

**2019 ARIA Proposal Final Report Public Abstract**  
**What Happens to Life in an Ocean World Plume?**  
**C.R. Stoker and K. Bywaters**

The NASA Cassini mission to Saturn discovered persistent jets of water being ejected into space from a subsurface ocean on the small moon Enceladus and evidence that this ocean is habitable for life. The ice resulting from these plumes forms the E Ring of Saturn. Missions are under study to fly through these plumes and collect and analyze samples to look for evidence of life. To support design and instrument selection for these missions, there is a critical need to understand what happens to microbial life adapted to a liquid environment when suddenly ejected into the vacuum of space. We experimentally determined the structural changes in microbial cells in liquid medium when ejected into vacuum. We first developed a vacuum chamber fitted with a feedthrough and nozzle allowing fluid to be injected into vacuum. The nozzle dispersed the fluid into micron-sized droplets. Fluid containing a population of *E. Coli* microbes was injected into the chamber and droplets were collected on microscope slides and small cups for imaging with a Scanning Electron Microscope (SEM). Epifluorescence microscopy, using a lipid stain, and SEM imaging were used to evaluate the cellular integrity of *E. coli* after injection through the pressurized nozzle into vacuum. The experimental samples showed a 94% decrease in visible intact *E. coli* cells as compared with control samples but showed a fluorescent residue in the shape of the sublimated droplets that indicated the presence of lipids. *E. coli* was selected for testing although other cell types could vary physiologically which could affect their response to a vacuum environment. More testing is needed to determine whether other types of microbial cells can survive the plume environment. However, these results suggest that lipids may be directly detectable evidence of life in icy world plumes, but organisms are unlikely to survive due to disruption of their cell walls. Results of this study were published in the Journal *Life* in 2020(1).

(1) K. Bywaters, C.R. Stoker, N. Batista Do Nascimento and L.G. Lemke (2020) Towards determining biosignature retention in Icy World plumes, *Life* 10,40; doi:10.3390/life10040040