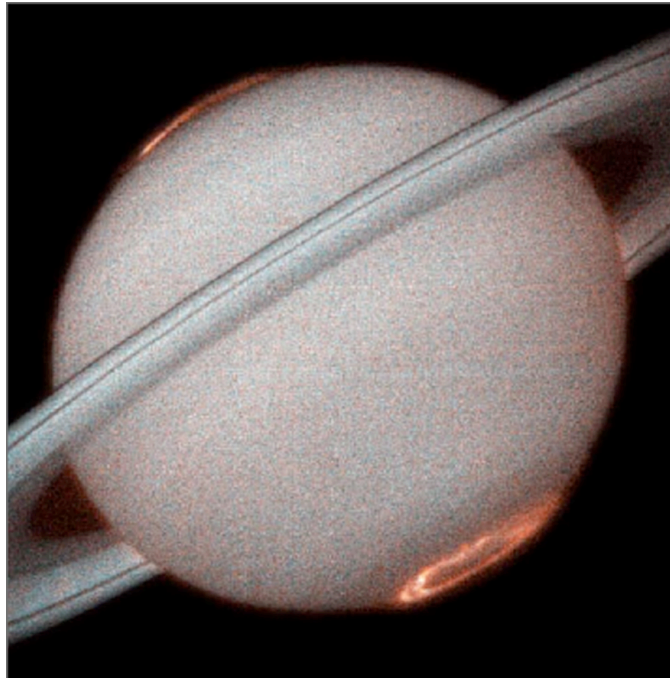


Guest Editorial

Sixth Special Issue on Space and Cosmic Plasma

Anthony L. Peratt, *Fellow, IEEE* and Carl-Gunne Fälthammar



Saturn northern and southern aurora in ultraviolet light. Hubble Space Telescope, 1998.

OUR KNOWLEDGE of space and cosmic plasma has made such great progress that it is appropriate to speak of a change in paradigm. This change started a few decades ago and was precipitated by

a) In situ measurements of the properties of plasmas in the magnetospheres, leading to the confirmation of Birkeland field-aligned currents, double-layer acceleration of charged particles, magnetic flux ropes in the ionospheres of planets, and a system of currents in the magnetospheres of the outer planets;

b) Discovery of an immense, filamentary, magnetic field-aligned plasma structure at the center of our galaxy;

c) Laboratory experiments duplicating the power laws of electromagnetic radiation from extragalactic sources and confirming the plasma processes responsible for the acceleration of charged particles to high energies; and

d) The advent and application of multidimensional, relativistic, and fully electromagnetic particle-in-cell simulations to space and cosmic plasma.

In recognition of the documented evidence that the basic properties of plasmas are the same everywhere, and the strong research interest in space and cosmic plasma since the appearance of the first Special Issue on this topic in December 1986, the IEEE TRANSACTIONS ON PLASMA SCIENCE is devoting a Sixth Special Issue to Space and Cosmic Plasma. Its subject areas of interest in this Special Issue include the following:

° Instabilities and filamentation in space and cosmic plasma.

° The origin of electric and magnetic fields in cosmic plasma; electric fields in space.

° Electric currents in space; the formation of Birkeland current systems and their relation to the evolution of astrophysical bodies.

- ° Charged-particle acceleration in cosmic plasma.
- ° Electromagnetic radiation mechanisms in cosmic plasma.
- ° The role of plasma and electromagnetic fields in planetary, stellar, galaxy, and cluster formation; separation of elements.
- ° Laboratory astrophysics: Terrellas, pinches, dense plasma focus, and electrical discharges.
- ° Scaling laws and the transfer of knowledge between astrophysical, space, and laboratory plasmas.
- ° Plasma Universe and anisotropic media redshift mechanisms

The goals of this Special Issue are to provide an update on the progress in these areas and to report on the exchange of knowledge between plasmas of all dimensions in size hierarchy. Observational, theoretical, experimental, and computational results are included.

