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The transient radiation belts of Saturn

E. Roussos (1), N. Krupp (1), T. P. Armstrong (2), C. Paranicas (3), D.G. Mitchell (3), G.H. Jones (4), S. M. Krimigis (5), N. Sergis (5), K. Dialynas (6), D.C. Hamilton (7)

(1) Max Planck Institute for Solar System Research, Katlenburg-Lindau, Germany (roussos@mps.mpg.de), (2) Fundamental Technologies, Kansas, USA, (3) John Hopkins Applied Physics Laboratory, USA, (4) Mullard Space Sciences Laboratory, UCL, UK, (5) Academy of Athens, Greece, (6) University of Athens, Department of Physics, Greece, (7) University of Maryland, Greenbelt, USA

Abstract

After operating five years in orbit around Saturn, Cassini's Magnetospheric Imaging Instrument (MIMI) has helped us to construct a first concise picture of the planet's inner magnetosphere and radiation belts. Particle data from MIMI's three sensors (INCA, CHEMS and LEMMS) reveal that the inner magnetosphere has both similarities and differences with that of the Earth, with many of the differences originating from the presence of many energetic particle sinks at Saturn (neutral gas, dust and icy moons) [1, 2, 3]. Several of these aspects are clearly visible in the response of Saturn's inner magnetosphere to three solar storms that impacted the system in 2005: what followed the occurrence of these interplanetary events was, as in the case of the Earth, the appearance of additional radiation belt components or the intensification of existing ones, in both ions and electrons (Figure 1). The new components decayed with time, at various rates, depending on their location in the magnetosphere and the energy of the electrons or ions that they contained. Furthermore, it has been found much of this variability is restricted outside the L-shell of the moon Tethys. Inside the orbit of Tethys, MeV ion fluxes showed negligible response to the solar storm occurrence and almost no variability for a period of 4 years. This revealed that icy moon absorption inhibits inward radial transport of energetic ions above certain energy, shielding the planet's inner radiation belts from solar wind influences and isolating these regions from processes in the middle and the outer magnetosphere.

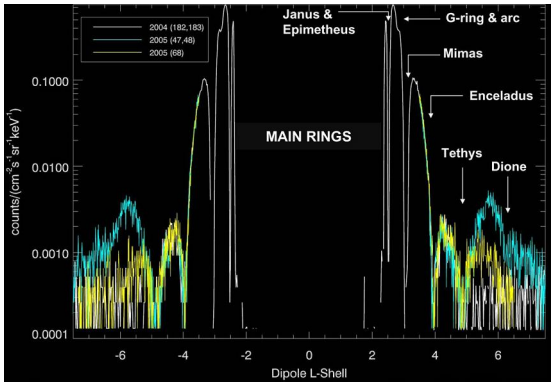

Figure 1: Differential ion fluxes from the LEMMS P2 ion channel (2.28-4.49 MeV/nuc) as a function of dipole L-shell. Negative L denotes the inbound part of the orbit, positive outbound. The 2004 profile (white curve) is the most common, and exists when Saturn's magnetosphere has not interacted with a solar storm for very long periods (weeks to months). Several moons' and rings' L-shells are indicated. The two 2005 profiles (yellow and turquoise), correspond to orbits with periapsis at L=3.5 and reveal a flux enhancement centered close to Dione's L-shell and that decays with time. The enhancement exists only outside Tethys's L-shell and appeared in response to a solar storm that impacted Saturn in early 2005 [1].

References

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