COSMIC RAYS IN THE HELIOSPHERE

Cover illustration adapted from Jokipii and Wibberenz, p. 365: Schematic illustration of the minimum phase of the heliosphere, dominated by the wavy current sheet oscillating about the equator. The radial grey arrows indicate the solar wind and the randomly moving dark lines indicate sample cosmic-ray trajectories.

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COSMIC RAYS IN THE HELIOSPHERE

*Volume Resulting from an ISSI Workshop
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Picture by R. von Steiger

Not on this picture: H. Debrunner, C. Steenberg, M. Zhang

FOREWORD

In every scientific discipline there are milestones – periods of significant accomplishment when it is appropriate to pause and summarize the state of the field. Such is the case for the study of the behavior of cosmic rays in the heliosphere. We are just passing through solar minimum conditions, when the heliosphere has a well-ordered and relatively simple configuration. We have been fortunate to have an array of spacecraft – unprecedented in the history of space exploration and unlikely to be repeated for generations – to provide comprehensive measurements of cosmic rays throughout the heliosphere. Ulysses has completed its historic first exploration of the heliosphere at high heliographic latitudes. Pioneer and Voyager have been exploring the outer heliosphere. The durable IMP-8 and now the WIND spacecraft have provided detailed baseline measurements at Earth. Concurrently, there has been a steady improvement in theoretical understanding of cosmic ray behavior through the use of ever more sophisticated numerical models.

This milestone in cosmic ray studies was celebrated with a Workshop on Cosmic Rays in the Heliosphere which was convened by L. A. Fisk, J. R. Jokipii, G. M. Simnett and K.-P. Wenzel at the International Space Science Institute (ISSI) in Bern, Switzerland. The Workshop was attended by 40 scientists from around the world, who have access to cosmic ray and heliospheric data, and knowledge of how cosmic rays should behave. The Workshop met twice, in September, 1996 and March, 1997. This publication is intended to summarize both the discussions and conclusions of the Workshop, and provide a comprehensive overview of the current understanding of Cosmic Rays in the Heliosphere.

The International Space Science Institute (ISSI) was a most suitable forum for this Workshop. ISSI has as its charter the responsibility of assisting the community of space scientists to gather experts in one location and collectively consider the important problems and, from this gathering, to produce a publication which will serve to summarize the state of knowledge and to guide future research. ISSI and its dedicated staff were most considerate and capable hosts of this Workshop, and through their excellent facilities made possible useful and productive interactions, and a most enjoyable experience.

The editors of this publication are pleased with the result, and hope the community will be as well. The publication, through a series of Introductory Papers, is intended to provide an overview of the state of knowledge of cosmic rays in the heliosphere prior to the Workshop. Four Working Group reports attempt to synthesize this knowledge, make progress in our understanding, and point out directions of future research. These chapters are followed by a summary of the parameters which are used in cosmic ray modulation. Finally, the Workshop, which was concerned primarily with solar minimum, did consider the less well chartered conditions and

consequences of solar maximum. These speculations are presented in the Epilogue. Each of the chapters was externally reviewed. The extensive efforts of the authors, and the timely cooperation of the reviewers, are greatly appreciated.

November 1997

L. A. Fisk, J. R. Jokipii, G. M. Simnett, R. von Steiger, K.-P. Wenzel