

SP31A-10 0830h POSTER

Electric Fields in the Hermean Magnetosphere

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Returning to Mercury with the BepiColombo mission will provide a unique opportunity to obtain in situ information on the electric field in Mercury's magnetosphere. The electric field plays a crucial role for plasma transport in the magnetosphere, for transfer of energy between different parts of the system, and for propagation of information. Measuring the electric field we will be able to better understand plasma motion and wave propagation in Mercury's magnetosphere. Together with knowledge of the magnetic field a better understanding will be derived of the magnetospheric current systems and their closure at or near the planetary surface. Further insight into possible substorms at Mercury will be gained. We summarize the scientific case for electric field measurements on BepiColombo and outline the instrument design which, because of the harsh environment, is a challenging task.

SP31A-11 0830h POSTER

Seasonal Dependence of The Vertical Distributions of Auroral Kilometric Radiation Sources and Auroral Particle Acceleration Regions

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Seasonal dependence of the vertical distributions of occurrence probabilities of auroral kilometric radiation (AKR) sources and auroral acceleration regions indicated by upflowing ion (UPI) events have been compared based on statistical analyses of plasma waves and energetic particles data observed by the Akebono (EXOS-D) satellite. The peak altitude in the vertical distribution of occurrence probability of AKR sources whose emission intensities are larger than -150 dBW/m²Hz occur at 5000-6000 km in the summer polar region and at 3000-4000 km in the winter polar region. The analyses have also clarified that the vertical distributions of occurrence probabilities of auroral acceleration regions show seasonal variations which are quite similar to those of the AKR sources. The analysis results are consistent with the studies on seasonal variation of auroral phenomena such as precipitating electrons, upflowing ions, UV aurora, AKR, electromagnetic ion cyclotron (EMIC) waves, and cosmic radio noise absorption (CNA) events. As the control mechanism of seasonal variations of auroral phenomena, ionospheric conductivity feedback mechanism is pointed out by Newell et al.(1996). As discussed by Borovsky(1993), there are many auroral theories, which are divided into electron-acceleration mechanisms and generator mechanisms. Among the mechanisms, not only ionospheric conductivity feedback mechanism but also several electron-acceleration mechanisms, which occur near the earth, are plausible to depend on the seasons. In those mechanisms, background cold plasma density is thought to be an important control factor for maintaining auroral particle acceleration processes.

SP31B WCC: TH-Auditrm
Wednesday 0830h

Relativistic Electron Dynamics: Focus on Losses III Posters

Presiding: R Friedel, Los Alamos
National Laboratory

SP31B-01 0830h POSTER

Conditions Leading to Energetic Electron Losses at GEO

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Many geomagnetic storms lead to large scale, permanent loss of geosynchronous relativistic electrons. Presumably processes during the main phase produce a non-adiabatic loss through the magnetopause and into the ionosphere. We provide a statistical analysis of geosynchronous loss events to demonstrate their association with certain interplanetary and magnetospheric phenomena. Generally, large losses accompany magnetic storms. However, substantial losses are possible even when "small" magnetic activity is present (below the usual threshold for a storm, Dst < -50 nT). Such non-storm losses are typically associated with low (350 km/s) solar wind velocity, high (10-20/cc) solar wind density, and small negative IMF B_z. During such losses, Kp, Dst, Pc5 ULF wave power, and AE all show signs of weak activity.

SP31B-02 0830h POSTER

Fluxes of trapped, quasi-trapped, precipitated and geosynchronous relativistic electrons in the spring 1994: CORONAS-I and GOES-7 comparison

