Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

PEM28-P01 Room:Poster Time:April 29 18:15-19:30

Observation of 630 nm auroral polarization with a newly-developed imaging spectrograph

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From the recent result of observation of OI 630nm auroral emission related to polar rain at high-latitudes using a polarization photometer, linear polarization parallel to geomagnetic field with 2-7% was reported [Lilensten et al., 2013]. From a theoretical approach, OI 630nm emission can be polarized up to 17% [Bommier et al., 2011]. However, these past measurements were limited in the polar cap region and its polarimetry characteristics is not clear. Therefore, we developed an imaging spectrograph which can measure auroral polarization in the wide field-of-view of 130 deg. from 420 nm to 680 nm with a accuracy of 1% polarization degree, which enable us to obtain polarization degrees at 557.7 nm aurora and 630 nm auroral emission simultaneously at various geomagnetic angle configuration. Here we consider that 557.7nm aurora is useful as a standard light source because a theory predicts 557.7nm emission does not produce polarization. We installed it in the middle of auroral region at Poker Flat Research range in November 2013and carried out precise calibration to extract artificial polarization which may be produce inside the optical system using an LED light source with a linear polarizer. From the calibration, we found the acrylic dome does not produce serious artificial polarization. Since then, automatic operation is continuously going on till the beginning of April 2014.

From the result on January 1st 2014, we obtain the polarization of 630 nm aurora with degree of 10%. Then, there was elevation angle dependence in both degree and direction. But, we also observed the polarization of no polarized 557.7nm emission. It has same elevation angle dependence as former. So, it is indicated that they are polarized by same processes like atmospheric scattering on the path from emission region to instrument. In this presentation, we report these results.

Keywords: aurora, polarimetry

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Development of polarization photometer and observation of OI 630 nm auroral polarization

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Auroral O630 nm emission is theoretically expected to be polarized due to the velocity anisotropy of precipitating electrons. On the other hand, auroral O557.7 nm emission should not be polarized because it is quadrupole transition [Lilensten et al., 2006].

Recent ground-based measurement data showed that auroral emission at OI 630 nm probably polarized with a degree of 1-4%, and the polarization is maximized in the magnetic perpendicular direction [Lilensten et al., 2008, Barthelemy et al., 2011]. This fact suggest that it would be possible to investigate auroral physical processes, like electron anisotropy, by remote-sensing the auroral polarization.

In this study, we aim to establish the procedures of polarimetry observation of aurora, and obtain its polarization degree by developing a new polarization photometer.

We developed the polarization photometer which measures the polarization parameters (Stokes vector) using a quartz waveplate mounted on rotation stage and a polarization beam splitter. We adopt a narrow band 630 nm for wavelength selection. The field-of-view of this photometer is 3 deg. Observation of OI 630 nm auroral polarimetry was performed at Poker Flat Research Range in Alaska for three weeks in January 2013. We rotated the waveplate and took data at nine positions in one rotation. The time resolution for one rotation is 30 s. In addition, we carried out the calibration at Polar Flat with a linear polarizer and LED lamp. Using the auroral polarization data set and calibration data, we estimated the linear polarization degree and circular polarization simultaneously for the world first time.

On January 17, aurora appeared in the whole sky around 14:00 UT. During this period, we estimated the auroral polarization degree at various points along geomagnetic meridian. The estimated polarization degree maximized at the point parallel to the local geomagnetic field, which is inconsistent with the past result. On January 18, the auroral linear polarization degree increased correlated with auroral enhancement at 11:30 UT. This fact suggest that auroral polarization may increase due to the change in anisotropy in precipitating electrons.

Keywords: aurora ground observation, polarization

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Approximate formula of daytime ionospheric conductance ratio

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Solar zenith angle (SZA) dependences of daytime ionospheric conductances are studied. In particular, we developed a simple theoretical form for the Hall to Pedersen conductance ratio against SZA. The European incoherent scatter (EISCAT) radar observations located at Tromso (67 MLAT) on 30 March 2012 were used to calculate conductances.

