SM21B-06 0945h

Field-line resonances in arbitrary magnetic field topology

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We present first results of a cold plasma field-line resonance model which can be utilized in arbitrary magnetic field topology. It turns out that for realistic magnetospheric magnetic fields there is no orthogonal coordinate system which is aligned everywhere with the background magnetic field. Therefore, a more general description based on covariant-contravariant formalism is required. We discuss the mathematical methods for computing the metric tensor coefficients required in this case and present the set of equations for covariant components of the perturbation electric and magnetic fields. An eigenvalue problem for these equations is solved numerically to compute the fundamental resonance frequency of a twisted magnetic field line and the results for several background field configurations are shown.

SM22A CC: 518 A Tuesday 1030h

Ground-Based Arrays for the 21st Century III *(joint with SA)*

Presiding: **R E Denton,** Dartmouth College**; B J Fraser,** Cooperative Research Centre for Satellite Systems

SM22A-01 1030h INVITED

Maximizing utility of THEMIS All-Sky Imager Array Data for Science, Space Weather, and Public Outreach

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THEMIS (Time History of Events and Macroscale Interactions during Substorms) is scheduled for launch in 2006. THEMIS will consist of five satellites on equatorial orbits with apogees at 10, 20, and 30 Re, relatively phased on those orbits so every four sidereal days the five satellites are in conjunction over central Canada. The primary scientific objective of the THEMIS mission is to elucidate the physical sequence of events leading up to and immediately following substorm expansive phase onset. THEMIS has a significant ground-based observational component which includes a continent wide array of 20 white light auroral All-Sky Imagers (ASIs). The ASIs will operate at a cadence of one image every five seconds, and will be used to identify the location and timing of auroral substorm onset. Data from the ASIs will be available in real time and retrospectively from a web page and ftp tree. The first of these imagers was deployed in Athabasca in the summer of 2003. The entire array will be operational by fall 2006. This new array will provide a staggering amount of data. Scientific exploitation of this data set demands work in advance on the development of summary files, merging images to create mosaics, automatic techniques for cloud detection and auroral classification, and the placing of the auroral features within a magnetospheric context. Archival, rapid retrieval, and data mining requires the establishment of effective metadata and storage capacity. Rapid identification of events, space weather, and sustaining public awareness of and interest in our activities requires and effective real-time web-based display capability.

SM22A-02 1045h

All Sky Imager Array for the determination of the onset times and locations of substorms

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As the ground based component of the THEMIS NASA MIDEX program an array of optical observatories will be deployed across the entire North American arctic region. There will be 16 stations located in Canada and 4 in Alaska. The purpose of the stations is to provide spatially contiguous high time resolution coverage of the entire North American arctic region to document the aurora magnetically conjugate to the 5 THEMIS satellites. The requirement is to measure the location of the onset to an accuracy of about 1 degree of latitude and the time of onset to better than 10 second accuracy. To minimize the cost and complexity of the program the instruments operate with panchromatic wavelength response and they image on bare CCD-s. The image repetition rate (cadence) will be one image every 5 seconds and the exposure time is 1 sec in duration. The cameras have a demonstrated sensitivity of better than 1 kR. The images consisting of the full data set will be stored at the field site on hard disks for annual collection. Summary data, integrated to a grid of resolution better than one degree latitude will be retrieved via the wired or satellite internet. The cameras will operate in climate controlled enclosures to facilitate unattended operation. A magnetometer will be collocated with the cameras at each field station. It is the intention of the project to have local teachers perform routine on site supervision of the instruments and to take advantage of the educational outreach potential of their participation in the program.

