ions and neutrals, and the composition of the moon surfaces, will be described. This is done in order to assess our ability to relate atmospheric and ionospheric composition measurements to a description of the surface composition [3]. The state of our understanding of the radiolytic production of volatiles and refractory species in these surfaces will be reviewed and the results of model atmosphere calculations [4,5] will be reviewed and new model calculations will be presented. Particular attention will be paid to important trace gas-phase molecules detected Europa, Ganymede or Callisto that might be indicative of material exchange between the irradiated surfaces and the putative sub-surface oceans. An important issue for astrobiology at Europa is the effect of the radiation environment and the highly oxidized surface chemistry on detection of any potential biochemical signatures of life or precursors transported to the sensible surface from an ocean. The model calculations of the icy satellite atmospheres will also be useful for planning of instruments for future missions such as JIMO.

[1] Cooper, J.F., R.E. Johnson, B.H. Mauk, H.B. Garrett, and N. Gehrels 2001. Energetic Ion and Electron Irradiation of the Icy Galilean Satellites. Icarus 149(1), 133-159. [2] Johnson, R.E., R.W. Carlson, J.F. Cooper, C. Paranicas, M.H. Moore, and M. Wong 2003. Radiation Effects on the Surface of the Galilean Satellites, ed. F. Bagenal, Jupiter: Planet, Satellites & Magnetosphere, Cambridge University Press, Cambridge, in press. [3] Johnson, R.E., R.M. Killen, J.H. Waite, W.S. Lewis 1998. Europa's Surface and Sputter-Produced Ionosphere. Geophys. Res. Letts. 25, 3257-3260. [4] Shematovich, V.I. and R.E. Johnson 2001. Near-Surface Oxygen Atmosphere at Europa. Adv. SpaceRes. 27, 1881-1888. [5] Leblanc, F., R.E. Johnson and M.E. Brown 2002. Europa's Sodium Atmosphere: an Ocean Source? Icarus 159, 132-144.

URL: http://www.people.virginia.edu/~rej

SM12C-04 1655h

Imaging Icy Moon Atmospheres and Energetic Ion Impact Patterns From JIMO Using Energetic Neutral Atoms

Barry H Mauk[1] (240-228-6023; Barry.Mauk@jhuapl.edu)

Edmond C Roelof[1]

Joachim S Saur[1]

Chris P Paranicas[1]

[1]The Johns Hopkins University Applied Physics Laboratory, 11100 Johns Hopkins Road, Laurel, UD 20723, United States

With column densities in excess of 1.E14 /cm2 (Hall et al., 1998; Carlson 1999), the atmospheres of Europa, Ganymede and Callisto provide substantial targets for the conversion of energetic ions from Jupiter's magnetosphere into energetic neutral atoms (ENA). Here we document the value of using the technique of ENA imaging to determine the dynamics and structure of the icy moon bound and extended atmospheres, and to further elucidate the electromagnetic environments of the moons that control the pattern of ion impacts onto the icy moon surfaces. ENA imaging has become a standard technique for characterizing the structure of planetary magnetospheres, and its value in determining the presence of neutral gas from icy moons has recently been demonstrated (Mauk et al. 2003). The Cassini mission will use such imaging to diagnose the upper atmosphere and the electromagnetic environment of Titan (Amsif et al., 1997). In the work presented here, Galileo inputs are used to simulate the ENA emission patterns from Jupiter's icy moons, as they would appear to the Jupiter Icy Moon Orbiter (JIMO) platform. We show that such imaging will provide important spatial and temporal information on the processes that control the structure of icy moon atmospheres. In combination with in situ charged particle measurements, it will also provide critical information needed to separate temporal from spatial variations as we try to understand the dynamic electromagnetic environments of the icy moons. Understanding these changing electromagnetic environments is vital to using electromagnetic fields to probe the interiors of these moons. Amsif, A., J. Dandouras, E. C. Roelof, J. Geophys. Res., 102, 22181, 1997 Carlson, R. W., Science, 283, 820, 1999. Hall, D. T., P. D. Feldman, M. A. McGrath, and D. F. Strobel, ApJ, 499, 1998. Mauk, B. H., D. G. Mitchell, S. M. Krimigis, E. C. Roelof, and C. P. Paranicas, Nature, 421, 920, 2003.

