PAYLOAD AND MISSION DEFINITION IN SPACE SCIENCES

This book is intended for scientists and engineers involved in the definition and development of space science missions. The processes that such missions follow, from the proposal to a space agency, to a successful mission completion, are numerous. The rationale behind approval of a mission, its definition and the payload that it will include are topics that cannot be presented in undergraduate courses. This book contains contributions from experts who are involved in today's space missions at various levels. Chapters cover mission phases and implementation, launchers and cruise strategies, including gravity-assist manoeuvers and different thrust scenarios. The payload needed for remote sensing of the Universe at various wavelengths and for *in situ* measurements is described in detail, and particular attention is paid to the most recent planetary landers. Whilst the book concentrates on the ESA Program Cosmic Visions, its content is relevant to space science missions at all space agencies.

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Preface

The steps needed to define a successful space science mission are numerous. The science drivers, the unique advantages this mission provides over past missions or earth-based experiments, and the payload that it includes are the key factors to guarantee its success. Finding the required information on such topics is not so straightforward, especially as they are usually outside the scope of undergraduate courses. The 2003 Canary Islands Winter School of Astrophysics aimed at providing a focused framework that helps fill this need. Space agencies follow a necessarily complex path towards the selection of a specific mission, as required by the enormous costs that are associated with space activities. The steps towards its completion are elaborate and require careful assessment at every stage. The orbit that will be used and the requirements that are imposed have impacts on the science and the mission budget. Thus, knowing how to make the best use of propulsion technologies and gravity helps from solar system bodies plays a crucial role. The first two chapters of this book cover all these topics and illustrate the complexity of defining space missions as well as how and where look for help (i.e. other than the rarely receptive funding agencies).

The instruments on-board will in the end make the science that has driven the mission. How the science questions translate into specific requirements, and then, into the actual instruments are crucial aspects in the definition of the payload. Depending on the wavelength range that will be observed by the remote sensing instruments (from gamma rays to radio waves), the instruments must use broadly different technologies. In contrast to most other areas of astronomy, space science allows experimentation *in situ* with the objects under study, from interplanetary particles and fields to large planets of the solar system. These topics, with the different physical processes involved and corresponding technologies, are covered to various degrees in this book. Most importantly, the link between science questions and payload requirements is maintained throughout the book. The examples of specific missions in which specific payload was used clarify the process of mission and payload definition in space sciences.

The Winter School itself and the present book have focused heavily on the current and planned ESA Cosmic Vision program. This decision was taken not only on the basis of natural geographical considerations, but also because the European Space Agency (ESA) program offers a balanced set of missions that cover all aspects of space sciences. Thus, the resulting book is clearly based on the expertise gained by the european space community over the past few decades. However, the links with programs from other space agencies (mostly National Aeronautics and Space Administration NASA) make the contents of the book of general validity. The recurrent illustrative references to certain missions such as the ESA mission Solar Orbiter are related to the natural bias of the editor, but I trust the reader will forgive me for that.

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I want to thank Nieves Villoslada (IAC), for her constant support to me during all phases of the organization of the Winter School (WS). This was the first (but not the last) of the schools that, although highly ranked by the European Union, obtained no funding (no thanks here). Nevertheless, it was her permanent enthusiasm that enabled us to make the WS a success.

As an aside, one result of this lack of funding was that my WS offered what I believe to be the worst meeting dinner ever. I apologize here to all participants and lecturers for such a nonsensical experience. One of the lecturers found a possible explanation for the outcome based on the supposed willingness of Spain to make food following UK standards (a British lecturer with a Scottish name). Although this may be true, I think the reasons were more doleful than that. One year after the event, I find it fantastic that, when meeting many of the participants and lecturers in different places, they continue to be my friends, and (caveat emptor!) have good memories of the WS. Thanks to all of them.

All the lecturers contributed to making the WS a success, but I would especially like to thank Prof. Balogh (Imperial College, UK), as he was able to stay with me throughout the whole event. I will always have good memories of my conversations with him. Special thanks as well to Prof. Alvaro Giménez (ESA), who had to take a total of six planes to participate in the WS. With his contribution to the event (explaining how to get involved in a space mission) during his lectures, he was able to create what I saw as an awe-inspiring atmosphere which must have convinced the participants to stay in this exciting field. Now we have to make the dreams come true!

Last, but not the least, I would like to thank Anna Fagan and Ramón Castro, for helping me with the edition of the different (and sometimes difficult) manuscripts and figures.

Thanks to my left ankle too!