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

PEM27-01 Room:421 Time:May 1 16:15-16:30

Micro-TypeIII radio bursts and outer corona

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We presents detailed features of micro-typeIII radio bursts and its relation to the outer corona, by using long-term observations made by the Geotail satellites. Micro-typeIII radio bursts are elements of the so-called type III storm, and are characterized by short-lived, continuous, and weak emissions. Their average power is estimated to be well below that of the largest type III burst by 6 orders of magnitude. The activity of micro-typeIII bursts with respect to the solar activity, lower frequency limit of the bursts and its relation to the solar activity, and the configuration of magnetic field line of which source electrons are trapped are investigated. The relationship between streamers and micro-typeIII bursts are discussed by using STEREO observations.

Keywords: micro-type-III burst, outer corona, solar radio burst, interplanetary space, inner-heliosphere

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PEM27-02 Room:421 Time:May 1 16:30-16:45

Coronal vector magnetic field and the plasma beta determined from the NoRH and multiple satellites observations

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In the solar corona, there are various kinds of eruptive phenomena, such as flares and coronal mass ejections, which are caused by interactions between the coronal magnetic field and plasma. Hence, it is important to precisely measure the coronal plasma parameters, including the magnetic field, plasma density, and temperature, in order to understand the mechanisms that generate these eruptive coronal phenomena.

The solar coronal vector magnetic field, plasma density, and temperature is derived from coordinated observations of the radio thermal free-free emission using the Nobeyama Radioheliograph (NoRH) and multiple line-of-sight extreme ultraviolet observations using the Solar Dynamic Observatory (SDO) and the Solar Terrestrial Relations Observatory (STEREO). We observed a post-flare loop on the west limb on 2013 April 11. The line-of-sight magnetic field was derived from the circularly polarized free-free emission observed by NoRH, which was combined with the tilt angle toward the Earth observed with STEREO and converted to a vector magnetic field. The emission measure and temperature were derived from the Atmospheric Imaging Assembly (AIA) onboard SDO. The derived temperature was used to estimate the emission measure from the NoRH radio free-free emission observations. The derived density from NoRH was 40% larger than that determined using AIA, which is due to the fact that the low temperature plasma is not within the temperature coverage range of the AIA filters used in this study. The derived plasma parameters (vector magnetic field, plasma density, and temperature) were used to derive the plasma beta, which is a ratio between the magnetic pressure and the plasma pressure. The derived plasma beta is about 6.2×10^{-3} at the pool top region. The plasma parameters derived in this study were all based on observational results, and the calculated vector magnetic field presented herein is one of the least affected by assumptions or modeling ever derived.

Keywords: Sun, corona, magnetic fields, polarization observation, Nobeyama Radioheliograph

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PEM27-03 Room:421 Time:May 1 16:45-17:00

Relationships among cosmic ray intensity, the photospheric magnetic field, and solar wind speed

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We visualize three-dimensional structure of the coronal magneic field by using the Radial-Field model for the coronal magnetic field devised by Hakamada with synoptic maps of photospheric magnetic field observed by the NSO/Kitt Peak, USA. As the rsults, we obtained the radial component of the photospheric magnetic field (Br_pho) and the one of the coronal magnetic field (Br_sou) on the source surface on the same field line in the coronal magnetic field. We estimate the solar wind speed (SWS) by using IPS technique divised by STE Lab, Nagoya Univiersity. According to our previous analysis on the Carrignton rotation bases, Log10|Br_pho|, Log10|Br_sou|show good correlations with the SWS for the data of [-1.0 <= Log10|Br_pho|<= 1.5, (0.1 G <= |Br_pho|<= 31.6 G), -1.5 <= Log10|Br_sou|<= 0.0, (0.0316 G <= |Br_sou|<= 1.0 G)]. In this study, we add the intensity of Oulu neutorn monitor (NM), and study relations among rotation averages of these NM, SWS, and Log10|Br_pho|. We found good simple correrations coefficients between Log10|Br_pho|-NM (r=-0.773), and SWS-NM (r=0.703), as well as, a good multiple correlaion (r = 0.785) among them by using the regression equation in the form of NM = a + b *SWS + c *log10|Br_pho|with a = 6363, b = 1.186, and c = -1400.0. However, Log10|Br_pho|-SWS also shows good simple correlation (r=-0.802). We calculated partial correlation coefficients between (a) Log10|Br_pho|-NM, (b) SWS-NM, (c) Log10|Br_pho|-SWS and obtained (a) r=-0.294, (b) r=0.130, (c) r=-0.364. These results suggest that, althogh the cosmic ray intensities shown by NM is determined by the intensity of photospheric magnetic fields on the open field lines and the solar wind speed occupied by these field lines, the dpendence of magnetic field is stronger than the one of wind speed.

