described in this section apply to both English and Arabic subcorpora. However, if the same procedure applies, this does not necessarily mean that the underlying conceptual systems for each language are the same.

To date, the only available method describing how conceptual metaphors are inferred from the linguistic metaphors is Steen’s procedure. Steen (2008:203) proposes a five-step procedure to infer the conceptual structure from the linguistic forms. This five-step procedure is as follows:

1. Identification of metaphor related words
2. Identification of propositions
3. Identification of open comparison
4. Identification of analogical structure
This complex five-step procedure initially described in Steen’s (1999; 2008) was further refined in a later work (Steen, 2011). Table 6.5—explained below—from Steen (2011:94) shows the five steps put into practice to analyse the conceptual metaphor in the example “Lakoff attacked Glucksberg”.

Table 6.5. Five-step analysis of ‘Lakoff attacked Glucksberg’ from Steen (2011:94)

<table>
<thead>
<tr>
<th>Steps</th>
<th>Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Text</td>
<td>Lakoff attacked Glucksberg</td>
</tr>
<tr>
<td>1. Identification of metaphor related words</td>
<td>attacked</td>
</tr>
<tr>
<td>2. Identification of metaphor related propositions</td>
<td>P1 (ATTACK, LAKOFF, GLUCKSBERG,)</td>
</tr>
<tr>
<td>3. Identification of open metaphorical comparison</td>
<td>SIM { F, x, y [F (LAKOFF, GLUCKSBERG)], [ATTACK (x, y)]}</td>
</tr>
<tr>
<td>4. Identification of analogical structure</td>
<td>SIM [CRITICIZE (LAKOFF, GLUCKSBERG)], [ATTACK (ATTACKER, ATTACKED)]</td>
</tr>
<tr>
<td>5. Identification of cross-domain mapping</td>
<td>TARGET &lt; SOURCE DOMAIN CRITICIZE &lt; ATTACK LAKOFF &lt; ATTACKER GLUCKSBERG &lt; ATTACKED possible inferences: ARGUMENTS &lt; WEAPONS</td>
</tr>
</tbody>
</table>

The first step consists of identifying the linguistic metaphor using an identification method such as the MIP (see Section 5.4.1) or the MIPVU (see Section 5.4.2). In Steen’s (Steen, 2011 :94) example, the linguistic metaphor (what he calls a “metaphor related word”) is ‘attacked’ as shown in Table 6.5 above.

The second step consists of identifying the metaphor proposition (P1) where the source domain (abbreviated as ‘s’) and the target domain (abbreviated as ‘t’) of the metaphor are the two parts of the proposition.

The third step consists of applying “a formal notation of the conceptual structure of the structure of the implied comparison” (Steen, 1999: 67) where SIM is used for similarity, $F$
is used for “activity (or relation)” (Steen:1999:67), “x” and “y” are two entities that share a similarity in doing $F$ (ibid.).

In step 4, $F$ (the activity) is CRITICIZED; LAKOFF and GUCKSBERG are the target domain ($t$). The source domain ($s$) is ATTACK, ATTACKED, ATTACKER.

In step 5, the cross-mapping between the source and the target domains of the conceptual metaphor is explicature. The action of criticising is mapped onto the action of attacking, Lakoff is mapped onto the attacker, and Glucksberg is mapped onto the attacked.

Steen’s procedure brings some insights into how the source and the target domains of the conceptual metaphor are identified. Furthermore, it highlights possible mappings between the source and the target domains. However, the formulation of the conceptual metaphor is not obvious. In the case of the linguistic metaphor ‘attacked’, Steen claims it is CRITICISM IS ATTACK and adds that it can also be the more general conceptual metaphor ARGUMENT IS WAR already identified by Lakoff and Johnson (1980). However, none of the mappings highlighted in Steen’s analysis could directly lead to conceptual metaphor ARGUMENT IS WAR. In a recent publication, Deignan (2017) points out that the move from step 4 to step 5 is the weakest link in Steen’s procedure. She states that:

The five steps make the structural and logical aspects of the process of working from linguistic to conceptual metaphor very clear, but the method in itself does not resolve every difficulty. The major problem for the analyst is that the method as set out here still does not provide an answer to the problem of how we can formulate one particular conceptual metaphor rather than another, based on language data. This leap, which takes place between steps 4 and 5, is dependent on the intuitions of the researcher. The issue arises not just when following the five-step method, but in all attempts to generalize from linguistic to conceptual metaphors (Deignan, 2017, Ebook)

As pointed out here, the final formulation of the conceptual metaphors is always dependent on the researcher intuition, no matter how detailed is the procedure to infer the conceptual metaphor. Consequently, some subjectivity is inevitable when formulating the conceptual metaphor.

In addition to the formulation of the conceptual metaphor, there is another problem that seems to be avoided by metaphor researchers, which is the allocation of the linguistic metaphor to a source domain be it called “semantic grouping” (Cameron 2010),
“conceptual domains” (Lakoff and Johnson, 1980) or “mental frames” (Kövecses 2005). The conceptual metaphor theory presupposes that there are distinct categories in the world and each linguistic metaphor can be easily connected to one of these categories. Let’s say the linguistic metaphor ‘attack’ in Steen’s example above belongs to the source domain WAR. Hence the formulation of the conceptual metaphor ARGUMENT IS WAR. In practice, the boundaries between these categories might not always be clear which makes the allocation of the linguistic metaphors to the sources domains another problem towards the identification of the underlying conceptual metaphors. For instance, the linguistic metaphor ‘cauldron’ in example 13 below, from the A&A English subcorpus, can belong to the source domain of COOKING or HEATING.

13. The early universe was a cauldron of a star formation. (file4076748)

To tackle this problem in the present study, some source domains that share one or more linguistic metaphors were grouped together. For instance, since the ‘cauldron’ is used for both cooking and heating, the source domains COOKING and HEATING were grouped together with the source domain of FOOD as one source domain labelled COOKING, HEATING AND FOOD.

In order to achieve the movement from the linguistic into the conceptual metaphor in a systematic way, we integrated an additional step borrowed from the discourse dynamics approach (Cameron 2010). As seen in the previous chapter, Cameron (2010:91) proposes to use the concept of “systematic metaphors” to group linguistic metaphors into conceptual groups and to establish a connection between the linguistic metaphor and the concept that underlies it. Cameron’s (ibid.) proposed solution differ from Steen’s in that it looks at all linguistic metaphors occurring in a set of data and tries to group them into conceptual groups whereas Steen (2011) applies his identification procedure to individual linguistic metaphors.

This step is particularly useful when using a bottom-up approach where the linguistic metaphors in a corpus are first identified and then grouped into conceptual domains. According to Cameron (2010: 92),

Systematic metaphors are sets of semantically connected linguistic metaphors, collected together from transcriptions or texts across one or more discourse events and labelled. For the researcher, a systematic metaphor
emerges upwards through processes of analysis and interpretation, and serves as a way of condensing discourse data (Cameron 2010:92).

In the present study, once all linguistic metaphors were identified, they were grouped into semantic/conceptual groups. Some semantic groups were later merged together and presented as one source domain as seen above with the source domain COOKING, HEATING AND FOOD. Another example is the source domain SPORTS AND GAMES. Initially, there were three separate source domains as shown in Table 6.6 below, which were merged together at a later stage.

Table 6.6. Early stage of linguistic metaphor categorization into the source domains SPORTS, GAMES and TOYS

<table>
<thead>
<tr>
<th>Source domains</th>
<th>Linguistic metaphors</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPORTS</td>
<td>ball, player, billiard ball, baseball, plotted, prize, endgame, football, outfielders, hurdles, league, derby, pinpointed</td>
</tr>
<tr>
<td>GAMES</td>
<td>roller-coaster, fireworks, swing, puppeteers, snowballs, jigsaw, puzzle, mudball, game, coaster</td>
</tr>
<tr>
<td>TOYS</td>
<td>dollhouse, Russian dolls, balloons pinwheel, ball, Lego bricks</td>
</tr>
</tbody>
</table>

Table 6.7 shows the early attempts to classify identified linguistic metaphors into three source domains which are SPORTS, GAMES and TOYS that appear to overlap. For instance, the linguistic metaphor ‘player’ can belong to each of these three categories. Because of this apparent closeness between all three categories, they were merged into one category labelled SPORTS, GAMES (TOYS are implied in games).

The identification of the conceptual metaphors in the A&A adopts Steen’s procedure but is applied in a less formalised way and integrates two more steps as shown below.

Step 1. Identifying all linguistic metaphors following the adapted procedure discussed in 6.2;

Step 2. Grouping the linguistic metaphors into conceptual groups which are the source domains (for instance MYTHICAL AND FANTASTIC CHARACTERS; SPORTS AND GAMES);

Step 3. Identifying the proposition(s). Given that the present study is concerned with metaphors in the subject-specific domain of A&A, and that the corpus has been constructed
accordingly, the target domain, of the metaphors relate to cosmic entities such as planets, stars, particles. These are all grouped together under the umbrella target domain which is UNIVERSE (COSMOS) or its subcategories COSMIC ENTITIES or COSMIC PROCESSES. Consequently, each of the conceptual metaphors formulated shows the mapping between one of these target domains and one of the source domains identified in the A&A English subcorpus presented later in Chapter 7;

Step 4. Corresponds to steps 3 and 4 in Steen’s (2011) procedure where the open comparison and the analogical structure are identified, bearing in mind that both the source and target domains are pre-identified. The key step in the procedure is to identify the activity $F$. For instance, in Steen’s example “Lakoff attacked Glucksberg”, identifying the activity is finding that attacking = criticizing, although again Steen does not describe this step clearly;

Step 5 corresponds to the identification of the cross-domain mapping between the source and the target domains (Steen’s step 5);

Step 6 corresponds to the formulation of the conceptual metaphor bearing in mind that the source domain—not covered by Steen—is one of those identified in step 2 and the target domain is one of those identified in step 3.

These steps are believed to lead to the formulation of conceptual metaphors with a certain level of generalisation that allows a description of both the linguistic and the conceptual metaphors used to explain A&A concepts.

Table 6.7 shows how this adapted procedure is put into practice to infer the conceptual metaphor from the indirect linguistic metaphor ‘cauldron’ presented in example 13 above.

<table>
<thead>
<tr>
<th>Step No.</th>
<th>Description</th>
<th>Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Identification of the linguistic metaphors by applying the procedure described in Section 6.2</td>
<td>Cauldron</td>
</tr>
<tr>
<td>2.</td>
<td>Grouping into a conceptual group</td>
<td>COOKING, HEATING AND FOOD</td>
</tr>
<tr>
<td>3.</td>
<td>Identification of metaphor related propositions</td>
<td>P1 (COOK, UNIVERSE, STAR,)</td>
</tr>
</tbody>
</table>
4. Identification of open metaphorical comparison and analogical structure

\[ F = \text{FORMATION} = \text{COOKING} \]

\[ \text{COSMIC ENTITIES}_1 \]

\[ \text{HEATING DEVICE}_2 \]

5. Identification of cross-domain mapping

\[ \text{TARGET} < \text{SOURCE DOMAIN} \]

\[ \text{FORMATION} < \text{COOKING/HEATING} \]

\[ \text{UNIVERSE} < \text{COOKING/HEATING DEVICE} \]

\[ \text{STAR} < \text{FOOD} \]

6. Possible conceptual metaphors expressed using the target domain COSMIC ENTITIES or UNIVERSE and the source domain COOKING, HEATING and FOOD

\[ \text{COSMIC ENTITIES} \]

\[ \text{FORMATION} \text{ IS} \text{ COOKING} \]

\[ \text{THE UNIVERSE} \text{ IS A} \]

\[ \text{COOKING/HEATING DEVICE} \]

The analysis of the example ‘The early universe was a cauldron of a star formation’ in Table 6.7 shows two possible formulations for the conceptual metaphor underlying the linguistic metaphor ‘cauldron’. These are COSMIC ENTITIES FORMATION IS COOKING, and THE UNIVERSE IS A COOKING/HEATING, DEVICE. The second formulation is retained as will be seen later in Chapter 7.2.5 because it allows the inclusion of other linguistic metaphors belonging to the same source domain.

It is worth mentioning here that the identification of the comparison structure is easier for direct metaphors, as also claimed by Steen (2011), compared to indirect metaphors as illustrated in example 10 below and described in in Table 6.8 that follows.

10. Particles are as spread out as baseball outfielders (file408257).

<table>
<thead>
<tr>
<th>Step No.</th>
<th>Description</th>
<th>Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Identification of metaphor related words</td>
<td>Baseball, outfielders</td>
</tr>
<tr>
<td>2.</td>
<td>Identification of the semantic group</td>
<td>SPORTS, GAMES and TOYS</td>
</tr>
<tr>
<td>3.</td>
<td>Identification of metaphor related propositions</td>
<td>P1 (PARTICLES), P2 (SPREAD OUT), P2 (BASEBALL, OUTFIELDERS)</td>
</tr>
<tr>
<td>4.</td>
<td>Identification of open metaphorical comparison and analogical structure</td>
<td>( F \text{ DISTRIBUTED} = \text{SPREAD OUT PARTICLES} )</td>
</tr>
</tbody>
</table>
Identification of cross-domain mapping

| TARGET <SOURCE DOMAIN DISTRIBUTION < SPREAD OUT PARTICLES <OUTFIELDERS UNIVERSE < BASEBALL FIELD |

Possible conceptual metaphors

| THE UNIVERSE IS A SPORTS FIELD |
| COSMIC ENTITIES ARE SPORTS PLAYERS |

Because the cross-domain comparison is explicitly expressed using the copular simile ‘as’, it is easier to identify the propositions and the open comparison. However, the problem of formulating the conceptual metaphors remains the same as for direct metaphors. In the present case, two conceptual metaphors are possible THE UNIVERSE IS A SPORTS FIELD, or COSMIC ENTITIES ARE SPORTS PLAYERS.

In addition, the conceptual metaphor can be formulated at a more specific level, in which case PARTICLES is the source domain rather than the more general designation COSMIC ENTITIES and BASEBALL is the target domain instead of the more generic designation SPORTS AND GAMES. The specific metaphor is PARTICLES ARE BASEBALL OUTFIELDERS.

A more general metaphor is the one that connects the previously identified source and target domains and is either THE UNIVERSE IS A SPORTS FIELD, or COSMIC ENTITIES ARE SPORTS PLAYERS.

The conceptual metaphors in the present study were formulated in a manner that reflects the connexion between identified target and source domains as shown earlier in this chapter. However, sometimes, a different formulation might be inevitable to bring together linguistic metaphors from the same source domain. Again, it should be stressed here that inferring conceptual metaphors from linguistic metaphors is a result of an interpretation of the data which can differ from one researcher to another.
6.4 Conclusion

This chapter has described the criteria and the analytical tools chosen to design and analyse the A&A bilingual corpus. In addition, it has described how the available linguistic metaphor procedures were adapted to fit the purposes of a genre-specific parallel corpus. This chapter has also detailed how conceptual metaphors are inferred from linguistic metaphors, and how Steen’s steps were adapted to fit the purposes of the analysis of a subject-specific corpus. It has also addressed the question of formulating the conceptual metaphor by connecting the target domain (subject-specific) to source domains identified in the data.

The next chapter reports and discusses the results of the analysis of the A&A English subcorpus.
Chapter 7. Conceptual and linguistic metaphors in the English subcorpus

This chapter reports on the analysis of the English-subcorpus and aims to answer the first and second research questions which are:

1. What are the conceptual domains underlying linguistic metaphors in the popular science articles of Astronomy and Astrophysics (A&A)? What functions do they fulfil in popular science texts of A&A and how are these functions distributed in the corpus?
2. What are the conceptual metaphors related to the identified source domains?

In order to answer these two research questions, the current chapter is divided into two main sections.

The first Section 7.1 aims to answer the first research question and part of the second one. Section 7.1.1 presents the quantitative findings related to the identified conceptual domains and how they are distributed across the metaphor functions in the A&A English subcorpus. Section 7.1.2 presents the identified source domains and how they relate to the different metaphor functions in order to find out possible similarities and or differences in conceptual metaphors between the source and target texts. Section 7.1.3 covers the groundwork to answer the second research question by looking at the identified metaphors from a culture-specificity perspective.

Section 7.1.4 deals with the culture-specificity of the source domains identified in 7.1.3. This was not a research parameter at the beginning of the study. However, during the earlier stages of the corpus alignment and the markup of the linguistic metaphors in the A&A corpus, it became apparent that several linguistic metaphors were tinted with the American culture. The question was then raised about the additional problems linked to the translation of the culture-specificity of these metaphors between English and Arabic. For this reason, pedagogical metaphors embedded in culture-specific source domains became the focus for further analysis in the second part of this chapter (Section 7.2). This focus is thought to bring additional insight to the issue of cultural specificity in scientific writing, particularly in the genre of popular science articles. This question has received little attention in both discourse studies and translation studies because scientific discourse is often seen as
culture- and rhetoric-free (Calsamiglia 2003; Rey, 2007; Rogers, 2015) as discussed earlier in Chapter 2.

Before moving onto a detailed qualitative analysis, of the culture-specific pedagogical metaphors in the A&A English subcorpus related to the second research question, Chapter 7.1.5 turns to metaphor signalling in the A&A English subcorpus, as mentioned earlier in Chapter 6. Metaphor signalling is one of the parameters also subsequently integrated into the analysis of the translated corpus to track possible shifts in the signalling pattern between the ST and the TT as discussed in Chapter 3.4.

The findings from the quantitative analysis of the corpus are summarised in 7.1.6. These findings relate to the number of linguistic metaphors identified in the STs, the source domains in which they are embedded and how these relate to the different functions metaphor fulfil in popular science texts as well as to the issue of metaphor signalling.

Section 7.2 answers the second research question dealing with the conceptual metaphors in the A&A English subcorpus. This part will focus on the analysis of pedagogical metaphors embedded in culture-specific source domains as a prelude to the analysis of culture-specific pedagogical metaphors in the Arabic translation in Chapter 8. Conceptual metaphors and linguistic metaphors related to each of the culture-specific domains are discussed in turn (Section 7.2.1 to 7.2.6). Section 7.2.8 deals with the specific issue of metaphor clustering, a recurrent phenomenon in the A&A English subcorpus which has an important implication for metaphor translation. Section 7.3 concludes this chapter by summarizing the quantitative and qualitative findings in the A&A English subcorpus.

7.1 Metaphors in the A&A English subcorpus: An overview
This section presents an overview of linguistic metaphors identified in the A&A English subcorpus, their functions and the source domains they embody. The frequencies are presented in order to understand what source domains are preferred in the A&A English subcorpus; type-token ratios (TTRs) indicates the diversity of source domains used in the A&A corpus and as a means to identifying novel and creative metaphors.

7.1.1 Distribution of metaphor functions across the corpus
As detailed in Chapter 6, the A&A English subcorpus was first analysed manually to identify linguistic metaphors. The identification was made according to the MIPVU
procedure (Steen et al., 2010b) adapted to the current study by the addition of a further step to allow the identification of the metaphor function: generic, terminological or pedagogical as seen in Chapter 6.2.1. This method led to the identification of 3,798 linguistic metaphors in the A&A English subcorpus (75, 124 words).

The analysis reveals the prevalence of the pedagogical function. Pedagogical linguistic metaphors represent 60.81% (2309/3798) of the identified linguistic metaphors followed by terminological metaphors 33.53% (1273/3798) and lastly generic metaphors 5.36% (216/3798), as shown in Table 7.1 Metaphor functions and their frequencies in increasing order in the A&A English sub-corpus below.

<table>
<thead>
<tr>
<th>Metaphor function</th>
<th>f</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generic</td>
<td>216</td>
<td>5.69%</td>
</tr>
<tr>
<td>Terminological</td>
<td>1273</td>
<td>33.53%</td>
</tr>
<tr>
<td>Pedagogical</td>
<td>2309</td>
<td>60.81%</td>
</tr>
<tr>
<td>Total LMs</td>
<td>3798</td>
<td>100.00%</td>
</tr>
</tbody>
</table>

These findings are not consistent with the findings from another study namely, Skorczynska Sznajder and Deignan (2006), where generic metaphors are found to be more frequent than pedagogical and terminological metaphors combined in a corpus of popular business texts.

The prevalence of pedagogical metaphors in the A&A English subcorpus might not be just a genre-specific feature but also a subject-specific feature. Although the primary function of the popular science article is the explanation of science to a non-specialist audience (Myers, 2003), the A&A English subcorpus displays a higher number of genre-specific metaphors (terminological and pedagogical) compared to the popular business corpus analysed by Skorczynska Sznajder and Deignan (2006). This might indicate that the A&A subject is more complex and requires a more frequent use of metaphors to put the complex and, often, abstract concepts within reach of a non-specialist audience. Additionally, a recent study of metaphors in biomedical texts translated from English into Arabic
Alshunnag (2016) did not provide any quantitative analysis that would have allowed to draw a comparison between the two subjects. The researcher simply assumed that the pedagogical function as opposed to the terminological function in Boy’s terminology was prevalent given the knowledge dissemination purposes of these texts. Alshunnag (ibid.) also assumed that conventional metaphors fulfil a pedagogical function whereas in the present study, a distinction is made between conventional metaphors called here “generic metaphors” and the two other functions (pedagogical and terminological). The quantitative analysis in Table 7.1 is provided as an evidence that the pedagogical function of metaphors is prevalent in the genre of popular science texts.

Although it is generally accepted that the primary function of popular science is to explain scientific concepts, the use of terminological metaphors cannot be avoided because A&A is a scientific domain with a codified terminology. Hence, it is not surprising that terminological metaphors feature in the A&A English subcorpus at a higher rate than generic metaphors.

However, the analysis reveals that terminological metaphors are often explained by other metaphors, often pedagogical as shown in example 1 below. (only pedagogical metaphors related to ‘black hole’ are highlighted in the example).

1. Why do giant black holes and stellar baby booms, two phenomena with little in common, so often go together? Black holes have a bad reputation. In many ways, it is deserved. They are the most efficient engines of destruction known to humanity. Their intense gravity is a one-way ticket to oblivion for anything that strays too close; inside them is undiscovered country from whose bourn no traveler returns. We see them only because the victims do not go quietly to their doom (file4081799).

In this example, the terminological metaphor ‘black hole’ is explained using many pedagogical metaphors which are ‘efficient engine of destruction’, ‘bad reputation’ ‘one-way ticket to oblivion’, and ‘undiscovered country’.

This interaction between the two metaphor functions often results in the concentration of several linguistic metaphors in the same segment of the text, a phenomenon described as “metaphor clustering” (Koller, 2003; Cameron and Stelma, 2004) or “mixed metaphor” (Kimmel, 2010). Metaphor clustering, as will be seen later in Section 7.2.8, is an interesting metaphor phenomenon that “seems to have the potential to reveal something of the conceptualisation and thinking processes of a speaker or writer, at points in talk or text
where producers do something ‘out of the ordinary’ with metaphor.” (Cameron and Stelma, 2004:108).

The metaphor clusters which result from pedagogical metaphors being used to explain terminological metaphors in the A&A English subcorpus may indicate that the A&A concepts underlying terminological metaphors are not easy to access by a non-specialist. This concentration of metaphors at specific moments in the text narrative indicates that the author is aware of the difficulty arising from the use of a specialised term in a popular science text. Hence, the use of a pedagogical metaphor to explain a terminological metaphor can be interpreted as a deliberate use of metaphors as a strategy to communicate scientific concepts to a non-specialised audience.

Furthermore, the use of pedagogical metaphors to explain terminological metaphors can also be explained using the concept of recontextualization introduced earlier in Chapter 2 where it was pointed out that popular science articles can be defined as a recontextualization of a primary research article. The use of pedagogical/generic metaphors to explain terminological metaphors can be one way to achieve this intralingual translation. The terminological metaphor embodies a highly abstract concept that cannot be accessed by a non-specialist without “translation” which, in the present case is, achieved by using a pedagogical/generic metaphor.

We can recall that generic metaphors are dead or lexicalised metaphors in Van Den Broek’s (1981) terms. They feature in popular science articles for different reasons: they can be used as cohesive devices or to fulfil interpersonal or other functions (see Goatly, 2011 for a more detailed account of metaphor function in the text).

Other examples of generic metaphors are the linguistic metaphor ‘dusted off’ and ‘revolutionary’ in example 2 below.

2. They dusted off an idea of Einstein’s, the so-called cosmological constant, which represents a new type of energy-an example of what is more generally known as dark energy. However,
many physicists are thinking that a revolutionary discovery calls for a revolutionary response. (file3178980)

The linguistic metaphor ‘dusted off’ is categorised as generic because the metaphorical meaning “get something ready to use that you have not used for a long time” is provided in a general language dictionary. In the present case, the definition is provided by the MEDA as the first meaning of the expression whereas its basic meaning “to wipe dust or dirt off the surface of something” is listed second. The order in which both meanings are listed indicates clearly that the metaphorical meaning is more widespread nowadays than the literal meaning. The linguistic metaphor ‘dusted off’ can be said to be lexicalised or even dead using Van den Broek’s typology (1981:78).

Similarly, the linguistic metaphor ‘revolutionary’ is also categorised as a generic metaphor because its metaphorical meaning is listed in the general English language dictionary. The MEDA, for instance, provides the metaphorical meaning of the word ‘revolutionary’ as “new and completely changing the way that something is done, thought about, or made”.

Metaphor clusters in the A&A English subcorpus also contain generic metaphors along with terminological and pedagogical metaphors as it is the case for instance in example 2 above. In this example, the generic metaphors ‘dusted off’ and ‘revolutionary’ co-occur with the terminological metaphors ‘cosmological constants’ and ‘dark energy’.

Both generic and terminological metaphors have an established meaning and are either lexicalised or conventionalised metaphors. Van Den Broek (1981:78) in his taxonomy of metaphors argues that conventionalised metaphors are not problematic from a translation point of view, perhaps because they are found in bilingual dictionaries. Whilst it can be accepted that generic metaphors might not pose specific translation problems for the pair of languages English and Arabic, it is not safe to make the same assumption about terminological metaphors because of the imbalance in the state of the development of these languages in scientific domains. Whilst English presents itself as a global lingua franca with a fairly well codified A&A domain, Arabic, like several other languages, is left behind (Montgomery, 2009; 2013). Consequently, terminological metaphors are still problematic from a translation perspective. However, it is argued here that, for the English and Arabic

13 http://www.macmillandictionary.com/dictionary/american/dust-off. [Last accessed 15/05/2017].
14 http://www.macmillandictionary.com/dictionary/american/dust-off.[Last accessed 15/05/2017].
15 http://www.macmillandictionary.com/dictionary/american/revolutionary_1. [Last accessed 15/05/2017].
pair of languages, terminological metaphors raise different problems from pedagogical metaphors. Terminological metaphor problems are linked to the lack of codification of the studied scientific domain whereas pedagogical metaphors raise issues of creativity and cultural specificity as will be seen in Chapter 8. The translation problems raised by terminological metaphors deserves a separate analysis that is not part of the scope of this study.

The frequency distribution of linguistic metaphors according to function gives some indication of the trends in the A&A English subcorpus, but it does not provide any information about the ‘richness’ of the metaphors belonging to each function. In order to shed light on the differences between the metaphor functions, a type-token ratio (TTR) is calculated. The TTR is the usual measure used to calculate lexical density. It calculates the number of different word types over the total number of words (tokens) in a text or a corpus. Generally, the more types that are found, the richer the vocabulary of a given text, i.e. there are fewer repetitions of the same type. The TTR is applied here to find out differences in lexical variation between the metaphor functions as a means to indicate novelty.

The analysis of the type-token ratio of the different metaphor functions indicates that although terminological metaphors are higher in frequency compared to generic metaphors, they are the least diversified metaphors in the corpus with only 7.23% TTR. Pedagogical metaphors, on the other hand, shows the highest rate of diversification with 60.76% TTR, as shown in Table 7.2 below.

<table>
<thead>
<tr>
<th>Metaphor function</th>
<th>Word Type f</th>
<th>Tokens f</th>
<th>TTR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generic</td>
<td>50</td>
<td>216</td>
<td>23.15%</td>
</tr>
<tr>
<td>Terminological</td>
<td>92</td>
<td>1273</td>
<td>7.23%</td>
</tr>
<tr>
<td>Pedagogical</td>
<td>1403</td>
<td>2309</td>
<td>60.76%</td>
</tr>
<tr>
<td>Total LMs</td>
<td>1545</td>
<td>3798</td>
<td>40.68%</td>
</tr>
</tbody>
</table>

The higher TTR of pedagogical metaphors as shown in Table 7.2 indicates a higher lexical variation meaning that pedagogical metaphors tend to be less repeated compared with terminological and generic metaphors. Terminological metaphors, on the other hand, are more repetitive. These values confirm the diversity and the richness of pedagogical
metaphors which are more likely to be creative and novel compared to terminological metaphors. Hence, pedagogical metaphors might pose more translation problems.

The richness of pedagogical metaphors in the A&A English subcorpus tend to be confirmed by the analysis of the source domains underlying each metaphor function as discussed in the next section.

7.1.2 Quantitative analysis of metaphor source domains identified in the A&A English subcorpus

This section reports on the metaphor source domains identified in the A&A English subcorpus. As has been argued in Chapter 6, the identification of the source domains is open to various interpretations as it relies on the researcher’s judgement in grouping the linguistic metaphors into conceptual groups (the source domains) while seeking some level of generalisation. In the current study, the starting point was the source domains that have already been identified in the literature, such as Lakoff et al.’s (1991) Master Metaphor List. Let us take one example from this list: the source domain MACHINE. Linguistic metaphors such as ‘vehicles’ and ‘assemblages’ can easily be grouped together into the source domain MACHINE. However, many other linguistic metaphors in the current English subcorpus do not fit into any of the source domains listed in Lakoff et al., (ibid.) as it is also the case in various studies of conceptual metaphors. In such a case, the researcher identifies the underlying conceptual metaphors as explained in Chapter 6 and the labelling of the conceptual domains remains subjective to a certain extent (Deignan: 2007). For the purposes of the present study, linguistic metaphors that do not fit within any of the source domains already identified in Lakoff et al., (ibid.) are grouped together into what seems to be a common denominator between them. For instance, the linguistic metaphors ‘tradeoff’, ‘merger’ and ‘merge’ are grouped together under the source domain labelled COMPANIES which does not exist in the above-mentioned list.

Single linguistic metaphors (15 in total) that could not be put into large semantic groups are put together under the label ‘Various’. This category includes linguistic metaphors such as ‘crib’, ‘jewels’, and ‘sculptor’.

The analysis of the corpus led to the identification of 21 source domains and 15 subdomains shown in Table 7.3 below, which displays the following information (VARIOUS is not a
source domain but a category that encompass non-classified linguistic metaphors and hence does not count as the 22nd source domain). Contextual examples are provided in Appendix 5 for the linguistic metaphors listed in the Table 7.3 below.

- Numerical data showing the identified source domains and subdomains and their related linguistic metaphors in absolute and relative frequencies.

- The source domains for each metaphor function. The source domains are coded into colours as follows:
  - Green: source domains highlighted in green underlie linguistic metaphors fulfilling all three functions: generic, pedagogical and terminological;
  - Blue: source domains highlighted in blue underlie linguistic metaphors fulfilling two functions. In the present case, this refers to source domains where pedagogical and terminological metaphors are embedded. No source domain was found to be shared between terminological and generic metaphors or between generic and pedagogical metaphors only;
  - Orange: source domains highlighted in orange are instantiated only in linguistic metaphors fulfilling a pedagogical function.

Table 7.3 Identified source domain, subdomains and their related LMs frequencies presented in a descending order of frequency per domain.

<table>
<thead>
<tr>
<th>SD identified in the A&amp;A English subcorpus</th>
<th>ABSOLUTE f</th>
<th>RELATIVE f/N</th>
<th>Subdomains</th>
<th>ABSOLUTE f</th>
<th>RELATIVE f/n</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>HUMAN BEINGS</td>
<td>750</td>
<td>19.75%</td>
<td>MORAL ATTRIBUTES</td>
<td>383</td>
<td>51.07%</td>
<td>behave</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>PHYSICAL ATTRIBUTES</td>
<td>260</td>
<td>34.67%</td>
<td>hand</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>BIRTH</td>
<td>45</td>
<td>6.00%</td>
<td>born</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>RELATIONSHIP</td>
<td>43</td>
<td>5.73%</td>
<td>companion</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>SOCIAL LIFE</td>
<td>11</td>
<td>1.47%</td>
<td>nursery</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>EMOTIONS</td>
<td>8</td>
<td>1.07%</td>
<td>tormented</td>
</tr>
<tr>
<td></td>
<td>n 750</td>
<td>100%</td>
<td>CONTAINER</td>
<td>526</td>
<td>13.85%</td>
<td>envelope</td>
</tr>
<tr>
<td>POWER AND CONFLICT</td>
<td>454</td>
<td>11.95%</td>
<td>VIOLENCE</td>
<td>150</td>
<td>33.04%</td>
<td>shot</td>
</tr>
</tbody>
</table>

Table 7.3 Identified source domain, subdomains and their related LMs frequencies presented in a descending order of frequency per domain.
<table>
<thead>
<tr>
<th>Category</th>
<th>Count</th>
<th>Percentage</th>
<th>Relevant Term(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMPETITION</td>
<td>141</td>
<td>31.06%</td>
<td>compete</td>
</tr>
<tr>
<td>MILITARY</td>
<td>103</td>
<td>22.69%</td>
<td>missile</td>
</tr>
<tr>
<td>POWER</td>
<td>60</td>
<td>13.22%</td>
<td>dominate</td>
</tr>
<tr>
<td>PHYSICAL OBJECTS</td>
<td>411</td>
<td>10.82%</td>
<td>debris</td>
</tr>
<tr>
<td>MACHINE AND MECHANICAL PROCESSES</td>
<td>332</td>
<td>8.74%</td>
<td></td>
</tr>
<tr>
<td>MECHANICAL PARTS</td>
<td>220</td>
<td>66.27%</td>
<td>pumps</td>
</tr>
<tr>
<td>COMPUTERS</td>
<td>60</td>
<td>18.07%</td>
<td>computers</td>
</tr>
<tr>
<td>VEHICLES</td>
<td>52</td>
<td>15.66%</td>
<td>trains</td>
</tr>
<tr>
<td>BIOLOGICAL ENTITIES AND PROCESSES</td>
<td>230</td>
<td>6.06%</td>
<td>embryo</td>
</tr>
<tr>
<td>LOCATIONS</td>
<td>188</td>
<td>4.95%</td>
<td>town</td>
</tr>
<tr>
<td>ARTS</td>
<td>129</td>
<td>3.40%</td>
<td></td>
</tr>
<tr>
<td>MUSIC</td>
<td>114</td>
<td>88.37%</td>
<td>drummer</td>
</tr>
<tr>
<td>PERFORMANCE</td>
<td>5</td>
<td>3.88%</td>
<td>acting</td>
</tr>
<tr>
<td>DANCE</td>
<td>10</td>
<td>7.75%</td>
<td>Twirling dancers</td>
</tr>
<tr>
<td>MYTHICAL AND FANTASTIC CHARACTERS</td>
<td>120</td>
<td>3.16%</td>
<td>gargantuan</td>
</tr>
<tr>
<td>TERRESTRIAL ATMOSPHERE AND GEOGRAPHY</td>
<td>73</td>
<td>1.92%</td>
<td>horizon</td>
</tr>
<tr>
<td>MOTION AND DIRECTIONALITY</td>
<td>72</td>
<td>1.90%</td>
<td>fly apart</td>
</tr>
<tr>
<td>ANIMAL KINGDOM</td>
<td>70</td>
<td>1.84%</td>
<td>bees</td>
</tr>
<tr>
<td>SPORTS AND GAMES</td>
<td>63</td>
<td>1.66%</td>
<td>Billiard balls</td>
</tr>
<tr>
<td>COOKING, HEATING, AND FOOD</td>
<td>58</td>
<td>1.53%</td>
<td>campfire</td>
</tr>
</tbody>
</table>
Table 7.3 shows that the largest source domain in the A&A English subcorpus is HUMAN BEINGS. 19.2% of the linguistic metaphors in the subcorpus are realisations of the source domain HUMAN BEING. This source domain is also one of the nine source domains shared between all three functions.