SM12C-05 1710h

Ion Composition in Jupiter's Inner and Middle Magnetosphere

Lara S Waldrop[1] (617-353-7430; lara@bu.edu)

Edmond C Roelof[2]

Donald J. Williams[2]

Theodore A. Fritz[1]

C. M.S. Cohen[3]

[1]Boston University, Center for Space Physics 725 Commonwealth Avenue, Boston, MA 02215, United States

[2]Johns Hopkins University/ Applied Physics Laboratory, 11100 Johns Hopkins Road, Laurel, MD 20723-6099, United States

[3]Caltech, MC 220-47, Pasadena, CA 91125, United States

While sputtering from Jupiter's moons is considered to be the ultimate origin of the non-thermal heavy ion population observed by in situ spacecraft, the nature of its evolution remains an open question in magnetospheric physics. Galileo's comprehensive observations of energetic ions in the Jovian magnetosphere between 9 and 30 R_J are used to investigate the relative contribution of various source populations as well as the subsequent acceleration and transport that the plasma experiences. Energetic Particles Detector (EPD) measurements of protons, oxygen and sulfur ions over consecutive energy pass-bands between .01-1 MeV/nucl display a strong radial dependence between 12 and 20 R_J, with ion intensities decreasing several orders of magnitude over increasing radial distance from Jupiter. Ion energy spectra soften considerably in this transition region as well, from a power law spectral index of $\gamma \sim$ 1-2 in the inner magnetosphere to a near-constant value of $\gamma \sim 3$ in the plasma sheet. In general, the heavy ion species are more concentrated in the inner magnetosphere and display softer spectra than the energetic protons, suggesting different transport mechanisms and plasma sources for the two populations. Simultaneous measurements of $\sim$100 MeV oxygen ions made by the Galileo Heavy Ion Counter (HIC) reveal that differential oxygen intensity is well ordered by particle energy normalized to the local magnetic field strength, E/B. Extrapolation of the EPD particle intensity using the measured spectral index is performed to yield species abundance ratios at E=25 keV/nucl throughout the inner and middle Jovian magnetosphere. The S/O abundance ratio exhibits little variation with radial distance, and its near constant value of 0.5 is consistent with an Iogenic SO_2 dissociation source. These results are presented in the context of other reported abundance ratios measured at different energy/nucleon ranges, and the implications for the inferred ion charge states are discussed.

SM12C-06 1725h INVITED

Auroral Emissions of Jupiter and the Galilean Satellites

Randy Gladstone[1] (rgladstone@swri.edu)

Anil Bhardwaj[2] (bhardwaj_spl@yahoo.com)

Kurt Retherford[1] (kretherford@swri.edu)

[1]Southwest Research Institute, 6220 Culebra Road, San Antonio, TX 78238-5166, United States

[2]Space Physics Laboratory, Vikram Sarabhai Space Centre, Trivandrum 695022, India

