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PREFACE

At the 31st Plenary meeting of COSPAR held in Birmingham, England, a symposium was convened by Commission D to discuss the results of the Inter-Agency Solar Terrestrial Program. The IASTP comprises the GEOTAIL, WIND, INTERBALL/TAIL, SOHO and POLAR missions launched prior to the conference and the INTERBALL/AURORA and FAST missions launched after the July 14-21, 1996 symposium. Also an integral part of the program are numerous existing satellites, such as IMP-8, DMSP and GOES, various ground-based observational programs such as the SuperDARN incoherent radars and theoretical support. The symposium attempted to reflect this diversity. The celebration of the outstanding success of the program to date was dampened by the destruction of the four Cluster spacecraft by the failure of the maiden launch of the Ariane 5. This four spacecraft mission had been expected to be the centerpiece of the IASTP effort. The Inter-Agency Solar Terrestrial Program is often referred to as the International Solar Terrestrial Physics program or ISTP program but we use IASTP here to emphasize the critical role that the Inter-Agency Consultative Group (IACG) has played in gaining approval for these missions, getting them successfully into space, and coordinating their operations. The IACG consists of the heads of the space agencies of the four main space-faring "countries" -- Europe, Japan, Russia, and the United States.

The symposium consisted of both invited and contributed papers with about equal numbers of each. The scientific program was organized with the assistance of co-convener A. Nishida with the advice of M. Acuna, C. Carlson, E. Friis-Christensen, W. J. Hughes, H. J. Opgenoorth, R. Schmidt, I. Sandahl, and L. M. Zelenyi. The symposium was a great success occupying a jammed four days of the conference. There were 107 presentations of which 47 were posters and the rest, oral. These sessions were all well attended and lively. Of the 107 presenters, 69 submitted papers for the proceedings, and of these 65 appear in this volume. These papers provide a good cross section of the results being obtained by the IASTP with somewhat less emphasis on the measurements from the spacecraft most recently launched and no results, of course, from the two spacecraft launched after the conference. The SOHO mission was well represented at the COSPAR meeting in the sessions of Commission E, the proceedings of which will be published in a separate volume.

This volume is divided into ten topical sections. The first section deals with the missions and program that constitute the IASTP. The first paper by D. N. Baker and R. Carovillano establishes the objectives of the IASTP program for furthering our understanding of solar terrestrial physics. This is followed by a review of the first IASTP mission, GEOTAIL, by A. Nishida and colleagues. L. M. Zelenyi and colleagues then review the two INTERBALL missions, the tail probe and the auroral probe, both of which were launched with accompanying subsatellites but only one of which worked entirely successfully. Next K. W. Ogilvie and M. D. Desch describe the WIND mission and its early successes, followed by a similar report on the POLAR mission by R. A. Hoffman. The loss of the four Cluster spacecraft in the Ariane 5 explosion and the efforts to recover the mission objectives with the Phoenix and Cluster II missions is described by R. Schmidt and colleagues. V. Domingo then reviews the SOHO mission, that not only is providing critical data on the outer layer of the sun, but also key data on the initiation of disturbances that are carried to the Earth and studied by the other IASTP spacecraft. This section of the book closes with a discussion by J. H. King of the spacecraft, other than those launched specifically as part of the IASTP programs, that are being utilized by IASTP researchers, and a review by H. J. Opgenoorth of the ground-based programs that are

essential to the success of the IASTP effort.

Beginning with Section Two the volume covers the individual successes of the program starting in the solar wind and moving through the magnetosphere. One of the ways the program is achieving its goals is through a series of four campaigns addressing specific areas. Two of these campaigns are discussed in this section. Campaign III investigating solar events and their manifestation in interplanetary space is described by R. A. Harrison, while campaign IV examining solar sources of heliospheric structure observed out of the ecliptic is described by A. B. Galvin and H. S. Hudson. A description of Campaign I can be found in Section Eight. Campaign II on the magnetopause and boundary layers is being led by G. Paschmann but has yet to get started, in part because of the destruction of the four Cluster spacecraft. After the description of the two campaigns follows a discussion of measurements of the structure of the interplanetary medium obtained by GEOTAIL and WIND. T. Terasawa and colleagues discuss the acceleration of particles ahead of the large magnetic cloud on October 18, 1995; R. P. Lin and colleagues discuss the WIND measurements of the solar wind, bow shock and upstream particles; and D. E. Larson and colleagues discuss the topology of the October 18, 1995 magnetic cloud. Finally, Z. Němeček et al. discuss INTERBALL multipoint studies of the solar wind.

Section Three covers the latest results in the foreshock, the region of backstreaming charged particles on magnetic field lines connected to the bow shock that is replete with ULF and VLF waves generated by wave-particle instabilities. The section begins with an article by D. Burgess on what we have learned about upstream waves over the last 15 years. Papers by H. Matsumoto and colleagues, by S. D. Bale and colleagues, and by Y. Kasaba and colleagues discuss the plasma waves associated with backstreaming electrons. Following are papers by K. Meziane et al. and by X. Blanco-Cano and S. J. Schwartz that discuss the low-frequency, ULF waves in the foreshock.