This finding is in line with earlier studies about metaphor where personification featured as key in different subjects and genres (Charteris-Black, 2004; Herrmann, 2013; Papadoudi, 2010; 2014; Semino, 2008). In the A&A English subcorpus, cosmic objects (inanimate beings) are often attributed the qualities of animate beings especially those of the human beings.

The source domain HUMAN BEINGS has also been reported to be the “most productive” source domain in a popular science and specialised bilingual comparable corpus of Italian and French astronomy texts (Giaufret and Rossi, 2010: 137). It can be argued that the findings from the present study confirm the findings in Giaufret and Rossi (ibid) despite differences in classifying some linguistic metaphors as instantiations of the source domain HUMAN BEINGS. For instance, Giaufret and Rossi (2010 :141) classify the French linguistic metaphors ‘naines’ (dwarfs), ‘géantes’ (giants) and ‘monstres voraces’ (voracious monsters) as belonging to the source domain HUMAN BEINGS whereas these are classified, in the present study, as instantiating the source domain MYTHICAL AND

<table>
<thead>
<tr>
<th>Domain</th>
<th>Count</th>
<th>Percentage</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>VEGETAL KINGDOM</td>
<td>60</td>
<td>1.58%</td>
<td>watermelon</td>
</tr>
<tr>
<td>ARCHITECTURE</td>
<td>50</td>
<td>1.32%</td>
<td>architecture</td>
</tr>
<tr>
<td>CLOTH FABRIC AND COMPANIES</td>
<td>52</td>
<td>1.37%</td>
<td>carpet</td>
</tr>
<tr>
<td>HUNTING</td>
<td>48</td>
<td>1.26%</td>
<td>merger</td>
</tr>
<tr>
<td>JOURNEY</td>
<td>40</td>
<td>1.05%</td>
<td>prey</td>
</tr>
<tr>
<td>VARIOUS</td>
<td>15</td>
<td>0.39%</td>
<td>traveling</td>
</tr>
<tr>
<td>RELIGION AND FAITH</td>
<td>17</td>
<td>0.45%</td>
<td>fate</td>
</tr>
<tr>
<td>TOTAL METAPHORS (N)</td>
<td>3798</td>
<td>100%</td>
<td></td>
</tr>
</tbody>
</table>

133
FANTASTIC CHARACTERS (all three metaphors are found in the A&A English subcorpus).

The second most frequent source domain in the A&A English subcorpus is CONTAINER. The universe and the different cosmic entities are described in terms of various types of containers such as a ‘basin’ and an ‘envelope’ or using attributes such as ‘filled’ and ‘emptied’ and even ‘inflated’. This source domain underlies terminological and pedagogical metaphors only. For example, the linguistic metaphor ‘inflation’ is a terminological metaphor embodying the source domain CONTAINER where the universe is mapped onto a container that expands like an inflated balloon. Pedagogical metaphors instantiating the source domain CONTAINER encompass a wider range of linguistic metaphors such as ‘well’, ‘pack’, ‘bowl’, ‘reservoir’, ‘bubble’ and ‘envelope’.

In addition to the source domains shared between two or all three functions, pedagogical metaphors are found to be exclusively embedded in seven source domains: MOTION AND DIRECTIONALITY; ANIMAL KINGDOM; COOKING, HEATING AND FOOD; ARCHITECTURE; COMPANIES; JOURNEY; and RELIGION AND FAITH.

The data from Table 7.3 confirms that pedagogical metaphors are richer and more diversified than terminological and generic metaphors as they are embedded in all 21 source domains identified in the A&A English subcorpus.

Given the richness of the data collected from the corpus, the qualitative analysis will focus on the pedagogical metaphors embodied in generally agreed culture-specific source domains given their potential challenge for metaphor translation. Some of the source domains found in the corpus such as the HUMAN BEING metaphors were the focus in different studies such as Giaufret and Rossi, 2010, Papadoudi, 2010) to cite only few. In order to make a new contribution to the analysis if conceptual metaphors in translation, it was chosen here to focus on culture specific domains as there are few studies about the culture specificity in scientific texts (Rey, 2000) but none is conducted from a conceptual perspective.

It is however important to mention that culture specificity as already pointed out in Chapter 5.1.3 is a fuzzy concept. The next section aims to explain how the concept of “culture specificity” is used in the present study.
7.1.3 Culture specificity across metaphor functions

The data from Table 7.3 above indicates that the linguistic metaphors in the A&A English subcorpus are embedded in a wide range of source domains which vary in their degree of cultural specificity in the ST. For example, linguistic metaphors belonging to the source domain SPORTS AND GAMES such as ‘baseball’ and ‘poker’ are seen in this study as none controversial culture-specific domain, whereas metaphors belonging to the source domain CONTAINER such as ‘envelope’ and ‘bowl’ might be argued to be culture-specific or not. A closer look at the distribution of these source domains across the different functions indicates that culture-specific source domains underlie, mainly, linguistic metaphors fulfilling a pedagogical function.

To better demonstrate this point, Table 7.4 below includes only the source domains from Table 7.3 that are deemed to be culture-specific. Table 7.4 below also shows the frequency and the TTR of the linguistic metaphors embedded in each culture-specific source domain for each metaphor function. The TTR helps to compare the three functions because the lexical variation for each metaphor group highlights the degree of creativity and novelty of metaphor, which in turn, shows a higher degree of difficulty in translation.

Table 7.4 shows that pedagogical metaphors display a greater diversity of culture-specific source domains in comparison to terminological and generic metaphors. It also indicates
that the source domains COOKING, HEATING AND FOOD; SPORTS AND GAMES; and RELIGION AND FAITH are instantiated by linguistic metaphors fulfilling a pedagogical function only.

In addition, Table 7.4 underlines that word/expressions used functionally as pedagogical metaphors have the greatest variation in the source domain ARTS. To better understand how this source domain is used in the corpus, the analysis of its sub-domains is provided here below.

The subdomain MUSIC is instantiated by a higher number of terminological metaphors \( (f=68) \) compared to pedagogical metaphors \( (f=60) \) whilst there is no generic metaphor is used to instantiate this subdomain. However, pedagogical metaphors show a greater diversity with TTR=65\% against TTR=7.35\% for terminological metaphors.

The subdomain DANCE underlies only pedagogical metaphors, which are also found to be diverse with a TTR= 91.66\%.

The subdomain PERFORMANCE is instantiated by generic metaphors and pedagogical metaphors. Generic metaphors show a greater diversity (TTR=100\%) compared to pedagogical metaphors (TTR=83.33\%).

The analysis of the TTR for the source domains in Table 7.4 above indicates that pedagogical metaphors are, in general, embedded in a wider range of culture-specific source domains compared to terminological metaphors and generic metaphors. They also tend to be more diversified; hence, they are more creative and novel than generic and terminological metaphors.

The analysis conducted so far has revealed that linguistic metaphors fulfil different functions in the A&A English subcorpus. Furthermore, they instantiate different source domains with vary in their degree of cultural specificity as will be seen later in this chapter. Thus, before going any further in the discussion of culture-specific source domains, the next section explains how source domains have been deemed culture-specific or low culture-specific domains.
7.1.4 Levels of cultural specificity of the source domains in the A&A English subcorpus

As discussed in Chapter 5.1.3, researchers argue that there are universal metaphors and culture specific metaphors. However, the term “culture-specific” refers to a fuzzy concept and there are no set criteria to distinguish clearly between what is culture specific and what is not. There are several studies that deal with culture specific metaphors but how culture specificity is defined is not always explicitly addressed in the literature, and the concept of “culture” is presented as given (see, for instance, the concept of “cultural model” in Lee (2006) and the concept of “cross-cultural variation” in Musolff (2016).

Bearing these conceptual issues in mind, the qualitative analysis in what follows will focus only on non-controversial culture specific domains. Applying Newmark’s (1988:94) definition of culture as “a way of life and its manifestations that are peculiar to a community that uses a particular language as its means of expression”, the following source domains are defined as either “culture-specific” or “culturally-bound” which is a term used when the pilot study was published (Merakchi and Rogers, 2013).

The culture-specific source domains presented in Table 7.4 above are put into three groups according to whether they are established culture specific domains or at the borderline of culture specificity or not culture specific. The presentation within the same group follows alphabetical order and does not denote any hierarchy inside the group. There is no reason to say that the source domain MYTHICAL AND FANTASTIC CHARACTERS is more culture-specific than the source domain ARTS, for example. Such detailed judgments are likely to be difficult to make with any clear justification.

The non-controversial culture-specific source domains in the A&A English subcorpus are deemed to be:

- ARTS and its subdomains: DANCE, MUSIC and PERFORMANCE: These are instantiated by linguistic metaphors such as ‘conga’, ‘puppeteers’, ‘Slam dancing’, and ‘Stradivarius’.

- CLOTH AND FABRIC: This source domain is instantiated in linguistic metaphors such as ‘filaments’, ‘fabric’, ‘pockets’, ‘blanket’, ‘carpet’, and ‘cloak’.
- FOOD, COOKING AND HEATING: This source domain is instantiated by linguistic metaphors such as ‘cauldron’, ‘crustal’, ‘oven’ and ‘swallow’.

- MYTHICAL AND FANTASTIC CHARACTERS: this source domain is instantiated by linguistic metaphors such as ‘Behemoth’, ‘Pied Piper’, and ‘Methuselah’.

- RELIGION AND FAITH: This source domain is instantiated by linguistic metaphors such as ‘doomed’, ‘fate’, and ‘Requiem’.

- SPORTS AND GAMES: This source domain is instantiated by linguistic metaphors such as ‘billiard ball’, ‘dollhouse’, ‘roller-coaster’ and ‘Russian dolls’.

Source domains in the A&A English subcorpus are at the borderline between culture specificity and no culture specificity.

- ARCHITECTURE: This source domain is instantiated by linguistic metaphors such as ‘architecture’, ‘gate’, ‘pillars’, ‘structure’ and ‘walls’.

- HUMAN BEINGS: This source domain is instantiated by linguistic metaphors such as ‘act’, ‘behave’, ‘feel’, ‘fingernail’, ‘leg’, ‘lips’, ‘take the rap for’, and ‘toe’.

- HUNTING: This source domain is instantiated by linguistic metaphors such as ‘hunting’, ‘pray’ and ‘stalking.

- JOURNEY: This source domain is instantiated by linguistic metaphors such as ‘arrivals’, ‘return’, ‘retinue’, ‘train’, and ‘travel’.

- POWER AND CONFLICT: This source domain is instantiated by linguistic metaphors such as ‘attacking’, ‘guided missile’, ‘tortured’, and ‘vengeance’.

The following source domains are deemed to be not culture specific:

- ANIMAL KINGDOM: This source domain is instantiated by linguistic metaphors such as ‘breed’, ‘cobweb’, ‘condor’, ‘flying’, ‘fully-fledged’ and ‘zoo’.

- BIOLOGICAL ENTITIES AND PROCESSES: This source domain is instantiated by linguistic metaphors such as ‘embryonic’, ‘embryos’, ‘gestation’, and ‘reproduce’.

- CONTAINER: This source domain is instantiated by linguistic metaphors such as ‘bubble’, ‘fill’, ‘reservoir’ and ‘wrapped’.

- LIQUID: This source domain is instantiated by linguistic metaphors such as ‘drop’, ‘flow’, ‘ripple’ and ‘liquid’.

- MACHINE AND MECHANICAL PROCESSES: This source domain is instantiated by linguistic metaphors such as ‘computers’, ‘processing’, and ‘sports utilities’, ‘vehicles’.
- MOTION AND DIRECTIONALITY: This source domain is instantiated by linguistic metaphors such as ‘outgoing’, ‘rolling down’, and ‘stagnate’.

- PHYSICAL OBJECTS: This source domain is instantiated by linguistic metaphors such as ‘material’, ‘mirror’, ‘minuscule’ and ‘paper’.

- TERRESTRIAL ATMOSPHERE AND LOCATIONS: This source domain is instantiated by linguistic metaphors such as, ‘agglomeration’, ‘home’, ‘fog’, ‘reside’, ‘thundercloud’, and ‘windy’.

- VEGETAL KINGDOM: This source domain instantiated by linguistic metaphors such as ‘bottlebrush flower’, ‘growth’, ‘plow’, and ‘seed’.

The source domain labelled VARIOUS is instantiated by linguistic metaphors that are unclassified and hence, is not included in the categorization. This category is instantiated by linguistic metaphors ‘bejewelled’, ‘cartographers’, ‘coin’, ‘conveyors’, ‘jewels’ ‘miniature’, ‘miniaturized’, ‘ornament’, ‘rings’, ‘sculptor’, ‘sculpts’, ‘waxes’, and ‘yield’.

To this point, the analysis has revealed that linguistic metaphors fulfilling different functions in the A&A English subcorpus instantiate various source domains with different levels of cultural specificity. Pedagogical metaphors instantiate more frequently culture-specific source domains than generic and terminological linguistic metaphors (as shown in Table 7.4). The analysis also shows that generic and terminological metaphors instantiating culture-specific source domain display a low level of lexical variation, as represented by the TTR.

As mentioned earlier, pedagogical metaphors embedded in culture-specific source domains are retained for further analysis given their variation and, hence, the additional challenge they might pose in translation. Now that the range of the source domains has been discussed and related to the distribution of the three metaphor functions selected here, we can move beyond linguistic metaphors to a consideration of conceptual metaphors, preparing the ground for translation analysis in Chapter 8.

However, before starting to discuss the conceptual metaphors underlying culture-specific pedagogical metaphors, the issue of metaphor signalling in the A&A English subcorpus should be addressed’. As already evoked in Chapter 3.4, the metaphor signalling pattern may differ between the ST and the TT. The basis for this assumption is the potential role the signals could play in explicitating the metaphor.
7.1.5 Metaphor signalling in the A&A English subcorpus

Metaphor signalling is reported to be a key feature of popular science texts compared to other genres such as research articles (genre-specific) or to other registers, such as conversation and fiction (Gentner, 1982; Goatly, 2011; Skorczynska Sznajder and Piqué, 2004; 2005; Skorczynska Sznajder and Ahrens, 2015).

Bearing in mind the importance of metaphor signalling in popular science texts and its potential for metaphor translation analysis as already discussed in Chapter 3.4, this section reports firstly on the metaphor signals identified in the A&A English subcorpus, then moves to the analysis of metaphor signalling across different metaphor functions. The question related to possible shifts in the signalling pattern between the ST and the TT will be answered in Chapter 8.

7.1.5.1 Direct and indirect metaphors in the A&A English subcorpus

The identification of direct metaphors in digital corpora is often made automatically by concordancing the metaphor signals listed in Goatly (2011:185-186) as seen in Chapter 6. Given that the analysis in the present study was conducted manually at the first stage, additional metaphor signals could be identified in the A&A English subcorpus: ‘so-called,’ ‘known as’, ‘dubbed,’ ‘named,’ ‘so called,’ ‘labelled’, and ‘do the same’ (highlighted in green in Table 7.5 below).

Table 7.5 below shows the identified metaphor signals, and their frequency in the A&A corpus including the additional signals that are not listed in Goatly (2011) (highlighted in green in Table 7.5 below). At this point, no distinction is made between the functionality of the linguistic metaphors (pedagogical, terminological and generic).

<table>
<thead>
<tr>
<th>Metaphor signal</th>
<th>$f$</th>
<th>like</th>
<th>31</th>
<th>called</th>
<th>16</th>
<th>so-called</th>
<th>13</th>
<th>known as</th>
<th>12</th>
<th>thought of</th>
<th>5</th>
<th>represent</th>
<th>2</th>
<th>analogous</th>
<th>3</th>
<th>somehow</th>
<th>2</th>
<th>similar</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>as</td>
<td>41</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>==</td>
<td>34</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

16 This dichotomy (direct vs. indirect metaphors) is used by Steen et al., (2010b). It is also used in the present chapter although some direct metaphors are not signalled as seen in Chapter 6.
<table>
<thead>
<tr>
<th>Term</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>literally</td>
<td>2</td>
</tr>
<tr>
<td>kind of</td>
<td>2</td>
</tr>
<tr>
<td>just as</td>
<td>2</td>
</tr>
<tr>
<td>imagine</td>
<td>2</td>
</tr>
<tr>
<td>dubbed</td>
<td>2</td>
</tr>
<tr>
<td>named</td>
<td>2</td>
</tr>
<tr>
<td>So called</td>
<td>2</td>
</tr>
<tr>
<td>analogy</td>
<td>2</td>
</tr>
<tr>
<td>analogies</td>
<td>2</td>
</tr>
<tr>
<td>just as</td>
<td>2</td>
</tr>
<tr>
<td>think of</td>
<td>1</td>
</tr>
<tr>
<td>Think</td>
<td>1</td>
</tr>
<tr>
<td>such as</td>
<td>1</td>
</tr>
<tr>
<td>somewhat</td>
<td>1</td>
</tr>
<tr>
<td>so to speak</td>
<td>1</td>
</tr>
<tr>
<td>resembling</td>
<td>1</td>
</tr>
<tr>
<td>resembled</td>
<td>1</td>
</tr>
<tr>
<td>much as</td>
<td>1</td>
</tr>
<tr>
<td>looks like</td>
<td>1</td>
</tr>
<tr>
<td>likely</td>
<td>1</td>
</tr>
<tr>
<td>labelled</td>
<td>1</td>
</tr>
<tr>
<td>just</td>
<td>1</td>
</tr>
<tr>
<td>is called</td>
<td>1</td>
</tr>
<tr>
<td>in terms of</td>
<td>1</td>
</tr>
<tr>
<td>consider</td>
<td>1</td>
</tr>
<tr>
<td>comparable</td>
<td>1</td>
</tr>
<tr>
<td>calls</td>
<td>1</td>
</tr>
<tr>
<td>as though</td>
<td>1</td>
</tr>
<tr>
<td>as small as</td>
<td>1</td>
</tr>
<tr>
<td>are called</td>
<td>1</td>
</tr>
<tr>
<td>analogue</td>
<td>1</td>
</tr>
<tr>
<td>Akin</td>
<td>1</td>
</tr>
<tr>
<td>to put it in</td>
<td>1</td>
</tr>
<tr>
<td>another way</td>
<td>1</td>
</tr>
<tr>
<td>Think</td>
<td>1</td>
</tr>
<tr>
<td>suppose</td>
<td>1</td>
</tr>
<tr>
<td>imagine</td>
<td>1</td>
</tr>
<tr>
<td>consider</td>
<td>1</td>
</tr>
<tr>
<td>compare</td>
<td>1</td>
</tr>
<tr>
<td>same (do, the)</td>
<td>1</td>
</tr>
<tr>
<td>54</td>
<td>217</td>
</tr>
</tbody>
</table>
Table 7.5 above shows that the metaphor signal ‘as’ is the most frequently used in the A&A English subcorpus, with ‘like’ ranking in third place. This is broadly consistent with the findings from previous studies where the copular similes (‘as’ and ‘like’) are found to be the most common metaphor signals. However, the use of the metaphor signal “inverted commas” (‘”’) - ranked second - is remarkably unusual compared to other studies (Goatly 1997, Skorzynska Sznajder and Piqué 2005, Skorzynska Sznajder 2010, Skorzynska and Ahrens 2015). The metaphor signal “inverted commas” indicates either a terminological metaphor or a pedagogical metaphor introduced somewhere else (“metaphors of someone else” as Skorzynska Sznajder and Ahrens (2015) express it).

The additional signals identified in the A&A English subcorpus are ‘called’ (fourth position), ‘so-called’ (fifth position) and its typographic variation ‘so called’ (28th position), ‘dubbed’ (19th position) and ‘named’ (31st position). All four additional signals (ignoring the typographical variation) are found to signal almost exclusively terminological metaphors as discussed in the following section.

Despite the wide variety of metaphor signals used in the A&A English subcorpus, direct metaphors are less frequent compared to indirect metaphors. Only 28% of linguistic metaphors are signalled (direct) (1079/3798) compared to 72% of metaphors that are not signalled (indirect) (2932/3798) as shown in Figure 7.1 below.
Despite the prevalence of indirect metaphors, the use of direct metaphors in the A&A English subcorpus remains higher compared to other studies such as Herrmann (2013) who reported that direct metaphors accounted for only 0.1% of the total number of metaphors identified in her corpus of scientific discourse (all genres included).

Having established the frequency of direct and indirect linguistic metaphors in the English source texts, we can now move on to explore potential relationships between the metaphor type (direct or indirect) and the metaphor function (pedagogical, terminological and generic) as the use of metaphor signals has been noted to vary across the metaphor functions.

7.1.5.2 Metaphor signalling across metaphor functions

The analysis of the present English subcorpus indicates that pedagogical metaphors are more frequently signalled than terminological and generic metaphors. Figure 7.2 below shows that 11 out of 1079 (1%) direct metaphors are generic metaphors, 35 out of 1079 (3%) direct metaphors are terminological metaphors and 1033 out of 1079 (96%) direct metaphors are pedagogical metaphors.

Figure 7.1 Percentages of direct metaphors vs. indirect metaphors in the A&A English subcorpus

![Figure 7.1 Percentages of direct metaphors vs. indirect metaphors in the A&A English subcorpus](image.png)
Generic metaphors are the least signalled in the A&A English subcorpus (1% of the total direct metaphors) which can be explained by the lexicalised, not to say the dead nature of the generic metaphor. An example of a signalled generic metaphor is provided below.

3. But in the myriad tracks they [particles] leave, physicists will seek evidence of the fleeting plasma. It’s not like looking for a needle in a haystack. It’s more like staring at a haystack and trying to figure out if there is a needle inside. (file3340183).

The metaphorical expression ‘look for a needle in a haystack’ is a common expression in the English language used to describe a difficult search. In example 3, the search for evidence of the colliding particles by analysing the tracks they leave is not only as difficult as the search for a needle in a haystack but worse.

In example 3, the generic metaphor ‘looking for a needle in a haystack’ is used as a basis for comparison where the level of difficulty of finding the evidence exceeds the level of difficulty metaphorically expressed by the expression “look for a needle in a haystack”. The function of the signal “like” is, hence, not to make the mapping between the target domain of the search for evidence and the source domain of the search for a needle explicit but as an intermediary to introduce a new mapping. The new mapping is a pedagogical metaphor ‘staring at a haystack and trying to figure out if there is a needle inside’ based on an image that is already known to the reader.

Generic metaphors and terminological are argued to be the less signalled. However, while generic metaphors are less signalled due to their degree of familiarity that restricts their
possible interpretations, terminological metaphors are less signalled for different reasons which are explained as follows.

Terminological metaphors are less signalled because they are used to define a specialised concept (“filling a lexical gap” using Goatly’s (1997) terms) and/or describe new scientific models (“theory-constitutive” in Boyd’s (1993) terminology). Therefore, they tend to be conventionalised and no metaphor signal is required to draw the reader’s attention to the potential mappings between the metaphor source and target domains. They are “closed metaphors” in Knudsen’s (2003) terms as seen in. They are, however, “reopened,” i.e. signalled, when the writer feels the need to tell the reader that they are drawing on a term used by specialists as seen in Chapter 3.4. This interpretation is highly probable given that terminological metaphors are signalled mainly by the signals ‘called’ (10/35), ‘so-called’ (7/35), ‘known as’ (6/35), ‘dubbed’ (4/35), ‘so called’ (2/35) and ‘named’ (1/35) and ‘known as’ (see table 9.5 above). Terminological metaphors are signalled by inverted commas only four times (4/35).

These same signals are also used in the corpus to introduce A&A specialised terms. For instance, the signal ‘called’ occurs 59 times in the A&A English subcorpus. In 10 cases, the signal ‘called’ is followed by a terminological metaphor and, in 49 cases, is followed by an A&A specialised term that is not metaphorical. It is worth mentioning that Table 7.5 seen earlier in this Chapter gives the frequencies for these signals when they are followed only by a linguistic metaphor and does not provide information about the overall use of the signals in the A&A subcorpus.

Example 4 below illustrates an instance where the signal ‘so-called’ is followed by a terminological metaphor ‘dark energy’. Unlike the other metaphor signals in Goatly’s list that serve to highlight the mapping between the source and target domains, the signal ‘so called’ seems to indicate only that the linguistic metaphor ‘dark energy’ is a codified term.

4. Only in 1998 did astronomers discover we had been missing nearly three quarters of the contents of the universe, the so-called dark energy—an unknown form of energy that surrounds each of us, tugging at us ever so slightly, holding the fate of the cosmos in its grip, but to which we are almost totally blind (file3145756).

The remaining linguistic metaphors in example 5 above are all pedagogical. Their occurrence after a terminological metaphor seems to serve the purpose of explaining the terminological metaphor “dark energy” to the reader.
Signalling pedagogical metaphors, however, highlights the mapping between the source domain and target domain as illustrated by example 5 below.

5. Because particles nearer to the planet move at a higher speed than do particles farther out, collisions hold back the inner particles which then fall toward the planet and push forward the outer ones which then move away from the planet. But the spreading takes time, and in this regard, a ring may be thought of as a viscous fluid that slowly diffuses inward and outward (file3165082).

In example 5 above, the movement of the particles in a ‘ring’ is mapped onto the movement of a viscous fluid where the particles spread slowly following an inward, forward pattern in a similar fashion to a viscous liquid. This cross-domain mapping is introduced by the linguistic signal “thought of as”.

When pedagogical metaphors are signalled, the mapping between the source and target domains of the conceptual metaphor are made explicit, hence, limiting the possible interpretations of the metaphor.

This section has shed light on the use of metaphor signals in the A&A English subcorpus and revealed clear differences in the metaphor signalling across functions. We return to the issue of metaphor signalling, this time from a translation perspective, i.e. tracking possible shifts in signalling patterns, in Chapter 8.

7.1.6 Conclusion
The main findings in the A&A English subcorpus are summarised as follows.

Pedagogical metaphors are found to prevail in terms of frequency in the data compared to terminological and generic metaphors. In addition, pedagogical metaphors are found to be used across a larger number of source domains with different degrees of cultural specificity.

Terminological and pedagogical metaphors are often found together, this is because pedagogical metaphors often explain terminological metaphors that are highly codified and perhaps obscure in meaning to the reader. Furthermore, generic metaphors are found to interact, though less often given their low frequency, with pedagogical or terminological metaphors. This interaction leads to the concentration of a number of metaphors in the same segment of the text (example 4 for instance), a phenomenon called “metaphor clustering” (Cameron, 2003). Metaphor clustering will be further discussed in Section 7.2 as it is connected to metaphor translation to be discussed in Chapter 8.
Furthermore, metaphor signalling is found to vary across metaphor functions. Generic metaphors are rarely signalled as they are lexicalised metaphors. Their metaphorical meaning is known to the reader which limits the possible interpretations of the metaphors. Terminological metaphors are signalled only to draw the reader's attention to their codified nature. Pedagogical metaphors are signalled by a wider range of metaphor signals. The fact that they are more frequently signalled than the generic and terminological metaphors is consistent with the wider range of signals found to mark them. When used with a pedagogical metaphor, the signal makes evident the cross-mapping between the source and target domain of the conceptual metaphor.

Whilst this section has provided an overview of the findings in the A&A English subcorpus, Section 7.2 will focus on pedagogical metaphors embedded in culture-specific source domains.

7.2 Culture-specific pedagogical metaphors: further analysis

Pedagogical metaphors are embedded in a wide range of source domains that vary in their degree of cultural specificity. As seen in Section 1.1.1 and Section 0, the source domains judged to belong to the most culture-specific domains are, in order of frequency for all metaphor functions, ARTS – and its subdomains MUSIC, DANCE and PERFORMANCE –; MYTHICAL AND FANTASTIC CHARACTERS; SPORTS AND GAMES; FOOD, COOKING AND HEATING; CLOTH AND FABRIC; and RELIGION AND FAITH.

In this section, each of these 6 domains and 3 subdomains will be analysed and presented separately. For each source domain, its related conceptual metaphors and linguistic metaphors are presented. Illustrative examples are given to show how a conceptual metaphor is instantiated by a linguistic metaphor. In addition, examples are given to illustrate both direct and indirect metaphors, metaphors in clusters and metaphors occurring alone.

Table 7.6 below shows the number of the conceptual metaphors and linguistic metaphors with a pedagogical function identified for each culture-specific source domain (or sub-domain in the case of ARTS). The full list of conceptual metaphors and linguistic metaphors embodying these culture-specific metaphors is found in Appendix 4.
Table 7.6. Number of culture-specific CMs and LMs in the A&A English subcorpus in order of frequency for all metaphor functions

<table>
<thead>
<tr>
<th>Source domains and their subdomains</th>
<th>CMs (f)</th>
<th>LM (f)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ARTS</td>
<td></td>
<td>63</td>
</tr>
<tr>
<td>ARTS-MUSIC</td>
<td>2</td>
<td>45</td>
</tr>
<tr>
<td>ARTS-DANCE</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td>ARTS- PERFORMANCE</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>MYTHICAL AND FANTASTIC CHARACTERS</td>
<td></td>
<td>33</td>
</tr>
<tr>
<td>SPORTS AND GAMES</td>
<td>6</td>
<td>63</td>
</tr>
<tr>
<td>COOKING, HEATING AND FOOD</td>
<td>3</td>
<td>58</td>
</tr>
<tr>
<td>CLOTH AND FABRIC</td>
<td>4</td>
<td>36</td>
</tr>
<tr>
<td>RELIGION AND FAITH</td>
<td>5</td>
<td>17</td>
</tr>
<tr>
<td>TOTAL</td>
<td>25</td>
<td>270</td>
</tr>
</tbody>
</table>

7.2.1 ART

The source domain ART is statistically one of the largest culture-specific source domains exploited to explain A&A concepts in the A&A English subcorpus. In order to show a detailed picture of how the source domain ART is used in the A&A English subcorpus, it has been further divided into three subdomains which are MUSIC, DANCE and PERFORMANCE.

7.2.1.1 MUSIC

The source subdomain MUSIC is a fertile source domain in astronomy and astrophysics that underlies a number of metaphors that have established themselves in the field. This is namely the case for the linguistic metaphor ‘string’ (a terminological metaphor) in the string theory made popular by Greene (1999) in his bestseller *The Elegant Universe*. Green (1999:135) explicitly acknowledges the power of musical metaphors in explaining the evolution of the universe.

*Music has long since provided the metaphors of choice for those puzzling over questions of cosmic concern.* From the ancient Pythagorean “music of the spheres” to the “harmonies of nature” that have guided inquiry through the ages, we have collectively sought the song of nature in the gentle wanderings of celestial bodies and the riotous fulminations of subatomic particles. *With the discovery of superstring theory, musical metaphors take on a startling reality,* for the theory suggests that the microscopic landscape is suffused with tiny strings whose vibrational patterns orchestrate the evolution of the cosmos. (Greene 1999: 135, emphasis added)

Greene’s statement illustrates the power of metaphors in the A&A field. It might also be understood from Greene’s statement that scientists are aware of the role metaphors play as a pedagogical tool. However, the use of metaphors can be double-edged: on one side, it adds
clarity as seen so far; on the other hand, it can add ambiguity if the source domain is highly specific or unusual as it is the case for some musical metaphors found in the A&A English subcorpus.

The subdomain MUSIC can be found in two conceptual metaphors in the A&A English subcorpus. They are in order of presentation; COSMIC ENTITIES ARE MUSIC LISTENERS/PLAYERS, and COSMIC ENTITIES ARE MUSICAL INSTRUMENTS.

7.2.1.1.1 COSMIC ENTITIES ARE MUSIC LISTENERS/PLAYERS

The conceptual metaphor COSMIC ENTITIES ARE MUSIC LISTENERS/PLAYERS is instantiated by different linguistic metaphors, direct and indirect, as illustrated further down. This conceptual metaphor is used to illustrate and explain various phenomena related to the age, composition, and geometry of the universe. See, for instance, example 6 below, where it is argued that the data collected by researchers (from the Wilkinson Microwave Anisotropy Probe (WMAP) as explicitly mentioned earlier in the text), about the variations in the temperature of cosmic microwave background (CMB), allow them to estimate the age, composition and geometry of the universe in the same way a careful listener to musical notes can determine the construction of a musical instrument.

6. What is more, researchers have been able to use these data to precisely estimate the age, composition and geometry of the universe. The process is analogous to determining the construction of a musical instrument by carefully listening to its notes. But the cosmic symphony is produced by some very strange players and is accompanied by even stranger coincidences that cry out for explanation (file3148136).

The direct mapping between the source subdomain MUSIC and the target domain UNIVERSE is signalled using the metaphor signal ‘is analogous to’. The comparison is made as if the construction of a musical instrument is something that can be easily guessed. One might say that carefully listening to musical tones can lead to the identification of the musical instrument played (a guitar rather than a piano for instance). However, it is hard to believe that listening to the notes will lead to the identification of how the piano is constructed unless the metaphor is intended to highlight that such a task is difficult but not impossible.

It can be said that the musical metaphors used in the corpus display a high level of technical specificity which makes them potentially less successful in bridging the understanding between the author and the reader. Most of the instantiations of the conceptual metaphor COSMIC ENTITIES ARE MUSIC LISTENERS/PLAYERS metaphor are single-use metaphors in the
corpus. Furthermore, most of them also occur in a single text in the corpus entitled “The cosmic symphony” except for example 8 below which explicitly refers to the cosmic symphony text.

7. Matter steadily wrested control of the cosmos away from radiation. Several hundred thousand years after inflation, matter declared final victory and cut itself loose from radiation. This era and its dramatic coda have now been probed by high-precision observations of the fossil radiation, see The Cosmic Symphony, on page 44 (file 314256).

In example 7 above, the control of the cosmos by the matter following the inflation is compared to a dramatic symphony where the final movement (the coda) shows the victory of matter and its independence from radiation. In this example, there is a clustering of linguistic metaphors from different source domains: ARTS and its subdomain MUSIC (‘dramatic coda’) and SPORTS AND GAMES (‘declare final victory’ and ‘cut loose’). In example 4, the overall effect of this amalgamation of linguistic metaphors gives a bigger picture where the reader is seated at a concert listening to the cosmic symphony where the hero ‘matter’ wins the battle over its opponent ‘radiation’ in the final act (‘coda’).17

7.2.1.1.2 COSMIC ENTITIES ARE MUSICAL INSTRUMENTS

In example 9 the different frequencies of the sound waves in the early universe are compared to the overtones of a musical instrument, specifically, a violin. The author argues that overtones allow the distinction of an ordinary violin from a Stradivarius - an expensive violin reputed for the high quality of its tones and overtones - and similarly the oscillations of the sound waves allow cosmologists to elucidate the shape and the composition of the universe.

8. Overtones are what distinguish a Stradivarius from an ordinary violin; they add richness to the sound. The sound waves in the early universe are similar, except now we must imagine the waves oscillating in time instead of space. (file3148136)

The linguistic metaphor, in example 8 above, is signalled by the metaphor signal “similar”, which indicates that a cross-mapping analogy is put into place. Although the linguistic metaphor ‘strings’ is widely used to explain the String Theory in Astronomy and Astrophysics, examples 5 above shows how a linguistic metaphor from the conceptual domain MUSIC might not fulfil its pedagogical role because of its level of cultural-specificity. The Stradivarius is culture-specific to Western musical culture and could, therefore, lead to translation difficulties.

17In this example, the pedagogical function might go along with an aesthetic function which can ignite the old debate related to the role of the metaphor in science and its “prejudices”, as Amenda Shaffer (2004) puts it in her article ‘Science as Metaphor: Where does Brian Greene stand in the pantheon of physicists?’ http://www.slate.com/articles/arts/culturebox/2004/07/science_as_metaphor.html. [Last accessed 6/1/2017].
Example 9 below is a further evidence of the complexity of the metaphors belonging to the subdomain MUSIC in A&A.