Keywords: cosmic ray intensity, photoshpheric magnetic field, solar wind speed

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PEM27-04 Room:421 Time:May 1 17:00-17:15

Does a Plasma Tail of Comet ISON (C/2012 S1) Cause the Interplanetary Scintillation?

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C/2012 S1 (ISON) (referred to as Comet ISON) showed a well-developed plasma tail (longer than 0.1 AU) before its perihelion passage on November 28, 2013. A plasma tail consists of ionized gases emitted from a cometary nucleus and orients itself in the anti-solar direction by an interaction with the solar wind. In this study, we investigated the plasma tail of Comet ISON with interplanetary scintillation (IPS) data. The IPS is a scattering phenomenon of radio waves by density fluctuations of the solar wind, and it is well known that interplanetary disturbances such as coronal mass ejections (CMEs) cause an abrupt increase in IPS. A cometary plasma tail may also be a potential cause for the IPS enhancement, while observational studies for C/1972 E1 (Kohoutek), 1P/Halley and other are still controversial (*e.g.* Ananthakrishnan *et al.*, 1975, 1987; Slee *et al.*, 1987; Abe *et al.*, 1997; Roy *et al.*, 2007). We identified radio sources whose lines-of-sight approached to Comet ISON's plasma tail between November 1 and 28, and obtained their IPS data using the Solar Wind Imaging Facility (Tokumaru *et al.*, 2011) of the Solar-Terrestrial Environment Laboratory, Nagoya University. From examinations for them, we confirmed four IPS enhancement events, which is likely to be related to the plasma tail passage. In this session, we report this preliminary result for them and discuss an IPS of a cometary plasma tail origin.

Keywords: Comet ISON (C/2012 S1), Cometary plasma tail, Radio scintillation

PEM27-05 Room:421 Time:May 1 17:15-17:30

Effects of phase and group velocities on wave spectra observed in the solar wind

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Waves propagating in a plasma medium which has a relative velocity to the observer are differently observed in the spectra from those in the plasma rest frame. As known in general, the observed frequency is Doppler shifted by the relative velocity between the medium and the observer, V_{rel}. The frequency shift is the result of the difference of the phase velocities of the waves in the medium rest frame and in the observer frame. When the wave vector has a finite angle with respect to V_{rel} and the component of V_{rel} parallel to the wave vector is considerable to the phase velocity, the difference of the phase velocities between the frames and the frequency shift become significant.

We note that the observed spectral density is also modified by V_{rel}. The modification of the spectral density is the result of the difference of the group velocities of the waves in the medium rest frame and in the observer frame. When the component of V_{rel} parallel to the group velocity vector is considerable to the group velocity, the difference of the group velocities between the frames and the modification of the spectral density become significant. In order to estimate the amount of the modification, we derive the analytical expression of the modified spectral density in the observer frame.

It is important to consider not only the frequency shift but also the modification of the spectral density of waves observed by spacecraft in a moving plasma, such as the solar wind. Indeed, the phase and group velocities of whistler-mode waves cause significant frequency shift and modification of the spectral density in the solar wind. By the modification of the spectral density, we can explain the characteristic properties of '1 Hz waves', which have been generally observed in the upstream regions of various bodies, and suggest that the broadband upstream whistlers are the same source waves. The understanding of the effects is necessary to reveal the true nature of waves propagating in a moving plasma and to discuss their generation processes.

