

Europa's and Ganymede's Surface Composition by Measuring Pickup Ions: Model Calculations

E. Sittler (1), J. Cooper (1), R. Hartle (1), P. Mahaffy (1), T. Cassidy (2) and R. Johnson (2)

(1) NASA Goddard Space Flight Center, Greenbelt, MD, USA, (2) University of Virginia, Charlottesville, VA, USA
(Edward.c.sittler@nasa.gov / Fax: +1301-286-1648)

Abstract

The composition of the surfaces of Europa and Ganymede can be inferred in 4π from the measurement of ejected neutrals and pick-up ions using the following *in situ* instrument suite on a spacecraft in a polar orbit about Europa or Ganymede at height ~ 100 km: 3D plasma ion mass spectrometer (IMS), 3D Ion Neutral Mass Spectrometer (INMS), 3D plasma electron spectrometer (ELS), hot plasma energetic particle instrument and vector magnetometer. The ejecta produced by sputtering of the surfaces of Europa and Ganymede has been shown to be representative of the surface composition [1]. Our model calculations include Jupiter's magnetospheric interaction with Europa [2], and a model of Europa's neutral exosphere with surface as its source term. We use measurements of Europa's surface composition from Galileo [3,4] for comparison purposes. The measurement approach is to alternate between times measuring pickup ions and times measuring plasma and magnetic field parameters along the spacecraft trajectory. By measuring the pickup ion energy, arrival direction and mass-per-charge, one can trace back in time its origin if the 3-D electric field and magnetic field are known. *In situ* observations of plasma flow velocities and vector magnetic fields can be used to determine the local convective electric field ($\mathbf{E} = -\mathbf{V} \times \mathbf{B}$) along the spacecraft trajectory. Then by combining this information with models of the magnetospheric interaction with Europa, one can generate 3D maps of the electric and magnetic field and compute the trajectories of the pickup ions back to their surface or exospheric source points. The INMS observations and neutral exosphere models are needed to estimate production rates of pickup ions. The hot plasma measurements are needed to

correct for sputtering rates which can be time dependent and electron plasma observations for electron impact ionization rates. Direct measurements of sputtered neutrals from the surface can also be obtained with high mass resolution in the neutral mode of the IMS. Instrument characteristics, field-of-view requirements, and modes of operation will be discussed. The minimum payload is the 3D IMS and vector magnetometer.

References

- [1] Johnson, R., et al., Europa (ed R. Pappalardo et al.), Univ of Arizona Press, in press 2009.
- [2] Saur, J., D. Strobel and F. Neubauer, *JGR*, **103**, 19947, 1998
- [3] Carlson, R., R. Johnson and M. Anderson, *Science*, **286**, 97, 1999.
- [4] Carlson, R., et al., Europa (ed R. Pappalardo et al.), Univ of Arizona Press, in press 2009.