SM22A-03 1100h

THEMIS Ground-based magnetometer arrays and their education and public outreach potential

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The THEMIS ground-based magnetometer array is unique in that 12 of the 20 magnetometers will be located at high schools and tribal colleges in the Northern United States as part of the THEMIS Education and Public Outreach plan. These magnetometers will help to teach students and teachers around the country about ground-based arrays, auroral physics, and space physics in general. This large ground-based array, together with an extensive THEMIS all-sky camera array in Canada and Alaska, will be used to determine the onset of substorms when the five THEMIS satellites are conjugate to these stations in the magnetotail. Because the twelve magnetometers that will be housed in schools are research-grade magnetometers, teachers and students will be able to learn about substorms using the same data which scientists will use. With the partnership of the Space Grant Consortium network, the Lawrence Hall of Science's Great Explorations in Math and Science (GEMS) teacher network, and the OSS Broker Facilitators, we are currently selecting schools and teachers that meet a very particular set of criteria both from the science and the education point-of-view. A competition in each of the states is being held to find the school best suited to teach about and house the magnetometer. We will give the results of the schools selected to participate in the THEMIS ground-based magnetometer array and education and public outreach program. We will also discuss education materials being developed to facilitate how the data will be used in the schools. In addition, through the Student Observation Network (S.O.N.) of the Sun Earth Education Forum, we will become part of a national network of classrooms who are willing to learn more and predict space weather. We will also present a brief overview of our THEMIS education and public outreach programs' Informal Education and Teacher Professional Development.

URL: http://cse.ssl.berkeley.edu/themis/

SM22A-04 1115h

Global Network of Fabry-Perot Interferometers to Observe Mesospheric and Thermospheric Dynamics

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Measurements of mesospheric and thermospheric dynamics have been obtained by numerous groups over the past several decades through the application of automatically-operating Fabry-Perot interferometers (FPI). These instruments are designed to observe the Doppler shifts and Doppler broadening of airglow emissions such as the atomic oxygen lines at 557.7 nm and 630.0 nm or a rotational line of OH molecular emissions. A variety of different FPI instrumental designs has been developed over the years in the acquisition of these results, but recent developments in detector technology have made possible the construction and deployment of FPI observatories on a scale not considered feasible until now. Moreover, operations of FPI observatories with data analyzed in real time for deposition by Internet into a central archival center for data assimilation purposes are now quite feasible. What would be the benefits and likely expenses for operating a network of such modernized FPI observatories? This paper will present a historical survey of past FPI research in terms of science results achieved, summarize the possible benefits to be gained, and close with a plan for the future expansion of the existing network of FPI observatories.

SM22A-05 1130h

Imaging Ionospheric Disturbances with a Global Array of the Ground-Based GPS TEC Receivers

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A prime example of distributed arrays of small instruments for space science research is found in the use of the existing global array of GPS receivers to provide high spatial/temporal resolution mapping of the total electron electron content (TEC) at equatorial, mid, auroral, and polar latitudes. Particularly dramatic effects are observed during major disturbances when magnetospheric electric fields perturb and redistribute the thermal plasmas of inner magnetosphere (plasmasphere/ionosphere). Enhancement and poleward displacement of the equatorial anomalies (EA), the formation of plasmaspheric drainage plumes which erode the outer plasmasphere and produce significant storm enhanced density and space weather effects at mid latitudes, and tongues of ionization which span the polar caps are all a part of the systematic redistribution of the low-latitude thermal plasma during strong events. The present distribution of GPS receivers permits mapping such features primarily over the land masses of North America and Europe, where 1x1 deg spatial and 30-sec temporal observations of vertical TEC can be achieved. Few receivers currently exist in developing countries and large gaps in coverage exist over the oceans. However, the large and meso-scale characteristics and evolution of these thermal plasma storm effects can be identified in the global maps. We address the cross-calibration of ground-based and space-based techniques to image and sample such features by comparing simultaneous observations of the major features observed during the strong storm on May 30,

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2003. GPS TEC mapping observed the rapid enhancement of the EA and the formation of a concentration of enhanced plasma in the Carribean sector. This corotating enhancement provided a continuing a source for the dusk-sector plasmaspheric drainage plume. The down-looking IMAGE FUV instrument can map enhancements in the equatorial emissions associated with the EA and observed the spatial extent and evolution of the co-rotating low-latitude ionospheric features in the American sector during this event. Simultaneous DMSP overflights provide in situ observations of topside plasma density at 880 km altitude. Pixel by pixel intercomparison of GPS TEC maps with the FUV observations determine the sensitivity characteristics of the FUV instrument for such studies (features with > 60 TECu are well imaged by the FUV instrument).

