

SPACE EXPLORATION SYMPOSIUM (A3)  
Solar System Exploration (5)

Author: Dr. Graham Dorrington  
RMIT University, Australia, Australia, graham.dorrington@rmit.edu.au

Dr. Hideaki Ogawa  
RMIT University (Royal Melbourne Institute of Technology), Australia, hideaki.ogawa@rmit.edu.au  
Prof. Pavel Trivailo  
RMIT University (Royal Melbourne Institute of Technology), Australia, pavel.trivailo@rmit.edu.au

EUROPA AND ENCELADUS PLUME SAMPLING USING ROTATING TETHER SYSTEM

**Abstract**

The recent indication of possible water plumes from Europa [1], somewhat similar to the Enceladus plumes observed and measured by Cassini [2], is likely to give rise to a near-future multiple fly-through mission aimed at sampling possible microbes from the subsurface ocean [3]. One of the main challenges with such a sampling mission, however, is that the relative encounter velocity of a Jupiter orbiter with Europa would be at least 1.5 km/s. At such high relative velocities any collected microbes would be destroyed and hard to identify. To reduce the encounter velocity to permit non-destructive sampling, one interesting possibility is to adopt a rotating tethered system, whereby the sampling instrument is spun at high rate using an electric propulsion system. This can be achieved with a tether system about 10 km in length. The use of such long tethers for planetary exploration must now be regarded as a feasible proposition since similarly long tethers have already been successfully deployed in low Earth orbit tests [4], although the spin rates envisaged would be somewhat higher. This paper aims to describe the technologies required for such a rotating tether sampling system, how it might be developed, the risks associated and the advantages it would have over other approaches such as the use of a lander [5]. The paper will also include consideration of orbital trajectories, Europa encounter conditions with and without tether rotation and modelling of tether dynamics - including a first order estimate of the interaction with the plume.

[1] Roth L. et al. (2014) "Transient Water Vapor at Europa's South Pole" *Science*, 343, 171-174.

[2] Perry M.E. et al. (2015) "Cassini INMS Measurements of Enceladus Plume Density", *Icarus*, 257, 139-162.

[3] Lorenz, R. (2016) "Europa Ocean Sampling by Plume Flythrough: Astrobiological Expectations", *Icarus* 267, 217-219.

[4] Kruijff, M., Heide, E.J. van der, (2009) "Qualification and In-Flight Demonstration of a European Tether Deployment System on YES2", *Acta Astronautica*, 64, 882-905.

[5] Di Benedetto, M. (2016) "Augmenting NASA Europa Clipper by a small probe: Europa Tomography Probe (ETP) Mission Concept" IAC16-A7-2-6-x35191, 67th International Astronautical Congress (IAC), Guadalajara, Mexico, 26-30 September 2016.