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Comparison analysis of the relativistic (>2 MeV) electron fluxes in the outer radiation belt (ORB) with geomagnetic activity and corresponding solar wind conditions during the spring-summer 1994 is performed using data obtained from geosynchronous satellite GOES-7 and from low altitude (500 km) highly inclined satellite CORONAS-I. On the dayside GOES-7 observed mixture of trapped, quasi-trapped and precipitating relativistic electrons with highly variable fluxes (up to 5 orders of value). The satellite CORONAS-I had opportunity to observe these fractions separately on different longitudes during its crossings of middle and high latitude regions. The dynamics of these fractions depends differently on the geomagnetic activity and solar wind conditions. In the beginning of geomagnetic storms the fluxes of trapped and quasi-trapped relativistic electrons drop out and precipitating electron fluxes increase significantly (more than two orders) and sometime exceed the pre-storm trapped electron fluxes. The relativistic electrons precipitate in wide range of L-shells from L 2.5 to L 8 with maximal fluxes on high L-shells (L>5). Such electron dynamics indicates intensive pitch-angle scattering of the relativistic electrons in the loss cone probably due to very strong variations of induced interplanetary VB electric field and solar wind density enhancements producing magnetosphere compression up to about 8 Earth radii in subsolar point. On the main phase of the magnetic storms the solar wind dynamic pressure becomes relatively small but induced electric field variations are still significant that leading to intensive substorm activity. During this time the electron precipitation is still intensive but the trapped and quasi-trapped electron fluxes begin to restore on L=3.5-4.5. The recovery phase of recurrent geomagnetic storms is accompanied by gradually decreasing fluctuations of VB electric field and corresponding substorm activity. On this phase the precipitating electron fluxes fall in general and the fluxes of trapped and quasi-trapped electrons growth gradually. This growth sometime achieves extremely high levels of intensity which produce the instability of ORB and intensive electron precipitation (enhancement of precipitating and quasi-trapped electron fluxes) from maximal electron intensity region which slowly moves with time toward its undisturbed location (L 3). Therefore the analysis shows that on the main and recovery phases of the magnetic storms the relativistic electrons are accelerated by some long lasting mechanism with effectiveness decreasing gradually on the recovery phase. The obtained experimental results are used for verification of different acceleration models.

URL: <http://dec1.npi.msu.su/english/data/lasre/index.html>

SP31B-03 0830h POSTER

Effects of high-energy particles in outer radiation belt on low-energy ion measurements: FAST observations at low latitudes

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Previous observations have shown that the O⁺ ion population is an important contributor to the storm time ring current. Its abundance in terms of energy density increases with increasing geomagnetic activity. On the other hand, mechanisms of this dramatic composition change of the ring current are poorly understood. While enhanced polar outflows during geomagnetically active periods are considered to be responsible for the composition change, the link of the outflows and high energy ring current is not clear due to the lack of low-energy ion observations in the inner magnetosphere at L less than 6 Re. Penetration of radiation-belt electrons into instruments makes direct observations of low-energy ions difficult in the inner magnetosphere. A correction method to remove this background is also one of key elements needed for inner magnetospheric missions in the future.

The Electrostatic Analyzer (ESA) onboard the FAST satellite had been operated in the mid-latitude regions above ~45 degrees for the past 4 years and observed ions below 12 keV. Radiation belt contamination is quite uniform in energy. Utilizing this feature, we developed an automated method to subtract the radiation contamination from ESA data. The variation of radiation penetration during the April 11, 2001 magnetic storm are examined in detail. Comparing the estimated background with LANL energetic particle data, we discuss accuracy and issues of the background subtraction methods. The background counts rapidly decreased during the main phase and stayed low for ~1 day. The variation is similar to that of electron flux in energies of 315keV-1.5MeV at the geosynchronous orbit. The comparison with simultaneous ion composition measurements, which suffer no radiation contamination, we conclude that the background subtraction works reasonably well during the main phase. Corrected ion data show the existence of multiple energy-banded ion components in the inner magnetosphere intensified at ILAT=55-62 degrees during the main phase. Simultaneous ion composition data indicate that these ions mainly consist of O⁺. Their implication on the supply mechanisms of O⁺ ions in the storm-time ring current will be also discussed.

SP31B-04 0830h POSTER

A VLF Beacon Transmitter at South Pole: a new Tool for Continuous Measurements of Relativistic Electron Precipitation

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It is well known that precipitating relativistic (>500 keV) electrons deposit their energy at the lowest levels of the lower ionosphere, at altitudes as low as 40-60 km, where they create secondary ionization enhancements and x-rays. It has also been known that VLF sounding (i.e., the measurement of the amplitude and phase of subionospheric signals) is a sensitive tool for the measurement of ionospheric conductivity (i.e., electron density and temperature), especially at altitudes below 90 km, and some of the early work on relativistic electron precipitation events has indeed relied on subionospheric VLF measurements. In recent years, the VLF remote sensing method has been extensively utilized to study a variety of lower ionospheric disturbances, including those associated with lightning discharges, heating by HF waves, the auroral electrojet, and relativistic electron precipitation enhancements.