The primary theme of the First Special Issue (1986) was electrical engineering, plasma science and the plasma universe. That of the Second Special Issue (1989) was the golden anniversary of magnetic storms and the aurorae and was dedicated to Hannes Alfvén in recognition of his 80th birthday. The Third Special Issue (1990) was primarily on plasma cosmology. The theme of the Fourth Special Issue (1992) was on plasma experiments in the laboratory and in space. The Fifth Special Issue (2000) focused on space weather effects and the consequences of this on observational satellites and data interpretation. This Sixth Special Issue is an update of selected topics in space and cosmic plasma. This issue also begins the topic of a Seventh Special Issue, Plasma Cosmogony, the study of the evolution of the solar system, scheduled for Spring 2006.

As has been the case with the past Special Issues, updates and speculations cover a broad range of space plasma topics. These include a re-evaluation of the methodology of space measurement techniques as reported in 'A critical overview on spacecraft charging mitigation methods.' Basic plasma theory is addressed in papers entitled 'A review of lower hybrid solitary structures', 'Some recent developments in understanding auroral electron acceleration processes', and 'Applications of the dense plasma focus to nuclear fusion and plasma astrophysics', followed by a tutorial examining the foundations of radiation thermodynamics: 'On the validity of Kirchhoff's law and its application to space and the cosmos'.

The theoretical and experimental discovery of several mechanisms by which photons can be red-shifted is a constant topic of study in optics and plasma physics. Their validity has been demonstrated in many thousands of experiments at all wavelengths and a number of devices using the Wolf Effect have been patented. In this vein, some of this work as applied to space plasmas is reported in 'Propagation of light in low pressure ionised and atomic hydrogen: Application to astrophysics', 'Optical redshifts due to correlations in quasar plasmas', 'Redshifts of cosmological neutrinos as definitive experimental test of doppler vs non-doppler redshifts'.

That mankind has witnessed plasma phenomena other than

lightning, today's aurorae, solar outbursts, and optical synchrotron sources in space, is suggested by evidence presented in 'Characteristics for the occurrence of a high-current, Z-pinch aurora as recorded in antiquity'.

On the cutting edge of laboratory astrophysics and planetary exploration are two papers of special interest: 'Collisionless laboratory astrophysics with lasers' and 'The Martian plasma environment: electric field and Langmuir probe diagnostics'.

An exciting discovery with far reaching consequences, whose mechanism is discussed in space plasma discharge circuits [1], is announced in the paper 'Trends in apparent time intervals between multiple supernovae occurrences'. Lastly, the dearth of comparative analysis in cosmology is addressed in the paper 'Two world systems revisited: a comparison of plasma cosmology and the big bang'.

Among the names of many who pioneered plasma cosmology as cited in the First Special Issue (1986) were the names K. Birkeland, I. Langmuir, P. A. M. Dirac, K. G. Jansky, G. Reber, E. V. Appleton, and H. Alfvén.

We sadly note the passing of Grote Reber on December 20, 2002, two days short of his 91st birthday. It is to Dr. Reber, the Father of Radio Astronomy, that the Sixth Special Issue on Space and Cosmic Plasma is dedicated [2].

Anthony L. Peratt
Guest Editor,
Plasma Physics Group
Los Alamos National Laboratory
Los Alamos, New Mexico 87545, USA
(alp@lanl.gov), (<http://plasmauniverse.info>)

Carl-Gunne Fälthammar
Guest Editor,
Division of Plasma Physics,
Alfvén Laboratory, Royal Institute of Technology, SE-100 44
Stockholm, Sweden
(Carl-Gunne.Falthammar@alfvenlab.kth.se),
(<http://www.plasma.kth.se/~falthammar/>).

REFERENCES

- [1] H. Alfvén, *Cosmic Plasma*, Dordrecht, 1981.
- [2] A. L. Peratt, 'Grote Reber: Father of Radio Astronomy, 1911-2002, this issue.

Anthony L. Peratt (S'60-M'63-SM'85-F'99) Ph.D: EE, 1971, University of Southern California, Los Angeles. MSEE, USC, 1967; UCLA, 1963-1964, BSEE, California State Polytechnic University. Staff Member, Lawrence Livermore National Laboratory (1972-1979); Guest Physicist, Max Planck Institut für Plasmaphysik, Garching, Germany (1975-1977); Guest Scientist, Alfvén Laboratory, Royal Institute of Technology, Stockholm, Sweden (1985); Los Alamos National Laboratory (1981-), Applied Theoretical Physics Division, Physics Division, Associate Laboratory Directorate for Experimental Programs; Scientific Advisor to the United States Department of Energy (1995-1999).

