[2]Institute of Geophysics and Planetary Physics, University of California at Los Angeles, 3845 Slichter Hall MS 156704, Los Angeles, CA CA90095, United States

[3]Los Alamos National Laboratory, NIS-1, Mail Stop D-466, Los Alamos, NM NM87545, United States

The cause of consecutive bursts of Pi2 pulsations associated with substorm onsets was investigated with magnetic, auroral and particle observations from space to the ground during 0200-0600 UT on 4 September 1999. The onset time of ground Pi2s maps to the same variation sequence in the IMF structure seen propagating to the Earth in multiple satellite observations in the upstream region. During the time of interest, the comparison of auroral and energetic particle data with IMF observations shows that one pseudobreakup and two successive substorm onsets appear in two distinct cycles of southward IMF followed by a northward interval. Especially the second onset occurs after the IMF becomes strongly northward and the By magnitude decreases as well. Two successive substorm onsets can be explained with the two-neutral-point model. The first onset occurs when the IMF turns southward. Reconnection at the near-Earth neutral point first begins on closed field lines within the plasma sheet, and the second onset occurs when the IMF turns northward reconnection at the distant neutral point ceases and reaches the open flux of the tail lobes. In addition, a decrease in the By magnitude may help reduce the magnetotail convection and release all the builtup flux to allow the onset to commence. In contrast, an increasing By magnitude would increase the magnetotail convection and weaken the onset into a pseudobreakup.

SM11B-03 0900h

Kinetic Ballooning Instability as the Substorm Onset Mechanism

C. Z. Cheng[1] (609-243-2648; fcheng@pppl.gov)

Sorin Zaharia[2] (szaharia@lanl.gov)

Jay R. Johnson[1] (jrj@pppl.gov)

[1]Princeton University, Princeton Plasma Physics Laboratory, Princeton, NJ 08543, United States

[2]Los Alamos National Laboratory, MS D466, Los Alamos, NM 87545, United States

AMPTE/CCE observations showed that the substorm onset in the near-Earth plasma sheet region ($\sim 8-10R_E$) is associated with a low frequency (in the Pi 2 range) instability that is excited 1-2 minutes before substorm onset. Because the instability is excited when β_{eq} increases from 20 to above 50, it is identified as a ballooning instability. To understand the ballooning instability it is necessary to have a good knowledge of the 3D structure of cross-tail current sheet in the near-Earth plasma sheet region prior to substorm onset. We obtain 3D quasi-static equilibrium solutions of the growth phase magnetosphere and find that a current sheet with an enhanced cross-tail current density is formed with thickness of $\sim 1R_E$ around the local midnight with an azimuthal domain of $\sim 60-70^\circ$ at $X \sim 7-10R_E$. In the current sheet the plasma beta is larger than 50 and the magnetic field curvature is enhanced. The associated ionospheric Birkeland current moves equatorward with an enhanced current density, and its latitudinal width shrinks. These features are consistent with the observed ionospheric growth phase signatures that the polar cap region expands equatorward, both the electron and proton aurora emissions move equatorward and brighten, and the auroral oval shrinks in width. The MHD ballooning instability is found to be unstable for the entire plasma sheet where the equatorial $\beta_{eq} \geq 1$, and the most unstable mode is located in the tailward side of the strong cross-tail current sheet region, which maps to the observed initial brightening location of the breakup arc in the ionosphere. However, the MHD β_{eq} threshold is too low in comparison with the AMPTE/CCE observations, which show that prior to substorm onset a low frequency instability is excited only when $\beta_{eq} > 50$. The difficulty can be mitigated by including kinetic effects, which greatly increase the stabilizing effects of field line tension and can enhance the β_{eq} threshold to limit the unstable region to the cross-tail current sheet region. The resultant kinetic ballooning instability has a real frequency in the Pi2 frequency range and can be responsible for substorm onset.