Daytime electric conductances in the ionosphere are associated with plasmas created by Solar extreme ultraviolet radiation into the neutral atmosphere of Earth. Previous conductance models have been either consistent or not with the ideal Chapman theory of such plasma productions.

Our results indicate that the SZA dependence of the Pedersen conductance can be consistent with the Chapman theory after modifications. Such modifications include an approximation of vertically-uniform plasma densities in the topside E region, and taking atmospheric temperature upward gradient into account. The Hall conductance decreases with increasing SZA more rapidly than the Pedersen conductance does. This is because that the Hall conductivity layer thins from noon toward night.

Keywords: ionospheric conductivity, ionosphere, conductance, EISCAT, incoherent scatter radar

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Temporal variation of electron density in the vicinity of the ionospheric trough

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The purpose of this study is to examine temporal variation of electron density in the vicinity of the ionospheric trough, and to understand its physical mechanisms on different geomagnetic activities.

Basu et al. [2008] showed that Subauroal Polarization Stream (SAPS) enhances in the south of the trough during storm main phase. At the same time, GPS-TEC map showed that the trough also extends longitudinally throughout the Northern American continent. In addition, they pointed out that the plasma density irregularities in the trough/SAPS region impact the GPS-based navigation systems.

So far, it remains unclear how the trough and such irregularities develop in a shorter time scale and what determines their spatial structure because adequate observation with sufficient temporal resolution has not been operated. Therefore, we had conducted EISCAT SP experiment (high speed meridional scans which take only 60-80 seconds to scan elevation angles from 25 to 89 degrees) in duskside-nightside (1630-2030 MLT) on Oct. 2013 - Dec. 2013, and obtained totally 9 events including 7 quiet-moderate events and 2 disturbed events.

We have been investigating on the following topics: (1) the difference of temporal variation of electron density between inside and outside the trough, (2) the characteristic of temporal variation of electron density in the vicinity of the trough. We have obtained the following results so far.

1. The quasi-periodic variations in electron density, on the time scale of 5-40 minutes, have been found outside the trough, which varies with time and altitude. Oh the other hand, such structures less occurs within the trough. This tendency is independent on geomagnetic activity.

2. The quasi-periodic variations in electron density, on the time scale of 5-10 minutes, have been found within the trough boundary, which is nearly consistent toward altitude in magnetically quiet-moderate condition. However, this cyclic pattern is inconsistent toward altitude in magnetically disturbed condition.

Keywords: ionosphere, trough

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Classification and occurrence characteristics of subauroral rapid plasma flows observed by SuperDARN Hokkaido HF radar

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The rapid ionospheric plasma flows equatorward of the auroral zone are called Sub-Auroral Polarization Stream (SAPS). As a result of the past studies of SAPS, Kataoka et al. [2009] reported that positions of SAPS shift toward lower latitude with developing Dst index using the SuperDARN Hokkaido HF radar.

In this study we investigate the occurrence characteristics of SAPS, with focus on the relationship between SAPS occurrence and solar wind / geomagnetic parameters, using the SuperDARN Hokkaido HF radar with the field of view covering the Far East region, which began its operation in 2006. In order to discuss characteristics of SAPS extensively, we take a wider range of velocity (>10 m/s) and MLAT (>40 deg) than the previous studies. As a result of the statistical analysis we identified two kinds of flows with a threshold of 150 - 200 m/s. MLAT of faster flows has correlation with SYM-H and AL index, whereas the slower ones have no such correlation. We will report on the details of correlation between flow characteristics of solar wind and geomagnetic parameters, including substorm and storm phases.

