

NASA Astrobiology Early Career Collaboration Award Report

Hypervelocity Capture and Analysis of Simulated Enceladus Plume Materials

Kenneth Seaton – Georgia Institute of Technology

Collaborator: Isik Kanik – Jet Propulsion Laboratory, California Institute of Technology

Research Description

There is substantial evidence that icy moons such as Europa and Enceladus possess all the necessary ingredients for life: a subsurface liquid ocean, a heat source, and the chemical building blocks required for life. They are thus excellent targets for future astrobiology missions, and flyby missions to these bodies to capture plume material are a viable approach: the captured material could be analyzed in situ or returned to Earth. However, the survivability of biosignatures during hypervelocity capture remains unknown. Ice grains containing organic compounds such as lipids and amino acids may be captured in a flyby mission in a way such that key chemical biosignatures are preserved, and this information would have key implications for how captured material should be studied to identify biosignatures.

My current research efforts involve the simulated capture of ice grains containing potential organic biomarkers with various capture media (e.g. aerogel, agar, inorganic substrates such as glass and aluminum foil) via high-velocity impacts (3-5 km/s) and analysis of the material post-impact using microfluidic techniques to assess the survivability of organic molecular biomarkers in Enceladus plume capture conditions. I plan to use a custom-built Laser-Induced Particle Impact Testing (LIPIT) system to carry out these experiments. Based on observations by multiple Cassini instruments, the Enceladus plume contains ice grains ranging from less than 1 nm to greater than 1 μm in size. The size of ice grains to be sampled during an Enceladus mission are expected to correlate with the altitude of the fly-by, with smaller grains at higher altitudes and vice versa. I hypothesize that ice grain size effects the survivability of the organic compounds within the grain upon high-velocity impact, so performing impact studies using various grain sizes will result in data that can be well-correlated with fly-by altitude to determine the optimum altitude for biosignature capture.

Outcome of Collaboration

At JPL, I synthesized ice grains of various sizes containing organic biomarkers using a liquid N₂ ice grain formation technique developed at JPL under the advisement of Dr. Kanik and collaborator Bryana Henderson. Now knowing how to properly do so, I will carry this technique back with me to Georgia Tech to implement in future ice grain capture experiments I plan to do. Additionally, I worked with Steve Jones, the scientist responsible for aerogel production for JPL's flight missions, in determining the optimal synthetic methodology to produce ultra-clean capture materials to be used in the impact experiments I will conduct. We met and discussed my specific needs regarding aerogel purity, how different synthetic methods could successfully fill these needs, and timelines

for production. I was shown how aerogel used for my project would be synthesized, introduced to his facilities, and met with his team.

Additionally, I was able to form additional meaningful collaborations during my short stay at JPL. I met with Morgan Cable, a member of the Hypervelocity Sampling Across the Solar System team at JPL, which is funded through JPL's Strategic Research and Technology Development program. As of my visit to JPL, I am now a member of this team, which is comprised of scientists tackling the same problem I am regarding hypervelocity sample capture, and having a network of brilliant, like minded researchers to reach out to is invaluable at this stage of my career. None of this would have been possible without the NASA Astrobiology Early Career Collaboration Award, and I am truly thankful for the opportunity to visit JPL and collaborate with the world-class scientists there.