修士論文

Studies on small scale particle acceleration processes in the solar corona

(太陽コロナ中における小規模粒子加速過程の研究)

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Type-I is one of the solar radio phenomena observed in meter wave length. Type-I is a relatively weak solar radio burst but occur more frequently than strong flare related bursts. Hence this burst is considered to play an important role of the coronal energy release. Although type-I is though to be emitted by non-thermal electrons in the corona, these electron acceleration processes have not been understood sufficiently. In this study, several investigations are performed to understand the particle acceleration processes which cause type-I emission.

Observation of type-I was performed using the ground based radio telescope of Tohoku University, IPRT. The IPRT has high sensitivity in the meter wave range and realize to investigate the intensity variation of the weak type-I emission more accurately than previous works.

As the first step of this study, relationship between type-I and micro-type-III has been investigated. Micro-type-III bursts are sometimes observed with type-I simultaneously in the hectometric and kilometric wavelength range. The data observed with WAVES onboard the WIND spacecraft was used to identify the micro-type-III. From the data analyses for IPRT and WAVES, following results are suggested:

- The intensity of the type-I emission enhances when the micro-type-III occurs.
- Type-I bursts and micro-type-III bursts are made by electrons which have the same origin.
- Particle acceleration regions of type-I are located in the closed loop regions next to the open field lines.
- The frequency gap between the type-I and micro-type-III is explained by electron density gap around the source region which is caused by the difference of magnetic configuration.

As the second step of this study, the relationships between type-I and soft X-ray

are investigated to study non-thermal particle acceleration processes which generate type-I radio bursts. The data of XRT onboard the Hinode spacecraft is used to identify solar soft X-ray phenomena. The results of this investigation are summarized as follows.

- There is no obvious relationship between the onset of type-I and micro flare or emerging flux tube.
- Type-I might be generated by smaller phenomena than micro flare or shock front of the emerging flux tube.

It is suggested that more information such as energy of non-thermal electrons and magnetic polarization of the source region is required to investigate particle acceleration processes more quantitatively. These information can be obtained by the radio spectrum with more high specifications. From these results a new observation system has been developed as the third step of this study.

To observe type-I sufficiently it is required to observe in the frequency range between 100 MHz and 500 MHz with time resolution of 50 ms and frequency resolution of 500 kHz. The minimum detectable sensitivity of the system is required to be better than 0.8 S.F.U.

- **Feed system:** The developed feed system composed of three dipole elements to observe wide frequency range The three elements are optimized to observe at 100 MHz, 200 MHz and 400MHz respectively..
- **Receiver system:** In the developed receiver system, signals are separated into left and right polarization components (LCP and RCP) in the polarization circuit. Then RCP is up-converted to higher frequency than LCP by 450 MHz using the superheterodyne system and then combined with LCP.
- **Digital frequency analyzer:** Signals are finally A/D converted and broken into spectrum by FFT in the frequency analyzer AC240 operated to observe with 10 ms of time resolution and 61 kHz of frequency resolution.

This system enables to observe in the frequency range between 100 MHz and 500 MHz. Minimum detectable sensitivity in the observation frequency range is better than 0.8 S.F.U. with 10 ms time resolution and 61 kHz frequency resolution.
This system also enables to observe LCP and RCP polarization with an uncertainly of about 2.5 %.These specifications are all meet the requirement to research particle acceleration processes of the type-I

As future works, test observation should be started using all feed and receiver systems.