Dragonfly: A New Frontiers Titan Astrobiology Lander

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We propose a Titan lander mission for New Frontiers to sample both water ice and organic sediments to assess prebiotic chemistry, to evaluate habitability, and to look for biosignatures. We carry a mass spectrometer to determine molecular masses of surface materials. A gamma-ray and neutron spectrometer will assess the bulk and inorganic atomic fractions within the regolith. We will monitor atmospheric conditions and listen for seismic activity using a meteorological and geophysics package. And a suite of cameras will characterize the landing site and provide context for each sample.

Titan's ubiquitous organic compounds created by photolysis of a methane-rich atmosphere set it apart from the other ocean worlds. On Titan, carbon can interact with liquid water **on the surface**. Cryolava flows and impacts create transient surficial liquid water environments. When organics (sitting on the surface or falling out of the atmosphere) mix with water, the resulting environment simulates what may have happened on the early Earth. Analyzing previously liquid water can therefore bring insights into prebiotic chemistry unattainable in the terrestrial laboratory and potentially shed light on the origin of life.

At the same time, we can also test for the possibility for complex chemistry using liquid hydrocarbon solvents. Although Earth-based life requires liquid water, it is not yet clear whether water is the *only* possible solvent for life. Titan's methane rain and methane/ethane seas allow us to constrain this possibility for "Life, Jim, but not as we know it". However, the best place to evaluate this chemistry is actually not within the seas themselves – instead we will sample organic sediments where those materials have been concentrated.

But how do we make sure that we get to the right location to sample? That's where we use the Titan environment to our advantage. With a thick atmosphere 4 times denser than Earth's and 7 times lower gravity, heavier-than-air flight at Titan is 38 times easier than it is here. So we designed our entire vehicle to be mobile as a quadcopter drone: Dragonfly. Dragonfly uses stored battery energy to fly up to over 10 km in a single hop, thus achieving accessibility for a high diversity of geologic settings.

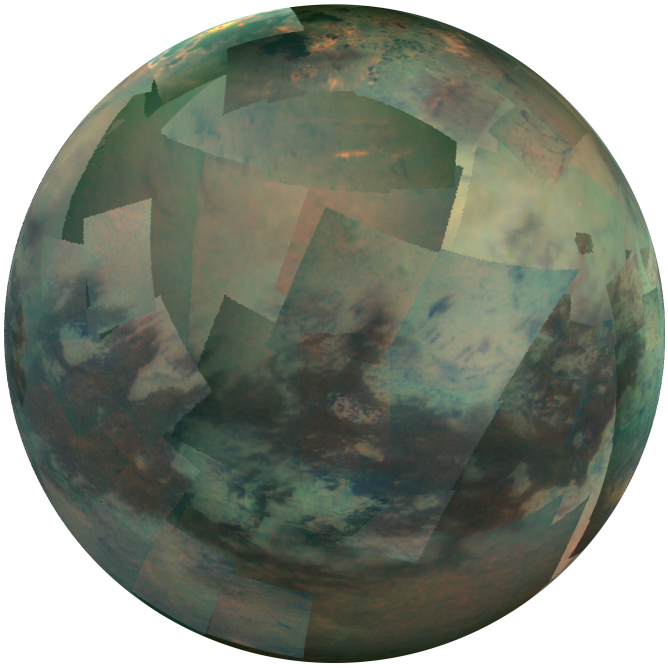

Figure 1: Near-infrared view of Titan. With organic sand dunes, fluvially dissected highlands, and icy craters, Titan affords access to a large diversity of terrains from our platform.

We will first land in an organic sand sea well-characterized by *Cassini* and then traverse to our water-ice target in a series of hops. In addition to enabling large-scale surface mobility, flight capability also allows us to hop on smaller scales as needed to pursue scientific leads within a particular area. Thus we can actively seek out and find the best opportunities for sampling astrobiologically relevant materials.