SM11B-04 0915h

Ballooning Instability in the Near-Earth Magnetotail: Theory, Simulation, and Observation

P Zhu[1]

A Bhattacharjee[1] (amitava.bhattacharjee@unh.edu)

L.-J. Chen[2]

Z.-W. Ma[2]

[1]University of New Hampshire, Space Science Center, Morse Hall, Durham, NH 03824, United States

[2]University of Iowa, Department of Physics and Astronomy, Iowa City, IA 52242, United States

Ballooning instabilities are widely believed to provide a possible mechanism for substorm onset. We present recent theoretical and simulation results on the ballooning instability of the two-dimensional (2D) near-earth magnetotail, and compare the predictions of theory with observations from Wind. The magnetotail is modeled by the analytic 2D static equilibrium developed by Voigt. It is shown by initial-value simulations that the magnetotail is unstable to ballooning modes with large but finite-k_y, not for very low or for very high values of plasma beta, but in a regime of intermediate beta (of the order 1-10). The stability at very high values of beta is due to the plasma compression involved in the ballooning displacement of flux tubes. The growth rate of the finite-k_y ballooning instability is found to increase with the wave number k_y, approaching a saturated value in the very large k_y limit. In the presence of Hall MHD or two-fluid effects. the ballooning modes propagate with a diamgnetic frequency that can be detected as a westward surge by in situ satellites at near-Earth distances. We compare the predictions of theory with three substorm events observed by the Wind satellite. By analyzing the time delay between earthward and tailward flux enhancements of energetic ions, the propagation velocity of the westward surge is estimated to be several kilometers/second, consistent with the predictions of drift-ballooning theory. A large anisotropy between the duskward and dawnward fluxes of energetic ions is observed to persist until local onset. The anisotropy is seen to be reduced significantly after onset, suggesting a reduction of the density (and hence, the pressure) gradient that is known to drive ballooning modes. The reduction process is impulsive and bursty, suggesting that the underlying dynamics is nonlinear, which is also consistent with a wavelet analysis of the magnetic fluctuations.

SM11B-05 0930h

In-situ multi point observations of a substorm onset using CLUSTER and POLAR data

Christopher Mouikis[1] (1-603-862-2905; chris.mouikis@unh.edu); Lynn M Kistler[1] (kistler@atlas.sr.unh.edu); Amitava Bhattacharjee[1] (amitawa.bhattacharjee@unh.edu); Reiner H.W. Friedel[2] (rfriedel@lanl.gov); Berndt Klecker[3] (Berndt.Klecker@mpe.mpg.de); Henri Reme[4] (herni.reme@cesr.fr); Iannis Dandouras[4] (Iannis.Dandouras@cesr.fr); A. Balogh[5] (a.balogh@ic.ac.uk); Axel Korth[6] (korth@linmpi.mpg.de)

[1]University of New Hampshire, Space Science Center 39 College Rd., Durham, NH 03824, United States

[2]Los Alamos National Laboratory, Space and Remote Sensing Sciences MS-D436, Los Alamos, NM 87545, United States

[3]MPE, Garching, Germany

[4]CESR, BP4346 31028, Toulouse, France

[5]Imperial College, London, United Kingdom

[6]MPAE, Max-Planck Str. 2, Katlenburg-Lindau, Germany

In the summer of 2002, the orbital planes of CLUSTER (apogee at ~20 Re) and POLAR (apogee at ~9 Re) were closely aligned in MLT with both missions having apogee in the tail. This provided a unique opportunity to study the relation between the inner magnetotail at near-Earth distances (POLAR) and the mid-tail region (CLUSTER) during substorm onsets. A considerable number of events have been identified for which CLUSTER observations suggest that an X-line was formed in the mid-tail region while high speed flows were observed at POLAR altitude. In particular, for this study we will focus in the August 21st, 2001 substorm event. The near-earth energetic particles (from POLAR/CEPPAD) will be analyzed for signatures of westward drift-Alfven wave propagation, a signature of the kinetic ballooning instability. Predictions of substorm theories that involve reconnection and the ballooning instability will be tested.