The different types of Jupiter's aurora are most naturally separated by magnetic latitude. At the highest latitudes (near the magnetic poles) the auroral emissions are connected with the outer magnetosphere and are patchy and highly variable, e.g., FUV flares with minute time scales and pulsating x-ray hot spots (coincident with quasi-periodic radio bursts and IR hydrocarbon auroras). The main auroral oval is formed by the breakdown of magnetospheric plasma co-rotation at L=20-30. This breakdown leads to a current system connecting the equatorial magnetosphere with the polar ionosphere. A paucity of charge carriers near Jupiter is thought to lead to field-aligned potential drops in the upward current (from the ionosphere toward the magnetosphere). The resulting electric fields accelerate electrons into the upper atmosphere where they impact H_2, leading to the emissions of the main oval. It is possible that the variable emissions at higher latitudes are due to a more intermittent return current. At lower latitudes there are faint diffuse auroras and also the flux tube footprint auroras of the Galilean satellites (no footprint has been seen yet for Callisto, but it would be very close to the main oval and hard to detect). Attached to the Io flux tube footprint is a tail of emission that extends downstream (relative to the direction of magnetospheric plasma flow past Io) for many tens of degrees. At the other end of the flux tubes, auroral emissions (as opposed to airglow emissions) have been observed at Io, Europa, and Ganymede. The study of these flux tubes, and their interactions with planet and satellite, would be an excellent goal for the JIMO mission.

SM12C-07 1745h

Analysis of variability in the Jovian synchrotron emission

Daniel Santos-Costa[1]

Scott J Bolton[2] (818 393 0926; scott.j.bolton@jpl.nasa.gov)

Steve Levin[2]

Robert Sault[3]

Richard Thorne[4]

[1]Observatoire de Midi-Pyrénées, Toulouse, Toulouse, F 7, France

[2]Jet Propulsion Laboratory, 4800 Oak Grove Drive, Pasadena, CA 91109, United States

[3]ATNF Paul Wild Observatory, Narrabri, Narrabri, A 7, Australia

[4]Department of Atmospheric Sciences, UCLA, UCLA, Los Angeles, CA 7, United States

The inner electron radiation belts of Jupiter are well known to induce strong synchrotron radiation characterized by short- and long- term variations: the short-term fluctuations correspond to longitudinal asymmetries arising from asymmetries in Jupiter's magnetic field while the long-term slow intensity fluctuations are probably associated to the solar activity. Studied in-situ by only a few spacecraft, our understanding of the electron radiation belts dynamics is dependent on understanding remote observations of Jovian synchrotron emission. Because the physics of synchrotron radiation is well understood, models can aid in the interpretation of the observations. In this paper, we discuss the source of the reported variations including the roles of dust, satellite interactions and wave interactions in the semi-stable trapped particle distribution functions. We report on results from two physical models of the Jovian electron radiation belts, a trapped particle transport code and a synchrotron simulation code. The present work focuses on the effect of the rings on the electron radiation-belt population using different dust particle and longitudinal distributions.

SM21A MCC: 2008 Tuesday 0800h

Dynamic Aurora: The Role of Alfvén Waves in I-M Coupling I *(joint with SA, AE)*

Presiding: **J Spann,** NASA Marshall Space Flight Center**; C Pollock,** Southwest Research Institute

SM21A-01 0800h INVITED

Auroral particle acceleration by Alfvén waves and ionospheric feedback

Robert L Lysak[1] (612-625-1323; bob@aurora.space.umn.edu)

Yan Song[1] (612-624-4053; yan@aurora.space.umn.edu)

[1]School of Physics and Astronomy University of Minnesota, 116 Church Street SE, Minneapolis, MN 55455, United States

Recent observations, particularly by Polar and FAST, have indicated that Alfvén waves can directly accelerate auroral electrons. A model for this interaction has been developed that can describe the linear modification of the Alfvén wave profile by the kinetic effects of electrons, including acceleration and heating of the electron population. While many of the heated electrons are accelerated upward into the magnetosphere by the mirror force, a significant fraction of the input Poynting flux due to Alfvén waves can be converted into precipitating electron energy flux. An important aspect of this particle precipitation is that the hot electrons do not arrive at the ionosphere in phase with the field-aligned current, which at ionospheric altitudes is largely carried by cold electrons. This phase shift has direct implications for models of ionospheric feedback that usually assume that the precipitating flux is in phase with the field-aligned current. The effects of quasi-static electric fields can be included in the model, which will introduce new particle populations such as the effects of secondary electrons of ionospheric origin that are reflected by the parallel potential drop. The possible role of Alfvén waves trapped in the ionospheric resonator in creating small-scale auroral structures through feedback and nonlinear interactions will be discussed.

