Characteristics of thin auroral filaments with co-existing high and low energy structures

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With the recent technological advancement of optical imagers through the introduction of EMCCD and sCMOS detectors in auroral observations it has become very clear that an active auroral display is extremely rich in fine scale filaments with arc widths perpendicular to the background magnetic field of less than 100 metres, and temporal variations occurring on fractions of a second. The ASK (Auroral Structure and Kinetics) instrument is designed to investigate these smallest auroral features, by using three EMCCDs in parallel for three different narrow spectral regions, and with optics giving a field of view of only 3.1° x 3.1°. The three cameras are co-aligned and are capturing simultaneous images with a frame rate of up to 32 Hz. Two of the ASK channels are providing information on the characteristic energy of the precipitating electrons, by monitoring molecular emissions (either O_2^+ at 562.0 nm or N_2 at 673.0 nm) caused by high energy precipitation and an atomic oxygen emission (O at 777.4 nm) caused by both high and low energy precipitation, respectively. The relative brightness of these two emissions are compared with the brightness modelled by a combined electron transport and ion chemistry model, to derive the characteristic energy of the precipitation causing the auroral forms.

We present data from a geomagnetically disturbed night over Tromsø, Norway, during which highly dynamic and structured aurora was observed, with filamentary structures of widths less than 100 m, often twisting into complex shapes (Figure 1).. Occasionally, the two simultaneous image sequences reveal unique observations of different morphology in the high energy and low energy precipitation. The observations indicate that there may at times be a separation of sources for the high and low energy precipitation. In addition, energy analysis of some of the thinnest structures from this event showed that they were the result of mono-energetic precipitation, without signatures of dispersion with time, which is at odds with the current understanding of the formation of fine scale aurora. Dual-frequency high energy pulsations were also detected on the same night. We discuss the detailed observations in the light of different theories of acceleration mechanisms that could act on the precipitating electrons.

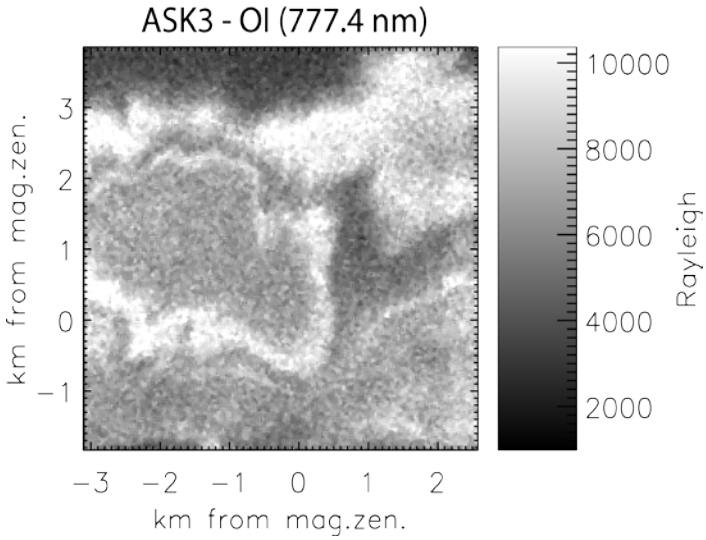

Figure 1. Auroral filaments captured with one of the ASK imagers.