9. The variation in the number of galaxies is a measure of the lumpiness of the galaxy distribution on a scale, in this case, of 40 million light-years. Cosmologists repeat the exercise with spheres of various radii to measure this lumpiness at different scales. An analogy is to express a complex sound regarding the contributions from sound wave of different wavelengths. A graphic equalizer on a home audio system can perform this function: it shows how loud the deep bass notes of very long wavelength are, how loud the treble of shorter wavelength is, and so on. In a live concert, a person with a musically trained ear can easily pick out the piccolo from the bassoon. Cosmologists do the same thing with the distribution of galaxies. The relative amount of structure on large and small scales is a powerful cosmological probe. (file 3161702).

The analogy in this example is built between the measurements of the number of galaxies based on the measurement of the lumpiness of the galaxy distribution in a similar way a person with a trained ear can distinguish the notes of the musical instrument, the piccolo from the notes of another similar instrument which is the from bassoon in a live music concert. A piccolo and a bassoon are wind instruments of different sizes. The first part of the analogy explains how difficult this task is as it includes distinguishing mixed short and long sound waves, a task that can be performed by a ‘graphic equalizer on a home sound audio’. The task seems to be challenging and requires a certain amount of training as indicated by the use of the expression “a person with a musically trained ear”. The level of difficulty in distinguishing the notes of two different but yet similar instruments (the piccolo and the bassoon) and distinguishing the distributional patterns in cosmology appear as the most explicit mapping for a non-specialist reader. Example 6 above mixes metaphors of high culture specificity (the various musical instruments referred to) as well as high-tech equipment such as a“graphic equalizer” and a “home sound audio” which might pose additional translation problems.

Metaphors belonging to the source subdomain of MUSIC used in the English Subcorpus were concentrated mostly in one text of the corpus. This fact indicates that the source subdomain MUSIC might be specific to the author rather than to the subject.

The source subdomain MUSIC displays a high level of culture-specificity. Linguistic metaphors instantiating this subdomain often occur in clusters and are generally signalled. The following section will focus on the conceptual metaphors and linguistic metaphors related to DANCE, another subdomain of the source domain ART.
7.2.1.2 DANCE

There are two conceptual metaphors related to the source subdomain DANCE in the A&A English subcorpus. These are STELLAR COLLISIONS ARE A DANCE, and COSMIC ENTITIES ARE DANCERS.

7.2.1.2.1 COSMIC ENTITIES COLLISIONS ARE A DANCE

The source subdomain DANCE metaphor seems to be mapped onto a specific object from the target domain COSMIC ENTITIES which are stars. It is used more specifically to describe the collision and the fusion of colliding stars as shown in examples 10 and 11 as follows.

10. It is a beautiful mating dance that ends in the perpetual union of the two stars (file 316176)

In example 10, the word ‘beautiful’ seems to preamble a romantic picture where two stars are mapped onto two partners dancing together. This romantic dance ends up in a union (the ‘perpetual union’). It is, however, disconcerting that this picture describes, in fact, a violent act where two stars smash into each other and fuse to become one bigger star (the perpetual union). The use of the linguistic expressions ‘beautiful’, ‘mating dance’, and ‘perpetual union’ tend to set the scene for romance that clashes with the violence of the smash up of the two stars.

The other possible interpretation could be that the ‘mating dance’ refers instead to the animal behaviour also known as ‘courtship’ where animals of opposite sex attract each other for reproduction (the ‘union’). Like the new-born that results from copulation, the union of the two stars results in the emergence of a new star.

The linguistic metaphor ‘mating dance’ occurs only once in the A&A English subcorpus and does not seem to be successful in conveying the meaning of the crash and fusion of two stars given its different possible interpretations. However, the linguistic metaphor ‘slam dancing’ in example 11 below seems to be more successful in conveying the meaning of the collision.

11. By 1970 it became clear that the answer to the second question was no. Nor could stellar slam dancing explain the narrow jets that emanate from the central powerhouse of many quasars (file 316764).

Example 11 illustrates a high specific type of dance where stars crash into each other’s in a similar fashion to an audience at rock concerts where the dancers hurl themselves at each other in a confined space (Merakchi and Rogers, 2013). The entailment between the source subdomain DANCE and the target domain COSMIC ENTITIES COLLISIONS is graspable. The
limited space, the high number of people and the randomness of movement and the inevitable crashing are all entailments that are put forward in this metaphor.

7.2.1.2.2 COSMIC ENTITIES ARE DANCERS
The conceptual metaphor COSMIC ENTITIES ARE DANCERS is used in the A&A English subcorpus to describe cosmic entities positioning and movement as illustrated in example 12 and 13 below. It could also be another underlying conceptual metaphor in examples 9 and 10 above where the dance is used for the crash/collision, and the crashing and the colliding bodies are the dancers.

Example 12 instantiates a metaphor cluster where direct and indirect metaphors embedded in different source domains are put up together. The dance metaphor is a direct one and is signalled by the metaphor signal “like”. In this cross-domain comparison, a stellar cluster is compared to a crowded dance floor where stars are compared to dancers lining up in a Conga dance (the immigrant stars).

The whole picture evokes a skilled (‘sharp eye’) detective (the satellite or the probe) searching for immigrants (stellar immigrants) among a population of natives (‘native star populations’). These immigrants let themselves to be caught by lining up like the dancers in the Conga. Even though the globular stellar cluster (‘dance floor’) is full of stars (‘crowded’), the ‘conga line’ (the ‘conga line’ itself is also named a ‘stream’ which is another metaphor) is the ‘lead’ to detect the immigrant stars.

12. Spotting stellar immigrants takes a sharp eye. In principle, they give themselves away by lining up in long streams, like a conga line on a crowded dance floor. Many streams lead back in a starry path to a globular star cluster or one of the Milky Way's satellite galaxies—presumably the original home of the stars in the stream or what is left of it. In practice, though, these streams are hard to find because they barely stand out against the relatively smoothly distributed native star populations. (file4226032).

The conceptual metaphor COSMIC ENTITIES ARE DANCERS is instantiated in example 13 below as a cross-domain mapping where the movement of two cosmic entities, a star and a planet is compared to the movement of twirling dancers.

13. The current leading approach [to find extrasolar planets] is the Doppler planet-detection technique, which involves analyzing wobbles in a star's motion. Here's how it works. An orbiting planet exerts a gravitational force on its host star, a force that yanks the star around in a circular or oval path— which mirrors in miniature the planet's orbit. Like two twirling dancers tugging each other in circles, the star's wobble reveals the presence of orbiting planets, even though we cannot see them directly. (file4226019)
When one of the dancers (the planet) tugs its partners (the star), the resulting circular movement momentarily hides the second dancer from sight. The presence of the second dancer (hidden from sight) is inferred from the twirling movement. Similarly, the wobbling of the stars indicates the presence of the planet that cannot be seen because planets do not emit light like stars and hence cannot be detected by the satellites and other probes used to observe the sky. Consequently, the researchers infer the presence of the planet from the “twirling” movement. The linguistic metaphor ‘twirling dancer’ occurred only once in the corpus and is hence considered as a novel metaphor.

Now that the subject discussed has covered MUSIC and DANCE subdomains, we move on to discuss the last subdomain of the ART SD which is PERFORMANCE.

7.2.1.3 PERFORMANCE
Cosmic entities are described in the A&A English subcorpus as either actors performing different shows such as the ‘puppeteers’ or the ‘ringmasters’ or as spectators of different cosmic shows such as the ‘fireworks’.

7.2.1.3.1 COSMIC ENTITIES ARE PERFORMERS
Cosmic entities are portrayed in the A&A English subcorpus as performers of different shows as instantiated by the linguistic metaphor “puppeteers” in example 14 below.

14. The satellites Cordelia and Ophelia keep Uranus’s ring corralled. Saturn’s F ring appears to be herded by Prometheus and Pandora. To be sure, most of the visible gaps and narrow ringlets remain unexplained. Perhaps they are manipulated by moons too small to see with present technology. The Cassini orbiter may be able to spy some of the hidden puppeteers (file408257)

In this example, metaphors from different source domains of different level of culture specificity cluster together. The linguistic metaphors ‘corralled’ and ‘herded’ instantiate the source domain ANIMAL KINGDOM; the linguistic metaphor ‘manipulated’ and ‘spy’ instantiate the source subdomain MORAL ATTRIBUTES of the source domain HUMAN BEINGS; the linguistic metaphors ‘ringlets’ instantiates the subdomain PHYSICAL ATTRIBUTE of the source domain HUMAN BEINGS; the linguistic metaphor ‘puppeteers’ instantiates the subdomain PERFORMANCE of the domain ART which is examined here. The conceptual metaphor COSMIC ENTITIES ARE PERFORMERS maps the target domain of COSMIC OBJECTS into the source domain of PERFORMANCE where the moons are compared.
to the puppeteers, the rings (a terminological metaphor referring to the disks orbiting planet Uranus) are the puppets and the Cassini orbiter (an unmanned spacecraft) is a spectator trying to unveil the puppeteers (moons) responsible for the movement of the puppets (the rings). As a puppeteer in a show can be visible or invisible to the audience, the use of the attribute ‘hidden’ limits the possible interpretations of the metaphor as it implicitly refers to the moons being too small to be seen. The trait highlighted, then, is the invisibility of the moon (the ‘puppeteer’) that makes the puppets (rings) move (also expressed by the linguistic metaphor ‘manipulated’).

The different actors play in different acts of the same big shows which are the cosmic events as explained below.

7.2.1.3.2 COSMIC ENTITIES ARE ACTORS IN SHOWS

If the cosmic entities are performers, then events taking place in the universe are the plays and the shows where they perform. In example 15 below, for instance, a potential collision between the sun and another star is described in terms of a ‘fireworks show’.

15. Of all the ways for life on Earth to end, the collision of sun and another star might well be the most dramatic If the incoming projectile were a white dwarf--a superdense star that packs the mass of the sun into a body a hundredth the size--the residents of Earth would be treated to quite a fireworks show (file318597).

In this metaphor cluster, the collision of a white dwarf (a terminological metaphor) with the sun is explained using linguistic metaphors belonging to different source domains. The linguistic metaphor ‘projectile’ instantiate the subdomain VIOLENCE of the domain POWER AND CONFLICT; the linguistic metaphors ‘packs’ and ‘body’ instantiate the source domain PHYSICAL ATTRIBUTE; the linguistic metaphor ‘fireworks show’ instantiates the source subdomain PERFORMANCE. The lights and perhaps colours are the most obvious features highlighted in this cross-domain mapping between the collision and the fireworks show. There might also be a loud noise resulting from this unfortunate encounter between the sun and the white dwarf, but the scene is perhaps too far for the noise to reach human ears.

Now that the subject discussed has covered the three subdomains of the source domain ARTS, we are moving into the discussion of the linguistic and conceptual metaphors of the source domain MYTHICAL AND FANTASTIC CHARACTERS which is another fertile source domain in the A&A subcorpus.
7.2.2 MYTHICAL AND FANTASTIC CHARACTERS

The scientific discourse of Astronomy and Astrophysics shows that the source domain MYTHICAL AND FANTASTIC CHARACTERS has often motivated the creation of terminology in the field since ancient times. Arabs, who were great amateur students of the sky and its mysteries gave stars and other cosmic objects various names denoting their imagery ranging from soft and gentle images such as Eridanus, to beasts and monsters such as Draco (the two hyenas) and Perseus (head of the ogre) (Al-Khalili, 2010). English also reflects this wonderment with the stars and the sky although the metaphors might not be the same; for instance, metaphors such as ‘brown dwarfs’, ‘white dwarf’, and ‘Methuselah stars’, to cite only a few, are found in the A&A English subcorpus.

This section describes, in detail, the conceptual metaphors related to the source domain MYTHICAL AND FANTASTIC CHARACTERS.

7.2.3 COSMIC ENTITIES ARE MYTHICAL AND FANTASTIC CHARACTERS

The source domain MYTHICAL AND FANTASTIC CHARACTERS underlies a number of terms related to A&A. It is, hence, not surprising that popular science texts of A&A are populated with various myths and fantastic creatures such as ‘monsters’, ‘giants’, ‘beasts’, ‘behemoths’ with attributes such as ‘ferocity’ and ‘voracity’ as described in the following examples.

16. Even those found at the centers of many galaxies, supermassive black holes--whose very name connotes a voracious monster that rules its galactic roost--are minuscule by cosmic standards. (file3145798).

In example 16, the target domain COSMIC ENTITIES is embodied in the linguistic metaphor ‘supermassive black hole’. This target domain is mapped onto the source domain MYTHICAL AND FANTASTIC CHARACTERS instantiated by the linguistic metaphors ‘monster’ and ‘voracious’. Thus, the conceptual metaphor is COSMIC ENTITIES ARE MYTHICAL AND FANTASTIC CHARACTERS. The attribute ‘voracious’ accentuates the greedy traits of a monster. The monster in question is probably of a bird type because it has a ‘roost’ over which it ‘rules’. It is worth mentioning that the linguistic metaphor ‘rules’ embodies another source domain which is POWER AND CONFLICT. Thus, this example also shows a metaphor cluster where linguistic metaphors from different source domain cluster together.

What supermassive black holes have in common with monsters is their gigantic size and a huge appetite: a supermassive black hole absorbs any matter coming close to it, in the same way, a
monster feasts on his prey. This second feature, the huge appetite, is emphasised using the verb “devour” and the adjective ‘greedily’ in example 17 and the verb ‘feast’ in example 18 below.

17. In many galaxies where black holes devour material greedily--generating a phenomenon that astronomers call an active galactic nucleus AGN--stars form at a precipitous rate in episodes known as starbursts. (file3145798).

18. The neutron star or black hole proceeds to feast on its ensnared prey, spewing x-rays (file4226081).

A black hole also mimics the behaviour of the monster who hides waiting for his prey to come closer as expressed by the linguistic metaphor “lurks” in example 19 below.

19. Imagine this technician traveling to the center of our Milky Way galaxy, wherein lurks a massive black hole Sagittarius A Sgr A, weighing as much as 4.5 million suns. (file3142991).

These monsters of space can be of a specific type such as the monster “behemoth” in example 20 below:

20. The black hole to be imaged is the behemoth in our backyard, Sgr A (file314298).

The ‘Behemoth’, is a monster from Jewish folklore characterised by a high strength and a huge appetite as described in the book of Job: “Look at Behemoth, which I made along with you and which feeds on grass like an ox. What strength it has in its loins, what power in the muscles of its belly! ” (Job: 40:15-16). Unlike the behemoth in the book of Job, black holes do not have loins and muscles but, yet, they are as robust and powerful. Their strength lies in their high gravity power that allows them to absorb any matter in their vicinity. The interior of the black hole resembles the belly of the behemoth and justifies the use of appetite-related words such as the adjective ‘voracious’ in example 16, ‘devour’ and ‘greedily’ in example 17 and ‘feasts’ in example 18 above.

The appetite is not the only mapping that is highlighted between the source domain MYTHICAL AND FANTASTIC CHARACTERS and the target domain COSMIC ENTITIES. The size feature is also highlighted, for instance, when the linguistic metaphor ‘giant’ is used as illustrated in example 21 below. It is worth mentioning that when ‘giant’ is an adjective, it falls within the generic function meaning ‘vast’. When ‘giant’ is used as a noun, it can be either a pedagogical or a terminological metaphor. For instance, a ‘red giant’ and a ‘white giant’ are terminological

metaphors for big red and big white stars respectively as opposed to ‘red dwarfs’ and ‘white dwarfs’ which are, respectively, small red and small white stars. The noun ‘giant’, but not the terminological metaphors ‘red giant’ or ‘white giant’, is a pedagogical metaphor and can refer to a big star as in example 21 below.

21. The giant, however, falls apart, although its core remains intact and becomes another white dwarf (file 3161364).

The linguistic metaphor ‘monster’ and those linguistic metaphors related to its appetite and size seem to be established in the A&A field as they are commonly used in other corpora19. In the next example (22), the Pied Piper is a pedagogical linguistic metaphor describing a ‘red dwarf’ (in itself a terminological metaphor).

22. CELESTIAL PIED PIPER, the red dwarf star Gliese 710, will crash through the Oort cloud in 1.4 million years—reanimating dormant comets, luring many out of their orbits and hurling some toward the planets. (file3164347).

In a similar fashion to the mythical character who lured rats out of a town with his magical flute, the celestial Pied Piper lures dormant comets out of their orbits. The linguistic metaphor ‘dormant’ is another instantiation of the source domain MYTHICAL AND FANTASTIC CHARACTERS alluding to the Sleeping Beauty fairytale. However, the dormant comets are not awakened gently with a kiss but are brought back to life ‘reanimated’ (another linguistic metaphor) with a crash. The linguistic metaphor ‘Pied Piper’ is used only once in the corpus and can be said to be a creative metaphor. In example 22, we are in the presence of a metaphor clustering where two terminological metaphors ‘red dwarf’ and ‘Oort cloud’ are explained in terms of a juxtaposition of pedagogical metaphors ‘Pied Piper’, ‘dormant’, ‘reanimate’, ‘luring’, and ‘hurling’. The ‘red dwarf’ is the ‘Pied Piper’, the ‘Oort cloud’ is the town, and the comets are the rats. In this plot, there is no flute. Unlike the original story, the red dwarf ‘lures’ the comets with a crash and kicks them ‘hurling’ out of the town (the Oort cloud).

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19 A Google search for the collocation “black hole monsters” returned many results that confirm this point: such as the linguistic metaphors ‘monster’, ‘feeding’, ‘giant’, ‘hungry’, ‘chowing down’, and ‘dining habits’ in the example below:

**Monster Black Hole Caught Feeding On Clumpy, Cloudy ‘Rain’**

A giant, hungry black hole appears to be chowing down on cold, clumpy clouds at the center of a nearby galaxy, a new study finds. The black hole’s dining habits are shedding light on how black holes throughout the universe may grow (Choi, 2016) [http://www.space.com/33113-monster-black-hole-eats-clumpy-cloudy-rain.html] [Last accessed 06/12/2016].
The ‘red dwarf’, in this cosmic tragedy, plays both roles: the ‘Pied Piper’ and the ‘Prince Charming’. The elements from the two stories seem to be coherent in this context and the meaning graspable by the reader of the source text.

The Pied Piper coexists in the corpus with another fantastic and biblical character that is ‘Rip Van Twinkle’ in example 23 below, in reference to the age of stars.

23. Rip Van Twinkle the oldest stars have been growing younger. Several years ago the biggest story in cosmology was the age crisis. (file3142994).

‘Rip Van Twinkle’, a twist on ‘Rip Van Winkle’, a fantastic character from the Washington Irving story which also alludes to the English lullaby “Twinkle, twinkle little star”, is said to have slept for 20 years. He woke up to a changed world where his descendants had grown older than him (at the age where he fell asleep). The story also finds its origin in the Torah where one of the followers of the prophet Jeremiah was also reported to have fallen asleep for over 60 years and woken up to a different time where his fellows were all gone, and his descendants were older than him (Colavito, 2012).

The linguistic metaphor ‘Rip Van Twinkle’ is used in the corpus to illustrate what is described as the “discrepancy” in the age of the universe (Chaboyer, 2001), or what is called the “age crisis” (ibid.) in example 14. Some stars that were thought to be old were found to be younger than their “descendant” stars which are also described in the corpus using a different metaphor “children being older than their mothers.” (ibid.).

As in the biblical story, being older than its own descendants is perceived as a “crisis” for the universe. In view of this rocambolesque story, astronomers knew there ought to be some explanation. ‘Rip Van Twinkle’ appears then a powerful metaphor to explain the “unexplainable”.

The source domain MYTHICAL AND FANTASTIC CHARACTERS is exploited in the A&A English subcorpus to explain some phenomena that are hard to grasp either because of their degree of abstraction or because the phenomena described take place in remote places in space and only imagination can give shape to the fuzzy images captured by telescopes and probes.

The examples provided illustrate how myths are exploited in A&A to illustrate and explain some features of the cosmic entities and phenomena such as the size, the huge capacity to absorb matter and in solving some riddles in cosmology such as the age crisis. In a similar way, another source domain has been exploited in making ungraspable concepts graspable which is the source domain of SPORTS AND GAMES presented in the next section.
7.2.4 SPORTS AND GAMES

Sports metaphors have been widely investigated in the discourse of economics (Charteris-Black, 2004; Cudd, 2007; Rodriguez Marquez, 2010; Samaniego Fernandez, 2002, 2013b). Cudd (2007:57), for instance, highlights that the central feature of sports metaphors is “competition” which she defines as follows:

Competition describes a situation that determines a winner (and therefore the nonwinners, or losers), under commonly known criteria for winning (losing), and usually awards some prize or recognition. Sports are competitive by definition. They determine their winners by their constitutive rules; they are what Alfie Kohn calls structurally competitive because the whole point of their structure is to determine a single winner, or at least when to give up trying to select one and declare a tie. (Cudd, 2007:57)

Competition, as Cudd (2007) points out, is the very nature of sports. When competition is used as a source domain, it can refer to a situation where there is a ‘winner’, or highlight the following or breaking of a set of rules or cases of failure to declare a tie when the game is not conclusive. In the universe, the dominant aspect of the competition metaphor is that of a single, overwhelming winner as seen later in this section. In the universe, the cosmic entities, compete with each other’s for the limited resources for growth. Whoever gets the more resource, wins the game and continues to grow and dominates whereas the losers are doomed to disappear.

In the A&A English subcorpus, competition goes with domination which appears as a characteristic feature of the cosmic game. It looks like domination is the ultimate purpose in the sports and games of the universe: Each of the cosmic entities seeks domination as shown in the examples ‘galaxies dominate’, ‘gravity dominates’, the ‘universe is dominated by matter’, and ‘dark energy dominates’. The only forces that did not manage to “overwhelmingly dominate” are “cosmic expansion” and its opponents’ in the ‘tug-of-war’ game’ (as seen later). This declaration of tie has an important consequence: the universe is what it is today because if expansion had won, there would have been no filaments and voids in the fabric of space, only a spread-out matter.

The sports metaphors have different facets that can successfully apply to the target domain of A&A. As seen in what follows, there are seven conceptual metaphors identified in the A&A English subcorpus. Each of these conceptual metaphors highlights some of the facets of the source domain SPORTS AND GAMES.
7.2.4.1 COSMIC ENTITIES FORMATION IS A GAME

The conceptual metaphor COSMIC ENTITIES FORMATION IS A GAME is instantiated in the corpus using different linguistic metaphors. Example 24 below, shows metaphor cluster explaining the concept of galaxy formation referred to as ‘construction’, a linguistic metaphor from a different source domain which is ARCHITECTURE.

24. In this way, galaxy construction was a bottom-up process, like building a dollhouse out of Lego bricks. The alternative would have been a top-down process, in which you start with the dollhouse and smash it to make bricks. (file4076748).

The galaxy formation is explained in terms of a game of Legos bricks. The current galaxies are thought to be formed according to one of the following scenarios;

In the first scenario, there were low mass haloes containing small galaxies (the “Lego bricks”) that grouped together (‘building’) to form one big entity (the ‘dollhouse’).

In the second scenario, there was one big entity (the ‘dollhouse’) that was ‘smashed’ resulting in small galaxies (the ‘bricks’).

Furthermore, the conceptual metaphor COSMIC ENTITIES FORMATION IS A GAME is instantiated using an indirect metaphor “jigsaw puzzle” as illustrated in example 25 below.

25. The nebulae are dust clouds illuminated by starlight. Jets stream outward, culminating in the Herbig-Haro objects. The jigsaw puzzle of star formation was coming together. In active galaxies, disks are crucial to the formation of jets. But how does this process work for an embryonic star? An intriguing coincidence has provided a crucial clue. (file3340533).

This example shows a metaphor cluster grouping linguistic metaphors from different source domains: The linguistic metaphor ‘embryonic’ instantiates the source domain BIOLOGICAL ENTITIES AND PROCESSES; the linguistic metaphor ‘jets’ instantiates the source domain LIQUID; the linguistic metaphor ‘clue’ instantiates the source domain PHYSICAL OBJECTS. In this example, the formation of the cosmic entity ‘star’ is compared to a jigsaw puzzle where the elements entering in the formation of the star (the jets) are the pieces of the puzzle. Once all the pieces are positioned correctly, the whole picture (the star) is revealed.

7.2.4.2 COSMIC ENTITIES COLLISIONS ARE A GAME

In the A&A English subcorpus, the source domain SPORTS AND GAMES is not only used for the target domain of COSMIC ENTITIES but is also used with the target domain of COSMIC
EVENTS. The target domain COSMIC EVENTS I mapped into the source domain SPORTS AND GAMES, more specifically into different kinds of games such as the ‘demolition derby’ game in example 26 below.

26. Dense star clusters are a veritable demolition derby. Within these tight knots of stars, observers in recent years have discovered bodies that are forbidden by the principles of ordinary stellar evolution—but that are naturally explained as smashed-up stars (file 3161764).

The demolition derby is a popular American car sport defined by the Cambridge English dictionary as a “car race in which the drivers drive their cars into other cars intentionally, with the winner being the last car still able to move.”20 In the stellar demolition derby, the stars drive into each other; the winner will be a bright star whereas the other stars will be smashed up like the cars in the derby. The possibility of a crash is also due to the confinement in a small space which is the sporting arena for the cars and the “cluster” for the star. The derby metaphor highlights both the space confinement and the violent outcome (smashed up cars and smashed up stars). The popularity of this sport makes the metaphor graspable by the reader of the original English texts and provides further evidence of how successful the source domain SPORTS AND GAMES is in explaining A&A concepts.

Another element from the source domain SPORTS AND GAMES is used in the S&S English subcorpus which is the games of billiards instantiated by the direct linguistic metaphor ‘billiard balls’ in example 27 below.

27. Eventually, some of the superplanets might be gravitationally thrust inward, others outward, an unlucky few even ejected from the planetary system. Like balls ricocheting on a billiards table, the scattered giant planets might adopt extremely eccentric orbits, as we now observe for three of the new planets. Interestingly, this billiards model for eccentric planets shows that we should be able to detect the massive planets causing eccentric orbits—planets perhaps orbiting farther out than the planets we have detected thus far (file3340187).

The balls in the billiard ball are thrown by different players from different angles, and it is hard to know which comes from where when they are “ricocheting” on the billiard table. Similarly, the orbits of giant planets can be hard to predict (‘extremely eccentric’) as they are ‘thrust’ into different directions by the gravitational forces. The billiard metaphor can be a specific case of the conceptual metaphor COSMIC ENTITIES COLLISIONS ARE A GAME which is PLANETS

ORBITING COLLISIONS ARE A BILLIARDS GAME. This conceptual metaphor is seen as a ‘model’ that can allow the detection of “the massive planets causing eccentric orbits”. If so, the instantiations of this conceptual metaphor are not only pedagogical but theory constitutive in Boyd’s (1993) terms.

7.2.4.3 THE UNIVERSE IS A GAME/SPORT WHERE COSMIC ENTITIES ARE PLAYERS

As stated earlier, one of the important aspects of the source domain SPORTS AND GAMES that is often highlighted in the A&A English subcorpus is competition as illustrated in example 28 below.

28. The clean division of bodies into planets and nonplanets reveals important aspects of the process that formed the solar system. All these bodies grew from a flattened disk of gas and dust orbiting the primordial sun. In the competition for the limited amount of raw material, some bodies won out. Their growth became self-reinforcing, so instead of a continuous spectrum of bodies of all sizes, the result was a single large body that dominated each orbital zone (file 3161704).

In this example, there are many linguistic metaphors from different source domains clustering together: The linguistic metaphors ‘competition’, ‘won out’ and ‘dominated’ instantiate the source domain SPORTS AND GAMES; the linguistic metaphors ‘bodies’, ‘body’, and ‘material’ instantiate the source domain PHYSICAL OBJECTS; the linguistic metaphor ‘grew’ instantiating the source domain VEGETAL KINGDOM; the linguistic metaphor ‘row’ instantiate the source domain COOKING, HEATING AND FOOD; and the linguistic metaphor ‘self-reinforcing’ instantiating the source domain POWER AND CONFLICT. The different bodies (the cosmic entities) compete for the ‘raw material’ (gas and dust) to grow. As a result of the competition, some cosmic entities grew bigger which is expressed using the linguistic metaphors ‘won out’, ‘dominated’ from the source domain SPORTS AND GAMES.

In a similar fashion, competition is declared between expansion and other phenomena affecting their gravity as illustrated in example 29 below.

29. The filaments and voids are not coherent bodies like, say, a planet. They have not detached from the overall cosmic expansion and established their own internal equilibrium of forces. Rather they are features shaped by the competition between cosmic expansion and any phenomenon affecting it and their own gravity. In our universe, neither player in this tug-of-war is overwhelmingly dominant. If dark energy were stronger, expansion would have won and matter would be spread out rather than concentrated in filaments. (file3145756).
In this metaphor cluster, all metaphors belong to the same source domain SPORTS AND GAMES. There are ‘competition’ between the cosmic entities ‘dark energy’ and ‘expansion’. The test of strength against each other is expressed using the linguistic metaphor ‘tug-of-war’. In this game (the tug-of-war), none of the competitors won. The scenario where dark energy would have been stronger would have resulted in its victory over dark matter.

### 7.2.5.4. COSMIC ENTITIES ARE TOYS

The conceptual metaphor COSMIC ENTITIES ARE TOYS can be seen as a special case of the conceptual metaphor COSMIC ENTITIES ARE SPORTS/GAMES. The source domain TOYS is used to some cosmic phenomena such as the imbrication of cosmic entities in each other as shown in example 30 below. In this example, a set of Russian dolls from the source domain TOYS is mapped onto specific elements from the target domain COSMIC ENTITIES which is the ‘magnetosphere’ or the ‘magnetic domain’. The magnetic sphere of Ganymede (itself a terminological metaphor), which is one of Jupiter’s moons, is embedded into Jupiter’s magnetic sphere which in turn is embedded in the sun’s magnetic sphere in the same way Russian dolls are imbricated into each other.

30. Like a set of nested Russian dolls, Ganymede has a magnetosphere contained within Jupiter’s huge magnetic domain, which in turn is embedded in the sun’s (file 3161700).

The next conceptual metaphor belonging to the source domain SPORTS AND GAMES to be discussed in what follows is also a specific case of the conceptual metaphor COSMIC ENTITIES ARE SPORTS/GAMES.

### 7.2.4.4 COSMIC ENTITIES GROUPING IS A SPORTS LEAGUE

The conceptual metaphor COSMIC ENTITIES GROUPING IS A SPORTS LEAGUE is used only once in the A&A English subcorpus and is instantiated by the linguistic metaphor “league”, as shown in example 31 below.

31. The result is striking: the planets are in a different league from the asteroids and KBOs, and Pluto is clearly a KBO. Such arguments persuaded the IAU to define a planet in terms of “clearing” its orbital neighborhood. (file 3208776).

In this example, the source domain SPORTS AND GAMES is mapped onto the target domain COSMIC ENTITIES: Planets form a different group of players distinct from the group of asteroids and KBO. Pluto being a KBO is hence excluded from the planets league. This conceptual metaphor highlights not only the divergence (belonging to different groups) but
also the competition feature. Pluto is competing to enter the Planet league (the whole argument is about Pluto's classification into a planet or not).

7.2.4.5 COSMIC ENTITIES FLUCTUATION IS A ROLLER COASTER RIDE

The conceptual metaphor COSMIC ENTITIES FLUCTUATION IS A ROLLER COASTER RIDE occurs in one text of the A&A English subcorpus. It was first used in the title of one of the articles composing the A&A English subcorpus ‘cosmic roller coaster ride’ in example 32 below and developed as the text unfolded. This conceptual metaphor is used mainly to explain a terminological metaphor which is the ‘inflation field’ as illustrated in example 33. The acceleration of the universe expansion is mapped onto the speeding up of the coaster on its journey uphill, and the deceleration is mapped onto the sharp trip downhill.

32 The great cosmic roller coaster ride (file 3142985).

33. The scalar field that drove inflation-, dubbed the "inflation field", evidently caused the expansion to accelerate for a long period before switching off abruptly. The dynamics were like the first moments of a roller-coaster ride. The coaster initially climbs slowly along a gentle hill. "Slowly" is a relative term; the process was still very fast in human terms. Then comes the breathtaking plunge during which potential energy is converted to kinetic energy (file 3142985).

The roller coaster metaphor has been exploited to describe fluctuating emotions (Keysar and Glucksberg, 1992) and is not found in any other corpus to be mapped onto the target domain of COSMIC ENTITIES. Consequently, it is considered as a novel and creative metaphor that highlights the fluctuation in the states of the matter that causes the expansion to ‘accelerates’ before ‘switching off abruptly’. The ‘acceleration’ and the ‘abrupt switch off’ which are linguistic metaphors from different source domains are then explained in terms of the two-step movement of the roller coaster belonging to the source domain SPORTS AND GAMES. The roller coaster starts climbing slowing and then accelerates when it goes downhill (expressed using the linguistic metaphor ‘breath-taking plunge’ which yet embodies a different source domain).

However, it is not clear whether the ‘switching off’ corresponds to the slow motion uphill or to the final stage where the roller-coaster stops. As long as the text unfolds, it becomes clear that only the first part of the roller-coaster metaphor works to describe the ‘expansion’ as explained in example 34 below.

34. To be more specific, physicists are checking whether string theory predicts a scalar field with two properties. First, its potential energy must be large, positive and roughly constant, so as to drive
inflation with vigor. Second, this potential energy must be able to convert abruptly into kinetic energy—the exhilarating rollercoaster plunge at the end of inflation. (file3342843).

The expansion corresponds to the second step in the roller coaster game which is the downhill movement ‘the exhilarating rollercoaster plunge’ whereas the first step corresponds more to the train when it is static rather than to the uphill movement of the roller coasters a shown in example 35 below.

35. The energy profile more resembled a train sitting on level ground than a slowly climbing roller coaster. (file3342843).

In this example, the initial linguistic metaphor ‘roller coaster’ embodying the source domain SPORTS AND GAMES is modified as the text narrative develops. The author explicitly acknowledges that the use of the conceptual metaphor COSMIC ENTITIES FLUCTUATION IS A ROLLER-COASTER RIDE to explain the energy fluctuation (also described by the linguistic metaphor ‘energy profile’ instantiating a different source domain) is not accurate. It was used as an argument at the beginning of the narrative structure and again as a counter-argument as the narrative progresses. It was modified later to become COSMIC ENTITIES ACCELERATION IS A ROLLER COASTER GOING UPHILL.

A new conceptual metaphor is introduced to explain the deceleration of the expansion which is an element of the target domain COSMIC ENTITIES. This conceptual metaphor is THE DECELERATION OF THE EXPANSION IS A TRAIN SITTING ON GROUND LEVEL. This conceptual metaphor is instantiated by the linguistic metaphors ‘train’, ‘sitting’, ‘level’, ‘ground’ in example 35 above.

Example 35 above shows the final stage of the development of the roller coaster metaphor where the mapping between the source domain ROLLER COASTER RIDE and the target domain COSMIC ENERGY FLUCTUATION is explicitly altered. The mapping between the fluctuation of the energy and the roller coaster movement does not highlight the movement up and the movement down as it is originally understood (from example 33). It rather highlights the movement up the hill and the initial stage where the train is on the ground floor.