Computer-based models of VLF propagation and scattering are now available so that the VLF method can now be quantitatively used to interpret ionospheric signatures of relativistic electron precipitation in terms of their spatial extent and the altitude profiles of ionization. In this talk, we will discuss a new VLF beacon transmitter that is being setup this year (December 2002) at South Pole, and which will allow continuous measurements of relativistic electron precipitation activity over the range $3 < L < 7$. The geophysical location of the transmitter facility and receiver sites make it ideally suitable for the quantification of such precipitation in a manner highly complementary to satellite-based measurements. Much of the systematic data on relativistic electron enhancements is based on satellite-based measurements which are not resolved enough (in pitch angle) to properly quantify the associated precipitating components. With the new South Pole Beacon facility, during austral winter, with much of the Antarctic ionosphere in dark, local time variations in the magnitude and spatial (i.e., L -shell) extent of relativistic electron precipitation will be determined with observations at regular intervals (every few minutes) over the course of a 24-hour period. The reception of the beacon signal is aided by the relatively low radio frequency interference environment at the various Antarctic sites.

SP31C WCC: MF-LionHV1 Wednesday 0830h

Extrasolar Planets

Presiding: D Sullivan, Victoria
University; C Alcock, University of Pennsylvania

SP31C-01 0830h

Detecting Extrasolar Planets by the Transit Method

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One method for detecting the presence of an extrasolar planet around a star is to look for the small reduction in light from the luminous host star due to the transit of the dark planetary disk between the observer and the star. This requires the plane of the planetary orbit to be closely aligned with the line of sight of the observer. Several space-based missions that are now in the planning stage are proposing to use this method to search for evidence of extrasolar planets down to Earth-sized objects. An extensive database of large numbers of regularly monitored stars is a requirement for these programmes. We have used a large database of stars that have been regularly monitored to search for signs of planetary transits. The database of stellar intensities was created by the NZ-based microlensing project, MOA, operating from the Mt John Observatory at Lake Tekapo in New Zealand, and covers a period of several years. We will present the method used, summarise our results, and draw conclusions about the prospects for other ground-based and space-based programmes.

URL: <http://www.vuw.ac.nz/scps/moa/>

SP31C-02 0845h

The Extrasolar Planet HD 209458b

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In spite of the now large number of extrasolar planets that have been detected around other stars, there remains only one that has been detected by two different methods. There is no doubt that the relatively bright star HD 209458 has an orbital companion with mass similar to that of Jupiter. The close proximity of this companion induces observable radial velocity variations in the host star, and the geometry of the orbit ensures that we also see the dark planetary disk transiting across the face of the stellar disk. The two objects are so close that the orbital period for the motion is close to 3.5 days. Consequently, observable transits appear every 7 nights within the observing season at a given site. Combining the radial velocity data with the transit data allows such quantities as planetary radius and density to be deduced. The speaker will survey what we know about this extrasolar planet, drawing on

his experience of measuring one of the first transits of this system at Mauna Kea Observatory in Hawaii in November 1999.

URL: <http://www.vuw.ac.nz/scps/astro/>

SP31C-03 0900h

Precise Stellar Radial Velocities and the Search for Extrasolar Planets

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Recently the discovery of extrasolar planets has raised much excitement worldwide, not only amongst astronomers and academics, but also the general public. In May 2001 Mount John University Observatory had the installation of the HERCULES spectrograph. Using the planet-detection method known as the radial velocity technique our goal is to measure velocity amplitudes of the order of 20 m/s. This is only slightly greater than the 13 m/s produced by Jupiter on our Sun. Currently approximately 90 sun-like stars are being monitored in the Southern Hemisphere with HERCULES and it is hoped that within the next few years several new planet findings will be confirmed. This session gives a detailed look at the technique employed, the spectrograph design, and some of our initial results obtained.

SP31C-04 0915h INVITED

Particle Acceleration Processes at the Earth, the Sun and the Super Nova Remnant SN1006

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Particle acceleration is an important and ubiquitous process. In this paper, the author will present and discuss acceleration processes observed in the Earth's atmosphere, above the solar surface, and in the environment of the super nova remnant SN1006.

