Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

PEM28-P01 Room:Convention Hall Time:May 20 13:15-15:15

Spectrum characteristics of solar radio type-I burst by statistical analysis

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Non-thermal electrons accelerated in the corona emit radio waves in the metric range. They are observed as several types of solar radio bursts. Type-I noise storm is one of the most frequently observed solar radio phenomena at a metric frequency range. They are thought to be a plasma emission around local plasma frequency. Type-I contains many complex fine structures in their spectra. They are thought to be caused by some inhomogeneities of particle acceleration, wave generation, radio emission, and/or radio propagation processes. However, the fundamental spectral structures have not been resolved sufficiently because of the limited time and frequency resolutions of the observation system. Now, more detailed analysis of spectrum structures of them are thought to be important to understand plasma processes in the solar corona. The purpose of this study is to extract fundamental spectrum parameters of type-I from high resolution observation and explain its generation processes.

Iitate Planetary Radio Telescope (IPRT) is a ground-based radio telescope developed by Tohoku University. Solar radio observation system of IPRT (AMATERAS) enables us to observe solar radio bursts in the frequency range between 150 and 500 MHz with the 10 ms accumulation time and 61 kHz bandwidth. It is suitable for observing characteristics of fine spectrum structures of solar radio bursts. The observational results for Type I bursts showed that the fundamental spectral structures have a duration of between 100 and 1000 ms. Typical full-width half-maximum of the burst bandwidth is between 1 and 5 MHz. Each element shows symmetric exponential growth and decay phases in time. We have also researched the peak flux distribution of type-I bursts. The observational results suggest that type-I bursts show a power-law distribution with the spectral index of 2 - 3. The index is larger than that of flares and radio type-III bursts (< 2). According to the logistic avalanche model (see Aschwanden et al 1998), the observed soft spectrum can be explained that source region of type-I is localized in a small region or the dominant instability of type-I grows slowly.

Keywords: Sun, corona, radio burst, ground-based observation, particle acceleration

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PEM28-P02 Room:Convention Hall Time:May 20 13:15-15:15

Power spectra of the electron density fluctuation in the solar corona obtained by radio occultation observations

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The Venus orbiter Akatsuki is now in orbit around the Sun. Using Akatsuki, we have conducted radio occultation observations of the solar corona from June 6, 2011 to July 8, 2011. The method utilizes radio waves that are transmitted from the spacecraft and penetrate the solar corona when the spacecraft is occulted by the sun as seen from the Earth. Due to the movement of small-scale density irregularities across the ray path, the frequency (phase) and intensity of the signal received at the ground station change with time. By analyzing these time series we could get information on the power spectrum of the electron density fluctuation. The observations were conducted at solar offset distances of 1.5-20.5 Rs (Rs is solar radius), a region which is not well studied in the previous observations. Coordinated simultaneous observations using the space solar telescope Hinode were also conducted from June 24 to 25 when the ray path from Akatsuki was especially close to the sun.

In this paper we will present the radial variation of the power spectrum of the electron density fluctuation. The spectra show Kolmogorov-like logarithmic slopes at far distances, while knee features are seen at close distances.

Keywords: radio occultation observations, solar corona

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PEM28-P03 Room:Convention Hall Time:May 20 13:15-15:15

Data assimilation of the solar wind in the inner heliosphere to estimate the source function and solar wind variation

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We develop a technique for predicting variations of the solar wind and source functions by incorporating wind velocity data from interplanetary scintillation (IPS) into a three dimensional magneto-hydrodynamic (MHD) solar wind model in the context of data assimilation using the Ensemble Kalman filter. In the data assimilation process, we constrain the solar wind source function which relates the observable magnetic field on the solar surface and terminal solar wind velocity. Previous studies estimated the function statistically, while we estimate the best fit model coefficients in this study.

