

Preface

Coronal mass ejections (CMEs) are large eruptions of plasma, magnetic field and energy from the Sun. They are the largest individual solar eruptions, releasing more than an order of magnitude of energy than the more popularly known solar flare. Much has been learnt about CMEs over the years regarding their composition, structure, onset and evolution. There is, however, still much we do not know. This book presents a brief review of CMEs, from the history of their observation to methods by which we detect them, to the status quo regarding related phenomena and models describing their onset and evolution. This is not a book written for an expert but rather it is aimed at those who are just starting out in the field of CMEs and space weather or would simply like to know little more about them: for example, graduate students or those from other fields who would like some background on the topic.

The motivation for writing this book arises from my desires when I was starting out in this field. The main problem was that, while I had ideas for areas in which I would like to do research, I did not know what work in these areas had already been accomplished, or what questions had yet to be answered. All of the texts written about coronal mass ejections have been written for experts by experts and so there was not much a beginner to the field could understand without spending a great deal of time trawling through the literature. I wished that there was a single source from which I could gain a brief overview of the status quo regarding coronal mass ejections and a number of references with expert details that I could investigate further. This is the purpose I hope this book will serve.

The book does contain a large amount of mathematics. This is difficult to avoid in a book involving physics as it is the language with which we communicate. The reader may disregard the mathematics involved if they so wish, but it does contribute greatly to our understanding of these topics and, in some places, the concepts cannot really be explained adequately in any other way.

It is important to highlight the structure of this book as it relates to the expertise of the author. There are many related areas on the topics of CMEs and space weather that I am not an expert on. While a world expert may not gain a great deal of insight from the following text (although it is hoped that it will be useful resource for those areas in which they do not specialise), this book is not intended for an expert audience. This is an introductory book primarily aimed at those who are just entering the field and would like to gain a brief oversight of coronal mass

ejections – what they are, what their importance is, and the status quo regarding data and theory developments. The book is also full of references from people far more qualified than I that discuss the many topics covered in more detail. I gladly yield to these experts and the references to elaborate on these topics.

The reader may also notice that some topics are covered in more detail than others. This is a reflection of the knowledge and expertise of the author. For example, Chaps. 4, 5 and 6 cover the theory of CME detection and data analysis techniques with great detail while Chaps. 8 and 9 only briefly review the models describing their onset and evolution. You may also notice that my history chapter (Chap. 2) almost exclusively discusses the history of CME observation and not modelling. This is not to imply that there is not a rich history of theoretical and modelling developments in describing CMEs, but rather because my expertise lie in the areas of observation and data analysis. I am not a mathematical modeler and so can only provide a brief review of these topics. The reader is encouraged, as with all of these topics, to learn more from the many references I have provided and to read further from other sources cited in those texts.

Finally, the reader will notice throughout the book certain opinions that are offered by the author. Chapter 11, in particular, has many of these. As with much of science, opinions are divided on many topics and some, including some experts, probably disagree with what has been discussed in places throughout the book. The reader themselves may come to different conclusions than those expressed by the author (or by the experts). If anything stated here can be proven incorrect then I will gratefully alter my views. It is important to realise that science is an evolutionary process, and what is “known” today may be “known to be incorrect” tomorrow. Our role as scientists is to express our viewpoints in as objective a manner as possible, and where necessary to yield those viewpoints when they are proven incorrect.

If there is a single message the reader should take away from this book it is this: The most severe space weather effects, (geo)magnetic storms, are not caused by solar flares. They are caused by coronal mass ejections. Therefore if one is interested in studying the causes of severe space weather it is the CME, and not the flare, that we should be investing our resources into. As this book shows, there is much that is not yet understood about this important and fascinating phenomenon.

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