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Preface

Your knowledge is vast as an ocean...
Stars stood still since I saw you last...

These are simple metaphors that enhance the virtues of a hypothetical interlocutor by referring to concepts which have no connection with the subject of the dialogue. Metaphors are generally used in common language and indeed we hardly realize the continuous use we make of this literary tool.

A metaphor is made up of two parts, one referring to the actual subject of interest that we want to qualify (*your knowledge...since I saw you*) and a second part containing an object of similarity (*ocean...stars*) not connected in any way to the first part. The choice of items in a metaphor helps to make more incisive the representation of the subject which is being investigated and makes it easier to dramatize a specific object of a metaphor, which can be a single item, as stated, or a physical process making the subject easier to understand and remember. A metaphor has an evident explanatory effect which is better achieved if the properties of the object of comparison are examined in depth and made clear. Extensively used since ancient times, the metaphor differentiates itself from a simile by not using adverbs or terms of comparison. It is much more effective if its components are distant from each other in the semantic sense. An extensive study of the metaphor in the Mid-

dle Ages can be found in the excellent essay by Umberto Eco[1]. A detailed account of how a metaphor could help to describe the many mathematical issues essential to a basic understanding of mathematics, can be found in the collection of essays titled *Mathematical Reasoning (Analogies, Metaphors and Images)*[2].

The role of metaphors in any linguistic construct is that of facilitating the reading by making it easy to understand concepts which would otherwise be abstruse. Metaphors are particularly useful in science, where one easily encounters terms or situations that are difficult to handle not only when trying to explain them but also when interpreting the subtleties of their properties. We term 'conceptual metaphors' those involving everyday language; however, these metaphors, which are the most common, critically depend on the particular culture they are embedded in. The meaning of a conceptual metaphor may not be understood by all cultures and therefore it loses universality. Scientific language, instead, is reasonably universal so a scientific metaphor can be understood by a larger portion of the society and therefore can better accomplish its goal.

Indeed, every mathematical idea can be thought to originate from a physical everyday ground-based experience enhancing the role of the science metaphors.

Some metaphors like *black holes, pulsars, fabric of space-time* have now become part of daily speech, succeeding in bringing to the attention of laymen but also of scientists not expert in the subject, the existence of objects or events which became familiar just because they were mentioned in the metaphors themselves. Most of the objects or events like those mentioned above are compared with extreme phenomena, like unusually large energy forces or very large bodies rare in Nature but able to capture the attention of a reader, making them easy to

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[1] Umberto, Eco, *La metafora nel Medioevo*, «Doctor Virtualis», Quaderno 3, CUEM 2004.

[2] Lyn English D., *Mathematical Reasoning*, Lawrence Erlbaum Associated, Inc. 1997.

remember. As useful examples, let us mention concepts which have become familiar even though they were alien to common sense such as supernovas, black holes, gamma ray bursts, gravitational waves, star or galaxy collisions, galactic cannibalism and so on.

In this book we shall examine some of the most common scientific metaphors and in particular those used in Cosmology and Astrophysics but also in science fiction, well aware of the limitations imposed by the large extent of the subject. We benefited considerably from continuous support and stimulating discussions with Jean Pierre Ané-Prince, Franco Cardin, Laura Fiorentini, Antonella and Francesco Sorge whom we thank warmly. Thanks are due to Karin Judkins Incarbone for her meticulous revision.