We perform the ”twin experiments” to evaluate the data assimilation method and containment of the source function and obtain results as follows : i) Variations of the solar wind and source function coefficients are well reproduced by the data assimilation. ii) Case for Ensemble number of being larger than 15 shows good estimation for 40 data per day case. iii) IPS data positions do not affect the prediction effectively because the source function affects large structure. The number of the state of a system is 21 (radial) x 360 (longitude and latitude) x 8 (MHD parameter) + 2 (source function coefficients) = 60,482, while SOHO/MDI magnetic field data is referred at the inner boundary and IPS observation ˜40 per day is assimilated. We discuss the applicability of this method to the observed solar wind.

Keywords: solar wind, data assimilation, simulation, MHD

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PEM28-P04 Room:Convention Hall Time:May 20 13:15-15:15

Relationship between solar wind speed and coronal magnetic field parameter through solar cycle 23 and 23/24 minimum

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Solar wind acceleration mechanism is one of the most important issues to be solved in solar wind physics. We have been studied the relationship between velocity of solar wind which comes from coronal holes and coronal magnetic field parameter. Precedence researches in our group showed that solar wind speed, V had been in proportion to a parameter Bp/f from solar minimum in cycle 22/23 to solar maximum in cycle 23, where Bp and f are magnetic field strength and expansion factor of the magnetic flux tube, respectively [1]. In solar minimum in the cycle 23/24, however, polar magnetic field gets weaker and solar wind has lower density, lower temperature, and lower mass flux than the previous minimum [2]. For this reason, we examined the relationship between V and Bp/f from 22/23 to 23/24 solar minima. In this analysis we used following data set. Solar wind velocity map in each Carrington rotation was derived from the interplanetary scintillation measurements at Solar-Terrestrial Environment Laboratory. Coronal magnetic field in each Carrington rotation was calculated by potential field source surface model using synoptic photospheric magnetic field data observed at Kitt Peak National Solar Observatory. As results, we found that V always correlates positively Bp/f over the solar cycle. Then we focused on the difference of slopes of the regression lines between two solar minima. The slope in the 23/24 minimum becomes larger, in other words, the fast solar wind in the 23/24 minimum has smaller Bp/f compared to that in the 22/23 minimum. This result was compared with a theoretical model of solar wind acceleration [3] by taking account of the declining of solar wind parameters. We confirmed that the difference of regression lines in two solar minima is consistent with global trend of solar and solar wind variations.

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Keywords: solar wind, interplanetary scintillation, solar cycle

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Long term variation of the solar diurnal anisotropy of galactic cosmic rays over four solar activity cycles

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The galactic cosmic ray (GCR) anisotropy observed with the muon detector network monitoring high-energy GCR intensity provides us with unique information of physical parameters, such as the spatial density gradient and the scattering mean free path of GCRs, which reflect the large-scale magnetic structure governing the GCR propagation in the heliosphere. The solar cycle variation of the anisotropy particularly gives important information on the temporal variation of the GCR propagation in the heliosphere. In this paper, we analyze the solar diurnal anisotropy observed with a network of surface and underground muon detectors monitoring the primary GCRs in a wide energy range of 50-500 GeV. This network includes a detector at Nagoya which has been in operation more than 40 years. The derived anisotropy shows clear 11-year and 22-year variations respectively in clear correlations with the solar activity- and magnetic-cycles. We will discuss the physical mechanisms responsible for these long-term variations.

Keywords: galactic cosmic rays, solar diurnal anisotropy, muon detector networks

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Long-term variation of the solar wind acceleration