SM22A-06 1145h

Potential of a Sensitive Low Frequency Radio Telescope for Heliospheric Studies

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A sensitive low frequency radio telescope array introduces a new generation digital aperture synthesis interferometer. A possible design could cover the 80-240 MHz frequency range and provide up to 32 MHz of observation bandwidth. Groups of orthogonal dipoles will serve as receptors and the collecting area will be distributed in a centrally condensed manner. The instrument will be optimised for high dynamic range snap shot imaging. The conversion of the receptor signal to the digital domain at the earliest available opportunity makes it possible to form multiple independent beams simultaneously. The current design allows up to 8 beams using the entire collecting area of the array and 256 beams per polarisation using only the part of the array lying within the central 2 km of the array (core). The instrument will also feature an *All Sky Monitor*, which will use the array core and will provide an image the entire field of view about every second. These unprecedented capabilities makes the instrument very effective for a variety of solar and heliospheric studies, in addition to its astronomical and astrophysical objectives. The high dynamic range imaging capability of the instrument makes it very useful for imaging the Sun. Due to steep spectral nature of the emission and the low frequencies of observation the instrument, it will be able to image the emission from the CMEs to distances beyond the fields of view of existing coronographs. When the CMEs become too faint to be imaged directly, interplanetary scintillation (IPS) techniques can be used to study them, allowing their evolution to be tracked till beyond 1 AU. The large multi- beaming capability of the array core makes it very attractive for IPS tomographic reconstruction of the velocity structure of the entire inner heliosphere. The full polarisation capability of the instrument allows us to exploit the effect of Faraday rotation (FR) to study the distribution of magnetic field and electron density along lines of sights to distant polarised sources. IPS and FR studies will yield information about both the quiescent and transient heliosphere. The use of IPS and FR data-sets from this instrument along with data from Thompson scattering imagers like SMEI and STEREO will provide much more complete information about the heliosphere. These data-sets when combined with good MHD solar wind propagation models will provide the opportunity for a tomographic reconstruction of the velocity, density, turbulence structure and magnetic field in the heliosphere. A very useful by-product of the calibration of this instrument will be exquisitely detailed information about the total electron content (TEC) of the ionosphere at the telescope site. The instrument will have about 5000 lines of sight piercing the ionosphere over a radius of 400 km, providing a very fine spatial sampling of the ionosphere. This information can be used to construct for the first time a 4D (3 spatial and 1 temporal) TEC model of the ionosphere at these spatial scales.

SM23A CC: 518 A Tuesday 1330h

What Controls the Degree of Conjugacy in Auroral Phenomena? I

(joint with SA)

Presiding: **N Ostgaard,** University of California, Berkeley**; J F Spann,** NASA Marshall Space Flight Center

SM23A-01 1330h INVITED

Conjugacy and non-conjugacy of auroral breakup observed by the Syowa-Iceland conjugate observatories

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Syowa Station in Antarctica and Japanese stations in Iceland provide an ideal set of observatories to study geomagnetically conjugate optical auroras. A campaign of auroral conjugate observations using all-sky TV cameras has been carried out since 1984 during the equinox periods when simultaneous optical observations are possible under enough darkness in both hemispheres. In this paper we will briefly review these conjugate auroral observations and give an outline of what we have learned regarding asymmetries, and to what extent these are controlled by the IMF or magnetospheric internal causes. Then we will focus on the examples of conjugacy and non-conjugacy of auroral breakup phenomena, which have been recorded during the last few years. An excellent conjugate event, which occurred on 26 September 2003, showed that the evolution of an auroral substorm from the growth phase through expansion phase to recovery phase was observed at the conjugate-pair observatories. Auroral breakup occurred at lower latitudes, and then the active auroral region expanded rapidly poleward. Afterwards, north-south (N-S) structured auroral forms appeared from higher latitudes and extended to lower latitudes several times. The sequence was concluded by N-S structured pulsating auroras. This excellent conjugate event allowed us to trace the conjugate point with high time- and spatial resolution. On the other hand, three non-conjugate auroral breakup events we examined showed that the start time of the auroral breakup (sudden luminosity enhancement and followed by poleward expansion) and the shape of the auroral forms were completely different in the conjugate hemispheres. During two of the three events, the poleward expansion started earlier at Syowa than that at the observatory in Iceland, but for one event the opposite was true. We will discuss these features in order to clarify how the IMF parameters and/or ionosphere-magnetosphere coupling processes control the conjugacy or non-conjugacy of auroral breakup.

