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A multi-scale magnetotail reconnection event at Saturn and associated flows: Cassini/UVIS auroral observations

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We present high-resolution Cassini/UVIS (Ultraviolet Imaging Spectrograph) observations of Saturn's aurora during May 2013 (DOY 140-141). The observations reveal an enhanced auroral activity in the midnight-dawn quadrant in an extended local time sector ($\sim$02 to 05 LT), which rotates with an average velocity of $\sim$ 45% of rigid corotation. The auroral dawn enhancement reported here, given its observed location and brightness, is most probably due to hot tenuous plasma carried inward in fast moving flux tubes returning from a tail reconnection site to the dayside. These flux tubes could generate intense field-aligned currents that would cause aurora to brighten. However, the origin of tail reconnection (solar wind or internally driven) is uncertain. Based mainly on the flux variations, which do not demonstrate flux closure, we suggest that the most plausible scenario is that of internally driven tail reconnection which operates on closed field lines. The observations also reveal multiple intensifications within the enhanced region suggesting an x-line in the tail, which extends from 02 to 05 LT. The localised enhancements evolve in arc and spot-like small scale features, which resemble vortices mainly in the beginning of the sequence. These auroral features could be related to plasma flows enhanced from reconnection which diverge into multiple narrow channels then spread azimuthally and radially. We suggest that the evolution of tail reconnection at Saturn may be pictured by an ensemble of numerous narrow current wedges or that inward transport initiated in the reconnection region could be explained by multiple localised flow burst events. The formation of vortical-like structures could then be related to field-aligned currents, building up in vortical flows in the tail. An alternative, but less plausible, scenario could be that the small scale auroral structures are related to viscous interactions involving small-scale reconnection.