First, new data on electrons will be reported that were obtained with cosmic ray detectors at Mt. Norikura. Knock-on electrons were observed to be accelerated to energies up to 20 MeV by the strong electric fields in thunder clouds. Most of the accelerated electrons were absorbed by ionization processes, but some were observed directly, thus providing clear evidence for DC acceleration. A periodicity analysis covering an eleven year period revealed a period of 26 days, corresponding to the solar rotation period.

Second, anomalous data obtained by the Tibet solar neutron telescope in association with the large solar flare of Sep. 24th, 2001 will be reported. Almost all solar neutron events detected in solar cycle 23 by world-wide solar neutron telescopes were contemporaneous with the detection of accelerated electrons. The energies of the neutrons were around 400 MeV, corresponding to ions with initial energies around one GeV. In the Sep. 24th event, however, the detected neutrons were not contemporaneous with electron acceleration as scored by hard X-rays. This implies that ion acceleration is not always accompanied by electron production. This observation will constrain theories of particle acceleration processes at the solar surface.

Finally, the author will propose a new hypothesis for ion acceleration to energies of order 100 TeV in the super nova remnant SN1006, for which detailed data by X-ray and high-energy Cherenkov telescopes are now available.

SP31C-05 0940h INVITED

The Taiwanese-American Occultation Survey of the Trans-Neptunian Region (TAOS)

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The Taiwanese-American Occultation Survey (TAOS) is designed to determine directly the number of small (~ 2 km) objects in the trans-Neptunian region of the Solar System. An array of four 50cm telescopes will monitor ~ 3000 stars simultaneously at 5Hz. When a trans-Neptunian Object transits one of these stars, an occultation event occurs. The rate of occultations is directly proportional to the number of trans-Neptunian objects. This talk will describe the current state of the survey, and discuss our expectations for the next few years.

SP31C-06 1025h

Detecting Extra-Solar Planets via High Magnification Microlensing Events

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Extra-solar planets can be efficiently detected in gravitational microlensing events of high magnification. High accuracy photometry is required over a short, well-defined time interval only, of order 10-30 hours. Most planets orbiting the lens star are evidenced by perturbations of the microlensing lightcurve in this time. Consequently, telescope resources need be concentrated during this period only. The Japanese/New Zealand collaboration MOA (Microlensing Observations in Astrophysics) continues to detect and alert microlensing events of high magnification to the community at <http://www.phys.canterbury.ac.nz/~physib/alert/alert.html> promoting follow-up observations.

Here we discuss some aspects of planet detection in these events including:-

1. zones of detectability of terrestrial, ice-giant and gas-giant planets
2. detectability of multi-planet systems
3. detectability of solar system analogues
4. detectability of habitable planets
5. effects of the size of the source star, and the presence of spots on the source star
6. effect of orbital rotation during an event
7. cluster computing for simulations and modelling
8. applications to proposed space-based missions

SP31C-07 1040h

Study by MOA of Extra-Solar Planets in Gravitational Microlensing Events of High Magnification

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A brief history of the development of the gravitational microlensing technique for detecting extra-solar planets will be given, including the original work of Einstein and Liebes.

A search for extra-solar planets that was carried out by the MOA collaboration in three microlensing events of high magnification using data from the MPS, MA-CHO, OGLE, PLANET and MOA groups will also be given. For all three events, exclusion zones for Jupiter-like planets were obtained, extending from about 0.5 AU to about 20 AU. These are the largest exclusion zones yet obtained for Jupiter-like planets orbiting normal stars. For one of the events, evidence was obtained for a planet with mass $\sim (0.4 - 1.5) \times M_{\text{Earth}}$ at a projected radius of either ~ 1.5 or ~ 2.3 AU. This is the first evidence for an Earth-mass planet orbiting a normal star.

Future possible developments of the microlensing technique will be described, including a network of telescopes in Chile, South Africa and Australia that has been set up to observe future events, and also the potential of using a 10-m telescope.

URL: <http://www.vuw.ac.nz/scps/moa/>

SP31C-08 1055h INVITED

EROS Gravitational Microlensing Survey: Results on Dark Matter and Stellar Atmospheres

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The latest results from the EROS microlensing survey towards the Magellanic Clouds and the Galactic Plane will be discussed. We combine these results with earlier ones from the EROS1 experiment. This makes our analysis sensitive to compact objects in the broad mass range $10^{-7} - 10 M_{\odot}$. We derive an upper limit on the abundance of planetary, sub-stellar and stellar