SPA-Magnetospheric Physics

SM11A CC: 518 A Monday 0830h

Magnetosphere-Ionosphere Coupling in the Solar System I *(joint with P, SA)*

Presiding: **J T Clarke,** Boston University**; K K Khurana,** Institute of Geophysics and Planetary Physics

SM11A-01 0830h INVITED

Solar wind-magnetosphere-ionosphere coupling at Earth, Jupiter and Saturn

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While the fundamental physical processes governing magnetospheric dynamics, that is the coupling of momentum from the solar wind and planetary rotation to the plasma circulation, are not expected to vary from planet to planet, the relative importance of each will. At the Earth it is the former which plays a dominant role, and as such auroral displays which are regularly viewed at high latitudes are mainly governed by interactions with the solar wind and the interplanetary magnetic field. Magnetospheres of the outer planets are much larger than that of the Earth, and generally planetary rotation is much quicker. Hence, at Jupiter we have a contrasting situation to the Earth, a system which is dominated by the effects of rotation. The main auroral emissions at Jupiter, which corotate with the planet, are thought to be formed by the breakdown of corotation of the equatorial plasma, and the large-scale magnetosphere-ionosphere coupling current system which is subsequently generated. Conversely, the polar emissions' appear to be ordered with respect to local time, indicating solar wind control. Recent work at Saturn indicates that this magnetosphere, however, represents an intermediate case between the Earth and Jupiter. Saturn's magnetosphere is also dominated by the effects of corotation, like Jupiter, but the currents produced by magnetosphere-ionosphere coupling are too small a magnitude, and flow at too low a latitude to account for Saturn's main aurora. Instead, it is proposed that the main aurora at Saturn is driven by the interaction between the solar wind and IMF. These ideas are now testable as Cassini recently approached Saturn and HST monitored the aurora. This review talk will discuss the relative roles of the solar wind and planetary rotation and the parts each play in Earth's, Jupiter's, and Saturn's environments.

SM11A-02 0850h

Implications of Jovian X-Ray Emission for Magnetosphere-Ionosphere Coupling

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The first observations of Jupiter made by the Chandra X-Ray Observatory revealed a powerful x-ray aurora located in the polar caps. The x-ray emission exhibited a forty minute periodicity. Such 40-minute periodicities have previously been seen in energetic particle fluxes and in Jovian radio emission. This paper presents scenarios in which the x-ray emission is produced by energetic heavy ion precipitation, either on open field lines connecting to the solar wind or on closed field lines reaching to the outer magnetosphere. Both scenarios require the existence of field-aligned electric fields at a radial distance of a few Jovian radii. The potential needed to produce the observed x-rays is either about 200 kV (solar wind case) or in excess of 10 MV (magnetospheric case). The estimated field-aligned currents are in the 10 to 1000 MA range depending on the scenario. Other implications of the observed auroral x-ray emission will also be discussed.

SM11A-03 0905h

Seasonal Dependence of Localized, High Latitude Dayside Aurora (HiLDA)

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The FUV instrument on the IMAGE spacecraft frequently observes intense ultraviolet (UV) emissions from a localized High Latitude Dayside Aurora (HiLDA) poleward of the general auroral oval location. It has been shown that this aurora is entirely created by high-energy precipitating electrons, which have probably been accelerated in a quasi-static field-aligned electric potential. Here we extend the previous case study to an investigation of the HiLDA occurrence in the Northern Hemisphere over more than 2 years and compare it with the averaged solar wind plasma and interplanetary magnetic field (IMF) properties. HiLDA occurrence is strongly biased towards low solar wind density and IMF with positive B_z, strong positive B_y (clock angles around 70°) and negative B_x components. Such IMF conditions are favorable for lobe reconnection in the Northern Hemisphere, and the creation of a dominating dusk convection cell with an upward field-aligned current in its center. Additionally, we investigate the seasonal occurrence of this phenomenon, which shows a maximum in the Northern Hemisphere during sunlit summer months and an almost complete absence in the dark winter. In contrast to the daylight-suppressed aurora in the auroral oval, the HiLDA can not be the result of ionospheric feedback due to the stronger ionospheric conductance in sunlight. Instead, in agreement with ionospheric convection models, it is caused by the asymmetry of field-aligned currents in different seasons, which result from the different dipole tilt angles in summer and winter. We further discuss two scenarios how the low solar wind density can enhance the field-aligned parallel potential over the dusk convection cell.