Processes at the collisionless shock are covered in Section Four. N. A. Krall introduces the topic with an overview of what is known about collisionless shocks. K. Tsubouchi and colleagues review the motion of the bow shock associated with a change in solar wind conditions. M. A. Balikhin et al. and V. N. Smirnov et al. examine processes associated with dissipation in the shock.

Section Five follows with three papers on the region behind the bow shock, the magnetosheath. S. M. Petrinec and C. T. Russell examine the jump in plasma parameters across the bow shock and the pressure distribution along the magnetopause. P. Song and C. T. Russell examine what we really know about the magnetosheath. S. M. Petrinec and colleagues examine how magnetic geometry affects the flow properties in the magnetosheath.

The region of coupling between the solar wind and the magnetosphere: the magnetopause, the boundary layer and the cusp, are covered in Section Six. M. Nakamura and colleagues show evidence for reconnection at the dayside magnetopause as revealed in the GEOTAIL measurements. O. Vaisberg and colleagues discuss plasma measurements from INTERBALL in the same region while J. Šafránková et al. show how the MAGION subsatellite can be used with the main INTERBALL tail spacecraft to measure the motion of the magnetopause. T. D. Phan and colleagues review the WIND measurements along the low-latitude flank of the magnetopause. M. Fujimoto et al. discuss the GEOTAIL observations of the low-latitude boundary layer and I. Sandahl et al. cover INTERBALL observations. Initial POLAR measurements in and near the

polar cusp are presented by C. T. Russell et al. and E. G. Shelley et al. The moon also is a source of detectable ions at high altitudes. E. Kirsch and colleagues show such measurements from both WIND and GEOTAIL. Z. Němeček et al. then examine energetic particles in the vicinity of the dawn magnetopause and H. Usui et al. examine electron cyclotron waves in the dayside magnetosphere.

With Section Seven we move into the magnetosphere proper covering the dynamics of the magnetosphere and the linkage between geomagnetic activity and the sun. The IASTP program consists of more than just a set of space-based observations. For the phenomena that occur within the magnetosphere, the measurements made on the surface of the Earth are important. This importance is underlined by the first four papers of this section covering small-scale dynamic features in the current systems at the edge of the polar cap (T. Moretto and E. Friis-Christensen); incoherent radar studies of ionospheric flows (S. W. H. Cowley and M. Lockwood); multipoint measurements to test models of the substorm process (M. Lockwood); and the inversion of ground magnetometer measurements to infer magnetospheric current systems and electric fields (D. J. Knipp and B. A. Emery). This section continues with a summary of what we know about how the solar wind couples to the terrestrial magnetosphere by J. G. Luhmann and what we know about the possible influence of solar variability on the Earth's climate by E. Friis-Christensen and H. Svensmark. The section closes with two papers on the substorm process. One by R. L. McPherron and a large supporting cast discusses an example of GEOTAIL measurements during a substorm; the other, by H. E. Spence and J. B. Blake, discusses remote sensing of energetic neutral particles during a substorm from the POLAR spacecraft.

Some of the earliest and some of the most recent measurements of the IASTP program have been made in the Earth's geomagnetic tail. The first spacecraft to be launched in this program was GEOTAIL which used close lunar flyby passes to adjust the orbit to keep the line of apsides of the orbit centered in the tail. Much later the INTERBALL tail probe was launched to join GEOTAIL in the exploration of the magnetotail and plasma sheet, but it did not maintain its line of apsides in the tail. Section Eight covers the region of the magnetosphere beginning with a summary of the results of the first IACG Campaign on the tail and plasma sheet by T. Mukai and L. M. Zelenyi. Then three papers follow on various aspects of GEOTAIL measurements: the structure of the distant magnetotail by K. Maezawa and colleagues; substorms, tail flows and plasmoids by T. Nagai et al.; and plasma acceleration and heating by M. Hoshino et al. Following these papers are three manuscripts on INTERBALL tail measurements: plasma sheet observations by Yu. Yermolaev; hot plasma structures in the magnetotail lobes by O. Santolik and colleagues; and a case study of the magnetotail boundary by S. P. Savin and a host of coauthors. Finally, the section closes with a theoretical discussion by R. L. Richard and company on the consequences of flux ropes in the magnetotail for ion populations.

Section Nine covers remote sensing and auroral processes beginning with a review of what we know about auroral acceleration by M. Temerin. This is followed by four papers on remote sensing of the auroral regions. The first of these by M. Brittnacher et al. discusses POLAR ultraviolet imaging; the second by J. Stadsnes et al. discusses X-ray imaging; and the last two by S. Barabash et al. and by P. C:son Brandt et al. cover energetic neutral atom imaging by Astrid. The section closes with two theoretical works, one by W. Lotko and A. V. Streltsov on standing ULF waves and the other (by D. N. Baker et al.) discussing the origin of relativistic particles in the magnetosphere.

Finally Section Ten covers the instrumentation and techniques of relevance to the IASTP program. It contains three papers. The first by A. Kiraga and colleagues discusses the limitations of electron density measurements in the ionosphere using various wave techniques. Next V. O. Papitashvili et al. discuss the magnetospheric coordinates needed to present and visualize space physics data. In the final paper, M. W. Dunlop and colleagues discuss techniques for analyzing discontinuities with four closely spaced satellites such as with Cluster.

In closing I would like to thank the referees who worked so hard at the meeting and afterward to review the papers, and thus permitted the timely production of this volume:

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