The conceptual metaphor COSMIC ENTITIES FLUCTUATION IS A ROLLER COASTER RIDE has been used in a unique way in the A&A English subcorpus to explain a complex phenomenon known as the ‘energy profile’.
7.2.4.6 COSMIC ENTITIES ARE A CONSOLATION PRIZE

The conceptual metaphor COSMIC ENTITIES ARE A CONSOLATION PRIZE is another special case of the conceptual metaphor COSMIC ENTITIES ARE SPORTS/GAMES instantiated by the linguistic metaphor ‘consolation prize’, in example 36 below. The linguistic metaphor ‘consolation prize’ occurs in a metaphor cluster grouping linguistic metaphors from different source domains. It is a direct metaphor introduced by the signal “kind of”. It is a pedagogical metaphor explaining a terminological metaphor that is the ‘scalar field’. The metaphor is further explained by another cross-domain mapping where perceiving the scalar fields is compared to perceiving the altitude in an airplane ride (not highlighted in example 36 below as linguistic metaphors instantiating this mapping belongs to a different source domain).

36. The good news is that string theory predicts no shortage of scalar fields. Such fields are a kind of consolation prize for creatures such as ourselves who are stuck in three dimensions: although we cannot peer into the extra dimensions, we perceive them indirectly as scalar fields. The situation is analogous to taking an airplane ride with all the window shades lowered. You cannot see the third dimension (altitude), but you can feel its effects when your ears pop. The change in pressure (a scalar field) is an indirect way of perceiving the dimension. (file3342843).

The source domain of SPORTS AND GAMES is mapped onto the target domain of COSMIC ENTITIES where the element ‘scalar field’ belonging to the target domain is described as the reward of human beings (‘creatures like ourselves’) who fails to perceive the multidimensions of the universe and can only guess their precedence (‘feel its effects’) thanks to the ‘scalar fields’ (the ‘consolation prize’).

This section has discussed all the conceptual metaphors related to the source domain SPORTS AND GAMES and illustrated some of the linguistic metaphors embodying them. In what follows, the conceptual and linguistic metaphors of the source domain COOKING, HEATING AND FOOD are discussed.

7.2.5 COOKING, HEATING AND FOOD

In this section, conceptual and linguistic metaphors related to the source domain COOKING, HEATING AND FOOD are discussed. This source domain group together three domains are blended together into one source domain given some inferential connexion noticed in the corpus. For instance, stars are food that is cooked in a cauldron or in an oven. The notion of heat is implied as the source of energy that makes the cooking possible.

In the A&A English subcorpus, cooking and food references are easily spotted as metaphorical. However, heating expressions are not necessarily metaphorical since astronomical entities are
mostly gaseous objects and their temperature ranges from freezing to scorching (the sun is an example of an extremely hot cosmic entity). Examples 37 and 38, below illustrate some of the many instantiations of the heat metaphor.

7.2.5.1 COSMIC ENTITIES ARE FOOD

The CM COSMIC MATTER IS FOOD implies that cosmic entities are eaters as shown in the metaphor cluster in example 37 below where the ‘black hole’ is the ‘fed’ like a baby with ‘gas’ (food) by a “galaxy merger” (the mother or the carer).

36. The black hole at the center of such a galaxy acts as another damper on star formation. A galaxy merger feeds gas into the black hole, causing it to fire out jets that heat up gas in the system and prevent it from cooling to form new stars. Apparently, once star formation in massive galaxies shuts down, it does not start up again (file3145756)

However, cosmic entities do not only feed on the cosmic matter; they sometimes feed on other cosmic entities as illustrated in the metaphor cluster in example 38 below where the neutron star or the black hole ‘feasts’ on another neutron star. The image is no more of the innocent baby fed with care reflected in example 36 above but a terrifying image of some sort of cosmic cannibalism.

38. Normally a close encounter of two celestial bodies is symmetrical: they approach, gather speed, swing past each other and, unless they make contact, fly apart. But if one is a neutron star or a black hole, its intense gravity can contort the other, sapping some of its kinetic energy and preventing it from escaping, a process known as tidal capture. The neutron star or black hole proceeds to feast on its ensnared prey, spewing x-rays. (file3185975).

In this example, the mapping between the source domain COOKING, HEATING/FOOD and the target domain of COSMIC ENTITIES highlights different features: the size of the meal (huge), the special occasion on which it is served (the encounter) and some of the side effects of indulging in a lot of food which is the vomiting (‘spewing’). The cannibalism feature is made more evident by the use of the linguistic metaphor ‘ensnared’ where the neutron star or the black hole tricks his ‘brother’ during the encounter and make it impossible for it to escape, hence the use of the linguistic metaphor ‘prey’. This latter can also be seen as an instantiation of another source domain which is the ANIMAL KINGDOM.

The conceptual GALAXIES DISTRIBUTION IS SPRINKLED RAISIN is a direct metaphor instantiated by the linguistic metaphor ‘sprinkled’, ‘raisin’ and ‘muffin’ in example 39 below.

39. But galaxies are not randomly sprinkled like raisins in a muffin (file 3161702).
In this example, the galaxies are mapped onto the raisin and the universe into a muffin. The uneven distribution of the galaxies in the universe is mapped onto the act of shaking a small amount of the raisin (‘sprinkle’). However, the statement is negated (“are not”), meaning that galaxies distribution might be thought of as sprinkled raisins in a muffin, but this is not true. The author argues that there is some sort of coherence in the distribution of galaxies that astronomers call “galaxy clusters” (Strauss, 2004).

7.2.5.2 THE UNIVERSE IS A COOKING/HEATING DEVICE

The conceptual metaphor THE UNIVERSE IS A COOKING/HEATING DEVICE is instantiated by the linguistic metaphor ‘cauldron’ in example 40 below.

40. The early universe was a cauldron of star formation, but the formation rate soon peaked and began to drop (file3145756).

A cauldron is a “round metal container used for cooking over fire” as defined by the MEDA. However, it is not any round metal container; the MEDA points out that the cauldrons are “traditionally used by witches to mix things together for their magic spells”21.

In this metaphor, the “early universe” is the ‘cauldron’, and the witches are the “winds from the nearby supergiant stars”(Conselice, 2007). The magical ingredients are a mixture of gas, dust and ice.

The heat of the universe is described using various other linguistic metaphors such as the linguistic metaphor ‘furnace’ in example 41 below.

41. As this giant central nebula, the precursor of our sun collapsed in on itself, the temperature at its center soared, Eventually, the heat and pressure were enough to ignite the thermonuclear furnace that would make life possible and that will probably burn for another five billion years (file 3208778).

In this example, the heat and pressure that resulted from the disintegration of the “giant central nebula” have ‘ignited’ the ‘furnace’ that enabled life on Earth. This ‘furnace’ remained lit (‘burn’) for billions of years. The universe is mapped onto the furnace, and the resulting life is perceived as the cooked meal. The long burning time indicates that the meal (life) was cooked slowly over a long period of time.

7.2.5.3 COSMIC PROCESSES ARE COOKING

The conceptual metaphor COSMIC PROCESSES ARE COOKING is instantiated by the linguistic metaphors “stirred up” in example 41 below.

42. They found that the empty space around Io is anything but\(^{22}\). It seethes with subatomic particles blasted out by volcanic eruptions and stirred up by Jupiter's magnetic field. (file 3164347).

In this indirect metaphor, Jupiter’s magnetic field is introducing a circular movement that resembles that of food stirred in a saucepan. Jupiter’s magnetic field is mapped onto the cook; the subatomic particles are mapped onto the food being mixed and moved around in the cosmic ‘cauldron’.

7.2.6 CLOTH AND FABRIC

The last high cultural source domain to be discussed in this chapter is the metaphor CLOTH AND FABRIC. This source domain, like the source subdomain MUSIC, is an established source domain in A&A. This section discusses how this metaphor is represented in the A&A English subcorpus.

THE UNIVERSE IS A FABRIC

The conceptual metaphor THE UNIVERSE IS A FABRIC is a popular metaphor in Astronomy and Astrophysics and is widely used to discuss gravity. The metaphor became popular following the publication of Greene's (2004) bestseller The fabric of the cosmos. The target domain UNIVERSE is mapped onto a source domain FABRIC as in examples 43 and 44 below.

43. Three recent hypotheses suggest the range of possibilities, galactic black, hole accretion disks, gamma, ray bursts and topological defects in the fabric of the universe (file 314257).

44. The figures reveal two dramatic Great Walls containing thousands of galaxies each, as well as filaments and voids at all scales. (file 3161702).

The universe is seen as a big piece of cloth (fabric) that bends when things move on it. This fabric is made of ‘filaments’ and ‘voids’. The things that cause the bending are the planets and other cosmic entities. Warps resulting from the movement on the surface of the fabric are often metaphorically called ‘ripples’ as in example 45 below.

45. If the satellite has a tilted orbit, the result is a series of vertical bending waves, an out-of-plane corrugation-small ripples in a cosmic carpet. (file 3165082).

\(^{22}\) Sentence incomplete in the original text.
The linguistic metaphor ‘carpet’ can be seen as the instantiation of a specific case of the conceptual metaphor THE UNIVERSE IS A FABRIC which can be formulated as THE UNIVERSE IS A CARPET. The feature shared between the source domain and the target domain is that both the universe and the carpet are made of filaments. The warps are seen in terms of ‘ripples’, a metaphor that refers to a different source domain which is LIQUID meaning undulations on the water surface. The linguistic metaphor ‘carpet’ is a novel23 culture-specific pedagogical metaphor and if we consider that the ‘ripples’ are used in the common language to designate the small ‘waves’ that occur on the carpet when it is not nicely fitted and sometimes after cleaning (also called wrinkles), then it can be argued that the whole “image” of carpet rippling is transferred into the target domain of COSMIC ENTITIES to designate gravitational oscillations.

In example 46, the UNIVERSE IS A FABRIC conceptual metaphor is instantiated by the metaphor ‘filaments’. The filaments are “thread-like structures that form the boundaries between large voids in the universe” (Esomba, 2012 :288). They resemble the threads of the fabric. These threads are the beams in example 45 below that could ‘thread’ the solar system.

46. These amazing outflows traverse distances larger than galaxies, yet they originate near the black hole as intense beams collimated tightly enough that they could thread the solar system -- the eye of a galactic needle. (file3147368).

The solar system in example 46 is nicknamed the ‘eye of the needle’ which is also a metaphor from the source domain CLOTH AND FABRIC (needles are used to sew the fabric) based on a metonymical mapping where the shape of the solar system is mapped onto the form of the eye of the needle. The word ‘eye’ itself is metaphorically used in the linguistic metaphor ‘eye of a needle’, but the expression ‘eye of a needle’ in the context of example 46 above can only be interpreted as a mapping between the shape of the galaxy and the shape of the needle as it appears through telescopes. The ‘eye of the needle’ metaphor is popular in other contexts, mainly in a moral or a religious context in both Christianity and Islam where it has the meaning despite a slight variation in the context. The expression in Christianity is attributed to Jesus

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23 A google search for the collocation “cosmic carpet” retired two results: the expression “riding the cosmic carpet” which is the title of a short text about emotions felt at the death of a close friend. Within the text, the collocation occurs only once (“He was so tapped in – as if plugged into the power socket of life, his world was electrifying. Everything he did was experiential – it was as if we were riding a cosmic carpet through consciousness itself.”) (Stone, 2013) (https://www.voicedialogueconnection.com/reflecting-presence/cosmic-carpet/). [Last accessed 16/06/2017]. However, in this context, the linguistic metaphor ‘cosmic carpet’ is used in a broader sense and not necessarily relates to A&A.
“Again I tell you, it is easier for a camel to pass through the eye of a needle than for a rich man to enter the kingdom of God.” (Mathew: 24) The expression occurs in the Quran in verse 40 of the Surah 7, here below interpreted and translated into English by Arberry (1964):

Those that cry lies to Our signs and wax proud against them-the gates of heaven shall not be opened to them, nor shall they enter Paradise until the camel passes through the eye of the needle. Even so We recompense the sinners (Arberry, 1964:147).

In both religions, “a camel entering the eye of a needle” is a metaphor that refers to how unlikely something is to happen. In Christianity, it refers to a scant chance of a rich person entering a paradise (expressed metaphorically by the ‘kingdom of God’). In the Quran, it refers to the slim chance of a disbeliever entering heaven.

The ‘fabric’, the ‘filament’ and the ‘thread’ are established metaphorical expressions that instantiate the UNIVERSE IS A FABRIC conceptual metaphor in the A&A English subcorpus. However, one single-use metaphor instantiating this conceptual metaphor is also found in the corpus which is the linguistic metaphor ‘carpet’ in example 44 above.

7.2.7 RELIGION AND FAITH

There are two conceptual metaphors related to the source domain dubbed here RELIGION AND FAITH. The first one is COSMIC ENTITIES ARE RELIGIOUSLY BURIED/UNBURIED BODIES where cosmic entities are described as dead bodies buried in a shroud or having no Requiem.

The second conceptual metaphor THE UNIVERSE AND THE COSMIC ENTITIES ARE DIVINITIES is linked to the superpowers of the universe which are often described using linguistic metaphors such as ‘immortal’ and ‘eternal’ as seen in examples below.

7.2.7.1 COSMIC ENTITIES ARE RELIGIOUSLY BURIED/UNBURIED BODIES

Two examples illustrate the use of religious metaphors in the corpus. These are the expression ‘requiem’ in example 46 and ‘shroud’ in example 47 below.

47. No Requiem Yet: The CMB may also provide crucial new evidence that could explain what happened during the very first moments after the big bang. Few aspects of cosmology are more bizarre than the period of inflation (file314813).

A requiem is a “Christian ceremony in which people pray for someone who has died” as defined in the MEDA. It is a custom in Christianity and other religions to have a farewell

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ceremony before the burial of a deceased person. However, the requiem might or might not take place if the body is missing. The missing body is implied in example 46 where the lack of knowledge of what happened in the early universe is mapped onto the lack of a body to bury, hence, the feelings of uncertainty. Hence, the subject cannot be closed in the same way a requiem cannot take place without a body.

Another instantiation of the conceptual metaphor COSMIC ENTITIES ARE DEAD BODIES is found in example 48 below.

48. The first observational obstacle yielded in the late 1970s, when astronomers began to observe star-forming regions at wavelengths that penetrate the dust shroud (file 3147368)

In this example of the linguistic metaphor ‘shroud’ which refers to “a piece of cloth that is wrapped around a dead body before it is buried.”26, the dust is perceived as a piece of cloth in which dead stars are wrapped.

7.2.7.2 THE UNIVERSE IS A DIVINITY

The universe and some of its components namely dark energy are attributed superpowers in the A&A English subcorpus such as the use of the linguistic metaphor ‘invisible hand’ and ‘fate’ in example 49 below.

49. The universe's invisible hand Dark energy does more than hurry along the expansion of the universe. It also has a stranglehold on the shape and spacing of galaxies WHAT TOOK US SO LONG? Only in 998 did astronomers discover we had been missing nearly three quarters of the contents of the universe, the so-called dark energy--an unknown form of energy that surrounds each of us, tugging at us ever so slightly, holding the fate of the cosmos in its grip, but to which we are almost totally blind (file4076748).

Example 49 illustrates a metaphor cluster and a metaphor extension at the same time. It is a metaphor cluster because metaphors from different source domains interact in the same context (source domains HUMAN BEINGS; POWER AND CONFLICT; RELIGION AND FATE). It is also a metaphor extension because it is a development of a metaphor introduced earlier in the text instantiated by the linguistic metaphor ‘invisible hand’. Both linguistic metaphors ‘stranglehold’ and ‘grip’ can be seen as extensions of the metaphor ‘invisible hand’.

The linguistic metaphor ‘invisible hand’ also overlaps between two source domains; MYTHICAL AND FANTASTIC CHARACTERS on one side and RELIGION AND FAITH, on the other side. It illustrates how some linguistic metaphors are less easy to classify. The linguistic

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metaphor ‘invisible hand’ which is itself a metaphor built on another source domain which is HUMAN BEINGS PHYSICAL ATTRIBUTES (‘hand’) is popular nowadays as an economic model of Adam Smith. However, as explained by Kennedy (2009), Adam Smith used this metaphor originally in his “History of Astronomy” (Smith 1980, 95) referring to pagan and heathen superstitions about the existence of the Roman god, Jupiter”. The ‘invisible hand’ is used in the A&A English subcorpus as a reference to divinity. Dark matter is mapped onto a divinity that has the power over the shape and spacing of the galaxies (‘stranglehold’) and over mankind (‘tugging at us’) and holding the “fate” of the cosmos in his hand (‘grip’).

There are further instantiations of the conceptual metaphor UNIVERSE IS A DIVINITY in the A&A English subcorpus such as the use of the linguistic metaphors ‘eternal’ and ‘immortal’ in example 50 below.

50. This process, which I have called eternal inflation, keeps going as a chain reaction, producing a fractallike pattern of universes. In this scenario the universe as a whole is immortal. Each particular part of the universe may stem from a singularity somewhere in the past, and it may end up in a singularity somewhere in the future (file4185979).

In this metaphor cluster, the universe is again attributed divine properties which are ‘immortal’ and ‘eternal’.

7.2.8 Metaphor clustering and metaphor extension: Inevitable phenomena to include for an accurate description of metaphor in the A&A corpus

One of the aspects of metaphor that is often neglected in metaphor studies is how metaphors interact with each other in a particular context. Cameron (2003) points out that metaphors are not equally spread throughout texts or conversations. In some texts segments, a peak of metaphor can be found which is measured by “metaphor density” (the number of linguistic metaphors per 100 (Cameron and Low, 2004: 367). The researchers (ibid.) argue that “clusters may involve vehicle repetition, vehicle relexicalization, or a series of different vehicle-topic combinations”.

Metaphor clustering is not seen as a function per se but can indicate that something is taking place in a particular segment of the text. Cameron and Stelma (ibid.:108) argue that metaphor clustering “seems to have the potential to reveal something of the conceptualisation and thinking processes of speaker or writer, at points in talk or text where producers do something ‘out of the ordinary’ with metaphor.”
Metaphor clustering was not one of the research parameters from the beginning of this study. However, the analysis of the A&A English subcorpus has revealed that the linguistic metaphors often occur next to each other are pedagogical metaphors or generic metaphor used to explain terminological metaphors as seen earlier in Section 7.1.

A broad definition was adopted to include the metaphor clusters in the analysis given their potential in shedding light on metaphor translation especially since metaphor clusters have been neglected in metaphor and translation studies (Dorst, 2017; Shuttleworth, 2017). Whenever two or more metaphors occur together in the same clause or sentence, they are considered as a metaphor cluster.

In the present study, we distinguish between metaphor clustering and metaphor extension which are two phenomena that researchers often amalgamate. Semino’ (2008:25), for example, considers the extended metaphor as a special case of metaphor clustering “where several metaphorical expressions belonging to the same semantic field or evoking the same source domain are used in close proximity to one another in relation to the same topic, or to elements of the same target domain”.

Semino’s definition of “extension” applies only to metaphor clusters where all the metaphor in the cluster belongs to the same source domain. This is, for instance, the case for the ‘roller-coaster’ metaphor analysed earlier in Section 7.2.4.5. However, the concept of metaphor extension can also refer to cases where different metaphors belonging to different source domains cooccur in a given context. This case is covered by the concept of “métaphore filée” (elaborated metaphor) as defined by Riffaterre (1969).

Riffaterre (1969:47) defines the métaphore filée as a set of metaphors related to each other in different ways: by the syntax and by the meaning.
The main difference between the “métaphore filée” as defined by Riffaterre (1969) and the metaphor extension, seen as a special case of metaphor clustering by Semino (2008), is that the “métaphore filée” constitutes the development of a first metaphor and might or might not relate to the same source domains.

In addition, Riffaterre (1969) does not limit the occurrence of the linguistic metaphors into “close proximity” as Semino does. His definition also includes linguistic metaphors that co-occur within the same “narrative structure” meaning that an extended metaphor is a development of a metaphor that is introduced earlier. As seen in examples 34, 35 and 36 above, the ‘roller coaster’ metaphor is first presented in an early section of the text, then challenged at a later stage. The different instantiations of this metaphor did not occur in “close proximity” but at different places within the narrative structure (argument, counterargument). Despite their lack of immediate proximity, they are still held together by the same thread creating a “cohesive force” as Hallyn (1994) calls it.

The cohesive force referred to by Hallyn (1994) is similar to what Halliday and Hasan (1976:285) call “collocational cohesion”. Halliday and Hasan argue that there is “always the possibility of cohesion between any pair of lexical items which are in some way associated with each other in the language” (1976:285). The colloquial coherence does not result only from the use any pair of lexical units that occur in proximity to each other as explained by Halliday and Hassan (1976:285-286)

27 The roller coaster metaphor is first introduced in the title “the cosmic roller coaster ride”, then reproduced at the end of section 1 entitled “going for a ride”, the use of the “ride” metaphor as a subtitle makes the reader anticipates the “roller coaster” metaphor which occurs at the end of section 1 (example 34). The next occurrence of the “roller coaster” metaphor takes place in section 3 (example 35) and the last occurrence of this metaphor is located at the last section of the text (example 36). The metaphor seems to be first introduced (title and section 1), developed (section 3) and finally challenged (last section). This distribution cannot be described as “close proximity” and hence this metaphor cannot be seen as a metaphor cluster but rather as an extended metaphor.

28 the term “métaphore filée” itself is a metaphor that comes from the word “fil” (thread) that is woven through the text. The underlying conceptual metaphor could be METAPHOR DEVELOPMENT IS WEAVING.
The concept of “colloquial cohesion” seems to lend itself to the analysis of metaphor clusters, where different linguistic metaphors that are semantically related (belong to the same source domain) or not (belong to different source domains) co-occur in the same chunk of the text. The proximity in occurrence is not limited to the sentence level but can be extended to “long cohesive chains” (Halliday and Hasan 1976:286). When the metaphors in the cluster belong to different source domains, they are still related by their “referential function”, meaning that they are used as lexical substitutes for the same lexical item or by other connections such as the cause to effect. Consequently, they are “in some way associated” as Halliday and Hasan express it (1976:285).

The example below illustrates a case of metaphor clustering in a popular science text about Astronomy and Astrophysics (not included in the aligned A&A corpus).

51. Some galactic natives were indeed born in or pushed into peculiar orbits, but a surprisingly large number of the anomalies, including Arcturus, are genuine immigrants. A better metaphor than “immigrants” might be “kidnap victims” or “subject peoples,” because astronomers think these stars were born into smaller galaxies that the Milky Way then captured, plundered and assimilated. Over time our galaxy may have vanquished hundreds of its neighbors. Their former inhabitants now intermingle with the Milky Way’s indigenous population (file4226032).

In this example, the linguistic metaphors ‘natives’, ‘born’ and ‘genuine immigrants’ in the first sentence of the example are semantically related. Stars “born” in a given galaxy, are seen as ‘natives’. Stars that are pushed away into other galaxies are seen as ‘anomalies’. These ‘anomalies’ are better described as ‘genuine immigrants’ as opposed to the ‘natives’. The linguistic metaphors ‘natives’, ‘born’ and ‘genuine immigrations’ belong to the same source domain which is IMMIGRATION. The linguistic metaphor ‘anomalies’ belongs to a different source domain which is GENETICS.

In the second sentence, a different “metaphor” is introduced to explain further why stars in the same galaxy are different from each other (explained earlier by the ‘immigration’ metaphor). A new set of linguistic metaphors belonging to a different source domain is introduced. The linguistic metaphors ‘kidnap victims’, and ‘subject people’ are all linguistic metaphors instantiating the source domain VIOLENCE. A connexion between the IMMIGRATION metaphors and the VIOLENCE metaphor can be established in the example. Immigrant stars
did not voluntarily immigrate. Their immigration is a result of an act of violence where they were first ‘kidnapped’, ‘plundered’, and ‘captured’ then subjected to the rule of a different galaxy. An ‘assimilation process’ has followed and resulted in these stars to become ‘genuine immigrants’. ‘Assimilation’ is understood here as the “process of becoming part of a community or culture”\(^\text{29}\) (another metaphor from the source domain IMMIGRATION).

The metaphor cluster is extended to the third sentence where “our galaxy” is argued to have repeated this process of assimilating stars from other galaxies through acts of violence and occupation as indicated by the linguistic metaphor ‘vanquished’. “Our galaxy” then transforms the ‘former inhabitants’ of the ‘ripped apart’ galaxies into ‘streams’ of stars that ‘mix into’ the ‘indigenous populations’ of the Milky Way Galaxy (our galaxy).

In this example, the linguistic metaphors, flagged in red, belong to different source domains and occur in proximity to each other in a whole paragraph which is in line with Kimmel’s (2010) definition of “mixed metaphors”. A connection can be established between all the linguistic metaphors in this cluster despite the different source domains they belong to. It can be further argued that an internal connexion exists between metaphors of the same source domain (cohesive collocation by belonging to the same conceptual domain). In addition, the different source domains present in the cluster are connected to each other by a cause to effect relationship where IMMIGRATION is caused by VIOLENCE. Consequently, the linguistic metaphors in the cluster are connected to each other internally (metaphors in each source domain have a colloquial cohesive force) and across the source domains (by a cause to effect relationship) creating a bigger cohesive force.

All linguistic metaphors in this segment fulfil a pedagogical function where the political concept of immigration is widely explored to explain the heterogeneous nature of the stars in the Milky Way galaxy. The metaphor of immigration intertwined with the metaphor of violence expands in the same segment creating a cohesive force that might be lost if one or more metaphors are not transferred into the target language in the translation as it will be shown later in Chapter 8.

\(^{29}\) [http://www.macmillandictionary.com/dictionary/american/assimilation?q=assimilation. [Last accessed 02/06/2017].]
Further research is needed to find out how metaphor clusters are used in the A&A English subcorpus. In addition, a methodological tool to define the metaphor clusters is needed. Some researchers (Cameron, 2002; Cameron and Stelma, 2004; Cameron and Maslen, 2010; Koller, 2003) have developed methodological frameworks for the identification of metaphor clusters and can be used for future research to refine the methodology.

7.3 Conclusion

The analysis conducted so far has demonstrated the importance of metaphors in conveying meaning to non-specialised audiences and in explaining abstract sciences. Astronomy and Astrophysics cannot be explained without metaphor as they are “metaphor driven models” to communicate scientific insights to “appropriate audiences” as Happel argues (2002:34).

The use of linguistic and conceptual metaphors to communicate the insights of Astronomy and Astrophysics to “appropriate audiences” is also a hint at potential changes in the use of metaphors to suit different audiences. The main argument in the current study is the critical role of metaphors as conveyors of meaning in the act of communication between a specialist (the author) and a non-specialist audience (the reader). As seen so far, metaphors used in the original English texts are based on shared experiences between the author and her/his audience. Published in the United States, Scientific American has as a primary audience of English readers, hence the use of specific cultural elements such as the ‘demolition derby’.

The focus of the next chapter is to identify how these cultural elements embedded in the linguistic metaphors are represented in the Arabic translations of Scientific American. The purpose of the next chapter is twofold: to identify the conceptual and linguistic metaphors used in the Arabic translations and identify the translation strategies used to render culture-specific pedagogical metaphors.
Chapter 8. Conceptual and linguistic metaphors in the Arabic subcorpus: How are they translated?

The previous chapter provided evidence that pedagogical metaphors are often embedded in culture-specific source domains peculiar to the source language and culture. It is reasonable to assume that transferring these cultural elements into a different language/culture is a challenging task, requiring various strategies to handle the transition from the source to the target texts in order to suit certain expectations of the target audience.

This chapter aims to answer the third research question related to how the conceptual and linguistic metaphors identified in the A&A English subcorpus are dealt with in the translation subcorpus. It is composed of six sections. Section 8.1 explores, in greater depth, why highly culture specific metaphors are the focus of this chapter. Section 8.2 sets the framework for the analysis by showing how the methodology, outlined in Chapter 6, is operationalised to report the results of the analysis. Section 8.3 reports the results of the analysis of the translation of the linguistic metaphors and the culture-specific domains underlying them, previously identified in the A&A English subcorpus, as seen in Chapter 7. Section 8.4 reports on additional cases that are not accounted for in the applied framework and which constitutes a contribution of the current study. Section 8.6 presents a discussion and an interpretation of the results in the light of the research questions. Section 8.7 summarises the key points discussed in the current chapter.

8.1 Introduction

It has been argued in this study that linguistic and conceptual metaphors, especially those fulfilling a pedagogical function, are conveyors of meaning in the act of communication between a specialist (the author) and a non-specialist audience (the reader), i.e., in popular science articles. This is particularly the case given the use of culture-specific source domains in the original American English texts, as seen in Chapter 7. Complex abstracts are explained using highly familiar cultural concepts and artefacts, such as the source domain MYTHICAL AND FANTASTIC CHARACTERS instantiated by linguistic metaphors such as ‘monsters’ and ‘behemoths’; the source domain COOKING, HEATING AND FOOD instantiated by linguistic metaphors such as ‘pancake’, ‘doughnut’, and ‘pretzel’; and the source domain SPORTS AND
GAMES instantiated by linguistic metaphors such as ‘demolition derby’ and ‘baseball’, both being popular American sports. It is assumed that since the Arabic translations are addressed to a different readership, these metaphors might be accommodated to suit their expectations if the pedagogical function is to be retained in the TT.

The focus of the current chapter is to identify how the cultural elements embedded in these metaphors are rendered in the Arabic translations of Scientific American. As claimed by Dagut (1976:28) “what determines the translatability of a SL metaphor is not its "boldness" or "originality" but rather the extent to which the cultural experience and semantic association on which it draws are shared by speakers of the particular TL”. Hence, are culture-specific metaphors used in the popular science articles studied here “untranslatable”? Rey (2007), as seen earlier in Chapter 4, seems to hold contradictory views on how a culture-specific metaphor in popular science texts is translated. On the one hand, she claims that the metaphor function determines how it is translated, on the other hand, she joins Dagut (1976) in his claim that the degree of commonness between the two languages/cultures determines how the metaphor is translated.

In her study of cultural elements in popular science articles translated from English into French, she argues that the translation of cultural elements depends on their functions, which she identified as interactive and or cognitive (referential) as seen earlier in Chapter 4 (ibid.). She claims that when the cultural element in the popular science text (be it embedded in metaphor or not) is used to fulfil an interactive function, it is often suppressed in the translation. On the other hand, a cultural element which is used to fulfil a cognitive function is transferred into the target text.

However, Rey (2007:137) acknowledges that the distinction between the two functions is not set in stone. This is because the same metaphor can fulfil both an interactive and a cognitive function. Hence, she situates the translation problem at the TT reader end and to what extent the cultural reference can be recognised and interpreted by the receiver of the translation.

Les suppressions portent dans la plupart des cas sur des éléments associés à la culture des lecteurs du texte de départ, des éléments qui ont pour but d’introduire une note familière dans un texte qui peut être assez ardu. On peut évidemment objecter que l’introduction d’un élément de ce type dans un texte scientifique n’est jamais fortuite et qu’il y a toujours une fonction cognitive latente: les comparaisons, les métaphores, les exemples visent à déclencher des représentations et à aider le lecteur à “visualiser” un phénomène souvent abstrait.
Le problème est alors de déterminer jusqu’à quel point la référence culturelle peut être reconnue et interprétée par le récepteur de la traduction (Rey, 2007:137).

[Elements associated with the culture of the target text reader have been, in most cases, deleted. These elements aim to introduce a familiar note in a text that is already difficult. It may be objected that introducing an element of this type in a scientific text is not fortuitous, and that it has always a latent function; comparisons, metaphors and examples aim to trigger representations that help the reader “visualise” a phenomenon that is often abstract. The problem then, would be to determine to which extent the cultural reference is recognised and interpreted by the translation receiver.]

Bearing in mind these different views about how culture-specific metaphors are translated, this chapter aims to shed light on how this issue is addressed in the Arabic translations of English A&A popular texts. To answer this question, the translation candidates in the Arabic subcorpus were analysed to identify the translation solutions used to render ST linguistic metaphors, if at all, using the analysis frame described in what follows.

8.2 Identifying linguistic metaphors and underlying conceptual metaphors in the TT and setting the frame for translation analysis

As seen in the previous chapter, there are six culture-specific source domains identified in the English subcorpus to which 26 conceptual metaphors are related. The conceptual metaphors were identified as the last step of a bottom to top process where linguistic metaphors were first identified and marked up in the A&A English subcorpus. At a later stage, the identified linguistic metaphors were searched for in the parallel bilingual A&A corpus, then were analysed to check their metaphoricity as explained in Chapter 6. Table 8.1 below summarises the quantitative findings in the A&A bilingual corpus.

<table>
<thead>
<tr>
<th>Source domain</th>
<th>LM (/f) in the ST</th>
<th>LM (/f) in the TT(f)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ARTS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ARTS-MUSIC</td>
<td>45</td>
<td>40</td>
</tr>
<tr>
<td>ARTS-DANCE</td>
<td>12</td>
<td>7</td>
</tr>
<tr>
<td>ARTS- PERFORMANCE</td>
<td>6</td>
<td>16</td>
</tr>
<tr>
<td>MYTHICAL AND FANTASTIC CHARACTERS</td>
<td>33</td>
<td>22</td>
</tr>
<tr>
<td>SPORTS AND GAMES</td>
<td>63</td>
<td>58</td>
</tr>
<tr>
<td>COOKING, HEATING AND FOOD</td>
<td>58</td>
<td>22</td>
</tr>
</tbody>
</table>

30 At this stage, it is not yet known whether the proposed translations are metaphorical, non-metaphorical or if the translation does not render the metaphor at all. Thus, they are considered as “candidates”. The Term “candidate” is also used to avoid the fuzzy term “equivalent”.

The quantitative analysis shows a drop in the number of linguistic metaphors in the A&A corpus from 270 in the English subcorpus to 190 in the Arabic subcorpus which means that 80 linguistic metaphors that occurred in the English subcorpus have not been transferred into the TT. The reduction of the number of the metaphors in the TT is due to the replacement of the linguistic metaphors by non-metaphorical expressions (reduction to sense in Newmark’s terms) as well as to omission. These cases of non-transfer represent under one third (29.62%) of the linguistic metaphors fulfilling a pedagogical function and embedded in culture-specific source domains. The great majority of metaphors (70.38%) have travelled from English into Arabic despite their cultural specificity, but how well?

The identification of the conceptual metaphors in the TT is made following the method outlined in Chapter 6.3. When the same linguistic metaphor is used in the ST and the TT, the underlying conceptual metaphor is identified as the same. When a different linguistic metaphor is used in the TT, the conceptual metaphor identification procedure is applied.

As mentioned earlier in Chapter 4.4, the corpus is analysed unidirectionally. This, in general, means that only linguistic metaphors that travelled from the ST into the TT can be identified in the TT. However, as already outlined in Chapter 4.4, there are few cases highlighted in the analysis where metaphors in the TT are found where none exists in the ST. These cases are spotted because they occurred in the vicinity of other linguistic metaphors in the TT that were paired to metaphors identified in the ST. This is the case, for instance, for the linguistic metaphor ‘رقعة الشطرنج’ (chessboard) in example 1 below

1. ST These [linear features that cross cut Mercury’s face] lineaments are called the Mercurian grid. One explanation is that the crust solidified when the planet was rotating much faster (file3214935).

TT و يطلق على هذه السمات المميزة للكوكب اسم شبكة عطارد. وتخلص أحد التفسيرات لهذه السمات الشبيهة برقعة الشطرنج في ان القشرة تصلبت عند ما كان الكوكب يدور حول محوره بسرعة أكبر (file3340220).

BT These features characterising the planet are called the Mercury grid. One explanation of these features resembling a chessboard is that the crust solidified when the planet was rotating at a much higher speed.

In this example, the linguistic metaphor ‘رقعة الشطرنج’ (chessboard) was identified because it occurred in the same context as the linguistic metaphors ‘Mercurian grid’ and ‘crust’ which
were identified in the ST and, hence, matched to their equivalent expressions in the TT. Consequently, the statistics provided in this chapter regarding the use of this strategy are limited to these cases and don’t cover all instantiations of metaphors used in the TT where none are used in the ST.

