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脈動オーロラにおけるマルチスケールな時間変動特性: On-off 脈動と数 Hz 変調
Multi-scale temporal variations of pulsating auroras: on-off pulsation and a few-Hz modulation

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Pulsating aurora (PA) is characterized by the periodically changing emission amplitudes with on-off pulsations of less than 1 s to a few tens of seconds. PA is also well-known as its patchy structure with the horizontal size of 10-200 km. The energy of precipitating electrons ranges from one to a few tens of keV, which is thought to result from pitch angle scattering due to wave-particle interactions near the magnetic equator. Recently, Nishimura et al. [2010] found a one-to-one correspondence between the intensities of PA and amplitudes of whistler mode chorus near the equator. Similarly, electron cyclotron harmonics (ECH) were observed with on-phase of PA. ULF wave is expected to control the excitation of both the whistler mode chorus and ECH by the modulation of the local plasma density. However, an important problem, identifying which mechanism is the most dominant, remains unsolved. In addition, since PA has the distinctive properties in a variety of spatial and temporal scales, we should investigate such multi-scale properties statistically to further understandings of the generation mechanism of PA. The purpose in this study is to reveal the precise spatial-temporal properties and to establish a generation mechanism of PA using ground-based instruments. We developed an EMCCD camera with a wide field-of-view (FOV) and 100-Hz sampling, which is optimized to spatio-temporal properties such as the small-scale structures (< 10-30 km) and rapid temporal variations (3-Hz modulations) in a 2-D plane.

The statistical study on the cross-scale properties was presented based on 53 events observed at Poker Flat Research Range during the period from December 1st, 2011 to March 1st, 2012. The observed modulation frequency ranged from 1.5 to 3.3 Hz. Any strong modulations were not seen in frequency range higher than about 3 Hz in our study, which may suggest that the TOF of electron makes the time-smoothing effect on the rapid variations higher than 3 Hz. Furthermore, the frequency of modulation showed relatively strong correlation to auroral intensity with the correlation coefficient of 0.52, and it can be explained with non linear wave growth theory suggesting that higher modulation frequency with larger wave amplitude of whistler mode chorus. In contrast, the on-off pulsations showed no significant correlations with any of other properties of PA. This result implies that the on-off periods may be determined by the balance of a variety of factor, such as a spatial size on the flux tube, a drift velocity of an energetic electron. Alternatively, long-term variations of the cold plasma density would control the condition for wave-particle interactions in the temporal scale of the on-off pulsation periods.

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