Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

PEM027-01 Room:103 Time:May 25 16:30-16:45

Initial results of auroral observations using an EMCCD camera in 2010/2011 winter campaign at Poker Flat Research Range

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Pulsating aurora is a phenomenon which shows periodic changes of emission intensity in the diffuse aurora. The emission is characterized by not sinusoidal change but pulsation, and its typical period is from a few seconds to a few tens of seconds [e.g., *Oguti et al*., 1981; *Yamamoto*, 1988]. Precipitating electrons which generate pulsating aurora were observed with 3 Hz modulations by rockets and low-altitude satellites, and the energy ranges from a few keV to a few tens keV [e.g., *Sandahl et al*., 1980]. Since pulsating aurora appears in diffuse aurora, electrons are thought to undergo cyclotron resonance with whistler mode waves in the equatorial region of the magnetosphere and to precipitate into the Earth's upper atmosphere by pitch angle scattering. Some simultaneous optical and VLF whistler mode wave observations have been carried out to demonstrate this idea [*Hansen and Scourfield*, 1990; *Tagirov et al*., 1998]. These studies suggested that appearance of auroral pulsations were related to VLF emission activity, however, one-to-one correspondence of order of a few hundred ms between auroral fine-scale structures with high temporal fluctuations and each element of VLF emission were not shown yet. In addition, recent simultaneous ground-satellite observations of pulsating auroras suggests not only mechanism associated with whistler mode waves but also one associated with Electron Cyclotron Harmonics (ECH), especially in high latitude regions ($L>6$) [*Liang et al*., 2010]. Therefore, continuous ground-based observations including optical and ELF-VLF measurements are still needed to reveal what drives pulsating auroras.

The purpose of this study is to investigate the characteristic of temporal variations in pulsating auroras using a high-speed camera equipped with an Electron Multiplying CCD (EMCCD). We are planning a new observation that addresses especially pulsating auroras. The plan is to carry out simultaneous observations with three cameras (two EMCCD cameras and another camera for guiding), a photometer, a VLF receive system (100 kHz sampling) for short term campaign and an ELF magnetometer (1 kHz sampling). EMCCD camera takes an image at mainly 670.0 nm (N_2 1st Positive Band) wavelength at intervals of 10 ms. The field of view is 48.9 x 48.9 degrees and the spatial resolutions equals to 1.6 km at an altitude of 110 km (8 x 8 binning). The photometer consists of a Schmidt-Cassegrain telescope (F10.0, f2000mm), an interference filter at 670.0 nm, a photo counting head and a photo counting unit. Its field of view is 0.22 x 0.22 degrees and corresponding to 840 x 840 m at an altitude of 110 km. It is designed to detect 10% fluctuations of intensity of pulsating auroras with a few kR by 1 kHz sampling.

The observation began to be operated at Poker Flat Research Range (MLAT 66.77 deg. MLON 262.97 deg.) in Alaska on November, 2010. Our instruments are working without fatal errors and many data of pulsating auroras have been acquired. Initial results of our observations will be reported in this presentation.

Keywords: aurora, pulsating aurora, optical observations, wave-particle interaction, substorm

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PEM027-02 Room:103 Time:May 25 16:45-17:00

Structure of field lines associated with ionosphere-driven interchange instability from the magnetosphere to atmosphere