SM11B-06 0945h

Impact of O+ on Substorm Development

L M Kistler[1] (Lynn.Kistler@unh.edu); C G Mouikis[1]; X Cao[1]; H U Frey[2]; R Friedel[3]; B Klecker[4]; I Dandouras[5]; G Parks[2]; A Balogh[6]

[1]University of New Hampshire, Space Science Center Morse Hall, Durham, NH 03824, United States

[2]University of California Berkeley, Space Sciences Laboratory, Berkeley, CA

[3]Los Alamos National Labs, Space Remote Sensing Sci, Los Alamos, NM, United States

[4]Max Planck Institute, Extraterrestrische Physik, Garching, Germany

[5]CESR, 9 Ave Colonel Roche, Toulouse, France

[6]Imperial College, London, United Kingdom

Using the CLUSTER ion composition data from the CIS instrument and CLUSTER magnetometer data we have analyzed the substorm development of all substorms which occurred during the 2001 and 2002 CLUSTER tail passes in order to determine how the concentration of O+ effects substorm growth phase and onset. Parameters analyzed include the length of the growth phase, the pressure increase during the growth phase, the pressure decrease at onset, and the plasmasheet thickness before and after onset. Substorm onsets were identified using observations from the IMAGE FUV instrument combined with geosynchronous injection signatures from the LANL satellites. The substorms have been divided into stormtime substorms and non-stormtime substorms. The clear difference between the stormtime and the non-stormtime cases is that the stormtime events contain a much higher concentration of O+, with O+ sometimes being the dominant species. Initial results show that the pressure increase during stormtime substorms is larger than for non-stormtime substorms, which indicates that the plasma sheet is more stable when heavy ions are present.

SM12A CC: 518 A Monday 1030h

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

Presiding: **B H Mauk,** The Johns Hopkins University, Applied Physics Laboratory**; K K Khurana,** Institute of Geophysics and Planetary Physics

SM12A-01 1030h INVITED

HST STIS Observations of Saturn's Auroral Variations Concurrent with the Cassini Solar Wind Campaign in Jan. 2004

John T. Clarke[1] (617-353-0247; jclarke@bu.edu); Jean-Claude Gerard[2] (JC.Gerard@ulg.ac.be); Denis Grodent[2] (D.Grodent@ulg.ac.be); Joe Ajello[5] (jajello@lively.jpl.nasa.gov); Gilda Ballester[3] (gilda@vega.lpl.arizona.edu); Lotfi ben Jaffel[4] (bjaffel@iap.fr); Scott Bolton[5] (Scott.Bolton@jpl.nasa.gov); Emma Bunce[6] (ejb10@ion.le.ac.uk); Jack Connerney[7] (jec@lepjec.gsfc.nasa.gov); Stan Cowley[6] (swhc1@ion.le.ac.uk); Frank Crary[8] (frank.crary@swri.org); Michele Dougherty[9] (m.dougherty@ic.ac.uk); Randy Gladstone[8] (randy@whistler.space.swri.edu); Tamas Gombosi[10] (tamas@umich.edu); Don Gurnett[11] (don.gurnett@uiowa.edu); Jacques Gustin[2] (gustin@astro.ulg.ac.be); Tom Hill[12] (hill@rice.edu); Margaret Kivelson[13] (mkivelson@igpp.ucla.edu); Tom Krimigis[14] (tom.krimigis@jhuapl.edu); Bill Kurth[11] (wsk@space.physics.uiowa.ed); Barry Mauk[14] (barry.mauk@jhuapl.edu); Renee Prange[15] (renee.prange@obspm.fr); Wayne Pryor[16] (Wayne_Pryor@centralaz.edu); John Richardson[17] (jdr@space.mit.edu); John Trauger[5] (jtt@lyot.jpl.nasa.gov); Hunter Waite[10] (hunterw@umich.edu); David Young[8] (dyoung@swri.org); Philippe Zarka[18] (Philippe.Zarka@obspm.fr)

