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ENA Dynamics at Saturn

J. Carbary, S. Krimigis, D. Mitchell, C. Paranicas, and P. Brandt

Johns Hopkins University Applied Physics Laboratory, USA (james.carbary@jhuapl.edu /
Phone: 443-778-8805)

The Magnetospheric Imaging Instrument (MIMI) on the Cassini spacecraft has observed energetic neutral atoms (ENA) at Saturn for three years from mid-2004 to mid-2007. The ENA emissions are concentrated in tori approximately concentric with the planet and lying at radial distances between $\sim 7 R_S$ and $\sim 12 R_S$ ($1 R_S = 60268$ km). Within the tori appear enhancements or “blobs” in the ENA emissions that move azimuthally around Saturn. By projecting the ENA images onto Saturn’s equatorial plane, one can readily generate movies of the blob motions and quantify the ENA motions. Significantly, the azimuthal speeds of the neutral hydrogen blobs are near or above corotation for radial distances inside the orbit of Rhea ($\sim 8.7 R_S$), while the speeds drop to $\sim 1/3$ corotation for radial distance outside. The 20-50 keV hydrogen and 64-144 keV oxygen neutrals were examined for periodic behavior by projecting their images onto a plane perpendicular to Saturn’s equatorial plane and summing the emissions along the vertical dimension (spin axis). The resulting “strip” images were then subjected to a Lomb periodogram analyses between mid-2004 to mid-2007. The hydrogens display erratic periods in the 8-13 hour range, while the oxygens exhibit a very strong, repeatable period of 10.8 ± 0.23 hours, which is close to the nominal period of Saturn kilometric radiation as well as the period of energetic particles in Saturn’s outer magnetosphere.