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On the basis of a magnetospheric energy principle the existence of an ionosphere-driven magnetospheric interchange instability has been suggested. The ionosphere-driven interchange instability is a new type of driving magnetospheric interchange instability. Therefore, a test of the existence of the ionosphere-driven interchange instability is very important in testing the validity and usefulness of the magnetospheric energy principle in discussing magnetospheric dynamics. The existence of the ionosphere-driven interchange instability is also important in discussing radiation belt dynamics and auroras in the inner magnetosphere, since in such a region the pressure gradient is so small that a conventional pressure-driven magnetospheric interchange instability cannot be destabilized. In the magnetospheric energy principle the existence of the neutral atomosphere under the ionosphere is completely neglected. Thus the magnetospheric energy principle cannot clarify the structure of perturbations from the magnetosphere to the neutral atmosphere. However, the magnetospheric energy principle has recently been extended to include the neutral atmosphere and it is now possible to discuss the structure of perturbations in the atmosphere associated with the ionosphere-driven interchange mode. Thus it is now possible to test the validity of the extended magnetospheric energy principle by examining the structure of perturbations not only in the magnetosphere but also in the atmosphere. In this paper the structure of magnetic field lines associated with the instability in the magnetosphere and in the atmosphere is clarified. Owing to the ideal MHD frozen-in law the concept of magnetic field lines is very useful in the magentosphere and field lines are interpreted to comove with plasma. On the other hand there is no electric current in the neutral atmosphere and the magnetic field is represented by a potential field. Since there is no plasma in the atmosphere, the concept of field line motion comoving with plasma is not useful. Nevertheless, in the atmosphere there is also a magnetic field and it is possible to define magnetic field lines. In the ionosphere, which is a boundary region between the magnetospheric plasma and the neutral atmosphere, there is a magnetic field and field lines can be defined. Owing to the existence of dissipation in the ionosphere the frozen-in law is not valid and the concept of field line motion comoving with plasma is not valid. According to the magnetospheric energy principle, when the unperturbed field line is incident vertically on the spherical ionospheric surface, a horizontal magnetic perturbation is induced at the ionosphere due to the convective motion of field lines by an electric field perturbation. In the magnetosphere the magnetospheric interchange instability has no horizontal magnetic field perturbation. Thus it is expected that field lines are kinked at the ionosphere in an ionosphere-driven interchange instability. Owing to the continuity of a tangential electric field across the ionospheric surface, there also arises a horizontal magnetic field perturbation just below the ionosphere. Since the magnetic field in the atmosphere is a potential field, this horizontal component of the magnetic field must decrease toward the earth's surface. Therefore, in the ionosphere-driven magnetospheric interchange instability it is expected that the magnetic field has no horizontal component in the magnetosphere, has a kink in the ionosphere and decreases rapidly toward the earth's surface in the atmosphere. If such a field line structure is truly observed, the existence of the ionosphere-driven interchange instability predicted by the magnetospheric energy principle is confirmed and hence the validity and usefulness of the magnetospheric energy principle in discussing magnetospheric dynamics are verified.

Keywords: magnetosphere, ionosphere-driven interchange instability, MHD instability, neutral atmosphere, magnetic field lines, energy principle

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PEM027-03 Room:103 Time:May 25 17:00-17:15

Spatiotemporal characteristics of Toroidal Pc 5 ULF during high-speed solar wind intervals

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ULF waves in frequency band between 1.67 and 6.67 mHz, especially Pc 5 magnetic pulsations, are believed to contribute to Relativistic Electron Enhancement (REE) in the outer radiation belt during magnetic storms. Many researchers suggested that high solar wind velocity and high long-duration Pc 5 power observed on the ground in the storm recovery phase are closely associated with the production of relativistic electrons (Baker et al., 1998; Rostoker et al., 1998; Mathie and Mann, 2000; O'Brien et al., 2001, 2003). Theoretically, the polarization (toroidal, poloidal or compressional modes) of the Pc 5 pulsations is discussed for the effectiveness of transporting radially energetic particles in terms of radial diffsion. Most of ground-based works focused on the activities of Pc 5 pulsations (e.g., amplitude or power), and they have rarely considered the polarization of Pc 5 pulsations because of difficulty to identify it by using only ground-based observations.

The purpose of this paper is to directly demonstrate the polarization characteristics and its spatiotemporal distribution of Pc 5 waves in the inner magnetosphere by the in-situ observations. We analyzed the magnetic and electric field data obtained by Time History of Events and Macroscale Interactions During Substorms (THEMIS) for the REE (14) / Non-REE (10) events under the high-speed solar wind conditions during 2008, and identified the polarization of these Pc 5 waves. It is clear that the Pc 5 polarization characteristics are strongly local time dependent. We found that the dayside toroidal Pc 5 wave at the outer radiation belt (L >8) is the important role of the radial diffusion mechanism.