SM21A-02 0820h

Oblique Alfven Waves as a Source for Stable Auroral Arcs

Paul L. Rothwell[1] (781-377-9664; Paul.Rothwell@hanscom.af.mil)

MIchael B. Silevitch[2] (msilevit@ECE.NEU.EDU)

Carl-Gunne Falthammar[3] (falthammar@plasma.kth.se)

[1]Air Force Research Laboratory/Space Vehicles Directorate, 29 Randolph Rd., Hanscom AFB, MA 01731, United States

[2]Center for Electromagnetics Research, Northeastern University, Boston, MA 02115, United States

[3]Division of Plasma Physics, Alfven Laboratory, Royal Institute of Technology, Stockholm 70, Sweden

We have recently developed [Silevitch et al., Rothwell et al., 2000] a model for the generation of oblique Alfven waves and their role in creating stable auroral arcs. The magnetospheric wave generator, in this approach, arises from the non-adiabatic motion of the O+ ions that, under certain conditions, can form stationary density striations as they drift Earthward from the magnetotail. Associated with these density striations is a periodic static spatial variation of the Earthward current density, which when viewed in the drift frame of the adiabatic hydrogen ions and electrons is seen as a tailward moving current wave. The resulting oblique Alfven wave forms a static wave pattern. As the magnetic-field aligned currents associated with these waves close in the ionosphere, the equatorial plasma constitutes a generator from which spatially alternating magnetic field-aligned currents carry energy to the ionospheric load and form stable auroral arcs. The coupling of the magnetospheric generator to the solar wind will be discussed as well as the implication of more recent results on this work. M. Silevitch, P. Rothwell,L. Block and C.-G. Falthammar, J.Geophys. Res., 105, 10,739-10,749, 2000. P. Rothwell, M. Silevitch, L. Block and C.-G. Falthammar, IEEE Transactions on Plasma Science,28, 2000.

SM21A-03 0835h INVITED

Dispersive Alfvén Waves: Lab Verification of Theory for Inertial, Kinetic, and In-between

Craig A. Kletzing[1] (319-335-1904; craig-kletzing@uiowa.edu)

Scott R. Bounds[1] (scott-bounds@uiowa.edu)

Fred Skiff[1] (frederick-skiff@uiowa.edu)

Walter Gekelman[2] (gekelman@physics.ucla.edu)

Stephen Vincena[2] (vincena@physics.ucla.edu)

[1]Department of Physics & Astronomy, 203 Van Allen Hall, The University of Iowa, Iowa City, IA 52242, United States

[2]Department of Physics & Astronomy, University of California, Los Angeles, 1000 Veterans Aven, Suite 15-70, Los Angeles, CA 90095-1696, United States

Shear Alfvén waves are thought to play a significant role in several regions of near-Earth space including the plasma sheet, magnetopause, and auroral zone. The interesting physics occurs when the waves have narrow perpendicular structure such that the perpendicular scale is of the order of the ion acoustic gyroradius or the electron skin depth. Despite the importance of these waves, there are few experimental tests of the basic theory of these wave for conditions for which finite $k_\perp$ is important. We present the results of a series of laboratory, measurements of the shear Alfvén wave dispersion relation for waves in the inertial ($V_{th} \ll V_A$) and kinetic regimes ($V_{th} \gg V_A$)as well as for when the waves are in-between ($V_{th} \approx V_A$). The measurements were performed at the LArge Plasm Device at UCLA using the University of Iowa Arbitrary Spatial Waveform antenna. This antenna allows us to probe the dispersive nature of these waves for non-negligible $k_\perp$. Examples of the kinds of waveforms which can be generated are shown to demonstrate the flexibility of the system. By comparing the arrival times of the waves at spatially separated points, the wave phase velocity is determined which is then compared to the theoretical dispersion relation. The dispersion relation shows the expected response in parallel phase velocity with increasing perpendicular wave number. We compare two-fluid and kinetic descriptions of the dispersion and find that the best agreement between theory and experiment occurs for the warm plasma dispersion relation including collisional damping.

