Plasma Observations at Saturn's Icy Satellites: A Review

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Plasma populations found in Saturn's magnetosphere are dominated almost entirely by water-group ions (O^+, OH^+, H_2O^+, H_3O^+), although a significant amount of H^+ and traces of atomic nitrogen and other minor species are present. Contributions from Titan (particularly nitrogen but also methane) are notably absent. The high abundance of water ions measured by the Cassini Plasma Spectrometer (CAPS) is not surprising, given that the main rings, E-ring, and inner moons are made of water ice. In this review we look at the icy satellites and rings as plasma sources, concentrating on Enceladus, which is by far the most complex and interesting source. In particular CAPS and other Cassini instruments have found both negatively and positively charged water molecules (16~19 amu/e), negatively and positively charged water cluster ions with masses of 30 ~ 1000 amu/e, and negatively and positively charged nano-particles that are most likely dominated by ice grains (~1000 to >>1000 amu/e). Positively charged water group molecules and small cluster ions could have been anticipated. However negatively charged ions are a complete surprise, as is a continuum of particle sizes from single molecules through cluster ions to nano-particles, all emanating from Enceladus' plume. In this paper we will review the current status of observations of all icy satellite plasmas and discuss their interactions with the satellites themselves and with Saturn's magnetosphere.