The identification of the conceptual metaphor is done following the steps outlined in Chapter 6.3. For instance, in the example above, the first step consists of identifying the linguistic metaphor ‘رقعة الشطرنج’ (chessboard) (step 1) by applying the linguistic metaphor identification procedure outlined in Chapter 6.2.2. Here, the linguistic metaphor is identified as a direct metaphor because of the use of the metaphor signal ‘الشبهة’ (similar to). The function fulfilled by this metaphor is pedagogical as no metaphorical meaning for this word is provided in the general dictionary nor in the specialised dictionary. This linguistic metaphor belongs to the source domain SPORTS AND GAMES previously identified (Table 7.3) as one of the source domains used in the English A&A subcorpus (Step 2). The propositions to which this metaphor relates can be expressed as P1 (LINEAR FEATURES, MERCURY/COSMIC ENTITY), P2 (SIMILAR, CHESSBOARD) (Step 3). The activity here is \( F \) Linear Feature = CHESSBOARD/SPORTS AND GAMES, MERCURY/COSMIC ENTITY, CHESSBOARD/SPORTS AND GAMES, (Step 4). The cross-domain mapping, here, is the similarity between the crosscut linear features of the target domain MERCURY (a more general level of conceptualization is COSMIC ENTITY) and the source domain CHESSBOARD (SPORTS AND GAMES is the general level of conceptualization) (Step 5). The most difficult step is step 6 where the conceptual metaphor is formulated. In this case, it can be a specific conceptual metaphor MERCURY LINEAR FEATURES ARE A CHESSBOARD as well as a conceptual metaphor of a higher level of generalisation COSMIC ENTITIES ARE SPORTS AND GAMES. This latter formulation is retained because, as explained in Chapter 6.3, a general level is sought to accommodate a large number of linguistic metaphors belonging to the same conceptual domain, which in turn, allows comparison between the conceptual metaphors in the two different languages.

To find out how conceptual metaphors and their instantiations are dealt with in the Arabic subcorpus, the identified conceptual and linguistic metaphors belonging to the culture-specific source domains, identified earlier in Chapter 7, are analysed according to the framework of translation strategies presented in Chapter 4.5. These scenarios are presented in this chapter.
starting with cases where the metaphor is not transferred into the TT to reflect our working hypothesis that the deletion/suppression of the metaphor was expected to feature prominently given the narrowed focus on culture-specific pedagogical metaphors. These four scenarios outlined below serve as a framework for the analysis of the conceptual and linguistic metaphors in the A&A bilingual corpus.

In the first scenario, neither the conceptual nor the linguistic metaphor is transferred to the TT. This results from the use of one of the following strategies identified in the literature review and summarised in Merakchi and Rogers (2013) (See Table 4.1 in Section 4.5).

- Use of a non-metaphorical expression in the TT;
- Deletion of the passage containing the linguistic metaphor;
- Deletion of the linguistic metaphor within a sentence.

In the second scenario, a different conceptual metaphor is used in the ST and the TT. This case results from one of the following strategies:

- Use of a different conceptual metaphor and the same linguistic metaphor;
- Use of a different conceptual metaphor and a different linguistic metaphor.

In the third scenario, the same conceptual metaphor is used in the ST and the TT resulting from one of the following strategies:

- Use of the same linguistic metaphor is the ST and the TT;
- Use of the same linguistic metaphor in the ST and the TT, but the entailments between the source and target domains of the metaphor are different
- Use of an extended linguistic metaphor;
- Use of a different linguistic metaphor that can be either more generic or more culture specific to the TT.

In the fourth scenario, a conceptual metaphor is introduced in the TT instantiated by a linguistic metaphor used in the TT whereas none is used in the ST.

The next section presents each of the culture-specific source domains, and subdomains analysed following this framework of four scenarios.
8.3 Culture-specific metaphors in Arabic translations

This section presents culture-specific conceptual and linguistic metaphors with a pedagogical function based on the analysis of English STs, seen in Chapter 7, and discusses illustrative examples of how these metaphors are rendered in the TT, if at all.

Linguistic metaphors belonging to each of these culture-specific source domains are discussed with regard to whether the conceptual metaphor is retained or not in the translation (scenario 1), a different conceptual metaphor is used in the translation (scenario 2), the same conceptual metaphor is used in the translation (scenario 3), or a conceptual metaphor is introduced in the TT where none exists in the ST (scenario 4). The analysis, in this section, is conducted from a translation point of view. The signalling pattern of the metaphor is also analysed in this Section. It is mentioned only when there is a shift in the pattern between the ST and TT.

In this section, some of the examples already analysed in the ST are analysed here from the translation point of view. Th example in the ST is provided along with the translation and a back translation. For ease of reference, whenever the English part of the example was seen in Chapter 7, a cross reference is made to this example by stating its number in the previous Chapter. The analysis provided in this chapter does not include the analysis of the mapping between the metaphor source and target domains as this is done in the previous chapter unless there is a shift or a change in the translation.

The first source domain to be discussed is ARTS with its three subdomains MUSIC, DANCE and PERFORMANCE.

8.3.1 ARTS

As seen in the previous chapter, there are three source subdomains of ARTS. These are MUSIC to be discussed in Section 8.3.2.1.; DANCE to be discussed in Section 8.3.2.2 and PERFORMANCE to be discussed in Section 8.3.2.3.

8.3.1.1 MUSIC

The analysis of the linguistic metaphors instantiating the source subdomain MUSIC, in the previous chapter, revealed that it is a fertile subdomain in Astronomy and Astrophysics especially when it comes to explaining the phenomena of space and time. This section examines how the linguistic metaphors and their underlying conceptual metaphors related to the subdomain MUSIC are dealt with in the TT.
The first scenario where the conceptual metaphor is not transferred into the TT is discussed in Section 8.3.2.1.1. It is followed by a discussion of the second scenario where a different conceptual metaphor is used in the TT in Section 8.3.2.1.2. The third scenario where the same conceptual metaphor is used in the TT is discussed in Section 8.3.2.1.3. Illustrative examples are provided for the different strategies outlined earlier. Section 8.3.1.1.4 shows that no additional linguistic metaphor embodying the source subdomain MUSIC is found in the A&A corpus. A summary of the key points about how the source subdomain MUSIC feature in the TT is provided in Section 8.3.1.1.5.

8.3.1.1.1 NO CONCEPTUAL METAPHOR IN THE TT

Most of the linguistic metaphors instantiating the source subdomain MUSIC have been rendered in the TT, with the exception of the linguistic metaphor ‘coda’, i.e. the last part of a musical work, in example 2 below, which is rendered by a non-metaphorical expression. The musical piece, in this example, is most likely to be a symphony as the metaphor occurs in a text entitled the cosmic symphony. The literal rendition of the linguistic metaphor ‘coda’ might be explained by the degree of the culture-specificity of the symphony as a Western musical culture. The absence of the conceptual metaphor in the TT might not affect the meaning but results in a decrease of the overall musical scene that the author of the ST set up for the text and where the linguistic metaphors embodying the source subdomain MUSIC are recurrent and cluster in several places as will be discussed later in Section 8.4.

2. (Example7 in Chapter 7).

ST Matter steadily wrested control of the cosmos away from radiation. Several hundred thousand years after inflation, matter declared final victory and cut itself loose from radiation. This era and its dramatic coda have now been probed by high-precision observations of the fossil radiation. (file 314256).

TT وانتزعت المادة تدريجيًا السيطرة على الكون من الإشعاع. وبعد عدة مئات من آلاف السنين، عقب الانفجار الانفجاري، أعلنت المادة انتصارها النهائي وانفصلت عن الإشعاع وقد جرى سبر هذا العصر وقسمة الأخير المثير بوساطة الأرصاد العالمية للإشعاع الأحفوري. (file3188224)

BT And matter gradually took control over the universe from radiation. Several hundred thousand years after the exploding inflation, matter declared its final victory and separated from radiation. This era and its last interesting part were probed by high-precision observations of the fossil radiation.
8.3.1.1.2 DIFFERENT CONCEPTUAL METAPHOR IN THE TT

The use of a different conceptual metaphor has featured very low in the A&A corpus. Only one case where a different linguistic metaphor instantiating a different conceptual metaphor is identified in the A&A corpus, as illustrated in example 3 below:

3. New observations of the cosmic background radiation show that the early universe resounded with harmonious oscillations in the beginning (file31874)

In this example, the linguistic metaphor ‘resounded’, instantiating the source subdomain MUSIC in the ST, is replaced by the linguistic metaphor ‘تعج’ (swarmed with) in the TT instantiating a different source domain ANIMAL KINGDOM. Instead of a universe producing different sounds, the image in the TT is that of buzzing oscillations swarming in the universe. The universe is no more a symphony but probably a hive with bees buzzing all around. Despite the use of a different conceptual metaphor, it can be argued that conceptual equivalence is achieved because the buzzing hive shares both features which are the harmony and the continuity of the sound with the original linguistic and conceptual metaphor.

Another possible interpretation takes into account a more basic meaning of the linguistic metaphor تعج (crowded) where this word means “filled with people”. In this case, the oscillations are the crowd which, is an instantiation of a different source domain HUMAN BEINGS. In this case, the conceptual metaphor would be COSMIC ENTITIES ARE PEOPLE.

If this interpretation is retained, this linguistic metaphor and its underlying conceptual metaphor could not be argued to achieve a conceptual equivalence because the crowd lacks the harmony which is one of the mappings highlighted in the ST. The next section illustrates cases where the ST and the TT use the same conceptual and linguistic metaphors.

8.3.1.1.3 SAME CONCEPTUAL METAPHOR IN THE ST AND THE TT

Often, the linguistic metaphors instantiating the source subdomain MUSIC are the same in the ST and the TT (by “same” it is meant a direct equivalent/correspondent). However, the linguistic metaphors in the TT have, in many occasions, been extended. Example 4 below
illustrates a case where the linguistic metaphors ‘symphony’ and ‘players’ are rendered into the same linguistic metaphors in the TT.

4. But the cosmic symphony is produced by some very strange players and is accompanied by even stranger coincidences that cry out for explanation (file3148136)

In example 4 above, the linguistic metaphor ‘symphony’ is rendered into Arabic by a loan (as defined by Newmark, 1988:84). The word comes from the Greek sumphōnia and is transliterated according to the Greek pronunciation. The word has an entry in old and modern Arabic dictionaries. However, the linguistic metaphor ‘players’ is rendered by a more specific word عازفون (plural of عازف) (musical instrument player). The word عازف (musical instrument player or instrumentalist) is a dedicated word for players of musical instruments in the TT. This case can be interpreted as either as an extension (music player) or a use of a more specific word to translate a generic word. However, it is worth mentioning that this is not a case where a culture-specific linguistic metaphor from the TT replaces a culture-specific metaphor from the source text which is a different strategy discussed later in Chapter 8.4.

Example 5 below illustrates a direct metaphor where the sound waves from the early universes are mapped to overtones emanating from two different types of the violin: an ordinary violin and a Stradivarius, as seen in Chapter 7.2.1.1. In this example, the linguistic metaphor ‘ordinary violin’ is rendered by the same linguistic metaphors in the TT with an extension (addition of the word ‘instrument’ in the TT).

5. (example 8 in Chapter 7.2.1.)

And overtones are what distinguish a violin instrument of a Stradivarius (Stradivarius) type from an ordinary violin instrument as it adds richness and softness to the sound. The sound waves that
emanated at early stages of the universe creation are similar, but we should now imagine that the waves oscillate in time instead of place.

The linguistic metaphor ‘Stradivarius’ has known a different treatment. It has been rendered by the same linguistic metaphor ‘ستراديفاريوس’ (Stradivarius) in addition to an extension and gloss. This illustrates a different translation strategy where the same linguistic metaphor is extended and accompanied by a gloss as will be explained later when additional translation strategies identified in the A&A corpus are dealt with (Chapter 8.4).

In addition to these cases, there are also cases where the conceptual metaphor is the same but is instantiated by the use of a different linguistic metaphor in the TT. This is the case of the linguistic metaphor ‘tube’ rendered by the linguistic metaphor ‘مزمار’ (flute) in example 6 below.

6.

ST To return to our pipe analogy, consider the cacophony that would result from blowing into a pipe that has holes drilled randomly along its length.

TT ولو عدنا إلى تشبيهنا الذي استعنناه بالمزمار، لأمكننا تصور تنافر النغمات الذي يحدث نتيجة النفخ في مزمار يحوي ثقوباً جرى حفرها عشوائياً على طول المزمار.

BT And if we return to our analogy where we used the flute, we could imagine the discord of tones that happens as a result of blowing into a flute that has holes drilled randomly along the length of the flute.

In example 6, the linguistic metaphor ‘pipe’ is rendered by the linguistic metaphor ‘مزمار’ (flute). The two instruments ‘pipe’ and ‘flute’ are woodwind instruments and might look alike. However, they are not identical. The pipe can be seen as a simple version of the woodwind instrument whereas the ‘flute’ refers to the modern instrument that is more sophisticated (Baines and Boult, 1967). The direct equivalence of the ‘pipe’ in Arabic would be ناي (pipe)31. However, the two terms “مزمار” and “ناي” are used interchangably in the dictionary. Despite the difference between the two words, the linguistic metaphor ‘مزمار’ (flute) can be said to achieve a conceptual equivalence because the cross-mapping in example 6 above is based on a feature present in both instruments which is the holes drilled in each one.

These examples analysed so far, especially when the same linguistic metaphor is used in the target text with an extension or when a different linguistic metaphor is used to instantiate the

31 The English-Arabic dictionary provides the Arabic equivalent آلة نفخ موسيقية (blowing musical instrument) to the word pipe (http://www.almaany.com/en/dict/ar-en/piper/. [Last consulted 08/04/2017]. However, a search in the Arabic dictionary for each word “مزمار” and “ناي” allows the matching of the definition of each of these words to its correspondent English word. It should be highlighted that a search in the Arabic into English dictionary for the words “مزمار” returns both “flute” and “pipe”.

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same conceptual metaphor tend to indicate that the use of the same conceptual metaphor does not show necessarily common conceptualisations between the SL and the TT as it is often presented in the literature. The translation solutions used to render linguistic metaphors instantiating culture-specific source domains by using the same conceptual metaphors and the same linguistic metaphor which is extended or a different linguistic metaphor instantiating the same conceptual metaphor indicate that these metaphors are not easy to transfer and that their presence in the TT is a result of a conscious effort from the translator to reproduce them. This might also indicate a certain awareness of the role of pedagogical metaphors in explaining scientific concepts. This hypothesis is strengthened by the additional translation strategies identified in the A&A corpus where more than one strategy (couplets) is used to render the same linguistic metaphor as will be seen later in Chapter 8.4.

8.3.1.1.4 CONCEPTUAL METAPHOR IN THE TT WHEREAS NONE IS USED IN THE ST
The data did not reveal any additional linguistic metaphor embodying the source subdomain MUSIC used in the TT as a rendition of a non-metaphorical expression or no metaphor in the ST.

8.3.1.1.5 Summary
This section provided examples of different strategies used to render the linguistic metaphors embodying the source subdomain MUSIC. None of the linguistic metaphors embodying this source domain was deleted. In addition, the linguistic metaphor from the source text was replaced by a non-metaphorical expression only once. The analysis of example 3 illustrates a difficult case where the interpretation of the metaphor is not straightforward. Furthermore, the analysis of scenario three reveals that the same conceptual and the same linguistic metaphor are often used in the TT. The linguistic metaphor can be extended as seen in example 5 or can be different but instantiating the same conceptual metaphor as seen in example 6. No examples illustrating scenario 4 were found for this subdomain.

The next section examines the linguistic and conceptual metaphors belonging to the source subdomain DANCE.
8.3.1.2 DANCE

As seen earlier in Chapter 7, there are two conceptual metaphors related to the source subdomain DANCE in the A&A English subcorpus. These are STELLAR COLLISIONS ARE A DANCE and COSMIC ENTITIES ARE DANCERS. The analysis of the linguistic metaphors embodying these conceptual metaphors indicates that these linguistic metaphors have travelled well into the TT as seen in this section.

8.3.1.2.1 SAME CONCEPTUAL METAPHOR IN THE ST AND THE TT

The conceptual metaphor COSMIC ENTITIES ARE DANCERS is rendered in the TT using the same linguistic metaphor in the TT. This is the case for the star dancing in example 7 and the planets dance in example 8 below where the linguistic metaphor ‘dance’ is rendered by a direct correspondent رقصة (dance).

7. (example 10 in Chapter 7.2.1.2)

ST It is a beautiful mating dance that ends in the perpetual union of the two stars (file 316176).

TT انها رقصة تزاوجية جميلة تنتهي بالاتحاد الدائم لنجمين (file 318597).

BT It is a beautiful mating dance that ends by a perpetual union of two stars.

8.

ST All the dark energy in our solar system amounts to the mass of a small asteroid, making it an utterly inconsequential player in the dance of the planets. (file 407674)

TT ومعادل الطاقة المعتمدة كلها في المنظومة الشمسية كتلة 32 نيزك صغير، وهذا ما يجعل منها حقا لاعبا لا وزن له في رقصة الكواكب. (file 4076747).

BT All the dark energy in the solar system is equivalent to a small asteroid which makes it really a player without any weight in the dance of the planet.

The image of the two stars dancing together with the dance ending in the perpetual union is rather a beautiful way to describe a stellar collision. The dance refers to the perpendicular movement of the two stars heading towards each other. The linguistic metaphor ‘dance’, in example 8 above, refers to the gracious elliptical movement of the planets orbiting the sun. Because dance is the most primitive form of art, it comes as no surprise that the linguistic metaphor ‘dance’ is the same in the ST and TT.

32 Spelling error in the text (كتلة).
8.3.1.2.2 Summary

Despite the cultural specificity of the source subdomain DANCE, the analysis of the Arabic subcorpus reveals that it is transferred into the TT in all cases. The second scenario was the only applicable scenario. No metaphors were found to be deleted or replaced by none metaphorical expressions. In addition, there were no additional linguistic metaphors instantiating this source subdomain in the TT. The directness and the indirectness of metaphors are the same in the ST and the TT.

The next section examines how the linguistic and conceptual metaphors belonging to the source subdomain PERFORMANCE are rendered in the TT.

8.3.1.3 PERFORMANCE

There are three conceptual metaphors identified in the corpus using the source domain of PERFORMANCE. These are COSMIC ENTITIES ARE PERFORMERS, and COSMIC ENTITIES ARE SPECTATORS, and COSMIC ENTITIES ARE SHOWS.

8.3.1.3.1 NO CONCEPTUAL METAPHOR IN THE TT

The analysis has revealed no case of deletion. However, many cases of none metaphorical rendition of the linguistic metaphors instantiating the source subdomain PERFORMANCE are found in the corpus. For instance, the linguistic metaphor ‘masquerade’ in example 9 below is rendered by a non-metaphorical expression in the TT.

9. ST The variations in galaxy numbers over such a volume are subtle, and it is easy to introduce errors into the sample; artefacts of the selection procedure might masquerade as clustering. (file408173)

TT و تكون التغيرات في اعداد المجرات في مثل هذه الحجوم طفيفة، و يسهل ادخال اخطاء في العينة ; و يمكن ان تظهر نتائج عملية الاختراق و كأنها تجمع عنقودي (file4081733).

BT And the variations in the number of galaxies in such volumes are subtle and it is easy to introduce errors into the sample, the results of the selection procedure might appear as if it were a cluster grouping.

The non-metaphorical expression تظهر (appear) used to render the linguistic metaphor ‘masquerade’ does not fulfil conceptual equivalence. The linguistic metaphor ‘masquerade’ refers to the act of disguise that finds its origin in a typical Western cultural artefact which is a “ball at which the guests wear masks and other disguises,” as defined in the EOD

33 http://www.oed.com/view/Entry/114657?rskey=AWo3x6&result=1&isAdvanced=false#eid

[Last accessed 10/03/2017].
entailment that the results might be deceitful like the people in the masquerade is not present in the TT.

Example 10 below also illustrates a case where the linguistic metaphor in the ST is rendered by a non-metaphorical expression in the TT, but the effect on the meaning is different.

10.  
   ST  The Cassini orbiter may be able to spy some of the hidden puppeteers (file408257)
   TT  وقد يتمكن مسبار كاسيني من كشف بعض الإساءات الخفية التي تؤدي إلى حدوث هذه الفجوات و الحلقات (file4082579)
   BT  The Cassini orbiter may be able to unveil some of the hidden causes that cause these gaps and rings.

In example 10, the linguistic metaphor ‘puppeteers’ is used in the ST as a lexical substitute to the sentence “Perhaps they [visible gaps and narrow ringlets] are manipulated by moons too small to be seen with present technology” (Burns et al., 2002).

The linguistic metaphor ‘puppeteers’ can be seen as a perfect substitute to the long sentence as the metaphor ‘puppeteer’ entails both the hide and the manipulation elements. The non-metaphorical rendition in the TT renders the meaning but results in a longer sentence as the translator has to reproduce elements from the previous sentence “the hidden causes that cause these [visible] and [narrow] ringlets”.

8.3.1.3.2 SAME CONCEPTUAL METAPHOR IN THE ST AND THE TT

The conceptual metaphor COSMIC ENTITIES ARE PERFORMERS is instantiated by the same linguistic metaphors in the ST and the TT in several cases. In example 11 below, the linguistic metaphor instantiating this metaphor is rendered by similar linguistic metaphor ‘إعداد المسرح’ (set the stage).

11.  
   ST  The same processes could set the stage for both Starbursts and AGNs (file4081801).
   TT  نفس العمليات تسمح بإعداد المسرح لحدث جميع الدوّى النجمية النشطة والانفجارات النجمية(file4081801)
   BT  The same processes allow setting the stage for the appearance of all AGNs and starbursts.

In example 11, the weak AGMs that produced extreme stellar activity are compared to the preparation of a stage for the performance consisting of the apparition of both AGMs and Starbursts. The linguistic metaphor ‘set the stage’, a generic metaphor, is rendered by similar
linguistic metaphor ‘باعداد المسرح’ resulting in the same conceptual metaphor COSMIC ENTITIES ARE PERFORMERS in TT. The metaphor is indirect in both the ST and the TT. However, it is important here to mention that whilst the linguistic metaphor ‘set the stage’ fulfils a generic function in the ST as the metaphorical meaning of the expression has an entry in the general language dictionary, the equivalent expression in the TT fulfils a pedagogical metaphor in the TT. The metaphorical meaning of the expression ‘باعداد المسرح’ is not listed in the Arabic general language dictionary, hence, according to the procedure outlined in Chapter 6, it is categorised as a pedagogical metaphor.

Similar treatment has been reserved for the linguistic metaphor ‘fireworks show’ in example 12 below rendered by the same linguistic metaphor in the TT resulting in the same conceptual metaphor in the TT. In this example, both the ST and the TT metaphors fulfil the same pedagogical function and are indirect (not metaphor signalling).

12.

| **ST** | If the incoming projectile were a white dwarf--a superdense star that packs the mass of the sun into a body a hundredth the size--the residents of Earth would be treated to quite a fireworks show (file318597). |
| **TT** | و إذا كانت القذيفة الواردة قزم أبيض و هو نجم مفرط في كثافته يكدس كتلة بقدر كتلة الشمس في حجم يعادل واحدا في المئة من حجم الشمس فان قاطني الأرض سيكونون مدعوين لمشاهدة عرض العاب نارية لا مثيل له (file3185976). |
| **BT** | If the incoming projectile were a white dwarf which is a star with an excessive density packing a mass equivalent to the mass of the sun in a size that equals one percent of the size of the sun, the residents of the Earth would be invited to some unprecedented fireworks show. |

8.3.1.3.3 Summary

This section has shown that the linguistic metaphors instantiating the subdomain PERFORMANCE did not all travel well into the TT. Example 10 illustrated a case where the TT used a non-metaphorical expression to render the linguistic metaphor ‘puppeteers’. Example 11 illustrated a case where the same linguistic metaphor is used in both the ST and the TT but their function is different. No examples were found to illustrate scenario 2 (use of a different CM in the TT) and scenario 4 (use of a CM in the TT where none is used in the ST).

Now that we have covered the source domain ARTS, we move on to analyse the second highly frequent culture-specific source domain in the A&A corpus which is MYTHICAL AND FANTASTIC CHARACTERS.
8.3.2 MYTHICAL AND FANTASTIC CHARACTERS

As seen in Chapter 7, the identified linguistic metaphors in the ST led to the formulation of one conceptual metaphor where COSMIC ENTITIES (target domain) are mapped onto the source domain MYTHICAL AND FANTASTIC CHARACTERS. This conceptual metaphor is COSMIC ENTITIES ARE MYTHICAL AND FANTASTIC CHARACTERS discussed here from the point of view of its transfer into the TT or not.

8.3.2.1 NO CONCEPTUAL METAPHOR IN THE TT

The linguistic metaphors instantiating this conceptual metaphor are not always transferred into the TT. This is the case, for instance, for the linguistic metaphors ‘voracious monster’ in example 13 and ‘sun monster’ in example 14 below.

13. (example 15 in Chapter 7.2.3)

ST Even those found at the centers of many galaxies, supermassive black holes--whose very name connotes a voracious monster that rules its galactic roost--are minuscule by cosmic standards. (file3145798).

TT Not translated.

BT Not applicable.

14.

ST Even a one-billion-sun monster would fit comfortably inside Neptune's orbit. (file418687)

TT حتي ان المنطقة داخل مدار الكوكب نيتون تتسع بسهولة لثقب اسود فائق كتلته تبلغ نحو مليار مرة كتلة الشمس. (file4186874)

BT Even though the region inside the orbit of Neptune is big enough for a black hole with a mass that is a billion time the mass of the sun.

In example 13, the whole passage containing the linguistic metaphor is deleted in the TT whereas the deletion takes place within the sentence in example 14 where only the linguistic metaphor ‘monster’ is deleted.

In example 15 below, the linguistic metaphor ‘doppelgangers’ referring to the apparition of a ghost of a living being, often a double with striking similarity34, is deleted within the sentence as was the case for example 15 resulting in no conceptual metaphor in the TT. In these examples, there is no cultural reason for the conceptual metaphor to be omitted.

The cascade of brane-antibrane annihilation tends to remove large branes, which easily find their antibrane doppelgangers and so annihilate. (file334284)

The serial of the annihilations of branes and anti-branes tends to push away the big branes that attract their antibranes easily and then annihilate.

Examples 13, 14 and 15 illustrate cases where there is no conceptual metaphor in the TT, i.e. this is a case of deletion of the conceptual metaphor in the TT (albeit in different ways).

Examples 16 and 17 below are cases where there is no conceptual metaphor in the TT as a result of a literal rendition of the linguistic metaphor in the TT.

In example 16 below, the linguistic metaphor ‘gargantuan’ referring to Rabelais’s comic giant known for his huge belly and insatiable appetite is replaced by a non-metaphorical expression in the TT ‘هائل’ (enormous) resulting in the loss of the conceptual metaphor in the TT.

16.

The shorter wavelengths of visible or ultraviolet light would somewhat reduce this gargantuan requirement but not by enough to be any less ridiculous. (file41687)

Our utilisation of a visible light of a shorter wavelength or ultraviolet rays will reduce somehow this enormous requirement but not in a way that makes it reasonable.

The deletion of the linguistic metaphor in the TT in example 15 and the use of a non-metaphorical expression in the TT in example 16 might be motivated by the absence of the same linguistic metaphor in the TT even though a cultural equivalent performing a similar function exists in the target culture. For instance, the Arabic character named أشعب (Ashaab) is famous for his greed and a huge appetite. He is often portrayed in the Arabic folklore invading banquets without invitation (Al-Hakim, 1938).

The metaphor around “Rip Van Twinkle” in example 17 below is also deleted although an equivalent cultural element exists in the TL/TC.

17. (Example 23 in Chapter 7.2.3)

Rip Van Twinkle the oldest stars have been growing younger. (file3142994).
The age of the oldest stars. The oldest stars were looking older than the universe.

The Rip Van Twinkle metaphor, is replaced in the TT by a non-metaphorical expression ‘the age of the oldest stars’ that attempts to capture both the “star image” and the mapping between the source domain and the target domain of the metaphor where both stars and Rip Van Winkle are the victims of a discrepancy in their age. At first sight, the absence of the conceptual metaphor in the Arabic translation might be interpreted as a case of absence of a conceptual equivalent in the target TL/TC. However, an equivalent story exists in the TL/TC. The Arabic version of the Rip Van Winkle story is known as the Companions of the cave and is cited in Surah number 18 (verses 9-12) in the Qur’an as shown in the English interpretation and translation by Arberry below.

Or dost thou think the Men of the Cave and Er-Rakeem were among Our signs a wonder? When the youths too refuse in the Cave saying, ‘Our Lord, give us mercy from Thee, and furnish us with rectitude in our affair (Arberry:1964:288).

The TL/TC story nevertheless differs in its details from the story in the ST. For instance, Rip Van Winkle is one individual in the ST whereas the Companions of the cave are many (unknown number) in the Qur’an. Rip Van Winkle is said to have slept 20 years whereas the duration of sleep ‘cast’ on the companions of the cave is unknown. However, both Rip Van Winkle and the Companions of the cave wake up to a different time where their youth was preserved making them appear younger than their own descendants. Both stories can be said to fulfil the same function. Hence, the deletion of the metaphor in the TT cannot be motivated by the absence of the same cultural element. However, in this case, the deletion might be motivated by the impossibility to reproduce the double allusion to both the character “Winkle Rip Van” and the children’s song “Twinkle, twinkle little star”.

The examples provided in this section indicate that the deletion of the metaphor in the TT cannot be attributed simply to the absence of a cultural equivalent in the TL/TC. The next section deals with the second scenario, where a different conceptual metaphor is used in the TT.
DIFFERENT CONCEPTUAL METAPHOR IN THE TT

A different conceptual metaphor can be used in the TT to render a metaphor that has no cultural equivalent in the TL. This is the case, for instance, for the linguistic metaphor ‘spirits away’ in example 18 below. The linguistic metaphor refers to the white dwarf acting like a spirit after a collision by taking some of the gas from the giant (the sun). This image is rendered into Arabic by the linguistic metaphor ‘يسلب’ (plunder) which instantiates a different source domain VIOLENCE a subdomain of POWER AND CONFLICT resulting in a different image where the stealthy operation of gas-stealing by a spirit becomes an act of terror and violence.

18.
ST It [the white dwarf] escapes unscathed and *spirits away* some of the giant's gas (file318597)
TT و يخرج القزم دون ان يصاب ب اذى، و *يسلب* بعض غاز العملاق (7976) .
BT The white dwarf leaves without getting hurt and plunders some of the giant’s gas.

The next example is borderline between two scenarios. It can be seen as a use of a different conceptual metaphor or as the use of the same conceptual metaphor instantiated by a different linguistic metaphor. The specific creature ‘behemoth’ is rendered into Arabic using the expression فرس بحر ضخمة (big hippocampus) in addition to the introduction of the metaphor signal تشبه (resembles). This can be interpreted as either a shift from the source domain of MYTHICAL AND FANTASTIC CHARACTERS into a different source domain which is ANIMAL KINGDOM or can be interpreted as the use of the same source domain MYTHICAL AND FANTASTIC CHARACTERS using a different linguistic metaphor where the linguistic metaphor فرس بحر ضخمة (big hippocampus) is seen as the interpretation of the ST ‘behemoth’.

In the present case, the first interpretation is preferred. The linguistic metaphor فيرس بحر ضخمة in the TT instantiates a different source domain. In addition, the mapping between the source and target domains in the TT is made explicit by the addition of the adjective “big”. The metaphor in the TT is made direct by introducing the metaphor signal “similar” whereas it is indirect in the ST making the metaphor even more explicit in the TT.

19.
ST Caloris, a *behemoth* 1,300 kilometers in diameter, is the largest of these craters (file321493)
TT و اكبر هذه الفوهات هي كالوريس Caloris التي يبلغ قطرها نحو 1300 كيلومتر و التي تشبه فرس بحر ضخمة . (file3340220)
BT The biggest of these craters is Caloris whose diameter reaches 1300 kilometres and which resembles a big hippocampus.
8.3.2.3 SAME CONCEPTUAL METAPHOR IN THE ST AND THE TT

In this section, various examples are provided to illustrate cases where the TT uses the same conceptual metaphor and a similar linguistic metaphor belonging to the source domain MYTHICAL AND FANTASTIC CHARACTERS

In example 20 below, the conceptual metaphor is the same in the TT resulting from the use of the same linguistic metaphors ‘devour’ and ‘greedily’ are rendered by direct equivalent in the TT.

20.

ST In many galaxies where black holes devour material greedily—generating a phenomenon that astronomers call an active galactic nucleus AGN—stars form at a precipitous rate in episodes known as starbursts (file3145798).

TT ففي كثير من المجرات حيث تلتهم الثقوب السوداء المادة بشراهة مولدة ظاهرة يسميها الفلكيون نواة مجرية نشطة (file4081801) active galactic nucleus AGN

BT In many galaxies where black holes greedily devour matter generating a phenomenon the astronomers call an active galactic nucleus (active galactic nucleus AGN), stars form at a very high rate of events known as stellar explosions (starbursts)

The same procedure is used to render the linguistic metaphors ‘beast’ in example 21 and ‘monster’ in example 22 below.

21.

ST Shooting the beast (file418687.)

TT اصطياد الوحش (file4186874).

BT Hunting the beast/monster

22.

ST Portrait of a Monster (file418687)

TT صورة فنية لوحش (file4186874)

BT Artistic picture of a monster/beast.

Both linguistic metaphors are rendered by the Arabic word وحش, which is a polysemous word used to designate not only a wild animal but also a monster (a mythical creature). The word ‘beast’ in English is also polysemous. The older meaning of beast is a wild animal. The modern meaning of beast includes ‘a dangerous and a strange animal’ which brings it to the realm of mythical characters. The example of the linguistic metaphor ‘beast’ illustrates that the boundary between the different source domains is not always clear.
In example 21, where the ST uses the linguistic metaphor ‘monster’ and the TT uses the linguistic metaphor ‘وحش’ (monster/beast), the polysemy of the word in the Arabic language may also affect the interpretation of the underlying conceptual metaphor in the TT. If ‘وحش’ is defined as a wild animal, then it might be said that there is a shift from the source domain MYTHICAL AND FANTASTIC CHARACTERS to the source domain ANIMAL KINGDOM.

This section has discussed examples where the same conceptual metaphor is found in the target text. The linguistic metaphor instantiating the same conceptual metaphor in the TT can be a direct equivalent/correspondent, or it can be a different linguistic metaphor.

8.3.2.4 Summary:

The source domain MYTHICAL AND FANTASTIC CHARACTERS was not transferred into the TT in many cases as a result of a deletion and non-metaphorical rendition. The metaphor type (direct, indirect) was also generally preserved except for example 19 where the indirect metaphor ‘behemoth’ is rendered by a direct metaphor resulting from the introduction of the metaphor signal. No additional linguistic metaphors instantiating the source domain MYTHICAL AND FANTASTIC CHARACTERS were found in the TT.

In the next section, the source domain ARTS and its subdomains MUSIC, DANCE and PERFORMANCE are analysed.

8.3.3 SPORTS AND GAMES

As seen in the previous chapter, there are seven conceptual metaphors in the A&A corpus belonging to the source domain SPORTS AND GAMES. The linguistic metaphors embodying the source domain SPORTS AND GAMES used in the A&A English subcorpus often refer to popular American sports and games such as poker, billiard, baseball, and demolition derby meaning they are culture-specific. In this section, we explore how the linguistic and conceptual metaphors belonging to the source domain SPORTS AND GAMES are rendered in the TT.

8.3.3.1 NO CONCEPTUAL METAPHOR IN THE TT

The conceptual metaphor COSMIC ENTITIES ARE SPORTS PLAYERS was not transferred into the TT in two cases. The first case results from the deletion of the linguistic metaphor ‘complex
game of billiards’ in example 23 below where the whole passage containing the linguistic metaphor is not translated.