PEM27-06 Room:421 Time:May 1 17:30-17:45

Monochromatic whistler waves at 8 Hz observed by Kaguya above the terminator of the Moon

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Magnetic fluctuations around the moon are characterized with 2 major categories: (1) large amplitude monochromatic waves of 0.01 Hz and (2) monochromatic or non-monochromatic whistler waves, both observed on the dayside surface of the moon or above the terminator. Their generation is associated with (1) the solar wind ions or (2) electrons, respectively, reflected at the surface of the moon or the local crustal magnetic field. The monochromatic whistler waves are found at 1-2 Hz with left-handed polarization due to the Doppler shift caused by the solar wind flow. The frequency range is determined by the group velocity of the whistler waves that can overcome the solar wind speed.

Differently from the previously known characteristics, a new type of monochromatic waves was found at 8 Hz in the magnetic field data obtained by MAP/LMAG onboard Kaguya. They concentrated above the terminator. They propagated in the direction of the background magnetic field and showed right-hand polarization. They are thought to be whistler waves propagating downstream, and the frequency was up-shifted due to the Doppler shift.

Keywords: moon, SELENE, KAGUYA, MAP/LMAG, whistler wave, solar wind

PEM27-P01 Room:Poster Time:May 1 18:15-19:30

Measurement result of the neutron monitor onboard the Space Environment Data Acquisition Equipment(SEDA-AP)

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To support future space activities, it is crucial to acquire space environmental data related to the space-radiation degradation of space parts and materials, and spacecraft anomalies. Such data are useful for spacecraft design and manned space activity.
SEDA-AP was mounted on "Kibo" of the ISS (International Space Station) to measure the space environment at a 400-kilometer altitude.

Neutrons are very harmful radiation, with electrical neutrality that makes them strongly permeable. SEDA-AP measures the energy of neutrons from thermal to 100 MeV in real time using a Bonner Ball Detector (BBND) and a Scintillation Fiber Detector (FIB). BBND detects neutrons using He-3 counters, which have high sensitivity to thermal neutrons. Neutron energy is derived using the relative response function of polyethylene moderators of 6 different thicknesses. FIB measures the tracks of recoil protons caused by neutrons within a cubic arrayed sensor of 512 scintillation fibers. The charged particles are excluded using an anti-scintillator which surrounds the cube sensor, and the neutron energy is obtained from the track length of a recoil proton.

There are three sources of neutrons in space;
1. Albedo Neutrons
Produced by reactions of galactic cosmic rays or radiation belt particles with the atmosphere
2. Local Neutrons
Produced by the reactions of galactic cosmic rays or radiation belt particles with spacecraft
3. Solar Neutrons
Produced by accelerated particles in solar flares
An accurate energy spectrum of the solar neutrons includes important information on high-energy particle generation mechanism in a solar flare, because neutrons are unaffected by interplanetary magnetic fields. These data will become useful to forecast solar energetic particles in future. Some candidate events involving solar neutrons were found as a result of analyzing data of the solar flare of $M>2$ since September 2009.

Moreover, it is important to measure albedo neutrons, since protons generated by neutron decays are thought to originate from the radiation belt. This theory is called CRAND (Cosmic Ray Albedo Neutron Decay). Our observation result is consistent with the CRAND theory prediction in the case of low-energy parts. Moreover, the flux and angular distribution of local neutrons were estimated using the nuclear simulation code "PHITS" to evaluate the influence of local neutrons on the structure of SEDA-AP and "Kibo".

The results of our analyses on solar and albedo neutrons are reported in this paper.

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PEM27-P02 Room:Poster Time:May 1 18:15-19:30

Interplanetary emission observed by HISAKI (SPRINT-A) satellite

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The HISAKI (SPRINT-A) satellite, which was launched last summer, has been observing the extreme ultraviolet emission around planets, such as Venus and Jupiter. In addition to the main observational target of Venus and Jupiter, HISAKI has detected the emission from interplanetary space. In this presentation the HISAKI observation of interplanetary emission is shown and its potential on the interplanetary issue is argued.

