Geophysical Research Abstracts, Vol. 9, 10928, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-10928

A combined dust impact detector and ion trap mass spectrometer for a Europa orbiter

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Orbit-based detection and analysis of material ejected from the Europan surface can represent an alternative approach to sampling Europan material without landing on the surface. Recent discussions on potential approaches for a European Space Agency Jupiter-Europa mission have favoured a mission profile based on a Europa orbiter, with a Jupiter-orbiting relay spacecraft. A lander (or penetrator) may prove too challenging for the 2015-2025 Cosmic Vision round. Problems include the harsh radiation and thermal environments, as well as the resource requirements for propulsion and safe landing.

Space in the vicinity of Europa will be populated by dust originating from the surface. Fragments of the surface will be ejected due to meteoroid hypervelocity impacts, as well as surface material being continually sputtered (the latter detectable by other means). It is also possible (although not supported by any experimental observations at this time) that material from sub-surface layers may be vented through cracks in the ice, in a similar fashion to the plumes recently detected on Saturn's satellite Enceladus. It is assumed then that while in orbit around Europa, a detector would encounter 'aerosol particles', i.e. a mixture of solid particles (mainly ices), liquids, and liquids/ice condensed around solid nuclei.

Relative impact speeds from these dust sources, to an in-orbit detector, would typically be no more than a few km/s. This impact speed is generally too low for complete vaporisation of the impactor/target (ionisation yield being a strong function of impact speed). Analysis of the impact plasma generated via time-of-flight through charged grids (as used on the Cassini CDA instrument) can be less than optimal at these low impact speeds.

We propose a combined dust impact and ion trap mass spectrometry detector with a mass and power budget in the 1 kg, 1 W range. The instrument could make use of the modest impact ionisation event to capture electrostatically (and then analyse) molecular and atomic species, although post-impact ionisation of neutral ejecta material is also possible. Analysis of impact events from particles in the 100 nm size range should be possible.

A range of instrument design concepts will be presented.