SM21A-04 0855h

3-Hz Alfvén Wave and Electron Bursts in the Upper Ionosphere During a Substorm Intensification

Johnathan K. Burchill[1] (403-220-8108; burchill@phys.ucalgary.ca); David J. Knudsen[1] (+33-1-3925-4765; knudsen@phys.ucalgary.ca); James H. Clemmons[2] (James.H.Clemmons@aero.org); Robert F. Pfaff[3] (rob.pfaff@gsfc.nasa.gov); Donald D. Wallis[4] (dwallis@eisa.com); Robert Rankin[5] (rankin@space.ualberta.ca); Clare E. Watt[5] (cwatt@space.ualberta.ca)

[1]University of Calgary, Dept of Physics and Astronomy, 2500 University Drive NW, Calgary, AB T2N 1N4, Canada

[2]The Aerospace Corporation, MS M2/254, 270 Coral Circle, El Segundo, CA 90245, United States

[3]NASA GSFC, Code 696, Bldg. 2, Room 213, Greenbelt, MD 20771, United States

[4]Magnemetrics, 2340 Briar Hill Drive, Ottawa, ON K1H 7A9, Canada

[5]University of Alberta, Department of Physics,, Edmonton, AB T6G 2J1, Canada

The GEODESIC auroral sounding rocket encountered two short-lived (several second) bursts of intense Alfvén waves between 800-900 km during a substorm intensification on February 26, 2000. The waves were detected with both vector electric field double probes and a vector flux gate magnetometer and carry a peak Poynting flux of 1 mW/m^2, and are downward-propagating. They have a frequency near 3 Hz and appear to be very coherent, existing within a very narrow bandwidth. They show no sign of reflection from the ionosphere below, and also no sign of direct coupling (density perturbations or particle heating) with the local plasma. The observations are consistent with a horizontal wavelength of order 1 km. The waves were associated with electron acceleration several thousand km above the ionosphere, resulting in velocity-dispersed bursts with energies exceeding 1 keV at times. The higher energies and the detailed shape of the dispersion curves challenge simple, two-fluid models of wave propagation and electron acceleration, and indicate the need for additional physical mechanisms to explain their characteristics. We discuss possible improvements to the models.

SM21A-05 0910h INVITED

The Structure and Dynamics of Poynting Flux in the Geomagnetic Tail and its Role in Generating Aurora

John R. Wygant (612 626 8918; wygant@ham.space.umn.edu)

University of Minnesota, 116 Church St. SE, Minneapolis, MN 55455

Recent observations from the Polar and Cluster spacecraft have provided evidence that a variety of processes observed in different locations in the geomagnetic tail during intervals of strong magnetic activity generate intense Alfvenic and steady state Poynting flux directed along magnetic field lines towards the Earth. This Poynting flux is often capable of providing the power necessary for the acceleration of auroral electrons and creating intense auroral displays. Strong electric and magnetic fields associated with MHD waves carrying Poynting flux directed towards the Earth are observed in the high beta plasma sheet near 9 Re during repetitive intervals of magnetic field dipolarization during major geomagnetic storms. Intense Poynting flux associated with Alfvenic surface waves have been also been observed in the low beta Plasma sheet boundary layer (PSBL) at altitudes of 4-7 Re immediately above the auroral acceleration region near the poleward boundary of the auroral zone. During the main phase and peak of major geomagnetic storms, measurements of electric and magnetic fields from Polar in the near Earth equatorial plasma sheet show evidence for spatially extensive (1-3 Re) regions of intense Poynting flux (both steady state and Alfvenic) towards the Earth. This Poynting flux maps to low latitudes over widths of 2-5 degrees. Finally, observations from the Cluster spacecraft studies demonstrate that strong Poynting flux is radiated from the reconnection region near 20 Re in association with magnetic field energy conversion in the tail. The in-situ values of Poynting flux from these regions are 0.1 to 1.0 mW/m2 and may be related to the observations in the PSBL The value of Poynting flux mapped to altitudes of 100 km are on the order 10-100 mW/m2 and are sufficient to power some of the most intense aurora observed in the Polar spacecraft UV Image and the IMAGE spacecraft WIC data sets. The properties of the structure and dynamics of the MHD waves associated with the Poynting flux will be summarized and compared to the temporal and spatial structure of the auroral forms simultaneously observed by the IMAGE and Polar Space based imagers.

