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Introduction to a Special Section

Introduction: Particles and fields

Thomas Moore, James Spann

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Abstract

A Conference on Measurement Techniques for Solar and Space Physics was held on 20–24 April 2015 in Boulder, Colorado, at the National Center for Atmospheric Research Center Green Campus. The present volume collects together the papers from this conference in the categories of particles and fields. This also includes neutral gas techniques as well as low-energy ionospheric plasmas and their interactions with spacecrafts.

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A Conference on Measurement Techniques for Solar and Space Physics was held on 20–24 April 2015 in Boulder, Colorado, at the National Center for Atmospheric Research Center Green Campus. This gathering of over 200 scientists and instrumentalists was born out of the desire to collect in one place the latest experiment and instrument technologies required for advancement of scientific knowledge in the disciplines of solar and space physics.

The two goals for this conference and the subsequent publication of its content are (a) to describe measurement techniques and technology development needed to advance high priority science in the fields of solar and space physics and (b) to provide a survey or reference of techniques for in situ measurement and remote sensing of space plasmas.

Toward this end, our goal has always been inspired by the two 1998 Geophysical Monographs (#s 102 and 103) entitled, “Measurement Techniques in Space Plasmas” (particles and fields) [*Pfaff et al*., 1998a, 1998b], which have served as a reference and resource for advanced students, engineers, and scientists who wish to learn the fundamentals of measurement techniques and technology in this field. Those monographs were the product of an American Geophysical Union Chapman Conference that took place in Santa Fe, NM, in 1995: “Measurement Techniques in Space Plasmas—What works, what doesn't.” Two decades later,

we believe that it is appropriate to revisit this subject, in view of recent advances in technology, research platforms, and analysis techniques. Moreover, we now include direct measurements of neutral gases in the upper atmosphere, optical imaging techniques, and remote observations in space and on the ground.

Accordingly, the workshop was organized among four areas of measurement techniques: particles, fields, photons, and ground based. This two-set volume is largely composed of the content of that workshop. Special attention is given to those techniques and technologies that demonstrate promise of significant advancement in measurements that will enable the highest priority science as described in the 2012 National Research Council Decadal Survey [*Baker and Zurbuchen et al*., 2013]. Additionally, a broad tutorial survey of the current technologies is provided to serve as reference material and as a basis from which advanced and innovative ideas can be discussed and pursued. Included are instrumentation and techniques to observe the solar environment from its interior to its outer atmosphere, the heliosphere out to the interstellar regions, in geospace, and other planetary magnetospheres and atmospheres.

To make significant progress in priority science as expressed in the National Research Council solar and space physics decadal survey and recent NASA heliophysics roadmaps, identification of enabling new measurement techniques and technologies to be developed is required. Also, it is valuable to the community and future scientists and engineers to have a complete survey of the techniques and technologies used by the practitioners of solar and space physics. As with the 1995 conference and subsequent 1998 publication, it is incumbent on the community to identify those measurements that are particularly challenging and still require new techniques to be identified and tested to enable the necessary accuracy and resolution of certain parameters to be achieved.

The following is a partial list of the measurement technique categories that are featured in these special publications:

1. *Particles*. Thermal plasma to MeV energetic particles, neutral gas properties including winds, density, temperature, and composition, and enhanced neutral atom imaging.
2. *Fields*. DC electric and magnetic fields, plasma waves, and electron drift instruments from which the plasma velocity information provides a measure of the DC electric field.
3. *Photons*. Instruments sensitive from the near infrared to X-rays. Contributions of techniques and technology for optical design, optical components, sensors, material selection for cameras, telescopes, and spectrographs.
4. *Ground based*. Remote sensing methods for solar and geospace activity and space weather. The focus includes solar observatories, all-sky cameras, lidars, and ionosphere thermosphere mesosphere observatory systems such as radars, ionosondes, GPS receivers, magnetometers, conjugate observations, and airborne campaigns.

The present volume collects together the papers in the first two categories above: particles and fields. This also includes neutral gas techniques as well as low-energy ionospheric plasmas and their interactions with spacecrafts. The companion volume collects together the papers for photons and ground-based categories. It is recognized that there are measurement techniques that overlap among the four categories. For example, use of microchannel plate detectors is used in

photon and particle measurement techniques or the observation of visible photons and magnetic fields in space and on the ground share common technologies. Therefore, the reader should consider the entire collection of papers as they seek to understand particular applications. We hope that these volumes will be as valuable as a reference for our community as the earlier 1998 volumes have been.

Ancillary

References

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