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We calcurate the three-dimensional sructure of the coronal magnetic field during the time interval of 1800 Carrington rotation (CR 1800) through CR 2075 by the Radial-Field model dvised by Hakamada with synoptic maps of Kitt Peak photospheric magnetic field data. This time interval covers almost two solar activity cycles of about 20 years. We constructed synoptic maps of Log10|Br_sou|, the common logarithm of the radial component of the coronal magnetic field on the source surface of 2.5 solar radii. We also constructed synoptic maps of Log10|Br_pho|, the common logarithm of the radial component of the photospheric magnetic field projected on the source surface along the coronal magnetic field line. We, further, constructed synoptic maps of the solar wind speed, V, estimated by the CAT method with results of IPS observations. Those three values can be compared directly with each other because of the values on the synoptic maps of the same format. We draw the disribution of V in xyz space; x-axis corresponds to Log10|Br_sou|, y-axis corresponds to Log10|Br_pho|, and Z-axis corresponds to V. It is found that the distribution of V has a planar structure in xyz space. We, thus, assume the empirical equation of V = a + b $*$ Log10|Br_sou| + c $*$ Log10|Br_pho|, and calculate the multiple correlation coefficient, r, and the multiple regression oefficients, a, b, and c. It is found that, although the r has smaller value, around 0.3, during the solar minimum phase, r is very high, around 0.7, during the solar maximum phase. These results suggest that the solar wind is accelerated not only by the mechanis related to the coronal magnetic field and photospheric magnetic field but also by an unknown mechanism which shows the long-term variations.

Keywords: solar wind, acceleration, long-term variation

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PEM28-P07 Room:Convention Hall Time:May 20 13:15-15:15

Determination of 3D configuration of magnetic clouds using 2D imaging data of solar wind

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The structure of magnetic cloud (MC) has long been studied by fitting in-situ magnetic field measurements to magnetic flux rope models. Such studies generally provide the size and orientation of the model structure, which are taken to be applicable only locally to the portion where the cloud passed the spacecraft. The obtained geometry often changes depending on the models used for the fitting. For example, for a single observational data set, a cylinder model and a torus model often give different cloud axis orientations. Thus we need further consideration about the global configuration to deduce the 3D structure of the MC. 2D images from heliospheric remote sensing measurements provide reliable constraints about the global MC structure. With the above in mind we attempt to study the global structure of MC by combining the model fitting results and the 3D reconstruction data from the Solar Mass Ejection Imager (SMEI) and interplanetary scintillations (IPS). For this purpose, we first select MC events in which the proton densities are high enough (generally $>$ 20 /cc) in the sheath regions behind the driven shocks and/or in the regions occupied by MCs. Then we examine possible 3D configurations which are consistent with the orientation of the MC axis obtained from model fittings. The global MC structure is finally obtained by applying the constraints from 2D image data. Our preliminary examination shows that the above procedure is helpful for determining the most probable 3D global structures of MCs.

Keywords: solar wind magnetic field, magnetic flux rope, solar wind density, model fitting, magnetic cloud

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Souce estimation of Electrostatic Solitary Waves (ESWs) observed by Kaguya near the Moon

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In KAGUYA (SELENE) LRS[1], WFC-L [2] observes waveforms of plasma waves in 100Hz-100kHz and a lot of electrostatic solitary waves (ESWs) have been observed. Some results have been reported [3].

An ESW potential generally has a two-dimensional structure. They have not only a parallel component to the background magnetic field, but also a perpendicular component. Then received ESW fields are distorted from well-known bipolar fields based on the one-dimensional potential. In order to evaluate the effects of the perpendicular components, the received ESW waveforms are fitted to ideal ESW waveforms based on the two-dimensional structures. We examined where ESWs are received near the moon. The source positions of the ESWs will be discussed based on the two-dimensional structures and the background magnetic field directions and magnetic anomalies.

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Keywords: electrostatic solitary wave, moon, Kaguya

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Proton entry into the plasma void formed downstream of an insulating, non-magnetized obstacle in the solar wind

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The proton entry into the plasma void formed downstream of an insulating, non-magnetized obstacle in the supersonic flow of the solar wind is studied by using a two-dimensional, electromagnetic particle-in-cell simulation. The protons are accelerated by the negative electric potential in the plasma wake, and the size of the proton void is much smaller than that estimated from the ratio of the solar wind bulk speed to the proton thermal speed. In the slow solar wind, the proton void shrinks because the protons are well accelerated within a short distance past the obstacle, due to the long time required to pass through the intense electric field near the wake boundary.

Keywords: moon, near moon wake, proton acceleration, solar wind, PIC simulation, electric potential