Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

PEM25-P01 Room:Convention Hall Time:May 25 18:15-19:30

Polarization characteristics of zebra pattern in type IV solar radio bursts observed with AMATERAS

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Type IV bursts are broadband continuum emission observed in metric to decimetric wavelength range that emanate from closed magnetic structures. They often show various spectral fine structures therein. Since most of them are considered to be generated by micro scale physical processes of plasma waves and energetic particles, their spectral characteristics reflect plasma condition of the source regions in the solar corona. In particular, zebra pattern (ZP) has a characteristic spectral pattern with a number of nearly parallel drifting narrowband stripes. Such characteristics of ZP can be used as a tool of the coronal plasma diagnostics, thus the comprehension of ZP has significant meaning for the solar physics. However, generation processes of ZP have been still discussed in spite of a large number of observational and theoretical studies. The purpose of this study is to investigate generation and propagation processes of ZP by evaluating scenarios suggested in previous studies (Zlotnik et al., 2014).

We analyzed an event appeared on June 21, 2011 around 200MHz, in particular on polarization characteristics and their frequency dependences using highly resolved spectra and polarization data obtained from AMATERAS, a solar radio spectropolarimeter developed by Tohoku University. The main observed polarization characteristics are, 1) the ZP emission accommodated right-handed and left-handed polarized components and the degree of circular polarization was about 50-70% in right-handed with almost no frequency dependence. 2) The frequency of right-handed and left-handed polarized components showed a slight difference by tens of kHz and it varied depending on the emission frequency. 3) The light-handed polarized component showed time delay by about 60ms and the delay slightly increased with frequency. In the case of assuming the DPR (Double Plasma Resonance) model as the original generation process of the ZP, the most plausible interpretations for these characteristics are as follows; the emission was generated in O-mode in completely polarized state at the source region and it was partly converted into X-mode near the source due to the scattering by low frequency waves such as ion sound waves or whistler mode waves, which yields the frequency shift, and then difference in group velocities between O-mode and X-mode causes the temporal delay.

Keywords: Solar radio, Zebra pattern, Polarization, AMATERAS

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Statistical analysis of spectral fine structures in solar radio type II bursts observed with AMATERAS

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Type II bursts are one of the solar radio bursts associated with flare and coronal mass ejections(CMEs). They are thought to be a plasma emission from non-thermal electrons accelerated by a shock wave. A type II burst appeared as a group of spectral fine structures whose typical duration is within one second is reported recently [e.g. Sato et al., the 26th JpGU meeting]. Such spectral fine structures can be interpreted as the motion of non-thermal electron beams accelerated in the shock region. The spectral fine structures are, therefore, thought to reflect electron acceleration processes by the shock.

In this study, we performed a statistical analysis to investigate generality of spectral fine structures of type II bursts to reveal their generation processes by using the meter wave band solar radio telescope AMATERAS developed by Tohoku University [Iwai et al., 2012]. AMATERAS enables us to observe solar radio bursts in the frequency range between 150 and 500 MHz with the 10 msec accumulation time and 61 kHz bandwidth. Many solar radio bursts have been observed by this system since its construction in 2010.

We identified occurrence of nine type II bursts from the AMATERAS database. Some of them showed fundamental-harmonic band structures and some of them showed band-splitting structures. In addition, it is notable that all of them were accompanied by spectral fine structures. This result implies a possibility that the spectral fine structures are general characteristic of type II bursts. We analyzed drift rates for the spectral fine structures of three events from them. As the result, some of the drift rates indicated more than 100MHz/s. By assuming a general coronal plasma density model, for example the Newkirk model [Newkirk, 1961], the particle speed for the drift rate is estimated to be unrealistic value. The result is similar to the past study [Sato et al., the 26th JpGU meeting] and implies the existence of peculiar plasma structure in the source region of the burst, while the wave generation and particle acceleration processes for the fine structures have not been understood. In this presentation, we will show precise characteristics of drift rates for the spectral fine structures in several type II bursts and also discuss inferred generation processes.

Keywords: corona, particle acceleration, radio burst, spectral fine structures, AMATERAS

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Preliminary results of a new solar radio wave observing system in the HF to VHF band

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Tohoku University has developed a new radio receiving system in the HF to VHF band in the Zao observation station. This system enables us to investigate fundamental plasma processes of particle acceleration, heating and plasma environment with the existing solar radio telescope IPRT/AMATERAS in the radial distance of about 1.1Rs - 4Rs from the photosphere. Furthermore, it also potentially contributes to disaster science/space weather research by enabling to obtain early information on occurrence of solar energetic particle events. The new system will consist of wide-band antenna array and high resolution spectro-polarimeter. In the last autumn the first set of antennas was constructed and tentative observations were started with low time and frequency resolutions. Although it is a minimum configuration, some wide-band solar radio bursts have been detected. In the presentation, we will introduce the new radio observing system and also show preliminary results of observed radio bursts.

Keywords: solar, radio, telescope, HF, VHF

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On the intensity of the 3-10 Hz magnetic fluctuations observed by Kaguya near the moon

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Possible relationship were examined between the power of the non-monochromatic fluctuations of the magnetic field over the frequency range of 3 - 10 Hz observed by Kaguya at an altitude of 100 km above the lunar surface and the speed of the incident solar wind observed by ACE, but none was found. Instead, control by magnetic connection between the spacecraft and the lunar surface was found. Intense wave activity was observed during the magnetic connection to the magnetic anomaly. The wave activity disappeared when the spacecraft was magnetically disconnected from the lunar surface, even when the detection of protons reflected by the moon persisted. It suggests that the wave was generated below the spacecraft altitude.

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Helium distribution in interplanetary space by Hisaki satellite

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The HISAKI (SPRINT-A) satellite has a unique characteristics of the long term planet observation, such as Venus and Jupiter. The interval of planet observational terms, 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: Interplanetry helium, EUV observation

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Model simulations of ionizations at the planetary atmosphere induced by energetic particles from a central star

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We are performing monitoring observations of millimeter-waveband spectral lines of carbon monoxide (CO) in the middle atmospheres of Mars and Venus with a 10-m telescope, Solar Planetary Atmosphere Research Telescope (SPART), to understand how the activities of central stars influence the middle and lower atmospheres of terrestrial planets in the solar system and of exoplanets.

For understanding the electron production rate at different altitudes of the planetary middle atmosphere induced by incident energetic particles from planets, we developed an analytical model, using which ionization losses are numerically calculated on the basis of the Bethe-Bloch formula. The ionization of carbon dioxide induced by the energetic particles is considered to increase the production rate of CO. With a basic model under conditions of relatively great solar proton events with incident-proton energies of less than 1 GeV, it was found that the ionization rate reaches its maximum at an altitude of 80-90 km in the Venusian atmosphere and at the ground in the Martian atmosphere. In addition, we also developed a Monte-Carlo simulation model using the Particle and Heavy Ion Transport code System (PHITS). With this model, highly accurate calculation can be achieved by implementing the latest nuclear-reaction database and algorithms for the transport processes including several particles such as electrons, positrons, pions, neutrons, muons, kaons, and photons, in addition to protons, neutrons, and photons. We found that the results of this Monte-Carlo model are in good agreement with those of the above analytical model. The calculated results also suggest that the effect of neutrons produced on the ionization processes is greater than that of protons produced at a low altitude in Venus (<80-km altitude).

In this conference, we will present the results of these models.

Keywords: terrestrial planet, planetary atmosphere, flare and CME, high-energy particle, heterodyne spectroscopy, radio telescope