SM21A-06 0930h

Generation of electron bursts by Alfven waves in the dayside auroral region

Yi-Jiun Su[1] (303-735-0366; ysu@lasp.colorado.edu)

Samuel T. Jones[2] (ssjones@colorado.edu)

Robert E. Ergun[1] (ree@lasp.colorado.edu)

Scott E. Parker[2] (sparker@colorado.edu)

[1]Laboratory for Atmospheric and Space Physics, University of Colorado, 1234 Innovation Drive, Boulder, CO 80303, United States

[2]Center for Integrated Plasma Studies, University of Colorado, Department of Physics Campus Box 390 University of Colorado, Boulder, CO 80309, United States

Various models have been considered to explain the acceleration of electrons by Alfven waves. Electron time dispersion and electron bursts are often observed in the auroral region. In this presentation, a linear 1-D gyrofluid simulation with finite-gyroradius and electron inertia effects is applied on a dayside auroral field line. A test particle code was constructed under gravitational and mirror forces. The time dispersion of precipitating magnetosheath electrons is generated due to propagating Alfven waves obtained from the gyrofluid code. In order to reproduce the electron burst signature observed from the FAST satellite, the ionospheric density gradient is reduced to maintain the parallel electric field of dispersive Alfven waves at a certain magnitude below the peak of the Alfven speed. Additionally, O+ ions are selected as the dominant species below 6400 km altitudes. Cold background electrons with an initial energy of 2 eV are trapped within the Alfven wave as it propagates toward the ionosphere, and are accelerated by parallel electric field to an energy of hundreds of eV. The energy-time spectrogram and distribution functions of electrons from our simulation will be compared with observations from the FAST satellite.

SM21A-07 0945h

Large-Amplitude Parallel Electric Fields Associated With Inertial Alfven Waves

R. E. Ergun[1] (ree@lasp.colorafo.edu); L. Andersson[1] (andersson@vlasov.colorado.edu); Y.-J. Su[1] (ysu@lasp.colorado.edu); D. L. Newman[2] (David.Newman@colorado.edu); M. V. Goldman[2] (goldman@spot.colorado.edu); C. C. Chaston[3] (ccc@ssl.berkeley.edu); C. W. Carlson[3] (cwc@ssl.berkeley.edu); W. Lotko[4] (William.Lotko@dartmouth.edu)

[1]University of Colorado, Laboratory for Atmospheric and Space Physics, Boulder, CO 80303, United States

[2]University of Colorado, Center for Integrated Plasma Studies, Boulder, CO 80303, United States

[3]University of California, Space Sciences Laboratory, Berkeley, CA 94720, United States

[4]Dartmouth College, Physics Department, Hanover, NH 03755, United States

We report observations of intense, localized parallel electric fields associated with inertial Alfven waves and accelerated electron fluxes. The parallel electric fields are localized to several hundred Debye lengths and carry potentials on the order of the energy of the accelerated electron fluxes. The structures are observed at the maxima or minima of the perturbation magnetic field of the Alfven wave indicating near-zero field-aligned currents. The localized electric field structures are not entirely consistent with published double layer models and may represent a new class of parallel electric field structures which are an important feature of the nonlinear evolution of Alfven waves and of the electron acceleration processes. These data are a unique example of cross-scale coupling from Alfven wavelengths to Debye scales.

SM