[1]Boston University, 725 Commoonweealth Ave, Boston, MA 02215, United States

[2]Univ. of Liege, Belgium

[3]Univ. of Arizona, Tucson

[4]Institut d'Astrophysiques, CNRS, Paris

[5]Jet Propulsion Lab., Pasadena

[6]Univ. of Leicester, UK

[7]NASA Goddard Space Flight Center, Greenbelt

[8]Southwest Research Institute, San Antonio

[9]Imperial College, London UK

SM

[10] Univ. of Michigan, Ann Arbor, M, United States

[11] Univ. of Iowa, Iowa City

[12] Rice Univ., Houston

[13] UCLA, Los Angeles

[14] Applied Physics Lab., Johns Hopkins

[15] Observatoire de Meudon, France

[16] Central Arizona Univ., Arizona

[17] MIT, Cambridge

[18] Observatoire de Paris, Meudon

Saturn's magnetosphere is often referred to as "intermediate between the cases of the Earth and Jupiter". Due to very limited measurements of Saturn's magnetosphere and auroral activity, however, it has never been clear in detail what this statement means. A recent campaign of HST STIS UV imaging of Saturn's aurora has been carried out over 8-30 Jan. 2004 concurrent with measurements of the approaching solar wind by Cassini. This imaging set is much more comprehensive than any earlier observations of Saturn's aurora, obtained at a time when Saturn's southern auroral oval is completely visible due to the large apparent tilt of Saturn. The data provide the opportunity to determine the mean distribution of the auroral emissions, the degree of corotation of any bright regions, any variations with local time of the emissions, the latitudinal motions of the main oval with time and location, and other parameters. In addition, each of these can be compared with the approaching solar wind conditions and Saturn's kilometric radiation (SKR) intensity from Cassini measurements. Quick looks at the data from HST and Cassini demonstrate that the measurements have been made successfully, and the coverage includes dramatic variations in Saturn's auroral activity as well as at least two solar wind shocks passing Cassini. This presentation will concentrate on the measured properties of Saturn's aurora in the context of comparisons with the magnetospheres of the Earth and Jupiter.

SM12A-02 1050h

The Solar Wind Upstream of Saturn: Cassini Plasma measurements and Saturn's Aurora

Frank J Crary[1] (210 522-6043; fcrary@swri.edu); David T Young[1] (dyoung@swri.edu); Bruce Barraclough[2] (bbarraclough@lanl.gov); Scott Bolton[3] (Scott.J.Bolton@jpl.nasa.gov); Andrew Coates[4] (ajc@mssl.ucl.ac.uk); Tom Hill[5] (hill@rice.edu); David McComas[1] (dmccomas@swri.edu); Dan Reisenfeld[2] (dreisen@lanl.gov); Abigail Rymer[4] (amr@mssl.ucl.ac.uk); Ed Sittler[6] (Edward.C.Sittler@nasa.gov); Jari Vilppola[7] (jari.vilppola@oulu.fi); John Clarke[8] (jclarke@soleil.bu.edu); Jean-Claude Gerard[9] (JC.Gerard@ulg.ac.be); Denis Grodent[9] (D.Grodent@ulg.ac.be); Hunter Waite[10] (hunterw@umich.edu); Randy Gladstone[1] (randy.gladstone@swri.org); Ron Elsner[11] (ron.elsner@msfc.nasa.gov); Michelle Dougherty[12] (m.dougherty@ic.ac.uk); Tom Krimigis[13] (tom_krimigis@jhuapl.edu); Don Mitchell[13] (don.mitchell@jhuapl.edu); Don Gurnett[14] (donald-gurnett@uiowa.edu); William Kurth[14] (william-kurth@uiowa.edu)

[1] Southwest Research Institute, 6220 Culebra Rd, San Antonio, TX 78228, United States

[2] Los Alamos National Laboratory, Group NIS-1 Mail Stop: D-466, Los Alamos, NM 87545

[3] Jet Propulsion Laboratory, MS 230-205 4800 Oak Grove Drive, Pasadena, CA 91109

[4] University College London, Mullard Space Science Laboratory Holmbury St. Mary, Dorking RH5 6NT, United Kingdom

[5] Rice University, Physics and Astronomy Department MS 108, Houston, TX 77251

[6] Goddard Space Flight Center, NASA/GSFC, Code 692, Greenbelt, MD 20771

[7] University of Oulu, Department of Physical Sciences, Linnanmaa FIN-90014, Finland