Dr. Peratt's research interests have included numerical and experimental contributions to high-energy density plasmas and intense particle beams; inertial confinement fusion; explosively-driven pulsed power generators; lasers; intense-power-microwave sources; particles; high energy density phenomena, new concepts in space propulsion and high performance computing, plasma cosmogony and cosmology.

He has served as session organizer for space plasmas, IEEE International Conf. on Plasma Science 1987-1989; Guest Editor Transactions on Plasma

Science, special issues on Space Plasmas 1986, 89, 90, 92, 2000, 03; Organizer, IEEE International Workshops on Space Plasmas, 1989, 1991, 1993, 1995, 1996, 1997, 1998, 2003; Associate Editor Transactions on Plasma Science 1989–; Elected member of IEEE Nuclear and Plasma Science Society (NPSS) Executive Committee (ExCom), 1987–1989; 1995– 1997; GENERAL CHAIRMAN, IEEE International Conference on Plasma Science, Santa Fe, New Mexico, 1994. IEEE NPSS ExCom Vice Chairman 1997; Elected to the IEEE NPSS Administrative Committee, 1997.

He holds memberships in the American Physical Society, American Astronomical Society, Eta Kappa Nu and has earned the United States Department of Energy Distinguished Performance Award, 1987, 1999; IEEE Distinguished Lecturer Award, 1993; Norwegian Academy of Science and Letters, University of Oslo Physics Department, and Norsk Hydro Kristian Birkeland Lecturer, 1995. Dr. Peratt is Author, *Physics of the Plasma Universe*, Springer-Verlag (1992); Editor, *Plasma Astrophysics and Cosmology*, Kluwer Academic Publishers (1995); Editor, *Advanced Topics in Space and Astrophysical Plasmas*, Kluwer Academic Publishers (1997).

Carl-Gunne Fälthammar was born in Markaryd, Sweden, on December 4, 1931. He received the degrees of Civilingenjör (graduate engineer) in 1956, Tekn. lic (approximately the Ph.D.) in 1960, and Docent (approximately Assistant Professor) in 1966, from the Royal Institute of Technology (KTH), Stockholm, Sweden.

In 1969, he was appointed Associate Professor of Plasma Physics at the Royal Institute of Technology. In 1975, he succeeded Hannes Alfvén as Professor of Plasma Physics. From July 1, 1967 to June 30, 1997, he was Chairman/Director of the Department of Plasma Physics at the Royal Institute of Technology, which, since 1990, is a Division of the Alfvén Laboratory. After retiring as Director he remains scientifically active as Professor Emeritus. His research interests include fundamental aspects of plasma electrodynamics, with application to space and astrophysical plasmas, especially in the context of auroral and magnetospheric physics. Professor Fälthammar is author or Co-Author of more than a hundred scientific articles in space and plasma physics, Co-Author with H. Alfvén of the book *Cosmical Electrodynamics, Fundamental Principles* (English 1963, Russian 1967, Chinese 1974, Japanese 1978) and Co-Editor with B. Hultqvist of the book *Magnetospheric Physics, Achievements and Prospects* (1990).

Professor Fälthammar has served in several international scientific organizations, including the Executive Committee of IAGA, the Space Science Committee of the European Science Foundation, the Council of the European Geophysical Society, and the Board of the European Physical Society Plasma Physics Division. He was Topical Editor of *Annales Geophysicae* 1991-1995. He is currently Associate Editor of *Astrophysics and Space Science*, and a Member of the Editorial Board of *Space Science Reviews*.

Since 1975, Professor Fälthammar is a Full Member of the Royal Swedish Academy of Sciences. He is also a Full Member of International Academy of Astronautics, Academia Europaea and the European Academy of Arts, Sciences and Humanities.

In 1989, he was awarded an Honorary Doctor's degree by the Faculty of Science of the University of Oulu, Finland. He is also a recipient of the 1996 Golden Badge Award of the European Geophysical Society, the 1996 Basic Sciences Award of the International Academy of Astronautics and the 1998 Hannes Alfvén Medal of the European Geophysical Society.