SM11A-04 0920h INVITED

Jupiter's M-I coupling: A dynamic and a steady-state approach

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In a standard picture of Jupiter's MI coupling [Hill, 1979], steady-state field aligned electric currents mediate angular momentum from Jupiter's ionosphere into Jupiter's middle magnetosphere to spin up the radially expanding magnetospheric plasma. These currents have been linked by Cowley & Bunce [2001] and Hill [2001] to the main auroral oval on Jupiter. In an alternative approach, Saur et al. [2002] showed that on the auroral field lines the intensity of small scale Alfven waves (identified as weak MHD turbulence) maximizes. Saur et al. [2002] relate these dynamic fluctuations in the presence of a net background current to the generation of the main auroral oval. Their description leads to a total energy in the accelerated electrons and a field aligned voltage in agreement with the observations of the aurora oval. In our talk we review both descriptions and discuss in particular overlapping and discriminating features. We will also compare the current ideas for the Jupiter system with understanding and observations at Earth. Aurorae at Earth are often divided in three regions/phenomena: A region with upward going current, one with downward going current, and an Alfven aurora.

SM11A-05 0940h

Galileo Observations of Electron Beams in Jupiter's Magnetosphere and Their Relationship With Auroral Processes

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It is now well established that Jupiter's main ring of auroral luminosity is magnetically conjugate to the equatorial plane of the magnetosphere at radial distances between about 20 and 30 R_J. It is widely believed that the main auroral ring is related to the breakdown of plasma corotation that occurs in the middle magnetosphere at about these same distances from Jupiter, but the mechanisms responsible for accelerating particles to the requisite energies for production of the emissions remain matters of speculation. Measurements from the plasma instrumentation (PLS) of the Galileo spacecraft exhibit evidence of electron beams in the plasma sheet at just those locations as are considered above. The energies, the intensities, and the angular distributions of the beams, as well as their locations, all are consistent with leakage of auroral electrons into the magnetosphere. The beams thus appear to be signatures of auroral processes and of the coupling of the magnetosphere to the ionosphere. In this presentation we discuss the properties of the beams and consider the implications of these observations for models of auroral processes.

SM11B CC: 518 C Monday 0830h

Reconnection? Nightside

Presiding: **J M Weygand,** Institute of Geophysics and Planetary Physics UCLA**; C Z Cheng,** Princeton University

SM11B-01 0830h

Reconnection Inside a Thick Near-Earth Plasma Sheet and its Evolution into Lobe Reconnection: Control of Substorm phases

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Reconnection can occur in the center of a thick near-earth nightside plasma sheet when boundary conditions are favorable. Outflow on the earthward side of the X line is provided by the well-known azimuthal convection around the earth. Outflow from the tailward side of the X line occurs by earthward motion of the X line and a magnetic island forms on the tailward side. The "thick-sheet reconnection" occurs at a "critical X line" at the outer boundary of the azimuthal convection channel. The outer boundary occurs where flux tubes become too tail-like to convect to the dayside (30 Re in a stretched tail). Thick-sheet reconnection is suppressed in the growth phase of substorms due to the time-variation of the topology produced by a large dayside reconnection rate and a small convection rate of flux tubes to the dayside. It is initiated when the time-variation of the topology changes as a result of a decrease in dayside reconnection and/or a large convection to the dayside. It then evolves on a time scale of several minutes into the traditional lobe-merging model. There are two options for the evolution of thick-sheet reconnection into traditional lobe merging and the expansion phase. The simplest is that thick-sheet reconnection eats through plasma sheet field lines until lobe field lines are involved. The more complicated option is that the earthward-moving X line and magnetic island come in contact with sub-auroral magnetic flux. The subsequent coalescence of the island with lower-latitude flux causes the formation of a second X line at distances 25Re which eats through the plasma sheet flux until lobe field lines are involved.

SM11B-02 0845h

Cause of consecutive bursts of Pi2 pulsations associated with substorm onsets

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