Coordinated Arase satellite and ground-based observations of pulsating electron and proton auroras

Mitsunori Ozaki[1]; Kazuo Shiokawa[2]; Yoshizumi Miyoshi[3]; Ryuho Kataoka[4]; Yusuke Ebihara[5]; Shin-ichiro Oyama[3]; Yoshimasa Tanaka[6]; Yuichi Otsuka[2]; Masahito Nose[7]; Tsutomu Nagatsuma[8]; Satoshi Kurita[3]; Martin Connors[9]; Reiko Nomura[10]; Kaori Sakaguchi[11]; Satoshi Yagitani[12]; Yoshiya Kasahara[12]; Hirotsugu Kojima[13]; Yasumasa Kasaba[14]; Atsushi Kumamoto[15]; Fuminori Tsuchiya[16]; Yuto Katoh[17]; Mitsuru Hikishima[18]; Shoya Matsuda[3]; Ayako Matsuoka[19]; Masafumi Shoji[3]; Keisuke Hosokawa[20]; Yasunobu Ogawa[4]; Akira Kadokura[4]; Yuka Sato[4]; Masaki Okada[4]; Takanori Nishiyama[4]
[1] Electrical and Computer Eng., Kanazawa Univ.; [2] ISEE, Nagoya Univ.; [3] ISEE, Nagoya Univ.; [4] NIPR; [5] RISH, Kyoto Univ.; [6] NIPR/SOKENDAI; [7] DACGSM, Kyoto Univ.; [8] NICT; [9] Centre for Science, Athabasca Univ.; [10] JAXA; [11] NICT; [12] Kanazawa Univ.; [13] RISH, Kyoto Univ.; [14] Tohoku Univ.; [15] Dept. Geophys, Tohoku Univ.; [16] Planet. Plasma Atmos. Res. Cent., Tohoku Univ.; [17] Dept. Geophys., Grad. Sch. Sci., Tohoku Univ.; [18] ISAS; [19] ISAS/JAXA; [20] UEC

Hot particle temperature anisotropies can excite chorus and electromagnetic ion cyclotron (EMIC) waves near the magnetic equator. The chorus and EMIC waves are candidate of drivers for generating pulsating electron and proton auroras by pitch angle scattering of high energy particles via wave-particle interactions. Both pulsating electron and proton auroras exhibit various kinds of temporal characteristics related with the wave activities. In fact, many previous reports showed that pulsating electron and proton auroras have the luminous variations related with the bundle of chorus and EMIC waves, and with the intervals of successive discrete elements of chorus and EMIC waves. Recently, high-speed (about 100 Hz) EMCCD images revealed fast luminous modulations of pulsating proton aurora related with the subpacket structures of Pc1 geomagnetic pulsations observed on the ground, which are equivalent to the EMIC waves in the magnetosphere. However, simultaneous observations of fast modulations of pulsating electron aurora and related subpacket structures of discrete chorus element have not been reported yet. Since pulsating auroras are faint, direct detection of fast luminous modulations is not easy, even with the most advanced EMCCD cameras. Going beyond correlating overall packet structures in luminosity and wave variations requires advanced temporal and spatial analysis techniques together with advanced EMCCD camera data.

In this study, we show temporal and spatial characteristics of pulsating electron and proton auroras at sub-auroral and auroral latitudes during coordinated Arase satellite and ground-based observations. For detecting the temporal characteristics, we used S transform, which is a signal processing technique for a time-frequency distribution. The S transform has an advantage that the frequency resolution is dependent with the time resolution. Such frequency dependent resolution is important for identifying the fast modulations of auroral luminosity. We identified electron and proton auroral patches having similar temporal characteristics of chorus and EMIC wave activities similarly in the previous reports. The similar temporal characteristics of the luminous and wave activities strongly supports the basic generation mechanism by pitch angle scattering via wave-particle interactions. Additionally, for detecting the spatial variations of auroral patches in the auroral images, we used Level Set Method (LSM), which is one of techniques to extract dynamic objects. An advantage of LSM is exact extraction of complex time-varying objects such as split and combination problems. The spatial variations between pulsating electron and proton auroras were quite different. The proton auroral patch was quite localized, so this localized patch can indicate a localized wave-particle interaction region in the magnetosphere. On the other hand, the electron auroral patch frequently showed split into a few patches and combination with surrounding patches. Such spatial split and combination of auroral patches may indicate more complex wave-particle interaction region for chorus waves.

In this presentation, we will discuss the difference between pulsation electron and proton auroras in details.