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A Comparative Examination of Plasmoid Structure and Dynamics at Mercury, Earth, Jupiter, and Saturn

James A. Slavin

NASA GSFC Bldg. 21/Room 208, Heliophysics Science Division, Greenbelt, MD 20771, United States
(james.a.slavin@nasa.gov, 001-301-286-1648)

The circulation of plasma and magnetic flux within planetary magnetospheres is governed by the solar wind-driven Dungey and planetary rotation-driven Vasyliunas cycles. The Dungey cycle is responsible for all circulation at Mercury and Earth. Jupiter and Saturn's magnetospheres are dominated by the Vasyliunas cycle, but there is evidence for a small Dungey cycle contribution driven by the solar wind. Despite these fundamental differences, all well-observed magnetospheres eject relatively large parcels of the hot plasma, termed plasmoids, down their tails at high speeds. Plasmoids escape from the restraining force of the planetary magnetic field through reconnection in the equatorial current sheet separating the northern and southern hemispheres of the magnetosphere. The reconnection process gives the magnetic field threading plasmoids a helical or flux rope-type topology. In the Dungey cycle reconnection also provides the primary tailward force that accelerates plasmoids to high speeds as they move down the tail. We compare the available observations of plasmoids at Mercury, Earth, Jupiter, and Saturn for the purpose of determining the relative role of plasmoids and the reconnection process in the dynamics these planetary magnetic tails.