An Overview of Space Weather Phenomena that Effect Technological Systems and Humans

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and

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Abstract

Space weather effects originating from solar activity can potentially affect technological systems, throughout the Solar System. In this two-part lecture we present an overview of some of the key effects involved.

We start with a short account of active solar phenomena and how they vary during the Solar Cycle. Then we discuss how the terrestrial magnetosphere acts as a shield against the Solar Wind. Energetic solar particles and galactic cosmic rays can, however, penetrate this barrier and reach the inner magnetosphere where they form particle populations that include the Van Allen radiation belts.

Next we discuss recent progress in using numerical models to predict the arrival of solar generated shocks at the Earth, Venus and Mars, following which we address the role of galactic cosmic radiation and solar proton events in constituting a hazard for interplanetary manned flight. Predictions of dose rates at three perspective landing sites on the Martian surface under representative solar maximum and solar minimum conditions are then presented based on simulations made using the Mars Energetic Radiation Environment (MEREM) software recently developed for the European Space Agency.

The second part of our lecture deals with space weather effects in the close Earth environment where the most vulnerable systems are: manned/unmanned spacecraft exposed to hazardous levels of particle and electromagnetic radiation; human activities dependent on satellite communications and positioning, and induced currents produced in long and complicated conductor networks on the ground. These effects are most serious during magnetospheric storms driven by Coronal Mass Ejections and in association with the fast solar wind streams that accompany Coronal Interaction Regions. We give some examples of technological failures in relation to severe space weather conditions and discuss ongoing challenges for modelling and forecasting such events.

Date: Thursday 21 October 2010
Time: 09:00-13:00
Room: Kastler Lecture Hall @ Adriatico Guest House

Susan McKenna-Lawlor

Susan McKenna-Lawlor, nee McKenna, Born in Dublin; educated at University College Dublin (UCD), the Dublin Institute for Advanced Studies (DIAS) and the University of Michigan. Ph.D in Space Physics from the National University of Ireland/ NUI (1976). Member of the Senate of NUI (1997-2002). Emeritus Professor at the National University of Ireland, Maynooth; Guest Professor at the Chinese Academy of Sciences. Founder and Managing Director of Space Technology Ireland Ltd. (1986 –present).

Participation in the development of space experiments launched/to be launched by several major space agencies (European, American, Russian, Chinese, Japanese and Indian). In the capacity of Principal Investigator/PI, she carried full scientific, technical and administrative responsibility for Ireland's EPONA experiment on the European Space Agency's Giotto mission, which made pioneering measurements during an encounter with Halley's Comet (1986); during an historic fly-by of Earth (1990) and at Comet Grigg-Skjellerup (1992). Also, she provided the Irish national instrument LION for the European Space Agency's Solar Heliospheric Observatory (SOHO) and acted/acts as Principal Investigator/Co-Investigator for experiments on ESA's Cluster (four-spacecraft) constellation, Mars Express, Venus Express, the SMART Mission (lunar) and the Rosetta/Philae mission (which is scheduled to land on Comet 67P/Churyumov-Gerasimenko in 2013).

She participated/participates in NASA's Skylab, Solar Maximum, WIND and Gravity Probe B (Relativity) Missions, and with the Russian Space Agency in respect of the Phobos Mission to Mars and its Moons (two spacecraft) and the Mars 96 mission (four experiments). She was recently PI for an experiment (NUADU) to measure Energetic Neutral Atoms which was launched on China's Double Star Polar Mission. She is a Leading Co-Investigator for the PICAM experiment which is under preparation for launch on the ESA/Japanese Mission BepiColombo to planet Mercury; a Co-Investigator for the near infrared spectrometer experiment (SIR-2) aboard the Indian Mission Chandrayan-1 to the Moon and is engaged in feasibility studies for an instrument under development for the proposed NASA/ESA Europa Jupiter System Mission.

She received an Irish Person of the Year Award in 1986; and was further awarded Associate Membership of the Royal Astronomical Society (London). In 1988 she received the Russian Tsiokovsky Gold Medal for "Outstanding Contributions to Cosmonautics" and in 1991 was made an Honorary Citizen of San Jose, California for technological achievement. Also, she was conferred with the Irish laureate Woman of Europe Award in 1994 and with the Book Award of the International Academy of Astronautics (1998) for Whatever Shines Should be Observed (reprinted 2003). She was awarded the Presidential Prize for Research Excellence by the National University of Ireland, Maynooth (2001). She received in 2004 an award from ESA in recognition of her outstanding contributions to the ROSETTA Mission and also participated in a Group Achievement Award from NASA for contributions to the success of the CLUSTER Mission in exploring geospace. She was the recipient of the Slovak Academy of Sciences International Prize in recognition of her outstanding scientific work and also was conferred with an honorary D.Sc by the University of Ulster (2005). This year she par ticipated in the Laurel Team award of the International Academy of Astronautics for significant inputs to the success of China's Double Star Mission.

She is the author/co-author of more than 150 academic publications on scientific and technical subjects, and is a co-author of Essential Spaceflight Dynamics and Magnetospherics by B. Rauschebakh, M. Ovchinkov and S. McKenna-Lawlor (Kluwer Academic Publ.),

Professional memberships include: The International Academy of Astronautics; the International Astronomical Union and Fellowship of the Institute of Physics (London).

Hannu Koskinen

Hannu Koskinen is Professor in Space Physics at the Department of Physics of the University of Helsinki, Finland. He received his PhD degree from the Uppsala University in 1985. During 1987-1997 he worked in space research at the Finnish Meteorological Institute in Helsinki and moved to his present position in 1997. Hannu Koskinen's scientific record includes both observational and theoretical studies on a wide range of topics in space plasma physics, including solar wind - magentosphere - ionosphere interactions, magnetospheric storms and substorms and solar wind interactions with the atmospheres of Mars and Venus. He has been a co-investigator in a dozen satellite missions to near-Earth space, Mars, Venus, a comet and, in the future, to Mercury. He led one of the first ESA space weather contracts "Study of plasma and energetic electron enviroments and effects" in 1996-1999 and has participated in several other space weather projects, both technical and scientific. Hannu Koskinen has been leacturing on space physics regularly at the University of Helsinki over two decades and given several quest lectures, e.g., in Alpbach and L'Aquila summer schools.