23.  
**ST** So the populating of the Oort cloud is really a complex game of billiards among the giant planets, with all of them contributing to the process. (file316434).

**TT** *Not translated.*

**BT** *Not applicable.*

The second case results from the use of a non-metaphorical expression to render the linguistic metaphor ‘league’ in example 24 below.

24.  
**ST** The result is striking: the planets are in a different league from the asteroids and KBOs, and Pluto is clearly a KBO (file320877).

**TT** و هذا يوصلنا إلى النتيجة المذهلة التالية: تنتمي الكواكب إلى مجموعة مختلفة عن مجموعة الكويكبات و أجرام حزام كوير ، (file3208777)

**BT** This leads us to the following striking result: the planets belong to a different group different from the group of asteroids and Kuiper Belt Orbits.

8.3.3.2 DIFFERENT CONCEPTUAL METAPHOR IN THE TT

The conceptual metaphor COSMIC ENTITIES ARE A GAME PLAYERS instantiated by the linguistic metaphor ‘tug-of-war’ in example 25 below is replaced by a linguistic metaphor belonging to a different conceptual metaphor in the TT.

25.  
**ST** By showing the amplitude of density fluctuations at different points in cosmic history, the CMB can reveal the tug-of-war between matter and dark energy (file318744).

**TT** و باظهار الاشعاع CMB "لسعة تارجحات الكثافة في مراحل مختلفة من " التاريخ الكوني "(9) فإن هذا الاشعاع يمكن ان يكشف عن الصراع العنيف بين المادة و الطاقة الخفية (file3188224).

**BT** By showing the radiation CMB (gloss) for the amplitude of the fluctuations density in different periods of “the cosmic history” (9), this radiation can reveal the violent struggle between the matter and the hidden energy.

In example 25, the linguistic metaphor ‘tug-of-war’ in the ST refers to a sport where two opposite teams pull on each end of a rope. The force on each side appears to fluctuate during the game until one side finally puts on more strength and pulls the rope on its side and win the game. The ST metaphor entails the force of matter, and dark energy is constantly tilting with
one of the two showing more strength than the other at certain times (different points in the cosmic history). The linguistic metaphor dürum sözü (violent struggle) in the TT instantiating the subdomain VIOLENCE of the source domain POWER AND COMPETITION does not render the whole picture. It highlights the struggle between the two forces but fails in highlighting the unbalance between them over time.

Similarly, the linguistic metaphor ‘demolition derby’ in example 26 below is rendered a different linguistic metaphor instantiating a different conceptual metaphor. The linguistic metaphor لعمليات تدميرية (destruction operations) in the TT instantiates a shift from the source domain SPORTS AND GAMES into the subdomain VIOLENCE of the source domain POWER AND COMPETITION.

26. (example 25 in Chapter 7.2.4)

ST Dense star clusters are a veritable demolition derby. Within these tight knots of stars, observers in recent years have discovered bodies that are forbidden by the principles of ordinary stellar evolution - but that are naturally explained as smashed-up stars (file 3161764).

TT فالحشود النجمية الكثيفة هي بقاع فعلية لعمليات تدميرية. فتضمن هذه العقد النجمية التي تكون النجوم فيها ملتزمة، اكتشف الفلكيون في السنوات الأخيرة أجساماً تستحيل وجودها طبقاً لمبادئ التطور النجمي العادي لكن يمكن تفسير وجودها طبيعياً على أنها نجوم محطمة. (file3185976).

BT The stellar crowds are true places to demolition operations and within these stellar knots where stars are crammed, observers, in recent years, have discovered bodies that are impossible to exist according to the principles of ordinary stellar evolution but whose natural existence can be explained as smashed up stars.

In example 26, the linguistic metaphor ‘demolition derby’ in the ST referring to the car race where cars deliberately head toward each other’s is part of a metaphor cluster (‘stellar cluster’, ‘tight’, ‘knots’, ‘bodies’, ‘forbidden’ and ‘smashed up’ are all linguistic metaphors). The use of the linguistic metaphor لعمليات تدميرية (destruction operations) in the TT does not render the mappings between the source domain SPORTS AND GAMES and the target domain of COSMIC ENTITIES (stellar clusters). The highlighted features of space tightness (tight knots), the impossibility to predict the outcome of the race (forbidden by the principles of stellar evolution), the intentional collisions are not rendered by the linguistic metaphor لعمليات تدميرية (destruction operations) which only renders the outcome of the derby which is the ‘smashed up’ stars.
8.3.3.3 SAME CONCEPTUAL METAPHOR IN THE ST AND THE TT

This section gives examples to illustrate cases where the same linguistic metaphor and the same conceptual metaphor are used in both the ST and TT as illustrated by example 27 below.

27. (Example 36 in Chapter 7.2.4.6)

**ST** Such fields are a kind of *consolation prize* for creatures such as ourselves who are stuck in three dimensions: although we cannot peer into the extra dimensions, we perceive them as scalar field (file3342893).

**TT** فمثل هذه الحقول مثل جوائز ترضية لمخلوقات من أمثالنا الماكثين في ثلاثة ابعاد: فنحن لا نستطيع رؤية الابعاد الاضافية، فإننا نتصورها بطريقة غير مباشرة بوصف ها حقولا عددية (file3342893).

**BT** Such fields are like a consolation prize for creatures such as ourselves staying in all three dimensions: although we cannot peer into the extra dimensions, we can imagine them in an indirect way as numerical fields.

In example 27, the linguistic metaphor ‘consolation prize’ instantiating the conceptual metaphor SCALAR FIELDS ARE A CONSOLATION PRIZE is part of a metaphor cluster. It is rendered in the TT by the same conceptual metaphor and the same linguistic metaphor جوائز ترضية (consolation prize).

Unlike the linguistic metaphor in example 27 above, the rendition of the linguistic metaphor ‘baseball outfielders’ in example 28 below seems to be more challenging.

28. **ST** Particles are as spread out as *baseball outfielders* (file3165082).

**TT** وتنشر الجسيمات انتشار لاعبي الدفاع في الملعب في لعبة البيسبول (file4082579).

**BT** And particles are spread the spread of defence players in a *field* in a baseball game.

In example 28, the linguistic metaphor ‘baseball outfielders’, is a metaphor from the baseball game. It refers to a specific position of a defender in this game where “any fielder positioned in the outfield, i.e. the left fielder, centre fielder or right fielder” (Svinks, 2011). The linguistic metaphor is translated into a more general level word from the sports games in the TT which is لاعبي الدفاع (defence players) with the addition of the expression “in the field in a baseball game”.

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game”. The expression لاعبي الدفاع (defence player) is an expression used to designate a defender in games such as a football game or a water polo game. The extension of the linguistic metaphor in the TT limits the possible interpretations and prevent a shift at the conceptual level. In the ST, the metaphor is signalled by the metaphor signal “as”. The metaphor signal is not rendered in the TT but the metaphor is made direct by the use of a grammatical form known as “cognate accusative”انتشار (spread). Despite the difference in the grammatical category, a simile in English, the cognate accusative in Arabic appears to fulfil a similar function in this example.

8.3.3.4 CONCEPTUAL METAPHOR IN THE TT WHEREAS NONE IS USED IN THE ST

In addition to the 3 scenarios seen above, there is one case of addition of a conceptual metaphor COSMIC ENTITIES ARE GAMES in the TT instantiated by the use of the linguistic metaphor رقعة الشطرنج (chessboard) in example 29 below. This metaphor does not match any linguistic metaphor in the source text.

29. (Example 1 in Chapter 8.2)

ST These [linear features that cross cut Mercury’s face] lineaments are called the Mercurian grid. One explanation is that the crust solidified when the planet was rotating much faster.

TT و يطلق على هذه السمات المميزة للكوكب اسم شبكة عطارد. ويتلخص أحد التفسيرات لهذه السمات الشبيهة برقعة الشطرنج في أن القشرة تصلبت عند ما كان الكوكب يدور حول محوره بسرعه أكبر.

BT These features characterising the planet are called the grid of Mercury. One explanation of these features resembling a chessboard is that the crust solidified when the planet was rotating at a much higher speed.

The added metaphor in example 29 refers to the linguistic metaphor ‘Mercurian grid’ in the same passage. The addition makes the grid feature more explicit in the TT using a popular cultural item from the TT which is the chess game. The metaphor is direct and is introduced by the metaphor signal الشبيهة(similar to).

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36 “The cognate accusative is known as mafʿūl muṭlaq (مفعول مطلق) in traditional Arabic grammar. In this syntactic role, a noun will be found in the accusative case mansūb (منصوب). The cognate accusative is used to add emphasis by using a verbal noun derived from the main verb or predicate that it depends on. Both the accusative and the verb will resonate phonetically as they will share the same root” definition from http://corpus.quran.com/documentation/cognateaccusative.jsp. [Last accessed 14/03/2017].
8.3.3.5 Summary

The analysis of the source domain SPORTS AND GAMES revealed different treatments of the linguistic metaphors belonging to this domain. The linguistic metaphors are often transferred into the TT despite their highly culture specificity. The next section examines how the source domain COOKING, HEATING AND FOOD is dealt with in the translation subcorpus.

8.3.4 COOKING, HEATING AND FOOD

The source domain COOKING, HEATING AND FOOD is another culture-specific source domain that might raise translation issues. As seen in Chapter 7, there are four metaphors related to this source domains in the ST. In this section, we explore how these conceptual metaphors and linguistic metaphors instantiating them are rendered into Arabic.

8.3.4.1 NO CONCEPTUAL METAPHOR IN THE TT

The conceptual metaphor COSMIC ENTITIES ARE FOOD instantiated using linguistic metaphor ‘kneads’ is not rendered in the TT in example 30 below where the whole passage containing the linguistic metaphor is deleted.

30. ST The moon does not participate in the orbital resonance that kneads the other Galilean moons(file3161700).

TT Not translated.

BT Not applicable

The linguistic metaphor ‘knead’ instantiating the conceptual metaphor COSMIC ENTITIES ARE FOOD referring to the continuous pressure of the orbital resonance that shapes Galilean moons in the same way a dough is shaped.

8.3.4.2 DIFFERENT CONCEPTUAL METAPHOR IN THE TT

The linguistic metaphor ‘feed’ instantiating the conceptual metaphor COSMIC ENTITIES ARE FOOD in the ST has been rendered by different linguistic metaphor in examples 31 and 32 below resulting in a different conceptual metaphor in the TT.

31.
Ironically, some astronomers have recently proposed that stellar collisions could help feed material into these holes. (file318597)

و من قبل المفارقة، فقد اقترح بعض الفلكيين، منذ عهد قريب، أن التصادمات النجمية قد تساعدها على ضخ المادة في تلك الثقوب. (file3185976)

Strangly, some astronomers have proposed, more recently, that the stellar collisions could help pump material into the holes.

In example 31, the linguistic metaphor ‘feed’ is replaced by the linguistic metaphor ضخ (pump) shifting the linguistic metaphor from the source domain COOKING, HEATING AND FOOD to the domain MACHINE AND MECHANICAL PROCESSES in the TT. The cosmic entity stellar collisions is no more seen as animate being fed by other animate beings (black holes) but rather as a machine pumping matter into a recipient (black hole). Despite the shift in the conceptual metaphor, both metaphors can be said to have achieved a conceptual equivalence as in both cases the image of the matter being pushed into the black hole by the stellar collision is retained.

In example 32 below, the linguistic metaphor ‘feed’ is rendered by the linguistic metaphor ‘يلتهم’ (devour).

The radio and x-ray emission from this location indicates that the mass is a supermassive black hole--not a truly active hole but one that does feed occasionally. (file408179)

و تدل الاصدارات الراديوية و اصدارات الأشعة السينية من هذا الموقع على ان هذه الكتلة هي ثقب أسود فائق الكتلة ليس بالضرورة ثقبا نشيطا بل ثقب يلتهم المادة من وقت لا آخر. (file408180)

The radio emissions and the x-ray emissions from this location indicate that the mass of this mass is a supermassive black hole which is not necessarily an active hole but a hole that devours matter from time to time.

This linguistic metaphor can be interpreted in two ways: The first interpretation is the use of the same conceptual metaphor and different linguistic metaphor in the TT. The linguistic metaphor ‘يلتهم’ (devour) in the TT is a more specific word for ‘feed’. The use of a more specific word in the TT highlights an additional element which is the voracity of the supermassive black hole.

The second interpretation is in line with the analysis of the linguistic metaphor ‘devour’ in the A&A English subcorpus in the Chapter 8.3.2 where the linguistic metaphor ‘يلتهم’ (devour) is presented as an attribute of the supermassive black hole monster. Hence, it instantiates a different conceptual metaphor which is COSMIC ENTITIES ARE MYTHICAL AND
FANTASTIC CHARACTERS. Consequently, the replacement of ‘feed’ in the TT by ‘يلتهم’ (devour) is considered as a case where a different conceptual metaphor is used.

The linguistic metaphor ‘food’ in example 33 below rendered by the linguistic metaphor دفع (push) is another example where a different conceptual metaphor is used in the TT.

33. 
ST The tides help to feed new long-period comets into the planetary region. (file334019).
TT تساهم قوى المد في دفع المزيد من المذنبات الطويلة الدور إلى داخل المنطقة الكوكبية (file3340216).
BT The tides help to push more long period comets inside the planetary region.

The linguistic metaphor دفع (push) instantiates a different source domain PHYSICAL OBJECTS where the comets are mapped onto physical objects that are pushed rather than as food given to an animate object be it an animal or a human being (the planetary region).

8.3.4.3 SAME CONCEPTUAL METAPHOR IN THE ST AND THE TT
The conceptual metaphor THE UNIVERSE IS A COKING AND HEATING DEVICE is the same in the ST and TT as illustrated in example 34 below:

34. 
ST The early universe was a cauldron of star formation. (file3145756).
TT كان الكون البدائي مرجلًا تتشكل فيه النجوم. (file4076747).
BT The early universe was a cauldron where stars formed,

However, the Arabic word ‘مرجل’ does not bear the same connotation as in English where the word is defined as being “traditionally used by witches to mix things together for their magic spells”37.

This can be seen as a case where the same linguistic metaphor is used, but the mapping between the source and the target domains of the conceptual metaphor differ from the source to the target text (Schäffner, 2004b). Furthermore, the linguistic metaphor ‘cauldron’ can be seen as an overlap between the source domain MYTHICAL AND FANTASTIC CHARACTERS and

FOOD, COOKING AND HEATING as the linguistic metaphor ‘cauldron’ refers to a cooking device specifically used by mythical and fantastic character which is a witch.\(^{38}\) In the TT, the “cauldron” is interpreted simply as a cooking device, hence the use of the word ‘مرجل’ defined as “قدّر من طين أو نحاس يُغلى فيه الماء” (a pot made of clay or bronze used to boil water).

Hence, the linguistic metaphor ‘مرجل’ is either a case where the same linguistic and conceptual metaphors are used in the ST and TT or a case where a different conceptual metaphor is used in the target text instantiated by the same linguistic metaphor.

### 8.3.4.4 Summary

Despite the culture-specificity of the source domain COOKING, HEATING AND FOOD, the linguistic metaphors instantiating it have often been rendered into Arabic using the same conceptual metaphors.

The next source domain to be examined is the source domain CLOTH AND FABRIC.

### 8.3.5 CLOTH AND FABRIC

In this section, examples are provided to illustrate the different treatments reserved to the source domain CLOTH AND FABRIC in the A&A bilingual corpus.

#### 8.3.5.1 NO CONCEPTUAL METAPHOR IN THE TT

The conceptual metaphor COSMIC ENTITIES ARE FABRIC is not always rendered in the TT. In some case, the whole passage containing the metaphor is deleted in the TT as illustrated in Example 35 below.

35.  
ST Craters and a massive curtain of fire are visible (file316170).

TT Not translated.

BT Not applicable.

The whole passage containing the linguistic metaphor ‘curtain’ in example 35 is deleted in the TT whereas the linguistic metaphor ‘threaded’ in example 36 below is replaced by a non-

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\(^{38}\) The witch is considered a mythical character based on the definition of the Macmillan English Dictionary as “a woman in stories who has magic powers. A man with magic powers is usually called a wizard”. [http://www.macmillandictionary.com/dictionary/american/witch?q=witch+](http://www.macmillandictionary.com/dictionary/american/witch?q=witch+) [Last accessed 23/6/2017].

metaphorical expression يملآن (fill) in the TT. In both examples, the conceptual metaphor is not rendered in the TT.

36.

ST  The outflows from the sun and its stellar contemporaries blew away the leftover gas and dust that threaded the space between them. (file3340512)

TT  هذا وقد عصفت التدفقات الخارجية الصادرة عن الشمس وما عاصرها من النجوم بالغاز والغبار المتخلفين، الذين كانوا يملآن الفضاء الكائن بين هذه النجوم. (file3340512)

BT  The outflows from the sun and its stellar contemporaries blew away the leftover gas and dust that filled the space existing between these stars.

The linguistic metaphor ‘threaded’ in the ST instantiates the conceptual metaphor THE UNIVERSE IS A FABRIC. This conceptual metaphor seems to answer some of the most difficult questions in astrophysics today. This conceptual metaphor entails that there is some sort of invisible filaments connecting cosmic objects. Between these filaments lay voids similarly to a piece of a kneaded cloth. The deletion of the linguistic metaphor results in a loss of an important image that does not fulfil a pedagogical function but is essential to the whole theory of space-time in modern astrophysics (a theory-constitutive metaphor in Boyd’s (1993) terms).

Similar effects also are produced by the use of a different conceptual metaphor to render the fabric metaphor in the TT as it is explained in the next section.

8.3.5.2 DIFFERENT CONCEPTUAL METAPHOR IN THE TT

Example 37 below illustrates a case where the linguistic metaphor ‘fabric’ instantiating the conceptual metaphor THE UNIVERSE IS A FABRIC is rendered by a different linguistic metaphor embodying a different conceptual metaphor belonging to the source domain ARCHITECTURE.

37.

ST  Three recent hypotheses suggest the range of possibilities, galactic black hole accretion disks, gamma, ray bursts and topological defects in the fabric of the universe (file 314257).

TT  وثمة ثلاث فرضيات جديدة تقدم الاحتمالات التالية: اقراص تنام لقوب سوداء مجرية، و انبعاثات لاشعة غاما، و عيوب طفولوجية في بنية الكون. (file4221914)

BT  There are three recent hypotheses that suggest the following possibilities: accretion disks of galactic black holes, and gamma ray emissions and topological defects in the structure of the universe.
In example 37 above, the rendition of the linguistic metaphor ‘fabric’ by the linguistic metaphor بنية (structure) results in the shift from the source domain CLOTH AND FABRIC into the source domain ARCHITECTURE. The Universe is no more seen as fabric but as a structure. However, the conceptual metaphor THE UNIVERSE IS A FABRIC has deep entailments that are not reproduced by the conceptual metaphor THE UNIVERSE IS A STRUCTURE.

In the next section, we will see how the same linguistic metaphor “fabric” is treated differently.

### 8.3.5.3 SAME CONCEPTUAL METAPHOR IN THE ST AND THE TT

In many cases, the conceptual metaphor the UNIVERSE IS A FABRIC has been reproduced in the TT using the same linguistic metaphors as illustrated in example 38 below.

38. **ST**
In addition to spawning density perturbations, inflation created fluctuations in the fabric of spacetime itself. (file318744)

**TT**
فإضافة إلى ما يحدثه الإنتفاخ من اضطرابات في الكثافة، فإنه وُلد تراجحات في بنية الزمكان (file3188224).

**BT**
In addition to the perturbations in density caused by inflation, inflation also caused fluctuations in the fabric of spacetime [space-time in English in the TT].

In example 38, the linguistic metaphor ‘fabric’ is rendered in the TT using the same linguistic metaphor بنية (fabric) resulting in the same conceptual metaphor in the TT. The same linguistic metaphor ‘fabric’ is rendered into the same linguistic metaphor in addition to a different linguistic metaphor instantiating a different conceptual metaphor in example 39 below.

39. **ST**
When two black holes collide, they shake the fabric of spacetime around them, producing gravitational waves that propagate out like ripples on a pond (file 418687)

**TT**
اذ يمكن للثنائيين، عندما يصطدم أحدهما بالآخر، أن يهزان بنية الزمكان (9) حولهما، وهذا ما ينتج موجات تثاقلية (10) تنتشر إلى خارج منطقة التصادم مثل التآكلات و التغضنات على سطح واجهة بركة ماء (file4186874).

**BT**
It is possible for two black holes when they collide, to shake the structure of the fabric of spacetime around them, which produces gravitational waves that propagate the collision zone like ripples and wrinkles on the surface of a stagnated pond.

(9) spacetime

(10)

In example 39 above, the linguistic metaphor ‘fabric’ occurring in a metaphor cluster is rendered in the TT by the same linguistic metaphor بنية (fabric) preceded by the linguistic metaphor بنية (structure) instantiating a different linguistic metaphor. The linguistic metaphor
in the TT becomes ‘the structure of the fabric’. The word ‘structure’ can be either seen as a new linguistic metaphor or as an extension of the linguistic metaphor ‘fabric’. In the present case, it is interpreted as an extension rather than a case where the same linguistic metaphor is used in the TT in addition to a different metaphor as will be discussed in Chapter 8.4.3. In the present example, the additional linguistic metaphor ‘structure’ is presented as an attribute of the linguistic metaphor ‘fabric’ whereas in the case presented in Section 8.4.3, the added linguistic metaphor is used as a separate entity separated from the same linguistic metaphor by the conjunction “or”.

In example 40 below, the linguistic metaphor ‘cloak’ is rendered by linguistic metaphor of a more general level in the TT which is معطف (coat).

It should be mentioned here that by the term “generic” in this context, we do not refer to the function of the metaphor ‘generic metaphor’ as opposed to ‘pedagogical metaphor’ but to the hyperonymic relation between the words ‘cloak’ and ‘coat’ which are both used as linguistic metaphors instantiating a specific case of the conceptual metaphor THE UNIVERSE IS A FABRIC.

40. Unlike Earth’s gaseous cloak, Mercury’s atmosphere is constantly evaporating and being replenished. (file3340220).

Unlike Earth’s gaseous coat, Mercury's atmosphere evaporates and comes back to life constantly. Despite the use of a different linguistic metaphor, the conceptual metaphor is the same in the ST and the TT.

8.3.5.4 Summary
The source domain CLOTH AND FABRIC seems to be rendered in most cases in the TT with few cases of deletion and non-metaphorical rendition of the linguistic metaphor in the TT. Few cases were also observed when more than one metaphor solution was retained to render the same linguistic metaphor into the TT. This is the case of the linguistic metaphor ‘fabric’ rendered by the linguistic metaphor ‘fabric’, or ‘structure’ or by both. This might indicate that the translator is not comfortable with the linguistic metaphor ‘fabric’. As already explained, this might also indicate that the translator is unaware of the role this metaphor plays in the ST.
8.3.6 RELIGION AND FAITH

In this section, the linguistic and conceptual metaphors related to the source domain RELIGION AND FAITH are examined. Unlike the source domains examined so far, this source domain does not seem to travel well between the ST and the TT as will be seen in this section.

8.3.6.1 NO CONCEPTUAL METAPHOR IN THE TT

The linguistic metaphor ‘doom’ in 41 below instantiating the conceptual metaphor COSMIC ENTITIES ARE BLESSED/CURSED BEINGS is not rendered in the TT where the whole passage containing the linguistic metaphor is deleted.

41.
ST  We see them only because the victims do not go quietly to their doom (file4081801)
TT  Not translated.
BT  Not applicable

Similarly, the linguistic metaphor ‘requiem’, in example 41 below, instantiating the conceptual metaphor COSMIC ENTITIES ARE RELIGIOUSLY BURIED BODIES has received similar treatment. The whole sentence was not translated.

42. (example 30 in Chapter 7.2.7)
ST  No Requiem Yet (file318744)
TT  Not translated.
BT  Not applicable

The linguistic metaphor ‘fossil relic’, in example 43 below, has been rendered by a non-metaphorical expression تبقى (remaining) resulting in no conceptual metaphor in the TT.

43. (Example 32 in Chapter 7.2.7).
ST  Many of these involve the cosmic microwave background radiation CMBR, a fossil relic of the hot early universe (file334284).
TT  ويتضمن كثير منها اشعاع الخلفية الكونية الميكروي الموحلة (CMBR) ، الذي تبقى من الكون المبكر الحار . (file3342893)
BT  Many of these contain the cosmic microwave background radiation [CMBR in English in the TT] that remained from the hot early universe.

In example 44 below, the linguistic metaphor ‘God’ has also been deleted in the TT because of a change in the sentence from active to passive.
Albert Einstein captured its essence when he said, "What really interests me is whether God had any choice in the creation of the world."  

Albert Einstein realised the core of the problem when he said that what really raised his interest was whether there was a choice when the world was created.

Example 35 highlights a popular metaphor that has often been discussed in the literature. Publication in the New York Times discussed the entailments of this metaphor. The God metaphor as explained by Overbye (1999) is a reference to the “the mystery and grandeur of the universe, the wellspring of awe, a reminder that there was something at the core of existence that all his equations could only graze, as he said once”, (Overbye, 1999). The conceptual metaphor in this example is THE UNIVERSE CREATION IS/IS NOT A DEVINE CHOICE and the word ‘God’ is the linguistic metaphor instantiating it. The conceptual metaphor is not transferred into the TT where the linguistic metaphor “God” is deleted as a consequence of the use of a passive form where the agent is not mentioned. The rendition of the active sentence by a passive sentence “(was there any choice when the world was created) resulted in no conceptual metaphor being used in the TT.

8.3.6.2 SAME CONCEPTUAL METAPHOR IN THE ST AND THE TT

In this section, some examples of the use of the same conceptual metaphor in the TT are presented. Example 45 illustrates a case where the conceptual metaphor and the linguistic metaphor are the same in the ST and the TT.

45.  

In this scenario the universe as a whole is immortal.

In example 46, both the ST and the TT use the same linguistic metaphor “immortal” to instantiate the conceptual metaphor COSMIC ENTITIES ARE DIVINITIES.

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In examples 46 below, the conceptual metaphor COSMIC ENTITIES ARE RELIGIOUSLY BURIED BODIES instantiated by the linguistic metaphor ‘shroud’ is replaced by a different conceptual metaphor in TT.

46. (example 34 in Chapter 7.2.7).

ST The first observational obstacle yielded in the late 1970s, when astronomers began to observe star-forming regions at wavelengths that penetrate the dust shroud (file3340533).

TT في اواخر السبعينات من القرن العشرين ذللت اول عقبة رصدية. حين بدأ الفلكيون برصد مناطق نشوء النجوم باطوال موجية تحترق حجاب الخمار (file3340512).

BT In the late 70s of the 20th century, the first observational obstacle yielded when astronomers began to observe the star forming regions at wavelengths that penetrate the dust veil.

In example 37, the linguistic metaphor ‘shroud’ instantiating the conceptual metaphor COSMIC ENTITIES ARE RELIGIOUSLY BURIED BODIES in the ST is replaced by a different linguistic metaphor حجاب (veil).

Both linguistic metaphors ‘shroud’ in the ST and حجاب (veil) in the TT are religious clothing. The ‘shroud’ is used to envelope dead bodies before they are buried whereas حجاب (veil) is a typical Islamic cloth worn by women. The linguistic metaphor ‘shroud’ in the TT refers to the “disk” of dust surrounding a dead star. Consequently, the mapping between the dead bodies and dead stars is not rendered by the linguistic metaphor ‘veil’. The linguistic metaphor ‘veil’ refers to the fact that the star is hidden by the dust. The use of the linguistic metaphor حجاب (veil), although it does not produce a shift at the conceptual level, does not succeed in reproducing the ST image of a dead star enveloped in a shroud (dust). It is worth noting that the use of a different linguistic metaphor in the TT does not result from the lack of the cultural element in the TT. Both Christianity and Islam are monotheist religions that share some practices such as the envelopment of dead bodies before the burial. There is a direct equivalent for the linguistic metaphor in the TL/TC which is كفن (literally a shroud). Hence, the rendition of the linguistic metaphor ‘shroud’ by a different linguistic metaphor in the TT might be a result of the unawareness of the translator of the mappings between the source domain RELIGION AND FAITH and the target domain COSMIC ENTITIES in the ST.

It should be mentioned here that the ‘shroud’ and the حجاب (veil) can be both seen as instantiations of a different source domain which is CLOTH AND FABRIC analysed in the previous Chapter 8.3.5. However, since the highlighted mapping in the ST metaphor is more
in relation to the function of the shroud as a cover for a dead body which is a religious ritual, the retained interpretation was that they both linguistic metaphors belong to the source domain RELIGION AND FAITH.

8.3.6.3 Summary

The source domain RELIGION AND FAITH is the only source domain where the deletion of the linguistic metaphors in the TT prevails. There is no doubt that RELIGION AND FAITH is a culture-specific domain, but the different treatment this source domain has received raises questions relating to the translation policy followed by the translators of مجلة العلوم (Majallat-Al-Oloom). Especially that the use of the same conceptual metaphors as the main strategy for culture-specific metaphors has emerged as a trend from the different source domains analysed so far.

8.3.7 General summary

Chapter 8.3 has provided examples of how conceptual metaphors related to highly culture source domains and linguistic metaphors instantiating them are translated into Arabic using selected examples within a four-step framework converging translation solutions found in the literature.

The analysis shows that despite the culture-specificity of the pedagogical linguistic and conceptual metaphors used in the A&A, scenario three where the same conceptual and linguistic metaphor are used in both the ST and the TT is preferred.

Table 8.2. Frequency of the conceptual metaphor translation scenarios in the A&A corpus

<table>
<thead>
<tr>
<th>CM translation scenario in the TTs</th>
<th>(f)</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. No conceptual metaphor in the TT</td>
<td>80</td>
<td>29.6%</td>
</tr>
<tr>
<td>2. Different conceptual metaphor in the TT</td>
<td>12</td>
<td>4.4%</td>
</tr>
<tr>
<td>3. Same conceptual metaphor in the ST and TT</td>
<td>177</td>
<td>65.6%</td>
</tr>
<tr>
<td>4. Additional conceptual metaphor in the TT whereas no conceptual</td>
<td>1</td>
<td>0.4%</td>
</tr>
<tr>
<td>metaphor is used in the ST</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>271</td>
<td>100%</td>
</tr>
</tbody>
</table>
Although the non-transfer of culture-specific metaphors fulfilling a pedagogical function was expected to feature greatly in the A&A corpus given the cultural gap between English and Arabic, Table 8.2 above shows a relatively low percentage of non-transferred metaphors (29.6%) compared to the percentages of metaphors transferred into the TT (strategy 3 with 65.6%).

The non-transfer of metaphors into the TT results of either the deletion of whole passages that contain a linguistic metaphor instantiating a conceptual metaphor, or the suppression of an individual linguistic metaphor while the context is preserved or the use of a non-metaphorical expression in the TT.

Scenario 2, the use of a different conceptual metaphor in the TT represents 4.4% of the total translation strategies used to render culture-specific conceptual metaphors into the TT. This is the result of the use of 12 ST different linguistic metaphors instantiating a different conceptual metaphor in the TT. It is worth mentioning here that a different conceptual metaphor can also result from the use of the same linguistic metaphor which, however, instantiates a different conceptual metaphor in the TT. This strategy has not been used in the A&A corpus.

Scenario 3, the use of the same conceptual metaphor in ST and the TT represents 65.6% of the overall translation strategies used to render culture-specific pedagogical linguistic metaphors in the TT.

This result was the least expected, and hence, the linguistic metaphors instantiating the conceptual metaphor that are the same in the ST and the TT are analysed in some details to understand how culture-specificity was managed.

The analysis of scenario 3, shows that the same conceptual metaphor s used in the TT as a result of one of the following treatments of the linguistic metaphors.

- The use of the same linguistic metaphor instantiating the same conceptual metaphor in the ST and TT. Only 97/177 instantiating the same conceptual metaphor are direct equivalents/correspondents to the ST linguistic metaphors;
- The use of an elaborated or extended metaphor in the TT;

- The remaining 80/177 linguistic metaphors which instantiate the same conceptual metaphors in both the ST and the TT have been transferred into the TT using additional translation strategies that will be discussed Chapter 8.4.
Scenario 4, the use of metaphor in the TT where none is used in the ST. Only one instantiation of an added linguistic metaphors introducing a conceptual metaphor in the TT was identified in the analysis. However, further metaphors could be identified by a bidirectional analysis which can be done in future research.

However, it turns out that the analytical framework does not cover all translation strategies used to render conceptual and linguistic metaphors in the A&A corpus. The translators of Majallat-Al-Oloom used some other creative translation solutions to overcome the culture-specificity of pedagogical metaphors which have not been identified in previous studies. These translation solutions are presented in Section 8.4

8.4 Additional translation strategies not accounted for in the applied framework

This section highlights additional translation strategies used to render culture-specific pedagogical linguistic metaphors in the A&A corpus that have not been identified previously. These translation strategies result in the same conceptual metaphor being used in the ST and the TT (Scenario 3). It covers further analysis of eighty linguistic metaphors. Only illustrative examples are given in this section. Furthermore, the deletion of linguistic metaphors occurring in a cluster have not been covered in the literature and is presented here as an additional result emerging from the analysis of the A&A corpus.

The first set of additional translation strategies resulting in the use of the same conceptual metaphor in the TT (scenario 3) are as follow.

- The use of a ‘specific’ linguistic metaphor in the TT to render a linguistic metaphor of a general level in the ST. This strategy is discussed in Section 8.4.1;
- The use of a specific linguistic metaphor from the TC to render a specific linguistic metaphor from the SC. This translation strategy has been mentioned by Papadoudi (2014) but has not been fully analysed in her work. This strategy is discussed in Section 8.4.2;
- The use of a combination of different translation strategies to render the same linguistic metaphor (the “couplet” in Newmark’s (1988) terminology). This translation strategy represents an important outcome of the analysis of the A&A corpus. It has been used to render nearly half (45%, 80/177) of the linguistic metaphors that resulted in the same conceptual metaphor in both the ST and TT (scenario 3). Some of these couplets were
identified in Merakchi and Rogers (2013) as seen in Chapter 4.3, in addition to new ones presented in this chapter.

The use of a combination of translation strategies to reproduce the same conceptual metaphor and linguistic metaphor indicates that these conceptual metaphors are not shared between the two languages. Hence, the use of additional elements to ensure that these metaphors can be understood by the TT reader. The combination of many strategies indicates that these metaphors, in particular, are difficult to transfer and the use of the same linguistic metaphor alone might not suffice for an appropriate interpretation of the metaphor by the TT reader. This strategy is discussed in Section 8.4.3.

The second addition deals with a specific case of scenario 4 where linguistic metaphors are deleted within a cluster.

- The deletion of metaphor within a metaphor cluster. As seen before in Section 7.2.7, metaphor clusters are particularly interesting cases because they represent moments in the discourse where the author tries to explain something particularly difficult, as argued by Cameron (2004). From a translation perspective, there is no available framework for the analysis of metaphors in clusters. Section 8.4.4 sheds light on one aspect of metaphor clustering translation as it focuses on the deletion of metaphors in clusters as opposed to the deletion of single metaphors already analysed in Section 8.3. It is argued here that the deletion of metaphor in a cluster endangers the overall cohesion and coherence of the TT. The key points discussed are summarised in Section 8.4.5;

In this section, selected examples from the different culture-specific source domains discussed in the previous Section and in Chapter 7 are provided.

