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Comparative ENA imaging of Earth, Saturn, Titan and Mars

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Remote imaging of space plasma by detection of energetic neutral atoms (ENA) have now been in use for ten years. The High Energy Neutral Atom (HENA) imager on board IMAGE mission is imaging the Terrestrial ring current and plasmasheet. The Ion Neutral Camera (INCA) on board Cassini is returning ENA images of Saturn's magnetosphere and its interaction with the moons. The Neutral Particle Imager (NPI) and Detector (NPD) on board Mars Express images the interaction between the solar wind and the martian atmosphere. These missions are providing unique global comparisons of the interactions between energetic ions and neutral gas around magnetized (Earth, Saturn) and weakly magnetized (Mars, Titan) bodies.

While the Earth's magnetosphere is largely a convection-dominated system where plasma-neutral interactions take place at low altitudes, INCA showed a corotating saturnian magnetosphere where energetic ions (10-200 keV) interacting strongly with neutral gas confined to the equatorial plane with no apparent energetic ions reaching the upper atmosphere of Saturn. Both the terrestrial and saturnian magnetospheres see frequent injections of energetic ions in the nightside region. At Earth these injections end up in the ring current region and magnetically drift around the Earth. At Saturn the injections end up in a corotation region where the energetic ions drift in the corotation electric field with only modest dispersion due to magnetic drifts. We discuss the relative importances of charge-exchange loss and transport of the energetic ions in the two systems.

Orbiting Saturn in about 16 (Earth) days at a distance of about 20 Rs, Titan sees energetic ion clouds corotating over it with a speed of about 150km/s. INCA images show how a large region around Titan "lights" up in ENAs every time a corotating plasma cloud sweeps past it. The extension of the ENA emissions around Titan are consistent with an H_2 exosphere extending to several 10,000 km altitude above Titan. At lower altitudes strongly asymmetric and directional ENA emissions indicate a complex interaction that requires treatment of the magnetic field geometry and single-particle trajectories to be explained. We will discuss and compare the plasma interactions at Titan and Mars based on recent findings by Cassini and the NPI and NPD imagers on board Mars Express.

Keywords: Energetic Neutral Atom; magnetosphere; Earth; Saturn; Mars; Titan; ring current; neutral gas