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Observations of negative ions at Titan and other objects in the Saturn system using the Cassini CAPS Electron Spectrometer (ELS)

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Abstract

The discovery of heavy negative ions by Cassini's CAPS Electron Spectrometer (ELS) in Titan's ionosphere was an unexpected result of the Cassini mission (Coates et al, 2007, Waite et al, 2007) and necessitates the reconsideration of chemical processes in this enigmatic atmosphere. Negative ions can be associated with complex hydrocarbon and nitrile processes which are linked to haze formation at lower altitudes. Cassini's CAPS ELS observed negative ions during Titan encounters at altitudes below 1400 km. The ions can reach masses up to 13,800 amu/q (Coates et al., 2009), while recurring peaks in the mass spectra can be used to identify different mass groups as reported by Coates et al. (2007) and Wellbrock et al. (2013). Similarly, close flybys of the moon Enceladus have revealed the existence of negatively charged OH mass cluster ions in the satellites' plumes (Coates et al., 2010), further identifying Enceladus as a water group source. In addition, negative pickup ions have been observed in the vicinity of Saturn's second largest moon, Rhea, when positive pickup ions were detected on the opposite side of the moon. This led to the discovery of an exosphere (Teolis et al., 2010), whose production is a result of magnetospheric particle bombardment. In this paper we review the highlights of ELS negative ion observations in these different environments. We also show some recent results of negative ion density profiles from selected Titan flybys demonstrating clear differences in the behavior of different mass groups.