8.4.1 Shift from a general LM in the ST into a specific LM in the TT

There are twelve cases (12/80) found where linguistic metaphors in the TT are more specific than the ones used in the ST. This is the case, in examples 47 and 48, for the linguistic metaphor ‘monster’ instantiating the conceptual metaphor COSMIC ENTITIES ARE MYTHICAL AND FANTASTIC CHARACTERS. These linguistic metaphors have undergone many shifts to preserve the equivalence at the conceptual level in the TT. The shifts take place at the hypernymic level of the linguistic metaphor in example 47 below. In this example, there is a
shift from a specific word in the ST into a general-level word in the TT which is a common procedure in translation. This example is provided here as a prelude to the analysis of examples 47 and 48, where there is a shift from a general-level word in the ST to a specific word in the TT.

Example 46 below refers to a specific mythological character, the ‘behemoth’ of the Jewish folklore (defined by the Oxford Dictionary online as “an animal mentioned in the book of Job, probably the hippopotamus”41). In this example, the metaphorical word ‘behemoth’ is replaced in the translation by a more general word (وحش, i.e. ‘monster/beast’). The metaphor is also extended in the TT by the addition of the attribute ‘lurking’ which is an extension of the animate and dangerous nature of the monster as previously mentioned in Chapter 7.2. This extension results in an increase in the sense of the danger in the TT.

47.

ST The black hole to be imaged is the behemoth in our backyard, (file314298).

TT و الثقب الاسود الذي سوف يجري تصويره هو ذاك الثقب الوحش القابع في ساحتنا الخلفية (file4186878).

BT The black hole being imaged is the monster lurking in our backyard.

Whilst the linguistic metaphor shifts from specific to generic, in example 46 above, which is a common procedure in translation, the linguistic metaphor shifts from a generic level in the ST to a specific level in the TT in examples 47 and 48 below.

48.

ST Black holes need not be gargantuan, ravenous monsters (file418687).

TT ليست الثقوب السوداءشرهة بالضرورة وليس مسوخا نهمة. (file418674).

BT Black holes are not necessarily greedy and are not ravenous Maskh

In example 48, the same conceptual metaphor is used in the ST and the TT resulting from the use of the same linguistic metaphor ‘monsters’ rendered as مسوخ (Musukh). However, the linguistic metaphor in the TT is more specific than the metaphor in the ST. مسوخ (Musukh), the plural of مسخ (Maskh), are mythical characters from Arab folklore known as a very ugly variety of djinn42. This shift might be seen as a compensation strategy for the literal rendition of the linguistic metaphor ‘gargantuan’ in the same example.


42 http://www.baheth.info/all.jsp?term=مسوخ . [Last accessed 18/03/2017].
The conceptual metaphor is also transferred into the TT in example 49, resulting from a hyperonymic semantic shift from the general level word ‘giant’ in the ST to the specific level word مارد (Marid) in the TT.

49.

ST Closing in on the giant(file4186876).

TT تضييق الخناق على المارد العملاق(file4186874).

BT Closing in on the giant Marid

The linguistic metaphor مارد (Marid) in example 49 refer to specific varieties of “djinn” 43 from Arabic folklore as in the previous example. The linguistic metaphor ‘giant’ is transferred into the TT using the same linguistic metaphor العملاق (giant) used as an attribute emphasising the size feature of the monster and making the metaphor more explicit in the TT.

8.4.2 Shift from a LM specific to the source culture to a LM specific to the target culture.

There are four 4/80) cases where a ST culture-specific is replaced by a culture-specific element from the TT in the A&A corpus. Example 50 below illustrates a case where the conceptual metaphor COSMIC ENTITIES ARE FOOD is used in the ST and the TT but the linguistic metaphor instantiating it is different from the ST to the TT. The linguistic metaphor ‘pancake’, specific to the SL/SC culture, is replaced by the linguistic metaphor الفطيرة المرقوقة (Markook bread) in the TT which is specific to the TC.

50.

ST In general, prolate, or football-shaped, clouds tend to form bars that fragment into binary systems, whereas more oblate, or pancake-shaped clouds flatten to disks that later fragment into several members (file422608).

TT وفيوجه عام فإن النجوم التي لها شكل متطاول أو شكل كرة القدم الأمريكية تميل إلى تشكل قضبان تتشظى إلى منظمات ثنائية؛ أمّا الغيوم الأكثر تسطحاً والتي لها شكل الفطيرة المرقوقة فإنها تتبسم تتأخذ شكل أقراص تنشئ فيما بعد إلى عدة عناصر(file3340212).

BT In general, stars that have an elongated shape or the shape of the American football tend to form bars that split into binary systems whereas more oblate clouds which have a Markook bread shape flatten to take the form of a disks that split into different elements.

43 The Macmillan English dictionary defines the “djinn as an evil spirit that can look like a human or an animal and that uses its special powers to influence people”  
http://www.macmillandictionary.com/dictionary/american/jinn?q=djinn. [Last accessed 20/04/2017]. However, the Djinn, in the Arab folklore, can be either evil or good. This might be the reason why the translator referred to varieties of djinn that are both evil (the Marid and the Maskh are by definition evil) instead of the hyperonymic word ‘djinn’.
The ‘Markook bread’, popular in Middle East countries, is a kind of a flattened round bread similar in shape to the pancake. Consequently, the mapping between the source domain COOKING/HEATING/FOOD and the target domain COSMIC ENTITIES is preserved in the TT as both the pancake and the Markook share similar features with are the round and flattened shape. The ‘pancake’ is also used as a pedagogical linguistic metaphor in English popular texts about A&A through the works of Jean-Pierre Luminet as pointed out by Giaufret, and Rossi (2013) who analysed the English and French translations of the metaphor ‘stellar pancake’. The authors report that this linguistic metaphor has known the same process of cultural adaptation when translated into French (crêpe stellaire) similar to the treatment it received when translated into Arabic.

8.4.3 Different translation strategies combined to render the same LM in the TT

There are 64/80 cases where the same conceptual and linguistic metaphors in the ST and the TT result from the combination of different translation strategies. A similar linguistic metaphor is used in the TT combined with one or more of the following: an extension, gloss, a footnote, a note within the text. These different combinations are illustrated in what follows.

8.4.3.1 Same LM + a gloss+ an extension

The use of the same conceptual metaphor embedded in the same linguistic metaphor and an extension have been previously identified in the literature (Papadoudi 2010, 2014). However, the use of both the linguistic metaphor, the extension and a gloss is a new feature identified in the A&A corpus. This case is illustrated in example 51 below.

51. A better test is the topology of the universe: Does it wrap around like a doughnut or pretzel? (Does the multi verse exist?)

وعند ذلك اختبار أفضل هو طبولوجيا الكون: فهل يلتفت الكون حول نفسه مثل كعكة doughnut أو مثل قطعة الحلويات الشهيرة pretzel

There is a better test which is the typology of the universe. Does it wrap around like a doughnut [in English in the TT] cake or the popular piece of cake Pretzel (in English in the TT) which has a knot form?

In this example, the linguistic metaphors ‘doughnut’ and ‘pretzel’ are based on a metonymy where the shape of the universe is mapped onto the shape of a doughnut or a pretzel.

Although both metaphors occur in the same cluster and belong to the same source domain, they receive different treatment in the TT. The linguistic metaphor ‘doughnut’ is rendered by a gloss
‘doughnut’ in English in the TT) preceded by the linguistic metaphor ‘كعكة’ (cake). The addition of the word ‘cake’ is an extension that makes the meaning more explicit in the TT. However, no direct equivalent is used in the TT in the form of a calque of the word ‘doughnut’. Hence, this can be seen as a special case of this combination where a gloss (the same linguistic metaphor) is used in the TT with an extension.

The linguistic metaphor ‘pretzel’, in the same example, is rendered by a different combination which is a note embedded within the text in addition to the gloss as will be explained later in Section 8.4.3.4.

Returning to example 5, which was partially analysed in Chapter 8.3.1, the linguistic metaphor ‘Stradivarius’ was rendered combining the same linguistic metaphor (a calque) with an extension and gloss. The gloss tends to feature in the A&A corpus in addition to the use of the same linguistic metaphor or a calque to render terminological metaphors as part of a general trend where terminology is often glossed in Modern Standard Scientific Arabic writing not only in translated texts but also in original texts (Sharkas, 2011). However, it was not expected that the gloss would be used in combination with other means to render linguistic metaphors fulfilling pedagogical metaphors, as these were thought to be replaced by cultural elements from the TL/TC.

8.4.3.2 Same LM + extension + a footnote

The following example 52 shows a case where the conceptual and the linguistic metaphor are the same in both the ST and the TT. The linguistic metaphor in the TT is combined with a footnote where a gloss is also provided.

52. ST We will watch as some stars die violently, while others are reborn, phoenix-like, during collisions.

TT ستشاهد كيف تموت بعض النجوم موتاً عنيفاً، في حين تعاد ولادة نجوم أخرى، مثل طائر الفينيق (4)، أثناء تصادمات نجمية.

BT We will watch how some stars die violently while other stars are reborn like the phoenix bird (4) during stellar collisions.

(4) Translation note: “the phoenix is a mythical bird the Egyptians pretended it lives for 5 or six centuries then burn itself to be reborn younger. It is also known as “al anqaa”.
In example 52 above, the linguistic metaphor ‘phoenix’ is rendered in the TT using the same linguistic metaphor فيلق (a loan) extended by the addition of the word طائر (bird) and a translation note. Choosing this couplet to render the linguistic metaphor ‘phoenix’ as a translation strategy does not appear to be well motivated in the present case. Moreover, the translation note acknowledges that the mythical character ‘Phoenix’ is known in Arabic. Furthermore, there is a non-loan based linguistic equivalent for this linguistic metaphor which is the word عنقاء (anqaa) as explained in the footnote. Hence, it is not clear why the translator has combined many translation strategies to render a linguistic metaphor that, according to him, refers to a mythical character that is well known to the TT reader.

8.4.3.3 Different LM + a gloss + a footnote

The next example illustrates another combination of translation strategies where the same linguistic metaphor is combined with a gloss and a footnote (unlike the previous combination where the gloss was provided in the footnote). This is the case for the linguistic metaphor ‘stellar slam dancing’ embodying the source subdomain DANCE in example 52 below.

53.

ST By 1970 it became clear that the answer to the second question was no. Nor could stellar slam dancing explain the narrow jets that emanate from the central powerhouses of many quasars (file 316764).

TT بحلول عام 1970، صار من الواضح أن الجواب عن السؤال الثاني هو لا. ثم إن الرقص النجمي العنيف (2) slam dancing لم يفسر التدفقات الضيقة التي تبعث من مصادر الطاقة المركزية للكوازارات. (file318597).

BT By the advent of the year 1970, it became obvious that the answer to the second question is no. Furthermore, the violent stellar dancing (2) [slam dancing in English in the TT] did not explain the narrow flows that emanate from the central sources of energies of many quasars.

Translation note: (2) a type of dance on a Rock music where the dancers purposefully hurl into each other's.

In example 53, the linguistic metaphor ‘stellar slam dancing’ refers to a type of dance specific to the American culture as discussed in Chapter 7.2.1.2. It is rendered in the TT by the use of a different linguistic metaphor الرقص النجمي العنيف (violent stellar dancing) belonging to the same subdomain DANCE of the source domain ARTS combined with a gloss and a footnote. The footnote explains the meaning of slam dancing as a type of violent dance where the audience at rock concerts hurl themselves at each other. The equivalent linguistic metaphor in the TT الرقص النجمي العنيف (violent stellar dancing) does not refer to a proper type of dance. It is rather an expression created by the translator to mirror what happens in a slam dance. Despite its creativity, this linguistic metaphor does not fully succeed in preserving the mappings between
the source domain SLAM DANCING and the target domain STELLAR COLLISIONS. Violence is not the only entailment that is highlighted by the metaphor in the ST. The expression “violent dancing” fails to show that the dancers intend to hurl themselves into each other. It also fails to account for the fact that dancers like stars are jammed in a restrained space. The use of the gloss and the note seems to compensate for the incapacity to render the meaning using the expression ‘violence dancing’ alone.

8.4.3.4 Same LM + a gloss+ a note embedded within the text

As has been introduced in Section 8.4.3.1, example 51 illustrated a case where the linguistic metaphor ‘doughnut’ was rendered by a gloss and an extension (discussed in Section 8.4.3.1) in addition to the linguistic metaphor ‘pretzel’ that received a different treatment which consists in a use of a gloss and a note embedded within the text. The linguistic metaphor ‘pretzel’ in the TT is rendered into Arabic as 'a popular piece of cake with a knot form with the word “Pretzel” (in English in the TT). This case can be seen as a special case of this combination where a gloss is used with the embedded explanatory note without any calque (in Arabic).

Another example illustrating how a similar linguistic metaphor is used in the TT in addition to an embedded note and gloss is the linguistic metaphor ‘conga line’, in example 54 below. In this example, the linguistic metaphor ‘conga line’ is also rendered in the TT combining many translation strategies showing once again that highly cultural metaphors cannot always be translated straightforwardly. In this case, the same linguistic metaphor is combined with a gloss and a note embedded within the text.

54.

ST Space Invaders Spotting stellar immigrants takes a sharp eye. In principle, they give themselves away by lining up in long streams, like a conga line on a crowded dance floor (file4226032).

TT يتطلب اكتشاف النجوم المهاجرة انتباها وفطنة شديدين. وهي، من حيث المبدأ، تفشي سرها من غير قصد بتوضعها جنبًا إلى جنب في تيارات طويلة، كما تفعل مجموعة تودي رقصة conga، التي يسير فيها الرافضون في خطٍ كنّ خلف الكونغاكا، التي يسير فيها الرافضون في خطٍ كنّ خلف conga， which is also rendered in the TT combining many translation strategies showing once again that highly cultural metaphors cannot always be translated straightforwardly. In this case, the same linguistic metaphor is combined with a gloss and a note embedded within the text.

The ‘conga’ dance in example 54 above has received a slightly different treatment. The ‘conga’ as defined by the MEDA is a “*Latin American dance performed in line with each person’s
hands on the hips of the person in front of them”⁴⁴. In this example, the conga line is a direct metaphor. It is part of a cross-domain mapping where the stars line up behind each other in a similar fashion to the dancers in conga dance. The note added reads “where dancers walk behind each other’s”. The explanation the linguistic metaphor ‘conga’, in the TT, is integrated to the text in a coherent manner preserving not only the conceptual metaphor but also the textual coherence.

It should be mentioned that the whole linguistic expression of the source domain “like a conga line on a crowded dance floor” is stretched in the Arabic translation with extensions that do not only include the definition of the conga dance but also the whole image of a group of dancers performing a conga dance by lining up behind each other. The notion of ‘people’ is implicit in the ST whereas it is made explicit in the TT.

The next section can also be considered as a special case of the couplet: same linguistic metaphor + an embedded note in the text+ gloss. The difference is that the gloss is provided as a footnote.

8.4.3.5 Same LM + an embedded note in the text + a gloss in the footnote.

A similar treatment is reserved for the linguistic metaphor ‘jigsaw’ in example 55 below where the linguistic metaphor in the TT is a literal translation (word-for-word) accompanied by a note within the text inserted between brackets and a footnote providing the English equivalent (the gloss).

55. The jigsaw puzzle of star formation was coming together. (file3340512).

And consequently, the puzzle of the cut images (a puzzle consisting of paper or small wooden pieces one should arrange to get a given picture 4) related to star formation was coming to a solution.

4. Jigsaw

In this example, the ‘jigsaw puzzle’ refers to the different pieces of evidence (the pieces of the puzzle) that start getting into place to reveal the whole picture (the star formation). The Addition of the explanation in the TT seems to compensate for the lack of knowledge of the

game in the TL/TC. The word ‘احجية’ (puzzle) refers more to a word game where a player is given some clues to find the answer to a specific question (a riddle is a closer equivalent). The addition of the gloss is another extra element for the informed reader who has knowledge of the SL.

8.4.3.6 Same LM + extension + footnote including a gloss

Example 56 below illustrates an even more complicated case where an extended metaphor is used to explain some statistic probabilities related to the possible crash between an asteroid and planet Earth. The linguistic metaphors used in this metaphor cluster illustrates a specific conceptual metaphor belonging to the source domain SPORTS AND GAMES which is COSMIC COLLISIONS ARE A GAME OF POKER.

56.

A repeat is only a matter of time, but when? Until we completely catalogue all significant near-Earth asteroids—a job we have just begun—poker analogies must suffice [...] The chance of a global calamity in any year is about the same as drawing a royal flush; your annual chance of dying by other means is about the same as drawing three of a kind. (Aspaugh, 2000).

The repetition of this event is only a matter of time. But when? The answer is that we cannot know that before editing a full catalogue of all important asteroids near Earth—a job we have just begun—therefore, we will content ourselves by analogies from the poker game. [...] The probability of a global calamity in any year is approximately equal to the probability that you draw a “royal flush,” and the probability of your death by other means is approximately the same probability that you will draw three cards of the same kind of the game cards. Translation note (4) A royal flush is when you draw a set of play cards bearing the same engraving and are ranked in a suit: ace, king, queen, jack, and ten.

In this example, the author of the ST explicitly acknowledges his intention to use the poker metaphor to explain some probabilities linked to how likely an asteroid is to hit Earth. This is introduced by the use of the expression “poker analogies must suffice” in example 54 above. The author (Aspaugh, 2000) explains that an antecedent happened 65 million years ago where an asteroid crashed into planet Earth extinguishing “well over half the species”. The word ‘repeat’ refers to the probability of this serious threat to take place again. Fortunately for the Earth inhabitants, the probabilities of an ‘asteroid death’ are as low as a ‘hand of royal flush’
in a poker game whereas the probabilities of a ‘non-asteroid death’ are as frequent as a ‘three of a kind’ hand in poker.

The conceptual cross-mapping between the source domain GAME OF POKER and the target domain COSMIC ENTITIES (which are in this case an asteroid and planet Earth) seems to work well for the ST reader acquainted with the poker game. However, it might be more challenging for the TT reader. The deletion of the linguistic metaphors instantiating the conceptual metaphor COSMIC ENTITIES COLLISIONS IS A GAME OF POKER would have taken away a pedagogical metaphor which was explicitly acknowledged to be used for its explanatory power. Furthermore, the deletion of these linguistic metaphors would have endangered the textual coherence because of the early hinting to the use of the metaphor in the text. The conceptual metaphor and the linguistic metaphors embodying it are preserved in the TT by the use of an extended literal translation enhanced with a translation note. The linguistic metaphor ‘drawing’ is extended in TT to become ‘the potential to draw’, the linguistic metaphor ‘royal flush’ is double signalled by the addition of a double inverted comma (the first signal being the simile signal “as”) and an explanatory translation note. The linguistic metaphor ‘poker’ is extended by the addition of the word ‘game’ (لعبة البوكر) (poker game), the linguistic metaphor ‘three of a kind’ is extended to become احتمال سحبك ثلاث أوراق من النوع نفسه من أوراق اللعب (the probability of drawing three cards of the same type from the game cards).

The extension of the metaphor in the TT and the accompanying note where a gloss is also provided makes the conceptual metaphor COSMIC COLLISIONS ARE A GAME OF POKER more explicit in the TT, hence more accessible.

8.4.3.7 New metaphor combined with the same LM + footnote including a gloss.

Example 57 below is an interesting case where a new metaphor is introduced in the TT in addition to the transfer of an existing metaphor into the TT combined with a footnote including a gloss.

57.

ST  Beyond the orbit of Neptune, astronomers found hundreds of icy worlds, some quite large, occupying a 
doughnut-shaped 
region called the Kuiper belt (file4226058).

TT  فقد اكتشف الفلكيون، خارج مدار نيوت، مئات من العوالم الجليدية، بعضها كبير جدا، كانت جميعها تشغل منطقة ظرفية

(1) doughnut
Astronomers discovered, beyond the orbit of Neptune, hundreds of icy worlds, some are very big and occupying a region that has the shape of a car tyre or the cake named doughnut\(^{(1)}\) and this region was named the Kuiper belt [Kuiper belt in English in the TT].

(1) Doughnut

In this example, the linguistic metaphor ‘doughnut-shaped’ used to explain a terminological metaphor ‘Kuiper belt’ is rendered into an extended linguistic metaphor in the TT. The linguistic metaphor ‘doughnut-shaped’ is rendered in the TT as ‘الكعكةِ المسماةِ دونَتْ’ (the cake named doughnut) in addition to a gloss and another new metaphor ‘إطار السيارة’ (car tyre). The addition of the linguistic metaphor ‘إطار السيارة’ (car tyre) resulted in the addition of a new linguistic metaphor in the TT. This case is different from scenario 4 presented in the previous section because the new metaphor is not added in the target text where no metaphor is used in the source text but as an additional linguistic metaphor to render a metaphor from the ST that is also transferred into the TT. This case since the ‘doughnut’ is a linguistic metaphor instantiating a culture-specific domain, the shape of it might not be known to the TT reader. This translation solution has made the entitlement between the shape of the doughnut and the shape of the Kuiper region explicit through the mediation of the new linguistic metaphor ‘car tyre’.

We have so far discussed the different couplet used to render culture-specific pedagogical linguistic metaphors in the A&A corpus. We now move to discuss a specific where a linguistic metaphor is deleted within a cluster. This scenario does not fit within the framework used earlier (scenario I, deletion of the linguistic metaphor in the TT). The reason why the deletion of a linguistic metaphor within a cluster is deemed different from the deletion of a linguistic metaphor used alone is that linguistic metaphors clustering together are bound by a cohesive force as discussed in Section 7.2.8. If one or more linguistic metaphors clustering together is/are deleted this might affect the overall meaning as will be illustrated in the following section.

The next section is not an exhaustive analysis of all cases of metaphors clustering in the A&A corpus, but presents illustrative examples identified in the A&A corpus (as explained in the methodology, Chapter 6). It was also highlighted in Chapter 7.2.7 that the metaphor clustering was not a research parameter from the beginning of the study but emerged as a feature of the A&A corpus during the analysis of the data. The next section does not cover all aspects of how metaphor clusters
are rendered into the TT in the A&A corpus but focuses only on cases of deletion considered as a special case of the non-transfer of the conceptual metaphor to the TT seen in the previous Chapter 8.2.

8.4.4 Deletion of a linguistic metaphor within a metaphor cluster

This section discusses some cases of the deletion of linguistic metaphors occurring in metaphor clusters. It tries to explain how this differ from the deletion of metaphors occurring alone in the A&A corpus, already analysed in Chapter 8.2.

Example 58 below illustrates linguistic metaphors from the source domain MYTHICAL AND FANTASTIC CHARACTERS.

58. (Example 22 in 7.2.3).

ST Celestial Pied Piper. The red dwarf star Gliese 710, will crash through the Oort cloud in 1.4 million years--reanimating dormant comets, luring many out of their orbits and hurling some toward the planets. (file3164347).

TT ان النجم القزم الاحمر گليز 710 سيخترق سحابة اورت خلال 1.4 مليون سنة, باعثًا الحياة في مذنبات هاجمة، مستدرجا الكثير. (file3340216)

BT The red dwarf star Gliese 710 will penetrate the Oort cloud in 1.4 million years reanimating dormant comets, luring many of them out of their orbits and hurling some of them towards the planets.

In example 58, the conceptual metaphor COSMIC ENTITIES ARE MYTHICAL AND FANTASTIC CHARACTERS is instantiated by linguistic metaphors that occur in close proximity in the same segment of the text. The linguistic metaphor ‘Pied Piper’ is deleted in the TT whereas the other linguistic metaphors ‘reanimating’, ‘dormant’, ‘luring’ and ‘hurling’ are replicated in the TT. The deletion of the linguistic metaphor ‘Pied Piper’ blurs the origin of this conceptual metaphor and its entailments for the TT reader. Hence, the whole image cannot be accessed by the TT reader.

The next example belongs to a different source domain, which is SPORTS AND GAMES

59. (Example 28 in Chapter 7.2.4)

ST Rather they are features shaped by the competition between cosmic expansion and any phenomenon affecting it and their own gravity. In our universe, neither player in this tug-of-war is overwhelmingly dominant. If dark energy were stronger, expansion would have won and matter would be spread out rather than concentrated in filaments. (file3145756).
In example 59, the cluster of linguistic metaphors ‘competition’, ‘dominant’, ‘stronger’ and ‘won’ are rendered in the TT whereas the linguistic metaphors ‘players’, and ‘tug of war’ are deleted. The deletion of these two linguistic metaphors results in a partial loss of meaning as it blurs the entailments between the source domain SPORTS AND GAMES where a specific sport is used and the target domain COSMIC ENTITIES, more specifically, the unbalanced forces of expansion and dark energy. The coherence of the whole picture is, however, preserved in the TT by the merging of the first and second sentences.

The next example illustrates a case where a direct linguistic metaphor ‘marshmallow’ instantiating the source domain COOKING, HEATING AND FOOD is deleted in the metaphor cluster.

60.

**ST.** The size matched theoretical predictions that the planet, located so close to its star, would have **puffed up like a roasted marshmallow** (Doyle et al., 2002).

**TT** (Doyle et al., 2002).

**BT** The size corresponds to the theoretical predictions that foresee that this planet, very close to its star may have swollen.

In example 60, the direct metaphor ‘roasted marshmallow’ is deleted. So, the source domain of a type of air-infused sweet that can be roasted by the fire (marshmallow) causing the air to expand, is omitted, whilst the linguistic metaphor ‘puffed up’ is translated by a different linguistic metaphor ‘swollen’ instantiating a different source domain (Merakchi and Rogers, 2013).

The next example relates to another source domain which is CLOTH AND FABRIC

61.
These amazing outflows traverse distances larger than galaxies, yet they originate near the black hole as intense beams collimated tightly enough that they could thread the solar system—the eye of a galactic needle (file418687).

In example 61, the linguistic metaphor ‘thread’ instantiating the conceptual metaphor THE UNIVERSE IS A FABRIC is rendered by a non-metaphorical expression تختترق (penetrate). The non-metaphorical rendition of the linguistic metaphor ‘thread’ makes the whole image less explicit on the TT as the connexion between the ‘beams’ and the ‘eye of the needle’ which is the ‘thread’ is not transparent to the TT reader.

The analysis of these cases of a deletion of a linguistic metaphor in a cluster shows that it is important to integrate a textual dimension for the study of metaphor in translation to account for the effect of the translation strategies used on the cohesion and coherence of the metaphors that are related in a text. Further analysis is needed to fully answer the question: How is linguistic metaphors clustering processed in popular science texts?

Now that we have covered the different additional translation strategies used to render culture-specific metaphors in the A&A bilingual corpus, we move to discuss the metaphor signalling in the TT. As introduced in Section 7.1.5, the analysis of metaphor signalling allows tracking possible shifts in signalling patterns between the ST and TT.

8.5 Metaphor signalling in the TT

This section reports on the identified metaphor signalling patterns in the TT for culture-specific pedagogical metaphors, some of which have been mentioned in the discussion of other features, and discusses the significance of these results from a translation perspective.

The analysis of the A&A corpus has revealed eight (8) possible patterns of metaphor signalling in translation between ST>TT as shown in table 8.3 below.
Table 8.3. Metaphor signalling translation patterns in the A&A corpus and their frequencies organised in decreasing number

<table>
<thead>
<tr>
<th>Signalling pattern in the A&amp;A corpus</th>
<th>Absolute frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Indirect&gt;indirect</td>
<td>132</td>
</tr>
<tr>
<td>(2) Indirect&gt;zero</td>
<td>51</td>
</tr>
<tr>
<td>(3) Indirect&gt;direct</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total for Indirect ST LMs</strong></td>
<td><strong>187</strong></td>
</tr>
<tr>
<td>(4) Direct&gt;direct</td>
<td>48</td>
</tr>
<tr>
<td>(5) Direct&gt;Direct (2 signals in the TT)</td>
<td>6</td>
</tr>
<tr>
<td>(6) Direct&gt;zero</td>
<td>29</td>
</tr>
<tr>
<td>(7) Direct&gt;indirect</td>
<td>0</td>
</tr>
<tr>
<td>(8) Zero&gt;direct</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total for Direct ST LMs</strong></td>
<td><strong>84</strong></td>
</tr>
<tr>
<td><strong>Grand Total</strong></td>
<td><strong>271</strong></td>
</tr>
</tbody>
</table>

Table 8.3 above shows that the dominant signalling pattern in the TT—well over half—is the rendition of indirect metaphors into indirect metaphors (132/271 of the total indirect culture-specific pedagogical metaphors). Similarly, direct metaphors, in most cases, are rendered into direct metaphors (48/84 where 84 is the total number of direct metaphors) in addition to 6 linguistic metaphors which were double signalled in the A&A Arabic corpus. These figures indicate that the linguistic metaphor signalling is, generally, preserved in the TT.

However, indirect metaphors have known a higher rate of deletion in the TT compared to direct metaphors with 51/191 (indirect>0) indirect metaphors deleted in the TT compared to 29/84 of direct metaphors (direct>0).

Moreover, direct metaphors have been emphasised in the TT by the introduction of an additional signal. This is the case for instance in example 56 in section 8.4.3.6 where the linguistic metaphor ‘royal flush’, signalled in the ST by the copular simile as is signalled in the TT by the copular simile مثل(as) in addition to the signal ‘double quotation mark’ (””).

It is also interesting to note that the only case where a linguistic metaphor is added in the TT is a direct metaphor (الشبيهة رقعة الشطرنج) (resembling a chessboard) in example 29 in Chapter 8.3.3.4.
These figures indicate a preference to preserve direct metaphors in TT which can be explained as follows:

- Direct metaphors might be thought to be more relevant than indirect metaphors as a means to explain the scientific concepts to a non-expert readership; hence, the relevance of transferring them into the TT. This point of view is reflected in the literature where direct metaphors (also called ‘analogies’ in Gentner (1983), Gentner and Bowdle (2001)) are thought to play an important pedagogical role in different scientific genres including popular science texts.

- The deletion of a direct metaphor might generate other problems related to the coherence and cohesion of the text especially for metaphors that are reused such as the linguistic metaphor ‘pipe’ in example 6 (Chapter 8.3.1) or extended such as the linguistic metaphor ‘roller coaster’ in example 31 (Chapter 7.2.4) or occurring in a cluster such as the linguistic metaphor ‘Pied Piper’ metaphor in example 58 (Chapter 8.4.4).

Despite this preference to preserve direct metaphors in the TT, the culture-specific pedagogical metaphors signalling is less than expected (see the discussion of metaphor signals in the ST in Chapter 7.).

The reason why metaphor signalling was expected to feature more prominently in the TT is that the culture-specificity is seen as a hindrance for metaphor interpretation by the TT reader. Hence, the necessity to make the metaphor explicit in the TT. As argued by Papadoudi (2010) who identified a trend to render indirect metaphors by direct metaphors in her corpus of popular technology texts translated from English into Greek, the signal is a way of making the metaphor explicit. Hence, drawing the reader’s attention to the presence of cross-domain mapping to avoid a literal interpretation.

The analysis of the A&A corpus reveals that, indeed, culture-specific metaphors are made explicit in the TT, but not through a shift in the metaphor signalling pattern.

The culture-specific metaphors are made explicit by combining many translation strategies where a literal translation of the culture-specific metaphor is combined with an extension, gloss, a note within the text or in the margin as discussed in Section 8.4.3 above. The additional elements (the notes and extensions more specifically) are seen as means of explicitation. If
Pym (2005)’s definition, provided below, of what counts as explicitness is applied, the translation strategies described in Chapter 8.4.1 and 8.4.2 where the ST metaphor is replaced by a culture-specific from the TT would also count as explicitation in addition to extension and notes.

Explicitation takes place, for example, when a SL [source-language] unit of a more general meaning is replaced by a TL [target-language] unit of a more special meaning; the complex meaning of a SL word is distributed over several words in the TL; new meaningful elements appear in the TL text; one sentence in the SL is divided into two or several sentences in the TL; or, when SL phrases are extended or “elevated” into clauses in the TL, etc.(Pym, 2005).

In this section, the hypothesis regarding potential shifts in the signalling of culture-specific metaphors fulfilling a pedagogical function in the TT was examined. It was found that the dominant metaphor signalling patterns are: direct>direct and indirect>indirect. However, the pattern indirect>zero is found to be higher in frequency than the pattern direct>zero. Hence, it is concluded that there is a trend to preserve direct metaphors in the TT. This trend might indicate that direct metaphors are considered to have a greater role in explaining the A&A scientific concepts compared to direct metaphors. In addition, the deletion of direct metaphors might generate more coherence problems.

It was also found that explicitation that was thought to be achieved by an increase in metaphor signalling in the TT is achieved by other means. These include the use of the extension, notes, gloss and a shift from a general level metaphor or a metaphor specific to the SL/SC in the ST into a pedagogical metaphor specific to the TL/TC in the TT.

Now that we have presented the results of the analysis of the metaphor in the TT, we move on to discuss these results.

8.6 Discussion and interpretation of results

In the previous sections, the different translation strategies used to render culture-specific metaphors with a pedagogical function into Arabic were analysed. This section presents a discussion of these translation strategies in the light of the second research question of the current study where the translation solutions for culture-specific metaphors used in the TT are investigated.
Linguistic metaphors embedded in culture-specific source domains fulfilling a pedagogical function analysed in Chapter 8.3 show that the culture-specificity of the pedagogical metaphor is a key element in communicating complex concepts between the author and his/her original readership. The original framework proposed in the literature used for metaphor analysis was found insufficient to render the complexity of translating culture-specific metaphors. This is the case, for example, for the ‘poker’ metaphor used to explain how unlikely a crash is between an asteroid and Earth. Whilst this metaphor works well for the original readership familiar with the poker game, it is more challenging for the TT reader. Hence, the use of a creative solution consisting of a combination of two or more translation strategies to transfer this metaphor into the TT was preferred, as seen in Chapter 8.4. The culture-specificity of metaphors in scientific texts in general and popular science articles, in particular, has been under-researched in both metaphor studies and translation studies.

In terms of the four scenarios analysis identified earlier, scenario 3 which consists of using the same conceptual and linguistic metaphors in both the ST and TT prevails in the corpus.

However, as seen in Chapter 8.4, the use of the same linguistic metaphor is, in almost half the cases, combined with another solution to transfer the linguistic metaphor into the TT.

Scenario 1 where the conceptual metaphor is deleted in the TT comes next in terms of frequency of use. This scenario encompasses the rendition of the metaphor by a non-metaphorical expression in the TT which prevailed over the deletion of the metaphor.

Scenario 2 where a different conceptual metaphor is used does not seem to be a preferred solution in rendering linguistic metaphors into the TT in the A&A corpus as it came third in terms of frequency of use.

Scenario 4 could only be verified in one case where a linguistic metaphor was added to the TT whereas none was used in the ST.

In addition, the analysis revealed that additional translation strategies (i.e. translation procedures) are used to render culture-specific pedagogical metaphors. These strategies include the shift from a general level or culture-specific linguistic metaphor in the S into a culture-specific linguistic metaphor in the TT, the combination of a literal rendition of the linguistic
metaphor in the TT with a gloss, and/or a note in the margin or a note embedded in the text or an extension.

The use of the same conceptual and linguistic metaphor in the source and target texts belonging to the genre of popular science in English Arabic pair of languages is also found to be prevalent in a similar study conducted by Alshunnag (2016). The researcher investigated the translation of conceptual and linguistic metaphors in popular science texts in a different subject field, which is biomedicine. He argues that the dominance of the use of the same conceptual metaphors and linguistic metaphors in the TT is attributed to the “desire to maintain the metaphorical sense of the ST imagery, which is significant for the communicative function of the TT” (2016:297).

Although we agree with Alshunnag (ibid.) in his explanation that the communicative, and more importantly, the pedagogical function of linguistic metaphors in the ST motivate their transfer to the TT, we disagree with him when he argues that similar conceptualisations between American English and Arabic culture have facilitated the transfer of the conceptual and linguistic metaphors to the TT.

Before the reasons for this disagreement are explained, it is worth noting that Alshunnag’s (2016) bilingual English Arabic corpus is composed of biomedical texts published in Scientific American magazine and its Arabic translation, which is the same magazine where the A&A articles used for this study are published. Alshunnag’s corpus is both genre specific (popular science articles) and subject-specific (biomedical texts). These features (subject and genre specificity) of Alshunnag’s study offer the possibility to interpret the findings of the current study beyond the A&A subject field and beyond culture-specific pedagogical linguistic metaphors.