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PEM027-04 Room:103 Time:May 25 17:15-17:30

Activities of Pc5 pulsations in high-latitudes associated with energetic ion enhancement at geosynchronous altitudes

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There have been two aspects associated with high latitude Pc5 pulsations. The first one is propagation characteristics in east-west direction (Saka et al., JGR, 1983) and the other one is association of the local injection of particles (Saka et al., JGR, 1992). Those results suggest that Pc5 pulsations in high latitudes are not only related to the flow shear in the solar wind but also to substorm injections.

We show in this report that Pc5 events (17 Jan and 10 Aug, 1994) observed at the high latitude stations in the morning sector are accompanied by energetic ion enhancement related to the inflation of inner magnetosphere that began 10 min after the onset of substorm injection (e.g., Saka et al., JASTP, 2010).

The dipole field configurations invoked by the inflation might be a favorable condition for the flow shear to excite field line oscillations. The Pc5 activities are then related to both the solar wind flow and local injection of particles.

Keywords: Pc5 pulsation, energetic particles, inner magnetosphere, geosynchronous altitudes, auroral region

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PEM027-05 Room:103 Time:May 25 17:30-17:45

Statistical analysis of the ion pitch angle distribution in the inner magnetosphere

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It is known that energetic particles are drifting around the Earth in the inner magnetosphere and many researchers have been studying their pitch angle distribution (PAD) and its cause in order to know some physical mechanisms occurred along their drift path. Various PADs, (e.g., normal, isotropic, head-and-shoulder, and butterfly types) have commonly identified by previous studies. In particular, for the butterfly PAD, there are several proposed generation mechanisms such as "particle injection and drift effect" [Konradi, 1973], "drift shell splitting + magnetopause shadowing" [West et al., 1973], "drift shell splitting + negative radial flux gradient" [Sibeck et al., 1987], "ring current effect" [Ebihara et al., 2008], and "multiple pitch angle scattering effect" [Shibahara et al., 2010].

In this study, we focus on the high-energy ions (10-200 keV) in the inner magnetosphere and conduct a statistical analysis of the PAD by classifying disturbance level and particle energy. We examine which of the generation mechanisms of the butterfly PAD mentioned above is the most plausible. We use the particle flux data measured by the CAMMICE/MICS instrument (1.0-200 keV/q) onboard the Polar satellite and select the event when the Polar satellite traversed the magnetic equatorial plane during 1996-2002.

For high energy ions (>= 50 keV), we find that normal, butterfly, and isotropic PAD can be seen respectively on the whole dayside, around midnight, and between the region where the normal and butterfly PADs were found. On the other hand, low-energy (~ 10 keV) ion PAD shows a quiet different characteristic. We classify the butterfly PAD into the "M-type" butterfly which looks like a smooth bowl and "U-type" butterfly which has a deep bite-out at 90 degree pitch angles, and find that most of the butterfly PAD is "M-type" but "U-type" butterfly can be seen on the night side in low-energy (~ 10 keV) ion. There are only a few butterfly PAD events in the pre-noon region, leading us to say that generation mechanisms except "magnetopause shadowing" theory should have a strong effect. In this presentation, we will show the statistical analysis results of the pitch angle distribution in the inner magnetosphere and discuss the generation mechanisms of the butterfly PAD.

Keywords: inner magnetosphere, pitch angle distribution

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PEM027-06 Room:103 Time:May 25 17:45-18:00

Magnetic Configurations around a Plasmoid in the Near-Earth Magnetotail

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Magnetic configurations around plasmoids propagating in the directions of earthward and tailward in the near-Earth plasma sheet were studied using MHD simulations and statistical analyses of Geotail observations. MHD simulations were done giving a single X-line. These results are appeared in the statistics of events. This fact making it possible to conclude that magnetic configurations around plasmoids in the near-Earth plasma sheet are the NFTE-like structure, not the flux rope-like structure.

