# Evolution of auroral wave numbers at a substorm onset

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Recent development of optical instruments for ground-based auroral observations, e.g. THEMIS All-Sky Imagers array, reveal existences of fine-scale auroral structures at substorm expansion-phase onsets, which we could not identify previously due to limitation of both temporal and spatial coverage/resolution. Donovan et al. [2006] reported a pseudo auroral break up occurred on a pre-existing aurora which consists of eastward propagating beads with a wavelength of ~100 km. Similar auroral structures with wavelengths between 50-200 km at substorm expansion-phase onsets were seen in observations by e.g., Friedrich et al. [2001] and Liang et al. [2008]. These authors considered possibilities that some plasma instabilities accompanied by substorm onsets were projected on such structures in the onset auroras.

In this presentation, we show time evolutions of auroral structures observed at a pseudo substorm onset on January 15, 2008 at Gillam, Canada (56.4N, 265.4E, dipole geomagnetic latitude 65.6N). The auroral initial brightening started at 2223 MLT just in the center of a field of view of a panchromatic (white-light) all-sky camera with a sampling rate of 30 Hz. The high-sampling images enable us to develop differential images every sampling interval (0.03 s). The differential images show that the size of the initial brightening during the first 1 second was only less than ~30 km over a longitudinal segment and that one of brightening edge expanded to westward with an average speed of ~20 km/s at an auroral altitude of 100 km in the first 10 s, and in the following 10 s, they decrease to ~10 km/s. This expanding aurora has longitudinal ripple-like structures. Using two-dimensional Fourier transformation analysis, we found that the brightening aurora had two longitudinal scales of ~100 km and a few tens kilometers. The larger-scale auroras changed their brightness with time of almost periodically ~10 s, while their waveforms moved hardly in the field of view. The larger-scale auroras are found to branch into the smaller-scale auroras step-by-step. Especially at the first 10 s, the harmonic structures appeared from lower to higher wave numbers which are separated by the factor of 2. These results show that smaller longitudinal phase (expanding) velocity are associated with higher longitudinal wave number, which is consistent with the dispersion relation of standard inertia Alfven wave in the ionospheric density cavity. In the presentation, we will discuss possible physics underlying these spectral characteristics in auroral structures.