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Magnetic latitude and MLT dependence of the bandwidth of MF/HF auroral radio emissions in the topside ionosphere

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In the ionosphere, auroral radio emissions are generated by precipitating auroral particles. Previous studies reported that the MF/HF auroral radio emissions emitted from the bottomside ionosphere were observed on the ground. The narrowband emissions are called auroral roar, and the broadband emissions are called MF burst. On the other hand, Sato et al. [2010] showed the spectrum and polarization of two events of MF/HF radio emissions observed in the topside ionosphere by the Akebono satellite. Based on the event studies, they suggested that the observed narrowband emissions are generated by the mode conversion of UHR waves enhanced in the auroral ionosphere where the upper hybrid frequency matches the harmonics of the electron cyclotron frequency as suggested for generation mechanism of the auroral roar observed on the ground [Weatherwax et al., 1995; Yoon et al., 1998; Weatherwax et al., 2002].

In this study, we have focused on broadband emissions observed in the topside ionosphere which are similar with broadband MF burst observed on the ground. We analyzed MF/HF broadband emissions (with wider bandwidth of $>$0.5 kHz) observed by the Akebono satellite. Because it is difficult to observe broadband emissions on the ground and in the topside ionosphere at the same time, we have performed statistical analysis. We found that the bandwidth of the MF/HF emissions was larger in the high latitude and in the dusk side. The bandwidth of the MF/HF emissions was greater than 1 MHz in higher geomagnetic latitude than 70 degree in the sector from 12 to 24 MLT. Previous studies suggested that the MF bursts observed on the ground were generated by the mode conversion of upper hybrid waves stimulated by the energetic auroral electrons [e.g. Sato et al., 2008]. Therefore, we can expect that the bandwidth of MF bursts depend on the generation processes of upper hybrid waves, mode conversion processes of upper hybrid waves, and propagation processes of converted electromagnetic waves in the auroral ionosphere.

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Time Variability of Characteristics of Pc5 during Passage of CIRs

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In this study, we analyzed the magnetic data observed at the high-latitude magnetic stations in Antarctica, H057 (-66.42, L=6.25), and Skallen (-66.42) to compare with the >2Mev electron flux observed by GOES 10 satellite. The pair of stations is located at the same latitude and within 1.7 degrees in longitude, which are quite suitable to estimate the azimuthal wave number.

We statistically analyzed the wave characteristics of the Pc5 pulsations by the superposed epoch (SPE) analysis for 14 magnetic storm events caused by the passage of CIRs (Corotating Interaction Region). The epoch time is defined as days from the passage of the stream interface (SI) of the CIR. The Pc5 power suddenly increases at 3-6 MLT sector from 0 day which is much stronger than that at dusk sectors. During 1-2 days, which is correspond to the recovery phase of the storms, the Pc5 power at the afternoon sectors (12-21 MLT) increases with the peak frequency of 2.5-3 mHz, whereas the Pc5 power at the morning sector does not become stronger.

On the other hand, the phase delay between the Pc5s at H057 and SKAL also shows the local time dependence especially during the epoch time of 1-2 day. At the noon and afternoon sectors, the Pc5 shows the eastward propagation and the phase lags between H057 and SKAL are less than 5 seconds. In contrast, at the morning sector, the Pc5 shows westward propagation with small azimuthal wave numbers.

These features indicate that the sources and generation mechanisms of Pc5 in the two periods (0-1 day and 1-2 day) are quite different. The premiere intensification of the Pc5 corresponds to the main phase of the moderate magnetic storm and can thought to be the forced oscillation caused by the strong disturbance of the solarwind dynamic pressure. In this case, the local time dependence of the phase structure does not show the obvious regularities. In the latter intensification of the Pc5 corresponds to the recovery phase of the storm (1-2 days). The westward (eastward) propagation at the morning (afternoon) sector and local time distribution of the Pc5 power could well correspond with the previous perception which could explain the Pc5 pulsations caused by the KH instability on the magnetopause.

The present result implies that the difference of the wave characteristics of Pc5s closely related the drift bounce resonance with the relativistic electrons. The drift bounce resonance might occur at the afternoon sector during the recovery phase of the moderate magnetic storm by the KH instability due to the passage of the high speed solar wind.

Keywords: Raadiation Belt, ULF wave