Keywords: Reconnection, Plasmoid, Magnetic Configuration, MHD simulation, Satellite observations

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Characteristics of fast plasma flows in the near-earth plasma sheet

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The Bubble model or the interchange motion of the plasma depleted flux tube, which is originally proposed to solve the so-called 'Pressure Balance Inconsistency', is one of the accepted candidates of the mechanism for high-speed flows observed in the near-earth plasma sheet. However it is not clear yet that it is quite so, and eventually how they are associated with (play a role in) the magnetospheric convection and substorm dynamics.

This study addresses the above problem by investigating the characteristics of fast flows in the central plasma sheet observed by Geotail. We use plasma moments and magnetic field data acquired respectively with LEP and MGF instruments during January 1993 to November 2005. We also include EPIC/STICS data for the derivation of plasma moments. By classifying the fast flow events according to the flow direction (earthward or tailward), flow speed, and distance from the earth, we examined the variations of physical quantities that will show the systematic change if the fast flow was a passage of 'Bubble.' The quantities include the ion pressure (P), north-south component of the magnetic field (Bz), and value equivalent to the specific entropy (PV^gamma, where V is the volume of the flux tube, but here we use Bz as an alternative).

As for the earthward flows, summing up the analysis results, we can conclude that the earthward flows can be basically interpreted as the passage of Bubbles. In addition, it is found for the first time that the speed range in which the Bubble-like features prominently appear shifts to the relatively lower-speed ($<$400km/s) range in the region closer to the earth($|x|<$15Re). This result not only indicates the flow breaking but also suggests that we should reconsider the categorical criteria for the selection of fast flows used in statistical studies. As for the tailward flows, we will discuss their characteristics in association with possibilities, such as bounces of bubbles, vortex-like flows, and the ballooning instability.

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Magnetospheric Dynamics on Southward/Northward Turning of IMF

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One of important problems in space plasma physics is to understand relationships among magnetic reconnection and initiation of substorm processes and magnetospheric dynamics when the IMF turns from northward to southward or vice versa. When the IMF is northward, a dipole-like magnetic field configuration is formed in a steady state and magnetic reconnection occurs in high latitude tail region. On the other hand, when it is southward, a tail-like configuration is formed and reconnection occurs at the dayside magnetopause and plasma sheet. The reconnection site shifts to subsolar region in the dayside magnetosphere when the IMF turns southward from northward. Then, reconnected magnetic flux transfers from the subsolar region to lobes through polar regions and is accumulated in lobe regions of magnetotail. As the result, plasma sheet thinning is happened and successively tail reconnection as formation of near-earth neutral line (NENL) begins and fast jet flows appear in both directions in the plasma sheet.

How do the processes of magnetic reconnection proceed at the dayside magnetopause and in the magnetotail? What are causal relationships satisfied in processes such as the initiation reconnection, formation of NENL, full spread of neutral line up to flank magnetopause, start of lobe reconnection? What do the plasma, momentum and energy carry toward the earth and how do the plasma sheet configuration change? We have studied the detail processes on magnetic reconnection in the plasma sheet and successive magnetospheric dynamics from a high-resolution and 3-dimensional global MHD simulation of interaction between the solar wind and earth's magnetosphere when the IMF turns from northward to southward and vice versa. As the results, the first reconnection occurs in closed field lines in the magnetotail and proceeds to full spread of reconnection line up to flank magnetopause and lobe reconnection in a few minutes, and then fast plasma flows appear in the plasma sheet. We will discuss what are important to carry the plasma, momentum and energy in the plasma sheet and to change the configuration of near-earth plasma pressure and magnetospheric convection.

Keywords: MHD Simulation, Interplanetary Magnetic Field, Magnetic Reconnection, Magnetospheric Dynamics, Substorms, Energy Transport