Annales Geophysicae

Special Topic

Theory and simulation of solar system plasmas

The General Assembly of the European Geophysical Society, held in Nice in April 1998, hosted, for the first time, a special session entitled "Theory and Simulation of Solar System Plasmas". The session was organised as many in our community shared the feeling that the usually object-oriented topical meetings in the field do not encourage enough interdisciplinary cross-fertilising between theory and observations. Our preparations for the meeting were directed towards the presentation of new theoretical knowledge of common interest to plasma physicists as well as to astrophysicists, and of interest both to solar as well as to planetary system exploration. Indeed, there is a great similarity in the plasma phenomena observed in different regions of space, in magnetospheres, in the solar corona, at planetary or cometary shocks, and other discontinuities.

As a result, this special EGS session gathered together scientists who are interested in the understanding of common and, perhaps, universal physical phenomena in different parts of the solar system. For the 1998 EGS General Assembly, we especially encouraged contributions concerning the following kinetic aspects of collisionless plasmas: particle non-adiabaticity, non-gyrotropic distribution functions and other effects which lead to off-diagonal terms of the plasma pressure tensor in the magnetic field frame. These effects are important in thin current layers and in reconnection zones, due to parallel electric fields. They are closely related to plasma heating and particle acceleration to high energies. Since important aspects of these problems are inaccessible to analytical calculations, they have to be treated by numerical simulations.

Judging by the response to our call for participation, there is, indeed, a lively interest throughout Europe in presenting theoretical and simulation results to a broader community. Also, observers and experimentalists expressed their interest by participating in the interdisciplinary session.

Due to the kind permission of the Editor-in-Chief of Annales Geophysicae, we were able to offer publication of related manuscripts both to the speakers at the EGS, and also to those who wanted to contribute to the interdisciplinary effort but did not make it to Nice. As a result, we can now proudly present the first special issue of Annales Geophysicae on "Theory and Simulation of Solar System Plasmas". One American and seven European groups submitted their manuscripts in time to be included in the special issue, after the usual review. They deal with the most important aspects of space plasma physics, with collisionless shocks and reconnection. New analytical results are presented, together with simulations from test particle calculations to MHD, and self-consistent kinetic approaches. The formation process of non-gyrotropic particle distributions as well as their consequences are discussed, as well as the physics of thin current layers and diffusion in phase space. These are all processes of universal importance for space plasmas in general. Hence, as these papers themselves demonstrate, they apply to many solar system phenomena from processes occurring in the solar atmosphere, to geomagnetic activity, and the precipitation of energetic electrons in the Earth's magnetosphere.

We thank the authors and hope the community will enjoy reading this fine collection of papers representing the current research status in the field of theory and simulation of solar system plasmas. We also thank the referees, the topical editors for magnetospheric and solar physics of the journal, K.-H. Glassmeier and R. Schwenn, as well as Ms Perret in the editorial office. They took care of the review process and did a great job to secure the high scientific level of the papers. We look forward to the follow-up Meeting in The Hague in April 1999. The preliminary programme already promises to be at least as interesting as the last.

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