# Proton-oxygen differences in energy spectral evolution during large-scale injections in Saturn's magnetosphere

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It is believed that radial transport with sharp, localized filamentary structures due to inter-change instabilities is the main transport process in Saturn's inner magnetosphere [e.g., Hill et al., 2005, GRL; Paranicas et al., 2016, Icarus; Azari et al., 2019, JGR]. Global injections of energetic particles (higher than 10 keV, non-thermal) were also observed, associated with large-scale reconfigurations of the magnetotail magnetic field probably caused by reconnection [c.f., Mitchell et al., 2015, AGU Monograph]. The pressure of the non-thermal plasma becomes comparable to and dominates thermal pressure outside 9 Rs and 12 Rs, respectively [e.g., Sergis et al., 2010, GRL]. The large-scale injections therefore play an important role in transport and acceleration. Our study focuses most on generation and transport of non-thermal $H^+$ and $O^+$ during the large-scale reconfiguration. Observations showed different responses (e.g., relatively high $O^+$ temperature) to the reconfiguration between the two species [e.g., Dialynas et al., 2009, GRL]. However, the dominant mechanism(s) of selective/mass-dependent acceleration is(are) not fully understood.

Using observations of energetic neutral atoms by the Ion Neutral Camera (INCA) of the Magnetospheric Imaging Instrument (MIMI), we examine the spatio-temporal evolution of energy spectra for hydrogen and oxygen atoms with energies of ~10 to ~300 keV. The time sequence of the spectral evolution during large-scale injections is of our particular interest. To characterize the relation of the spectral evolution to the magnetic field dipolarization, we utilize in-situ ion observations by INCA and Charge Energy Mass Spectrometer (CHEMS) and magnetic field measurements by the Cassini magnetometer (MAG). For an example event of large-scale injections on 2 July 2004, energy ranges that make the dominant contribution to ion energy density, which we term 'contributing energies', were higher for $O^+$ than $H^+$. This is qualitatively consistent with observations in the Earth's magnetotail [Keika et al., 2018, GRL]. The oxygen-proton difference indicates that $O^+$ is effectively or selectively energized during the magnetic field reconfiguration in the magnetotail. We discuss how universal the ion acceleration during the magnetic field reconfiguration is to the magnetospheres of different magnetized planets.