[8] Boston University, CAS Astronomy 725 Commonwealth Ave, Boston, MA 02215

[9] University of Liege, BAT. B5 Labo de physique atmosphérique et planétaire (LPAP) allée du 6 Août, 17, Liege 4000, Belgium

[10] University of Michigan, 2418B Space Research Building 2455 Hayward Steet, Ann Arbor, MI 48109, United States

[11] Marshall Space Flight Center, Marshall Space Flight Center, Huntsville, AL 35812

[12] Imperial College London, Space Atmospheric Physics Group The Blackett Laboratory Prince Consort Road, London SW7 2BW, United Kingdom

[13] JHU Applied Physics Laboratory, Applied Physics Laboratory 11100 Johns Hopkins Road, Laurel, MD 20723, United States

[14] University of Iowa, Department of Physics and Astronomy, The University of Iowa, Iowa City, IA 52242

For a full solar rotation in January and early February, 2004, the Cassini spacecraft and Hubble and Chandra Space Telescopes were used to make simultaneous observations of the solar wind and Saturn's aurora. We report here on initial results from data taken with the Cassini Plasma Spectrometer's electron and high-resolution ion sensors in the solar wind upstream of Saturn. These measurements, combined with those of other particles and fields instruments on Cassini show two shock and corotating interaction regions, which reached Saturn approximately twelve hours later. An auroral response to each of these events was observed by the Hubble Space Telescope.

SM12A-03 1105h

Study of Seasonal Variability in Ionospheric Response to Solar Wind Driving Using the CISM Coupled Magnetosphere Ionosphere Thermosphere Model

Michael Wiltberger[1] ((303)497-1532; wiltbemj@ucar.edu)

Wenbin Wang[1]

John G Lyon[2]

[1] National Center for Atmospheric Research High Altitude Observatory, 3450 Mitchell Lane, Boulder, CO 80301, United States

[2] Dartmouth College Department of Physics and Astronomy, 6127 Wilder Laboratory, Hanover, NH 03755, United States

The Center for Integrated Space Weather Modeling (CISM) has developed the Coupled Magnetosphere Ionosphere Thermosphere Model by coupling the Lyon Fedder Mobbary global magnetohydrodynamic simulation of the solar wind - magnetosphere system to the Thermosphere Ionosphere Nested Grid (TING) model. The magnetospheric driving during an intense geomagnetic storm can result in significant amount of Joule heating in the ionosphere which in turn effects of motion of the neutral gases in the thermosphere. We use the CMIT model to study the spatial distribution of the Joule heating and energetic particle precipitation as a function of solar wind conditions, season, and solar cycle. In addition, we illustrate the impact of neutral wind driven current systems on the magnetosphere by comparing events with and without this coupling.

SM12A-04 1120h INVITED

Auroral Processes at Earth, Jupiter and Saturn.

Denis Grodent (+32 4 366 9773; d.grodent@ulg.ac.be)

LPAP, Universite de Liege, Belgium, Institut d'Astrophysique et de Geophysique, B5c Allee du 6 Aout, 17, LIEGE 4000, Belgium

We review the main characteristics of the auroral ultraviolet emissions at Earth, Jupiter and Saturn. Based on auroral morphology considerations, we discuss and compare the different solar wind - magnetosphere - ionosphere coupling processes giving rise to these emissions. Earth's magnetosphere is usually described as 'open', meaning that its field reconnects with the interplanetary magnetic field (IMF) frozen in the solar wind. This reconnection process allows solar-wind plasma and energy to be transferred to the magnetosphere and to provide the main driving force for the auroral emissions. Different cases of solar-wind plasma conditions have been recognized to give rise to different types of auroral features. Jupiter is opposed to Earth, with a 'closed' magnetosphere. Its larger distance to the Sun and its enormous magnetic field make it difficult for the reconnection process with the IMF to occur efficiently. Io's volcanism is considered to be the prime (internal) plasma source for the magnetosphere, and corotation enforcement of this outward moving plasma is the likely process generating field aligned currents, responsible for the main auroral emissions. Saturn's aurora has not been as extensively studied as Earth's and Jupiter's. Owing to fainter magnetic field and internal plasma source than Jupiter, it has been expected to be intermediate between the cases of Earth and Jupiter. Recent detailed analysis of the Terrestrial, Jovian and Saturnian auroral morphology and dynamics suggests that the simple open/closed/open-closed magnetosphere picture is somewhat oversimplified. They show a much more complex situation with, for example, auroral activity without solar-wind reconnection at Earth, Earth-like reconnection signatures at Jupiter, or extreme auroral variability at Saturn.

