Geophysical Research Abstracts
Vol. 13, EGU2011-5356, 2011
EGU General Assembly 2011

Saturn Ring Observer: Less Challenging Than Previously Thought

Thomas R. Spilker (1), Philip Nicholson (2), Matthew Tiscareno (2), Linda Spilker (1), and the The SRO Study Team

(1) Jet Propulsion Laboratory, MS 301-165, Pasadena, United States (thomas.r.spilker@jpl.nasa.gov, 001-818-393-9815), (2) Cornell University, Ithaca NY, United States

In April 2010, JPL led a study for the 2012 Planetary Science Decadal Survey's Giant Planets Panel addressing the "Saturn Ring Observer" concept, a class of missions that could perform detailed, close-up observations of Saturn's rings. The study charter specified two primary objectives: 1) investigate the method(s) by which such a spacecraft might be placed in a tight circular orbit around Saturn, using chemical or nuclear-electric propulsion or aerocapture in Saturn's atmosphere; and 2) identify technological developments for the next decade that would enable such a mission in the post-2023 time frame (after the next saturnian equinox), with a particular focus on power and propulsion. The "tight circular orbit" is a non-Keplerian orbit identical to the orbits of ring particles except that it is displaced 2-3 km perpendicular to the mean ring plane. A spacecraft in such an orbit would appear to "hover" over the ring particles orbiting Saturn directly "beneath" it, so the study team dubbed this the "hover orbit". From the hover orbit, imaging instruments of moderate resolution could provide individual ring particles' sizes, shapes, and spin states for particles larger than a few cm in diameter. After the study was initiated the study team found that operations technologies would be important drivers so they were examined also.

The science return of such a mission goes far beyond understanding the dynamics of Saturn's rings. Phenomena observable in Saturn's rings are thought to be applicable to planetary rings in general, and to the dynamics of much larger-scale structures such as accretion disks and protoplanetary disks. Notably, an understanding of the rate of energy dissipation in particle collisions, currently an area of large uncertainties, would significantly improve models of planetary origins, especially with respect to time scales. Ring dynamics is not a topic for experimental investigations in current or envisioned ground-based laboratories. The largely unknown shapes, densities, surface textures, regolith characteristics, and other pertinent aspects of the ring particles, along with the extremely small forces that manifest in observable behavior in the rings, defy reliable simulation on Earth. The natural laboratory of Saturn's rings is the best location available to investigate these phenomena.

Despite using the best trajectory and propulsion methods known at the time, previous implementation studies of SRO concepts had to deal with extreme delta-V budgets that made chemical propulsion implementations impractical, so they used nuclear electric propulsion (NEP) or aerocapture. The new study identified types of trajectories that could deliver a spacecraft from Saturn approach to hover orbit initiation (HOI) for $\sim$3.5 km/s delta-V, within reach of a single chemical bipropellant stage and, for some mission concepts, allow launch on an Atlas launch vehicle. Hover spacecraft designs using chemical engines, radioisotope electric propulsion (REP), and NEP were considered, with all three found capable of supporting missions with at least threshold science return. This type of mission could use REP and possibly NEP of surprisingly low specific power, coupled with electric propulsion engines only slightly improved over current ones. The paper summarizes the results of the 2010 study.