EPSC Abstracts
Vol. 5, EPSC2010-309, 2010
European Planetary Science Congress 2010

The relation between magnetospheric particle acceleration and radio emissions at Saturn and Earth: insights into exo-magnetospheric acceleration processes?

P. C. Brandt (1), D. G. Mitchell (1), C. M. Jackman (2), P. Zarka (3), M. Freeman (4), B. H. Mauk (1), D. Delcourt (5), W. S. Kurth (6), C. P. Paranicas (1), A. Ukhorskiy (1), J. F. Carbary (1)
(1) The Johns Hopkins University Applied Physics Laboratory, Laurel, MD, USA (pontus.brandt@jhuapl.edu / Fax: +1-240-228-0386)
(2) Imperial College, London, UK
(3) Observatoire de Paris, Meudon, France
(4) British Antarctic Survey, Cambridge, UK
(5) LPP Ecole Polytechnique, Palaiseau, France
(6) University of Iowa, Iowa City, Iowa, USA.

Abstract

The planets of the solar system display a range of different space environments and solar interaction regimes, from non/weakly magnetized, to magnetized with convective- versus rotation-dominated magnetospheres. All magnetized planets with an appreciable magnetosphere are immersed in a dynamic energetic particle (hot plasma), as well as cold plasma, environment. These planetary magnetospheres are also significant emitters of low-frequency radio waves (*Zarka*, 2007) that are consistent with a cyclotron-maser instability believed to be driven by magnetospheric particle acceleration processes, modulated by the solar wind (*Jackman et al.*, 2009; *Jardine and Cameron*, 2008; *Galopeau et al.*, 1995).

Radio observations in the <200 MHz range is so far the only technique that shows promise to provide constraints on the magnetospheric processes of exoplanets (especially from the so-called hot-jupiters) and their stellar-wind interaction. The thrust of this presentation is therefore to understand the relation between radio emissions and magnetospheric acceleration processes in our own solar system as a laboratory to determine what remote radio observations of exoplanets may tell us about magnetospheric processes.

Terrestrial radio emissions in the 30-800 kHz range have long been known to be associated with auroral intensifications and magnetospheric substorms [Gurnett et al., JGR, 1975; Liou et al., JGR, 2000]. In a similar fashion, recent results from the Cassini mission have revealed that the periodic radio signals emitted from Saturn's high-latitude magnetosphere are highly correlated with simultaneous large-scale (several planetary radii) injections of energetic particles as observed in energetic neutral atom (ENA) emissions on the nightside at radial distances beyond about 8 RS (*Mitchell et al.*, 2009). These observations imply that the current system driven by the injected energetic particle pressure may play a critical role in catalyzing the kilometric radiation bursts.

In this presentation we first provide a brief review of the proposed magnetospheric "engines" of radio emissions. Second, we analyze observations from the Ion Neutral Camera (INCA) and the Radio Plasma Wave System (RPWS) on board Cassini and how the nightside energetic particle injection events recurring in the midnigh/post-midnight sector are highly correlated with the (periodic) bursts of Saturn Kilometric Radiation (SKR). We contrast this with terrestrial observations of energetic particle acceleration during substorms obtained by the high-energy neutral atom (HENA) camera on board the IMAGE mission and Auroral Kilometric Radiation (AKR) by the Geotail and FAST missions. We conclude by comparing the particle acceleration mechanisms and their possible relation to the kilometric radiation generation process of the two planets.

References

Galopeau, P. H. M., P. Zarka, and D. L. Quéau, Source location of Saturn's kilometric radiation: The Kelvin-Helmholtz instability hypothesis, *J. Geophys. Res.*, *100*, 26,397–26,410, doi: 10.1029/95JE02132, 1995.

Jackman, C. M., L. Lamy, M. P. Freeman, P. Zarka, B. Cecconi, W. S. Kurth, S. W. H. Cowley, and M. K. Dougherty, On the character and distribution of lower-frequency radio emissions at Saturn and their relationship to substorm-like events, *Journal of Geophysical Research (Space Physics)*, *114*, 8211–+, doi:10.1029/2008JA013997, 2009.

Jardine, M., and A. C. Cameron, Radio emission from exoplanets: the role of the stellar coronal density and magnetic field strength, *Astronomy and Astrophysics*, *490*, 843–851, doi:10.1051/0004-6361:20078658, 2008.

Mitchell, D. G., et al., Recurrent energization of plasma in the midnight-to-dawn quadrant of Saturn's magnetosphere, and its relationship to auroral UV and radio emissions, *Planet. Space Sci.*, *57*, 1732–1742, doi:10.1016/j.pss.2009.04.002, 2009.

Zarka, P., Plasma interactions of exoplanets with their parent star and associated radio emissions, *Planet. Space Sci.*, *55*, 598–617, doi: 10.1016/j.pss.2006.05.045, 2007.