As argued earlier, the use of the same conceptual metaphors in the TT cannot be the result of similar conceptualisations between American English and Standard Modern Arabic. The similarity is rather created by the translation process. As seen in Section 4.3, the concept of a ‘similarity-creating metaphor’ was used by Fuertes-Olivera and Pizarro-Sánchez (2002) to explain the similar conceptual metaphors and linguistic metaphors found in specialised business texts translated from English into Spanish. Fuertes-Olivera and Pizarro-Sánchez (2002) argue that the similarity at the conceptual and linguistic levels between the English and
Spanish metaphors is the result of the use of literal translation. Samaniego Fernández et al., (2005) go even further to argue that the literal translation of metaphors impacts the target systems and contributes to intercultural standardization as stated below:

A relevant number of novel TT metaphors come from literal translations of linguistic material in the ST. In these cases, by making intentional or unintentional use of literal translations translators are in fact introducing new linguistic expressions and thus new conceptual structures in the target culture in the long run and in our opinion this contributes to intercultural standardization (Samaniego Fernández et al., 2005:77).

Although Samaniego Fernández et al., (ibid.) study presents a major methodological issue because the authors do not provide a valid identification method for ‘novel metaphors’ in the TT, their argument could explain the prevalence of the use of the same conceptual and linguistic metaphor in the A&A Arabic subcorpus. The use of the same conceptual and linguistic metaphors to render culture-specific metaphor is a result of a literal translation and not from similarities in the conceptual and linguistic systems between the two languages as argued by Alshunnag (2016).

Furthermore, this interpretation takes into account the power inequalities between English and Arabic. It should be remembered here that English, in the current global context is used as a global lingua franca whereas Modern Standard Arabic still relies on translation as a necessary channel to transfer knowledge (Salama-Carr, 2015:152). In this case, the creative translation solutions used in the A&A corpus allows not only to filling in lexical and terminological gaps in the TL but also to introducing new concepts.

The additional translation strategies that emerge from the analysis support this argument. The literal translation (more than half of the total metaphors) of culture-specific metaphors is often accompanied by other strategies to facilitate the passage of the ST linguistic metaphor into the TT. As seen in the previous section, different solutions were used to overcome problems posed by the degree of cultural specificity of the pedagogical metaphor. These solutions range from the replacement of a culture-specific elements of the ST by a culture-specific element to the use of different combinations of the same linguistic metaphor, an extension, gloss, notes within the text or notes in the margin. The use of notes in particular in combination with a literal rendition of the culture-specific metaphor indicates that the translator has concluded that the TT reader might not be able to interpret the metaphor if not aided. This is further evidence that
the use of a similar conceptual and linguistic metaphor results from the translation process and not from a pre-existing similarity between the two languages/cultures.

It was argued so far that translators import culture-specific metaphors from the ST into the TT by using different solutions to preserve the functional equivalence at the conceptual level. When the passage of these metaphors into the TT is particularly difficult (impeding the comprehensibility of the linguistic metaphor to the TT reader), additional elements are used to aid the reader in accessing the mapping between the source and the target domain of the metaphor. It has also been argued that this procedure of using the same conceptual and linguistic metaphors results in the creation of new and novel metaphors in the target text and contributes to enriching the target system as argued in an earlier study where a sample of the A&A corpus (circa 75000 words) was analysed (Merakchi and Rogers, 2013).

The analysis of the whole A&A corpus (circa 150,000 words) has shed light on an additional dimension of metaphor use in the A&A corpus, which is the textual dimension. The analysis of cases of deletion has led to the identification of the deletion of a linguistic metaphor occurring in a cluster as an additional problem in rendering culture-specific pedagogical linguistic metaphors into the TT. It has been argued that the deletion of a metaphor from a cluster affects the cohesion in the TT and might blur the mappings between the source and target domains of the metaphor in the TT. This is the case for instance in example 58 in Chapter 8.4.4 where the deletion of the linguistic metaphor ‘Pied Piper’ obscured the mapping between the target domain COSMIC ENTITIES and the source domain MYTHICAL AND FANTASTIC CHARACTERS.

None of the previous research has considered the different implications resulting from the deletion of metaphor in a cluster as opposed to the deletion of an isolated metaphor. The translation of clustering pedagogical metaphors needs to be further investigated to understand how the dynamics of cohesion and coherence are affected in the TT.

Furthermore, the metaphor signalling pattern was not found to vary significantly between the ST and the TT although an increase in metaphor signalling was expected to be found. The increase in metaphor signalling was expected to feature in the A&A corpus as a means of explicitation, as explained in Chapter 8.5. However, the invariance in the signalling pattern does not undermine the assumption that culture-specific pedagogical metaphors are made more
explicit in the TT. As already mentioned in Section 8.5, culture-specific metaphors with a pedagogical function are, indeed, made more explicit in the TT by the use of a different means which consists of combining different translation strategies.

8.7 Conclusion

This chapter set out to answer the second research question about how conceptual and linguistic metaphors are translated into Arabic in the genre of popular science articles about Astronomy and Astrophysics. It has focused on metaphors fulfilling a pedagogical function because they are prevalent and lexically more varied in the A&A corpus, as discussed in Chapter 7. Pedagogical linguistic metaphors were found to be embedded in a wide range of source domains which vary in their degree of culture-specificity. Given their potential for translation, the culture-specific source domains, previously analysed in Chapter 7, were analysed and discussed in this Chapter from a translation perspective.

The culture-specific domains were analysed according to a framework where translation solutions were grouped according to the transfer or non-transfer of the conceptual metaphor into the TT.

The first scenario, as originally conceived before the analysis reported in this Chapter, consisted in the non-transfer of the conceptual metaphor into the TT as a result of three different strategies for dealing with a linguistic metaphor:

- Deletion of the passage containing the linguistic metaphor;
- Deletion of the linguistic metaphor within a sentence in the TT;
- Use of a non-metaphorical expression in the TT.

Although this scenario was expected to feature highly given the culture-specificity of the source domains where the linguistic metaphors are embedded, it did not prevail in the A&A corpus, accounting for just under 30% of the 270 metaphors analysed.

In addition to these three translation strategies, a new strategy was identified in the A&A corpus where the conceptual metaphor was partially transferred into the TT as a result of a deletion of a single metaphor in a cluster containing linguistic metaphors instantiating the same or different source domains.
The second scenario consisted in the use of a different conceptual metaphor in the ST and the TT as a result of two different strategies for dealing with the linguistic metaphor:

- Use of different linguistic metaphor instantiating a different conceptual metaphor in the TT;
- Use of the same linguistic metaphor instantiating a different conceptual metaphor in the TT.

This scenario was realised in the A&A corpus using only the first translation strategy and accounted for under 5% of the metaphors analysed.

The third scenario consisted in the use of the same conceptual metaphor in the TT as a result of the following translation strategies to deal with linguistic metaphors:

- Use of a similar linguistic metaphor in the TT;
- Use of a similar linguistic in the TT with an extension;
- Use of a general level linguistic metaphor in the TT to translate a specific linguistic metaphor in the ST;
- Use of a specific linguistic metaphor from the TT culture to render a general level metaphor in the ST which was discussed in Merakchi and Rogers (2013);
- Use of a specific linguistic metaphor from the TT to render a specific metaphor from the ST. This strategy was analysed in Merakchi and Rogers (2013) and briefly discussed in Papadoudi (2014).

This scenario featured highly in the A&A corpus—accounting for nearly two-thirds of cases—not only as a result of using the above-mentioned strategies but also as a result of new translation strategies identified in the A&A corpus. These strategies consist in the use of seven different combinations of translation strategies (couplets in Newmark’s terms). One of these translation strategies, which consists in the use of a different linguistic metaphor with a gloss and a footnote, was analysed in our earlier study (Merakchi and Rogers, 2013). In addition, the full analysis of the A&A corpus has revealed five other combinations of translation strategies dealing with linguistic metaphors and resulting in the same conceptual metaphor in the TT. These strategies are:

- Use of the same linguistic metaphor with a gloss and extension;
- Use of the same linguistic metaphor with a gloss and a footnote,
- The use of the same linguistic metaphor with a gloss and a note embedded within the text;
- Use of the same linguistic metaphor with a note embedded within the text and gloss in a footnote;
- Use of the same linguistic metaphor with a footnote including a gloss.
As discussed earlier in Chapter 4, some scholars have identified a scenario where a conceptual metaphor is created in the TT resulting in the use of a linguistic metaphor in the TT where none is used in the source text. This can be either the result of the translation of a non-metaphorical expression into a linguistic metaphor or nil into a linguistic metaphor. However, in order to identify this scenario, the corpus should be analysed bidirectionally. In the present study, the analysis was done unidirectionally. Hence, it can only be reported here that one case of addition was accidently flagged out as the added metaphor in the TT occurred next to another metaphor which was coded as a translation of a metaphor from the ST. This is the case for the linguistic metaphor ‘chessboard’ instantiating the source domain SPORTS AND GAMES which was added into the TT and discussed in Chapter 8.3.3.

Two additional translation strategies identified in the A&A corpus consists of the use of a new linguistic metaphor instantiating a different source domain in addition to the use of a similar linguistic metaphor from the ST with a gloss (strategy 6) or with a gloss and a footnote (7). This is the case for the linguistic metaphor ‘doughnut’ rendered by the same linguistic metaphor which is extended in the TT كعكة الدونت (the doughnut cake) and another new metaphor إطار سيارة (car tyre). As explained earlier in this chapter, the linguistic metaphor إطار سيارة (car tyre) appears to serve as a metaphor to explain a metaphor. The Kuiper region is said to have the shape of a doughnut or a car tyre in the TT. If the TT reader cannot access the mapping consisting of the round shape of the doughnut directly, then the car tyre image facilitates the access by providing an alternative image which the TT reader is familiar with.

These additional translation strategies identified in the A&A corpus indicate that the mapping between the source and the target domain of a culture-specific metaphor might not be easily accessible to the TT reader and requires explicitation. Explicitation was not achieved through further signalling of the linguistic metaphors as expected as the metaphor signalling pattern is found to be largely unchanged as discussed in Section 8.5. As mentioned earlier, what is explicited in not the cultural artefact itself, for instance the game of poker but the entailments between the cultural artefact as a source domain with the target domain which is the cosmic object or the cosmos.

This explicitation role is, however, fulfilled by the different couplets identified in the A&A corpus, which seems to make the mapping between the source domain and the target domain of the conceptual metaphors more explicit, hence accessible to the TT reader. Explicitness
indicates, on the one hand, a certain awareness by the translators of Majallat-Al-Oloom of the role pedagogical metaphors play in explaining scientific concepts; in addition to a conscious or subconscious effort to make the TT accessible (Frankenberg-Garcia 2009a); on the other hand, it indicates that highly culture specific metaphors used in A&A are difficult to translate and require creative translation solutions.

Furthermore, the results from this study seem to corroborate the findings of Manfredi (2014), who investigated the translation of lexical and grammatical metaphors in the headings of the American popular science magazine National Geographic and their Italian translation. Manfredi (2014) reports a general trend towards explicitation in her bilingual parallel corpus. Hence, the explicitation of metaphors might be considered as a feature of the genre of popular science articles as well as a translation strategy to cope with cultural variation between the source and target texts.
Chapter 9. Conclusion

This chapter presents a summary of the main findings of the current study (Section 9.1), before outlining the limitations of the study (Section 9.2) and how this research can be extended in the future (Section 9.3).

9.1 Findings

This study aimed to explore the role of metaphors and their translations in the dissemination of the scientific knowledge in the field of astronomy and astrophysics in a global context where English is argued to be a global lingua franca of scientific communication.

To answer this question, the following subquestions were answered:

✓ What are the linguistic metaphors used in popular science articles of Astronomy and Astrophysics (A&A), what functions do they fulfil and to what extent are they signalled?

✓ What are the source domains in which these linguistic metaphors are embedded and what are the conceptual metaphors related to them?

✓ How are these conceptual and linguistic metaphors addressed in translation?

In order to answer these questions, it was important to review the scope of popular science and its genres. In the present study, it is argued that popular science writing is an intralingual translation in the sense that it is a complex operation of meaning transfer by recontextualization and adaptation to the particular needs of the non-specialist readership.

In order to suit the needs of this specific readership made up of non-specialists in the A&A field, chosen for its complex and often, highly abstract concepts, metaphors are used as an important strategy of recontextualization and adaptation. A bilingual digital corpus of parallel texts from Scientific American and its Arabic translation مجلة العلوم specifically compiled to answer the research questions, provides the empirical basis of the study. In order to capture and process the relevant data, a series of steps was devised for both the English source-texts sub-corpus (75, 124 words) and the Arabic sub-corpus (80,524 words), initially based on the MIPVU metaphor identification strategy and on explicitating the steps to infer the conceptual metaphors from the linguistic data. MIPVU was developed for monolingual research, and it was adapted to fit the purposes of a translation-oriented research.
The analysis established that the main function of metaphors in the English popular science texts studied here is to explain scientific concepts. In other words, their main function is “pedagogical”. In addition, metaphors in the texts studied fulfil a terminological function. This function is also found in specialised texts. The third function dubbed the “generic function” encompasses metaphors from the common stock of the language that can serve different purposes such as appealing to the reader’s attention. The pedagogical and terminological functions are considered to be genre-specific and are used in popular science articles and research articles whereas generic metaphors are not genre-specific. An analysis of the type-token ratio for each metaphor function also revealed the greater lexical variation exhibited by pedagogical metaphors. These findings indicate that metaphors play an important role in scientific language in general and in the development of modern scientific language in Arabic through the combination of literal translation with other translation strategies such as notes and gloss.

More importantly, the degree of culture-specificity found in the data challenges the way English is viewed as a global lingua franca. The language of the sciences has been argued to be neutral and rhetoric free whereas the current study demonstrated that cultural elements are embedded in metaphors in English texts. These cultural issues can rise a challenge in intercultural communication where language is used a global lingual franca.

The data also revealed that pedagogical and terminological metaphors interact to support the comprehension of complex scientific concepts. Often expressed metaphorically, scientific terms are explained by means of pedagogical metaphors, leading to a concentration of metaphors in certain segments of the text, described in this study as metaphor clusters, which then became part of the translation analysis.

In order to understand how conceptual and linguistic metaphors travel between English as a global lingua franca and Modern Standard Arabic, it was necessary to review different approaches to metaphor translation starting with the traditional linguistic approaches and moving on to the conceptual approach.

The analysis of the different metaphor translation frameworks led to the conclusion that a multidimensional approach encompassing the conceptual, the linguistic and the cultural aspects of metaphor is more likely to shed light on metaphor translation issues in the chosen
genre. The application of this genre-based framework to the study of metaphor in translation can be argued here to be an addition to the existing research on metaphor translation.

An important part of this study was the elaboration of a reliable method for a multidimensional analysis of conceptual and linguistic metaphors in the English and Arabic subcorpora. The first step towards the analysis of the metaphor was the elaboration of a reliable method for metaphor identification. MIPVU, originally developed to work with the English language, was adapted for the analysis of the English subcorpus. An additional step was integrated to allow the identification of the metaphor function (generic, pedagogical, terminological). In addition, some steps were modified to allow the identification of linguistic metaphors in the A&A Arabic subcorpus. Although the English and Arabic parallel texts were aligned in order to capture the Arabic data through the unidirectional analysis, a reliable method was necessary to verify the metaphoricity of words when the TT uses different words from the ST. The main challenge consisted in finding a way to overcome the lack of a reliable Modern Arabic Language dictionary to help in the identification of basic meanings of potentially metaphorical words in MIPVU. This problem was overcome by using a reference corpus (TenTen Arabic) as a means to capture the basic meaning of words where frequency of use is taken as a criterion.

The methodology used allowed the identification of numerous linguistic metaphors in the English source texts, the majority of which were found, as noted, to fulfil a pedagogical function and to exhibit a greater lexical variation. Moving on to the conceptual dimension of the linguistic metaphors captured from the data, it was established that the source domains of the pedagogical metaphors—which became the focus of the study—were embedded in a wide range of source domains with different levels of cultural specificity. These culture-specific pedagogical metaphors were then the focus of the analysis in Chapter 7 and Chapter 8 because of their potential for translation analysis in view of anticipated cultural gaps, lexical richness and importance of pedagogical metaphors to the communicative nature of the genre.

In an earlier study (Merakchi and Rogers 2013), it was found that the dominant translation strategies for the culture-specific metaphors in a sample of the present corpus tend to indicate creative linguistic attempts by the Arabic translators to retain the conceptual metaphor in the target text. The full analysis of the A&A corpus has confirmed this earlier finding by identifying a full range of solutions, including couplets, where different translation strategies were combined to make the ST conceptual and linguistic metaphor accessible to the non-
specialist TT reader. The prevalence of the literal rendition of the culture specific metaphors along with the use of the couplet indicates a trend to foreignize culture specific metaphors. However, further research needs to be done to find out whether this is a general language trait that is developing in scientific language in Arabic or is the result of the policy implemented by the translation body, the Kuwait Foundation for the Advancement of the Sciences (KFAS) as suggested by Al-Shunnag (2016).

Most of the newly identified translation strategies dealing with the pedagogical linguistic metaphors were found to have contributed to the transfer of the same conceptual metaphor to the TT. This prevalence in using the same linguistic and conceptual metaphors between English and Arabic has been interpreted by some researchers as a similarity in the conceptualisation between these two languages. However, the analysis of the A&A corpus has revealed that the use of the same conceptual metaphors between English and Arabic in the A&A corpus is, in many cases, not the result of a similarity at the conceptual level between English and Arabic. It is, as argued elsewhere (Fuertes-Olivera and Pizarro-Sánchez, 2002), rather a result of a similarity-creating process where the similarity results from the translation strategies used. This is clearly evidenced by the use of the couplet to translate culture-specific pedagogical metaphors where an equivalent alone is deemed insufficient to convey the meaning. The equivalent is often a loan, accompanied by a gloss and/or a note to help the reader to decode the metaphor. These strategies also result in the creation of novel metaphors in the target text and are seen as a way of enriching the Arabic language. These novel metaphors fill lexical and or terminological gaps. For instance, the terminology specific to the poker game as seen in Chapter 8.4 and metaphors that are common in the SL such as ‘set the stage’, ‘smoking gun’ which become novel in the TL.

9.2 Limitations of this study
This study set out to find out how linguistic and conceptual metaphors are used in the popular science articles of A&A and how they are translated into Arabic, if at all. The analysis of the A&A corpus compiled for the purposes of this study has revealed that this is an ambitious task given the number of linguistic metaphors identified in the A&A corpus. This led to the focus on pedagogical metaphors, especially those embedded in culture-specific source domains. A comprehensive account of linguistic metaphors and their underlying conceptual metaphors necessitates an analysis of the less culturally specific source domains in order to establish
whether the translation strategies identified in the A&A corpus are peculiar to the culture-
specific source domains or to all source domains used in the A&A corpus.

The results reported in Chapter 8 reveal that there are metaphors added in the TT where none
are used in the ST. This result is based on a unidirectional analysis of the corpus and a full
account of how many metaphors are added in the translation requires a bidirectional analysis
which can be done in the future to stand the scope of the research.

The analysis of the A&A corpus has revealed that pedagogical and terminological metaphors
often interact in metaphor clusters in the chosen genre. A phenomenon which seems to have a
crucial importance in translation and which remains unexplored (Dost, 2017; Shuttleworth,
2017). Within the scope of this study and the methodology devised, it was only possible to deal
with one aspect of this phenomenon which is the deletion of a single metaphor occurring in a
cluster.

The results of the current study are also limited to the English and Arabic pair of languages and
to the specific field of A&A. It needs to be extended to fields of study, and a larger corpus
might also be required.

9.3 Future research

The methodological framework developed to investigate metaphors in the current study led to
the identification of three metaphors functions which are generic, terminological and
pedagogical. However, the qualitative analysis focused only on pedagogical metaphors and
more specifically on the culture-specific ones leaving room for a further study to understand
how these metaphors interact in the chosen genre and whether a correlation exists between the
metaphor function and the translation strategies used the render them.

Furthermore, the A&A corpus is extendible in size and in the number of languages analysed
and can be used to conduct a diachronic study to further explore how metaphor translation has
contributed to enriching the target system.

In the present study, the corpus is analysed unidirectionally (from English into Arabic). The
analysis can also be extended to include the other direction (from Arabic into English) to
validate the findings about the use of additional metaphors in the translated corpus. Further
research might also be conducted to account for the textual dimension of linguistic metaphors,
specifically how coherence and cohesion are preserved when translating metaphor clusters. A further analysis of how pedagogical and generic metaphors interact with terminological metaphors in the chosen genre can shed some light in this issue that remains almost totally unexplored in translation studies where a methodological framework for dealing with metaphor clustering in translation needs to be built. The analysis provided in Chapter 7 indicates that the issue of metaphor clustering plays a cohesive and a coherence role that needs to be further investigated in translation.
References


--------, (2015) 'Does deliberate metaphor theory have a future', Journal of Pragmatics, 90, pp. 73-76.


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Corpus references

English subcorpus references


Arabic subcorpus references


## Appendices

### Appendix 1. list of the A&A corpus text in English and their codes in Sketch Engine

<table>
<thead>
<tr>
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<th>Date of publication</th>
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<th>Word count in Word Office</th>
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<td>A little big bang.</td>
<td>Mukerjee, M.</td>
<td>March 1999</td>
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<td>3,545</td>
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<td>file334018 3</td>
<td>Black hole computers.</td>
<td>Lloyd, S. Ng, Y. J.</td>
<td>Nov 2004</td>
<td>4,316</td>
<td>4,816</td>
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<tr>
<td>file422191 3</td>
<td>Cosmic rays at the energy frontier</td>
<td>Cronin, J. S Gaisser, T. K. Swordy, S.</td>
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<td>Johnson, V</td>
<td>Dec 1995</td>
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<td>4,675</td>
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<td>The galactic odd couple.</td>
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<td>Jul 2003</td>
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<sup>45</sup> Words number for each individual article provided here are only an estimate provided by Sketch Engine and is not equal to the total value the tool specifies in the list of corpora which is 75, 124 words. The total value (number of words) in Sketch Engine (75, 124) shows a slight discrepancy compared to the total number of words counted in Word office (76,097).
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### Appendix 3. Goatly’s list of metaphor signals translated into Arabic

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<td><strong>1. Explicit markers</strong></td>
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<td><strong>2. Intensifiers</strong></td>
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<td><strong>3. Hedges and downtoners</strong></td>
<td>لا يعني تمامًا، ببساطة، ببساطة، فيها، فيها</td>
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<td><strong>4. Semantic metalanguage</strong></td>
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<td><strong>5. Mimetic terms</strong></td>
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<td><strong>6. Symbolism terms</strong></td>
<td>رمز، نوع، نوع، نوع</td>
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<tr>
<td><strong>7. Superordinate terms</strong></td>
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<td><strong>8. Copular similes</strong></td>
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<td><strong>9. Precision similes and other comparisons</strong></td>
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<td><strong>10. Clausal similes</strong></td>
<td>ك، كما لو</td>
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<td><strong>11. Perceptual processes</strong></td>
<td>بدي، ظهر</td>
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<td><strong>12. Misperception terms</strong></td>
<td>تخيل، خيال، وخليج، وهم، زائف، سراب</td>
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<td><strong>13. Cognitive processes</strong></td>
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</tr>
<tr>
<td><strong>15. So to speak</strong></td>
<td>ما يعبر عنه</td>
</tr>
<tr>
<td><strong>16. Orthography</strong></td>
<td>&quot; &quot;, &quot;</td>
</tr>
<tr>
<td><strong>17. Modals + Verbal Processes</strong></td>
<td>يجب، يتوقع</td>
</tr>
<tr>
<td><strong>18. Modals (can be verbal or nominal in Arabic)</strong></td>
<td>يجب، يتوقع، يجب، يتوقع</td>
</tr>
<tr>
<td><strong>19. Conditionals</strong></td>
<td>NA</td>
</tr>
<tr>
<td><strong>20. As it were</strong></td>
<td>NA</td>
</tr>
</tbody>
</table>
Appendix 4. List of culture-specific source domains, their related conceptual metaphors and linguistic metaphors.

<table>
<thead>
<tr>
<th>SD</th>
<th>CMs</th>
<th>LMs</th>
</tr>
</thead>
<tbody>
<tr>
<td>MYTHICAL AND FANTASTIC CHARACTERS</td>
<td>COSMIC ENTITIES ARE MYTHICAL AND FANTASTIC CHARACTERS</td>
<td>Behemoth (3), gigantic (3), monster(s)(3), Rip Van Twinkle (2), gargantuan (1), giant (2), Phoenix (1), Pied Piper (1), spectral (3), spirits away (1), doppelgangers (1), devour (2), voracious (1), lurks (2), beast (1), feast(2), dormant(1), luring(1), hurling (1), enchant (1)</td>
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<tr>
<td>ARTS-MUSIC</td>
<td>COSMIC ENTITIES ARE MUSIC LISTENERS/PLAYERS COSMIC ENTITIES ARE MUSICAL INSTRUMENTS</td>
<td>Symphony (5), live (1) concert (1), coda (1), overtones (8), Stradivarius (1), violin (2), bassoon (1) piccolo (1), resounded (1), notes (3), musical (3) instruments (3), tones (1), graphic equalizer (1), home (1) audio (1) system (1), treble (1), pipe (8), musicians(1), listeners (1), players (1), person(1), musically(1),</td>
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<tr>
<td>ARTS-DANCE</td>
<td>STELLAR COLLISIONS ARE A DANCE COSMIC ENTITIES ARE DANCERS</td>
<td>dance (2), slam (1) dancing (1), Conga (1), line (1), crowded (1) dance (1) floor (1), twirling (1), dancers (1), tugging (1)</td>
</tr>
<tr>
<td></td>
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<tr>
<td>ART-PERFORMANCE</td>
<td>COSMIC ENTITIES ARE PERFORMERS COSMIC ENTITIES ARE ACTORS IN SHOWS</td>
<td>puppeteers (1), shows (2), ringmaster (1), spectacle (1), masquerade (1)</td>
</tr>
<tr>
<td></td>
<td></td>
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</tr>
<tr>
<td>SPORTS AND GAMES</td>
<td>COSMIC ENTITIES FORMATION IS A GAME COSMIC ENTITIES COLLISIONS ARE A GAME THE UNIVERSE IS A GAME/SPORT WHERE COSMIC ENTITIES ARE PLAYERS COSMIC ENTITIES ARE TOYS COSMIC ENTITIES GROUPING IS A SPORTS LEAGUE COSMIC ENTITIES FLUCTUATION IS A ROLLER COASTER RIDE SCALAR FIELDS ARE A CONSOLATION PRIZE</td>
<td>player(2), roller-coaster(2), balloon(s)(2), dollhouse(2), set(1), nested(1), Russian(1) dolls(1), fireworks(2), swing(4), billiard ball(2), billiard(s)(1), baseball(1), pinwheel(1), plotted(1), prize(1), puppeteers(1), snowballs (2), endgame(1), football(1), ball(10), jigsaw puzzle(1), mudball(1), outfielders(1), huddles(1), league(1), game(1), coaster(2), Lego(1), bricks(2), pinpointed(1), smash(1), demolition derby(1), ricocheting(1), billiard table(1), competition(1), tug-of-war(1), won(1), won out(1), dominant, (1), dominated(1), ride(1), climbs (1),</td>
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</tr>
<tr>
<td>COOKING, HEATING AND FOOD</td>
<td>COSMIC ENTITIES ARE FOOD THE UNIVERSE IS A COOKING/HEATING DEVICE</td>
<td>crust (4), feed (10), glow (3), sprinkle (4), swallow (2), crustal(1), pizza(1), puffs up(1), raisin(1),</td>
</tr>
<tr>
<td>Categories</td>
<td>Examples</td>
<td></td>
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<tr>
<td>---------------------------------</td>
<td>--------------------------------------------------------------------------</td>
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</tr>
<tr>
<td>COSMIC PROCESSES ARE COOKING</td>
<td>sandwiched(1), sap(2), scallop(2), scrambled(1), soup(2), wrapped(2),</td>
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<tr>
<td></td>
<td>wraps(1), doughnut(2), fed (4), Muffin (2), teacup (1), campfire (1),</td>
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<td></td>
<td>cauldron (1), chips1), coal (1), coffeepot (1), pancakes (1), kneads),</td>
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<td></td>
<td>pretzel (1), spewing (2).</td>
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</tr>
<tr>
<td>RELIGION AND FAITH</td>
<td>doom (4), fate (5), strays (2), requiem (1), shroud (1), fortunes (1),</td>
<td></td>
</tr>
<tr>
<td></td>
<td>blessed with (1), fatal (1), immortal (1)</td>
<td></td>
</tr>
<tr>
<td>CLOTH AND FABRIC</td>
<td>filament(s)(8), fabric (5), pockets (2), filigree (2), knot(s)(3), patch(es) (6), thread (2), ribbons (1), scraps (1), blanket*(1), bundle (1), carpet (1), cloak (1), curtain (1), (eye) needle (1),</td>
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</tbody>
</table>
### Appendix 5. Contextual examples for all identified source domains

<table>
<thead>
<tr>
<th>SOURCE DOMAIN</th>
<th>EXAMPLE</th>
<th>File number</th>
</tr>
</thead>
<tbody>
<tr>
<td>HUMAN BEINGS-MORAL ATTRIBUTES</td>
<td>When radiation was still trapped by matter, the tightly coupled system of photons, electrons and protons behaved as a single gas, with photons scattering off electrons like ricocheting bullets.</td>
<td>file3187446</td>
</tr>
<tr>
<td>HUMAN BEINGS-PHYSICAL ATTRIBUTES</td>
<td>The universe's invisible hand</td>
<td>file4076748</td>
</tr>
<tr>
<td>HUMAN BEINGS-BIRTH</td>
<td>Moreover, some astronomers have suggested that the sun was born during a sartburst.</td>
<td>file4081799</td>
</tr>
<tr>
<td>HUMAN BEINGS-RELATIONSHIP</td>
<td>A massive star goes out with a bang: a supernova explosion, which generates x-rays directly, scatters hot x-ray-emitting debris, and leaves behind a neutron star or a smallish black hole, capable of cannibalizing a companion star and spewing x-rays.</td>
<td>file4081799</td>
</tr>
<tr>
<td>HUMAN BEINGS-SOCIAL LIFE</td>
<td>This region, the Orion Nebula, is a giant stellar nursery embracing thousands of newborn stars.</td>
<td>file3340533</td>
</tr>
<tr>
<td>HUMAN BEINGS-EMOTIONS</td>
<td>But the other large moons have revealed surprises of their own: beams of electrons that connect Io, the most volcanically tormented body in the solar system, to Jupiter; a magnetic field generated within Ganymede, the first such field ever discovered on a</td>
<td>file3161700</td>
</tr>
</tbody>
</table>
moon; and the subtle mysteries of Callisto, including signs that it, too, has an ocean.

According to modern numerical simulations of the process, once the spinning cloud starts to collapse, it proceeds quickly to the formation of one or more stars, a protoplanetary disk, and a leftover envelope of gas individual atoms and molecules and dust very large clumps of atoms.

The recent age crisis, too, was the first shot in a revolution the realization that the universe is dominated not by ordinary matter or even by dark matter but by a type of dark energy about which cosmologists know almost nothing.

Rather they are features shaped by the competition between cosmic expansion and any phenomenon affecting it and their own gravity.

The stars are transformed from ballistic missiles with a preset flight path into guided missiles that home in on their target.

What is more, another mysterious component, the inflaton, dominated the very early universe and seeded cosmic structure.

The debris from the fireball will encode a secret: whether or not, in the tremendous heat of impact, protons and neutrons disintegrated, liberating quarks along with particles called gluons.
<p>| MACHINE AND MECHANICAL PROCESSES - MECHANICAL PARTS | Supernova Pumps | file4221913 |
| MACHINE AND MECHANICAL PROCESSES - COMPUTERS | It also implies a universal bound for all black hole computers: the number of bits in the memory is proportional to the square of the computation rate. | file3340183 |
| MACHINE AND MECHANICAL PROCESSES - VEHICLES | As in the air, a small disturbance in gas density would have propagated as a sound wave, a train of slight compressions and rarefactions. | file3187446 |
| BIOLOGICAL ENTITIES AND PROCESSES | For younger systems, where accretion is still important, the largest bodies are not strictly planets but are called planetary embryos, and the smaller bodies are called planetesimals. | file3208776 |
| LOCATIONS | Like a dying old town emptied of its young, the halo is home only to the elderly. | file4077155 |
| ARTS - MUSIC | Star formation farther out in the galaxy was thought to march to the beat of a different drummer. | file4081799 |
| ARTS - PERFORMANCE | Astronomers, acting as cosmic cartographers, are creating ever more detailed three-dimensional maps of the locations of galaxies and galaxy clusters. | file4081732 |
| ARTS - DANCE | Like two twirling dancers tugging each other in circles, the star's wobble reveals the presence of orbiting planets, even though we cannot see them directly. | file4226019 |
| MYTHICAL AND FANTASTIC CHARACTERS | Overview Black Hole Factories * Black holes need not be gargantuan, ravenous monsters. | file4226057 |</p>
<table>
<thead>
<tr>
<th>Section</th>
<th>Text</th>
</tr>
</thead>
<tbody>
<tr>
<td>TERRESTRIAL ATMOSPHERE AND GEOGRAPHY</td>
<td>The matter gains vast quantities of energy as it falls closer to the hole's horizon, producing heat 20 times more efficiently than nuclear fusion, the next most potent energy generator known.</td>
</tr>
<tr>
<td>MOTION AND DIRECTIONALITY</td>
<td>Normally a close encounter of two celestial bodies is symmetrical: they approach, gather speed, swing past each other and, unless they make contact, fly apart.</td>
</tr>
<tr>
<td>ANIMAL KINGDOM</td>
<td>Like bees in a swarm, these stars move on ever changing orbits.</td>
</tr>
<tr>
<td>SPORTS AND GAMES</td>
<td>So the bounce was not a brief push by a repulsive force, like the collision of billiard balls.</td>
</tr>
<tr>
<td>COOKING, HEATING AND FOOD</td>
<td>Mixing of the layers of gas during the collision can add fresh hydrogen fuel to the core, with a rejuvenating effect rather like tossing twigs on a dying campfire.</td>
</tr>
<tr>
<td>VEGETAL KINGDOM</td>
<td>A higher-density star will suffer much less damage than a tenuous one, just as a cannonball is barely marked as it blows a watermelon to shreds.</td>
</tr>
<tr>
<td>ARCHITECTURE</td>
<td>The new definition of a planet reflects advances in our understanding of the architecture of our solar system and others.</td>
</tr>
<tr>
<td>CLOTH AND FABRIC</td>
<td>If the satellite has a tilted orbit, the result is a series of vertical bending waves, an out-of-plane corrugation-small ripples in a cosmic carpet.</td>
</tr>
<tr>
<td>COMPANIES</td>
<td>Disturbances of the galaxy disk, such as an interaction or merger, could likewise pour fuel into the black hole.</td>
</tr>
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<td>---------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>HUNTING</td>
<td>The neutron star or black hole proceeds to feast on its ensnared prey, spewing x-rays.</td>
</tr>
<tr>
<td>JOURNEY</td>
<td>The rest of the ejecta will be traveling too close to the beam line.</td>
</tr>
<tr>
<td>VARIOUS</td>
<td>In essence, the universe sculpts itself.</td>
</tr>
<tr>
<td>RELIGION AND FAITH</td>
<td>The fates of planets whose parent stars undergo close encounters is another recent addition to the topic of stellar collisions.</td>
</tr>
</tbody>
</table>