Keywords: HISAKI (SPRINT-A) satellite, extreme ultra violet emission, interplanetary, resonance scattering

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PEM27-P03 Room:Poster Time:May 1 18:15-19:30

The Behavior of Distributions for Magnetic Polarities on the Surface of the Sun and Solar Minimum

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Time series of satellite image data for SOHO/MDI Continuum and Magnetogram from 1997 to 2010, and for SDO/HMI Continuum and Magnetogram from 2011 to 2013 are analyzed. The new time series data derived from fractal analysis of the time series images illustrated in 1200x1200 pixels from 1997 to 2013 are generated and fractal measures and packing exponents are analyzed by box-counting method. Then the occupancies of sunspot pixels in Continuum and of pixels for the positive and negative magnetic polarities in Magnetogram are calculated and packing exponents for sunspot pixels in Continuum and packing exponents for positive polarity pixels and negative polarity pixels in Magnetogram are evaluated. For packing exponents of Continuum and Magnetogram from 1997 to 2013, power spectra with peaks are calculated by using Fourier transform, respectively. A first peak which appears the power spectra is determined, and time intervals between nearest neighbor peaks are valued. The correlations between sunspot numbers and occupancies of the positive and negative magnetic polarities for 17 years are anatomized. As the correlation coefficients are calculated by using the least squares method, the correlation between sunspot number and occupancy of positive magnetic polarities has a very high correlational relationship because the correlation coefficient is 0.86 and it for negative magnetic polarities is low.

Furthermore, the behavior of occupancies of sunspot pixels in Continuum and of pixels for the positive and negative magnetic polarities in Magnetogram and the packing exponents represented with time series are described in detail and discussed. Fluctuations for occupancies of positive magnetic polarities are similar to it for Zurich number from 1997 to 2013. As observing the occupancies and packing exponents of positive and negative magnetic polarities, the two and three different fluctuations appear in (1) 1997-2005 and 2009 and (2) 2006-2008 including the time period that solar cycle 24 began on January 4, 2008, respectively. In addition, the occupancies and packing exponents of them have a single fluctuation in (3) 2010-2013. Therefore, the periods for characterizing solar activity from 1997 to 2013 are divided into three periods in (1), (2), and (3). Specially, for 2 years before solar minimum on 2008, the packing exponents start fluctuating suddenly and sharply in 2006 and the fluctuation disappear in the end of 2009.

Keywords: Time Series Analysis, Fourier Analysis, SOHO/MDI Continuum, Magnetogram, Solar Minimum

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PEM27-P04 Room:Poster Time:May 1 18:15-19:30

Fine spectral structures of a solar radio type-II burst observed with AMATERAS

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Solar radio type-II bursts are metric to hectometric radio bursts that show frequency drifting spectral structures caused by the plasma emission from shock-accelerated electrons. The bursts are known to sometimes show rapidly drifting fine structures; for example, about 20% of type-II bursts are composed of both negative and positive rapidly drifting elements, which are called as ”herringbone” structure (hereafter HB) [Roberts, 1959]. Such the drifting fine structures are interpreted as the motion of non-thermal energetic electron beams accelerated by the shock. However, their particle acceleration mechanisms and regions have not been understood well. The purpose of this study is to extract characteristics of the fine spectral structures of type-II bursts from high-resolution observations and investigate their acceleration processes.

AMATERAS is a ground-based solar radio receiving system developed in 2010 by Tohoku University [Iwai et al., 2012]. This system enables us to observe radio phenomena in 150 - 500 MHz with the 10 ms accumulation time and 61 kHz bandwidth. So far some type-II bursts with fine spectral structures have been observed. Among them, a type-II burst observed on November 12, 2010 around 200MHz showed distinctive fine structures whose spectral characteristics were different from those of HB. The fine structures showed no core structure which were normally confirmed in HB, but showed various rapidly drifting nature and composed whole body of a slowly negative-drifting type-II burst. The statistical drift rate analysis showed that negative drift cases were dominant and some of them indicated more than 100MHz/s. The particle speed for the drift rate by assuming a general coronal plasma density model, for example the Newkirk model [Newkirk, 1961], is estimated to be unrealistically fast. This implies that the rapidly drifting fine structures were generated by energetic electron beams in an outward moving steep density gradient region such as a shock front.

In this presentation, we will show revealed statistical characteristics of the fine structures and discuss inferred generation processes of the type-II burst. We will also introduce characteristics of fine spectral structures of the other events of type-II burst.

