NASA SBIR 2017 Phase I Solicitation

S4.06 Sample Collection For Life Detection in Outer Solar System Ocean World Plumes

Lead Center: ARC

Participating Center(s): GSFC, JPL

Technology Area: TA8 Science Instruments, Observatories & Sensor Systems

This subtopic solicits development of in-situ instrument technologies and components to advance the maturity of instruments focused on the collection of samples for life detection from plumes in the Ocean Worlds (e.g., Europa, Enceladus, Titan, Ganymede, Callisto, Ceres, etc.). These technologies must be capable of withstanding operation in space and planetary environments, including the expected pressures, radiation levels, launch and impact stresses, and range of survival and operational temperatures. Technologies that allow collection during high speed (>1 km/sec) velocity passes through a plume are of interest as are technologies that can maximize total sample mass collected while passing through tenuous plumes. Technologies that reduce mass, power, volume, and data rates without loss of scientific capability are of particular importance.

For synergistic NASA technology solicitation, see ROSES 2016/C.20 Concepts for Ocean worlds Life Detection Technology (COLDTECH) call:

- https://nspires.nasaprs.com/external/solicitations/summary.do?method=init&solId={5C43865B-0C93-6ECA-BCD2-A3783CB1AAC8}&path=init.

For the NASA Roadmap for Ocean World Exploration see:

- http://www.lpi.usra.edu/opag/ROW.

The icy moons of the outer Solar System are of astrobiological interest. The most dramatic target for sampling from a plume is for Enceladus. Enceladus is a small icy moon of Saturn, with a radius of only 252km. Cassini data have revealed about a dozen or so jets of fine icy particles emerging from the south polar region of Enceladus. The jets have also been shown to contain organic compounds, and the south-polar region is warmed by heat flow coming from below.

As a target for future missions, Enceladus rates high because fresh samples of interest are jetting into space ready for collection. Indeed, Enceladus has been added to the current call for New Frontiers missions with a focus on habitability and life detection. Particles from Enceladus also form the E-ring around Saturn. The particles in the E-ring are known to contain organics and are thus also an important target for sample collection and analysis. Recent data have indicated a possible plume at Europa that may also be carrying ocean water from that world into space. In addition to plumes, there are other energetic processes that can spray material from the surface of these low-gravity worlds into space where they could also be collected in-flight and analyzed.

Collecting samples for a variety of science purposes is required. These include samples that allow for determination of the chemical and physical properties of the source ocean, samples for detailed characterization of the organics present in the gas and particle phases, and samples for analysis for biomarkers indicative of life. Thus these “Ocean Worlds” of the outer Solar System offer the opportunity for a conceptually new approach to life detection focusing on in-flight sample collection of material freshly injected into space. Technologies of particular interest include sample collection systems and subsystems capable of:

- Capture, containment, and/or transfer of gas, liquid, ice, and/or mineral phases from plumes to sample processing and/or instrument interfaces.
- Technologies for characterization of collected sample parameters including mass, volume, total dissolved solids in liquid samples, and insoluble solids.
- Sample collection and sample capture for in-situ imaging.
- Systems capable of high-velocity sample collection with minimal sample alteration to allow for habitability and life detection analyses.
- Microfluidic sample collection systems that enable sample concentration and other manipulations.
- Plume material collection technologies that minimize risk of terrestrial contamination, including organic chemical and microbial contaminates.

Proposers are strongly encouraged to relate their proposed development to NASA's future Ocean Worlds exploration goals. Proposed instrument architectures should be as simple, reliable, and low risk as possible while enabling compelling science. Novel instrument concepts are encouraged particularly if they enable a new class of scientific discovery. Technology developments relevant to multiple environments and platforms are also desired.

Proposers should show an understanding of relevant space science needs, and present a feasible plan to fully develop a technology and infuse it into a NASA program.