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Ring currents at Earth, Jupiter and Saturn: Dominance of internal plasma sources

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Although the concept of the Earth's ring current was proposed early in the space age, its detailed nature in terms of composition and energy content was not determined until the mid-eighties by the AMPTE mission (Krimigis et al, 1985). It was observed in the L-range $\sim$3 to $\sim$5, with most of the pressure in the energy range $\sim$20 to $\sim$300 keV, and to consist of both H+ and O+, with the oxygen accounting for the development and early decay of the storm main phase while H+ persisted for longer time periods. Jupiter's ring current was first measured partially by Voyager, with heavier ions (O+, S+) playing a dominant role. Galileo's survey (Mauk et al, 2004) showed that it extended from $\sim$ 6 to $\sim$ 20 R_J, the main contribution coming from heavy ions with E $>$ 50 keV and plasma beta in the range $\sim$0.1 to $\sim$ 10. Recent Cassini/MIMI measurements of Saturn's ring current (Sergis et al, 2006) revealed a region in the L range $\sim$ 9 to $\sim$ 18, most of the pressure in the range $\sim$ 10 to $\sim$ 200 keV, and consisting of both H+ and O+ ions with the O+ providing most of the pressure during active periods when beta exceeds $\sim$ 1. At all three planets the ring current is maintained by particle injections within the parent magnetosphere. In the case of Earth, ionospheric sources dominate; at Jupiter, Io's volcanoes provide the gas that is subsequently ionized and accelerated; at Saturn the gas is provided by the icy satellites (Enceladus) /rings and ionization and acceleration ensues. It is possible that similar physical processes underlie the formation of the ring current at each planet. A description of the findings at each planet will be presented with emphasis at the latest results from Saturn, and the implications will be discussed in the context of current models.

Krimigis et al, Geophys. Res. Lett., 12, 329-332, 1985

Mauk et al, J. Geophys. Res. 109, A09S12, 2004

Sergis et al, Geophys. Res. Lett., (submitted), 2006