Keywords: Sun, radio wave, type-II burst, fine structure, generation process

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PEM27-P05 Room:Poster Time:May 1 18:15-19:30

Spectral fine structure of solar radio bursts observed with IPRT/AMATERAS: Characteristics of Zebra Pattern

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It is known that there are a variety of complex fine structures in solar radio bursts in the meter to decimeter wave bands such as broadband pulsations, narrowband spikes, fiber bursts and zebra patterns (hereafter ZP). Since they are thought to be caused by some inhomogeneities or modulations of wave generation and/or radio propagation processes, they have significant information about plasma parameters and dynamical plasma processes in the solar corona. Among the various fine structures, ZP has a particularly characteristic spectral pattern with parallel drifting narrow stripes of enhanced emission. Although several models for generating ZP have been proposed so far, the generation mechanisms have not been revealed well yet.

AMATERAS (the Assembly of Metric-band Aperture Telescope and Real-time Analysis System) is a radio spectro-polarimeter installed in a large radio telescope named IPRT in Fukushima, which was developed for solar radio observations in 2010 by Tohoku University (Iwai et al., 2012). The specifications of this system are time resolution of 10 ms, frequency resolution of 61 kHz and the minimum detectable flux of 0.7 s.f.u. in the frequency range of 150 MHz to 500 MHz, which are enough to observe fine structures of solar radio bursts and analyze their spectral characteristics. In this study we focus on an event on June 21, 2011 associated with C7.7 class flare. In this event enhanced ZP appeared around 200MHz with about 30 stripes in fast drifting envelopes like type III bursts or broadband pulsations. The emission was strongly polarized in right-handed and shows a distinctive time delay of the left-handed component relative to the right-handed component by several tens msec increasing with emission frequency. In the presentation, we will show the characteristics of ZP precisely and also discuss the expected generation processes.

Keywords: solar radio, AMATERAS, zebra pattern

Japan Geoscience Union Meeting 2014
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PEM27-P06 Room:Poster Time:May 1 18:15-19:30

Upgrade of the multi-station IPS system and solar wind observations at the cycle 24 maximum

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Since interplanetary scintillation (IPS) serves as a useful method to determine global distribution of the solar wind, IPS observations have been regularly conducted over more than 30 years using the multi-station system of the Solar-Terrestrial Environment Laboratory (STEL) of Nagoya University. Such long-term data collection is made possible by continuous maintenance and improvement of the system. The STEL has four antennas dedicated for IPS observations at Toyokawa, Fuji, Kiso, and Sugadaira. The system at Toyokawa was upgraded to a new antenna (called the Solar Wind Imaging Facility Telescope, SWIFT, Tokumaru et al., 2011) in 2008. After that, the observation control and data acquisition systems at Fuji and Kiso were upgraded in 2010 to enable 3-station IPS observations using Toyokawa, Fuji and Kiso antennas. However, the low-noise phased-array receivers of Fuji and Kiso antennas, which are a vital part to archive high sensitivity, remained unchanged, and some other parts such as reflectors, gears, motors, became superannuated. In order to improve these problems, we have performed extensive work for upgrading Fuji, Kiso and Sugadaira antennas since 2013.

The items for this upgrade are as follows; (1) installation of low-noise amplifiers using HEMTs (FE327-V5) and the phased-array control system, (2) development of the phase/gain calibration system using the loop method and the receiver temperature measurement system using a noise source for Fuji and Kiso antennas, (3) fabrication of reflector and replacement of gears and motors (for Kiso). The work at Fuji almost completed by the end of 2013, and that at Kiso will be made in this spring.

Owing to the upgrade project, IPS observations for 2013 was made for the period between April and August. Obtained IPS data clearly show that the fast wind reappears over the northern pole. This is not the case for the southern pole, and the slow wind is found to be dominant in the southern hemisphere. The disappearance and reappearance of the fast wind over the northern pole preceding that over the southern pole have been observed in solar maxima of two previous cycles, so that this is regarded as a common feature of the solar dynamo activity. While our IPS data for this cycle show good correlation between fast wind areas and polar fields, they reveal that the slope for this cycle differs from the ones for past cycle. This fact suggests that higher-order magnetic moments for this cycle may have more contribution for formation of fast winds than past cycles. The solar wind structure is expected to significantly change with declining solar activity toward the next minimum, and we intend to finish work for the upgrade project as soon as possible in order to miss observing this change.

Keywords: solar wind, interplanetary scintillation, heliosphere, solar cycle, space weather