SM23A-02 1350h INVITED

What do Empirical Field Models Tell us on the Geomagnetic Conjugacy ?

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Empirical magnetospheric magnetic field models are natural tools for studying the geomagnetic conjugacy, since they are based on large amounts of spacecraft data and, by their construction, are supposed to faithfully represent the actual magnetospheric geometry as a function of the geomagnetic disturbance and characteristics of the incoming solar wind, as well as its asymmetry due to seasonal and diurnal changes of the Earth's dipole tilt. The very notion of geomagnetic conjugacy makes sense only for closed magnetic field lines, whose footpoints lie equatorward from the poleward boundary of the auroral oval. On the other hand, the field lines originating progressively equatorward from the auroral zone, map into the inner magnetosphere, where the total field rapidly increases earthward and becomes essentially dipolar, so that the location of conjugate points in that region is virtually unaffected by the external factors and the dipole tilt. Therefore, when studying the conjugacy, our region of interest is limited within a relatively narrow interval of geomagnetic latitudes. During strong geomagnetic storms, the combined effect of the increase of the ring and tail currents can result in a dramatic deformation of the previosly quasi-dipolar nightside magnetic field, so that the tail-like stretch of the field lines (and, hence, the amplitude of the conjugate footpoint shift) can greatly increase and penetrate deeper into the inner magnetosphere. Another storm-time effect, distinctly revealed by the models, is the development of a strong partial ring current on the dusk side, manifested in a remarkable dawn-dusk asymmetry of the magnetic field depression at low latitudes. Finally, empirical models persistently indicate a significant penetrated component of the IMF inside the magnetosphere. All these factors can affect the location of conjugate points, and it is the purpose of this talk to present a survey of most important effects.

SM23A-03 1410h

IMF Control of Auroral Phenomena in the Conjugate Hemispheres

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Based on simultaneous imaging data from IMAGE and Polar, we examine the IMF control of the occurrence and location of auroral features in the conjugate hemispheres. The imaging data have revealed that transpolar arcs during northward IMF can exist in one hemisphere but not in the other and we have attributed this to the sign of the IMF Bx component, which controls in which hemisphere lobe reconnection is most efficient. Examining auroral substorm onsets in the conjugate hemispheres, we have found that the onset locations are systematically displaced in one hemisphere compared to the other, meaning they have different geomagnetic coordinates (e.g., apex, CGM). Our results indicate that the relative displacement of onset locations in the conjugate hemispheres is controlled by the IMF clock-angle. These findings are used to examine how well these asymmetries in the nightside magnetosphere are included in existing magnetic field models. In this paper conjugate observations of dayside cusp precipitation during northward IMF will be presented and examined as well.

SM23A-04 1425h

Simultaneous Observations of Conjugate Northern and Southern Auroras from a Single Camera.

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Most studies of the solar wind-magnetosphere-ionosphere system assume that the northern and southern auroral ovals are symmetric. However, evidence has been steadily accumulating for interhemispheric differences in the nature of the northern and southern auroras at magnetically conjugate locations. From late September to early November of the years 2000-2003, the apogee for the Polar spacecraft was located at ∼9 RE near the equator with a local time in the premidnight magnetotail. From this vantage point, the far ultraviolet sensitive Earth Camera of the Polar/Visible Imaging System (Polar/VIS) acquired simultaneously (in a single image frame) observations of magnetically conjugate northern and southern auroral locations for most of the nighttime sector. The image frame cadence was 54 s. These conjugate observations have the advantage of being acquired from a similar perspective with a single camera, a single bandpass sensitivity, and exactly simultaneous timing. The altitude of Polar was sufficiently high to allow determination of the latitudinal distribution of auroral luminosities at a spatial resolution of ∼150 to 200 km. The timings, motions, and auroral locations of several events will be presented.