Geophysical Research Abstracts,
Vol. 11, EGU2009-6448-1, 2009
EGU General Assembly 2009

Io Volcano Observer (IVO)

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In early FY2008, NASA solicited study concepts for Discovery/Scout-class missions that would be enabled by use of 2 Advanced Stirling Radioisotope Generators (ASRGs). We proposed an Io Volcano Observer (IVO) study concept, because the ASRGs enable pointing flexibility and a high data rate from a low-cost mission in Jupiter orbit. Io presents a rich array of inter-connected orbital, geophysical, atmospheric, and plasma phenomena and is the only place in the Solar System (including Earth) where we can watch very large-scale silicate volcanic processes in action. Io is the best place to study tidal heating, which greatly expands the habitable zones of planetary systems. The coupled orbital-tidal evolution of Io and Europa is key to understanding the histories of both worlds.

IVO utilizes an elliptical orbit inclined > 45º to Jupiter's orbital plane with repeated fast flybys of Io. Io will have nearly constant illumination at each flyby, which facilitates monitoring of changes over time. The view of Io on approach and departure will be nearly polar, enabling unique measurement and monitoring of polar heat flow (key to tidal heating models), equatorial plumes, and magnetospheric interactions. We expect to collect and return 20 Gbits per flyby via 34-m DSN stations, >1000 times the Io data return of Galileo.

The minimal payload we considered included (1) a narrow-angle camera, (2) a thermal mapper, (3) an ion and neutral mass spectrometer, and (4) a pair of fluxgate magnetometers. The camera will acquire global km-scale monitoring and sampling down to 10 m/pixel or better. One key objective is to acquire nearly simultaneous (<0.1 s) multispectral measurements to determine the peak lava temperatures, which in turn constrains the temperature and rheology of Io's mantle and whether or not the heat flow is in equilibrium with tidal heating. The thermal mapper will be similar to THEMIS on Mars Odyssey, but with bandpasses designed to monitor volcanic activity, measure heat flow, and constrain silicate lava compositions. The ion and neutral mass spectrometer, to be contributed by the University of Bern and the Swedish Institute of Space Physics, will determine the composition of Io's escaping species, atmosphere, and volcanic plumes. Two Fluxgate Magnetometers are to be contributed by the Institut für Geophysik und extraterrestrische Physik of the Technische Universität Braunschweig, to characterize magnetospheric interactions with Io, and perhaps place tighter constraints on whether or not Io has an internally generated magnetosphere. Various science enhancement options are being considered.