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Observations of energetic particles and neutrals at Saturn from the Cassini magnetosphere imaging instrument (MIMI)

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The MIMI investigation comprises three sensors covering the indicated energy ranges: the Ion and Neutral Camera (INCA) – 3 keV/nuc $<$E$<$200 keV/nuc (ions/neutrals): Charge-Energy-Mass-Spectrometer (CHEMS) – 3$<$E$<$230 keV/e (ions),, and Low Energy Magnetospheric Measurement System (LEMMS) 0.02 $<$E$<$18 Mev (ions)/0.015 $<$E$<$1 Mev (electrons). Also, LEMMS measures high-energy electrons (E$>$3 Mev) and protons (1.6 $<$ E $<$ 160 Mev) from the opposite end of the dual field-of-view telescope. The Saturn observation sequences began in January 2004 and culminated in Saturn Orbit Insertion on July 1, 2004. The MIMI sensors observed substantial particle activity in interplanetary space for several months prior to SOI. These included several interplanetary shocks associated with corotating interaction regions, numerous increases most likely originating from particle streams in the vicinity of the Saturnian bow shock and energetic neutral atoms (ENA) emanating from Saturn's magnetosphere. Measurements by MIMI following SOI revealed: a dynamical magnetosphere with a day-night asymmetry and an 11-hour periodicity;

several water-product ions (O^+, OH^r, H_2O^+), but little N^+; inferred quantities of neutral gas sufficient to cause major losses in the trapped ions and electrons in the middle and inner magnetosphere; a Titan exosphere that is a copious source of ENA. Furthermore, INCA imaging through ENA has revealed a previously unknown radiation belt residing inward of the D-ring that is most likely the result of double charge-exchange between the main radiation belt and the upper layers of Saturn's exosphere. Finally, MIMI data show that there is ample evidence for the presence of injections of plasma on the night-side of the planet, some substorm-like in the magnetotail and others in the 7-10 R_S region that subsequently corotate with the planet for a number of days before dissipating. The observations will be presented and discussed in the context of current theoretical models of Saturn's magnetosphere.