URL: http://lpap.astro.ulg.ac.be/jupiter

SM12A-05 1140h

Comparisons of Saturn Kilometric Radiation and Saturn's UV Aurora

W. S. Kurth[1] (william-kurth@uiowa.edu); D. A. Gurnett[1] (donald-gurnett@uiowa.edu); J. T. Clarke[2] (jclarke@bu.edu); M. Desch[3] (mdesch@pop600.gsfc.nasa.gov); M. Kaiser[3] (mkaiser@pop600.gsfc.nasa.gov); P. Zarka[4] (philippe.zarka@obspm.fr); B. Cecconi[4] (baptiste.cecconi@obspm.fr); A. Lecacheux[4] (alain.lecacheux@obspm.fr); P. Galopeau[5] (patrick.galopeau@cetp.ipsl.fr); J. C. Gerard[6] (gerard@astro.ulg.ac.be); D. Grodent[6] (d.grodent@ulg.ac.be); M. Dougherty[7] (m.doughterty@ic.ac.uk); F. Crary[8] (fcrary@swri.edu)

[1] Univ. of Iowa, Dept. of Physics and Astronomy, Iowa City, IA 52242, United States

[2] Boston Univ., Dept. of Astronomy, Boston, United States

[3] NASA/Goddard Space Flight Center, Greenbelt, MD, United States

[4] Observatoire de Paris, Meudon, France

[5] CETP/UVSQ, Velizy, France

[6] Univ. of Liege, Inst. Astrophysique Geophysique, Liege, Belgium

[7] Imperial College, Blackett Lab., London, United Kingdom

[8] Southwest Res. Inst., San Antonio, TX, United States

During the period 8 to 30 January 2004, a campaign to study the correlation between the solar wind and the response of Saturn's aurora was carried out using Cassini and the Hubble Space Telescope. In particular, fields and particles instruments on Cassini were used to monitor the solar wind near Saturn and Saturn kilometric radio emissions nearly continuously. STIS images from Hubble were obtained approximately every other day to record Saturn's UV auroral morphology and intensity. In this paper we focus particularly on the relationship between the Saturn kilometric emissions and the auroral brightness and morphology. The radio emissions are generally believed to be generated by the cyclotron maser instability on auroral field lines similar to the situation for auroral kilometric radiation at Earth. A number of studies have shown a direct relationship between the radio emissions and discrete auroral arcs at Earth. Hence, one expects a relationship between the radio emissions and the aurora at Saturn. During the campaign, two corotating interaction regions (CIRs) swept past Cassini and Saturn (which were of order 0.5 AU apart at the time). Accompanying the CIRs were high solar wind densities. As expected from Voyager studies, the higher solar wind density resulted in generally more intense radio emissions. The UV images show that Saturn's UV aurora brighten considerably in response to the CIRs, as well. Furthermore, the brightest aurora usually appear in the local morning, consistent with the Voyager-determined SKR source region on field lines connecting to the magnetopause and the Kelvin-Helmholtz hypothesis for the origin of accelerated electrons. A more detailed examination of the auroral phenomena show much more complex variations, however. The radio emission frequency extent and peak frequency vary remarkably from one Saturn rotation to the next. Similarly, the auroral morphology changes dramatically. For example, it appears the evolution of the auroral oval to higher latitudes (higher L-shells) is correlated with a shift in the frequency of peak radio emissions to lower frequencies. This can be explained through an analysis of the cyclotron maser beaming geometry. We examine this and other aspects of the correlations between the radio emissions and the aurora.