DRAGONFLY

Flights of Exploration Across Saturn's Moon Titan

Dragonfly is a proposed mission concept to send a rotorcraft-lander to Saturn's large, exotic moon, Titan. Designed to sample surface materials and determine composition in different settings, this revolutionary mission concept offers the capability to explore diverse locations and characterize the habitability of Titan's environment, investigate the progression of prebiotic chemistry, and even to search for chemical hints of water-based or hydrocarbon-based life.

Clouded in Mystery

The Voyager spacecraft observed Titan in 1979 and 1980 but could barely detect the surface through the moon's thick, hazy atmosphere. Hubble Space Telescope near-infrared images in 1994 revealed large bright and dark surface regions, but the details of Titan's landforms remained a mystery until the arrival of the Cassini spacecraft in 2004. In more than 120 close flybys, using radar and near-infrared imaging, Cassini mapped much of Titan's surface and studied its atmosphere in detail. Cassini also delivered the Huygens probe, which in 2005 touched down on Titan, measuring the atmosphere and imaging part of the surface close-up during and after descent. Titan is also an "ocean world"—Cassini observations point to a liquid-water ocean beneath the moon's water-ice crust.

An Exotic World

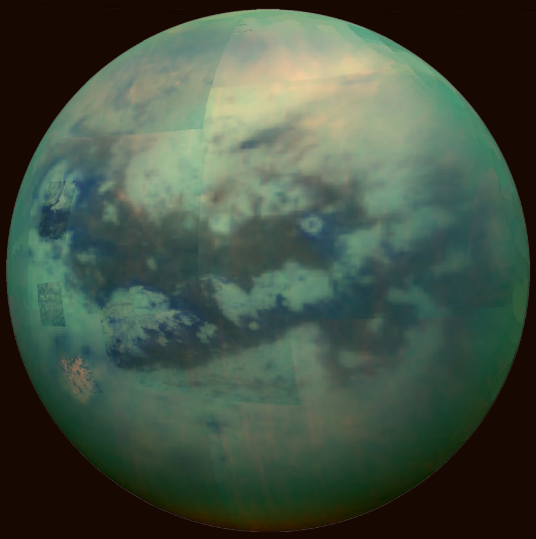
Titan's surface has rivers, lakes, and seas of liquid ethane and methane—the main component of natural gas—as well as vast expanses of organic sand dunes. In Titan's atmosphere, the methane can form clouds and even rain, following seasonal patterns that are in some ways similar to Earth's weather. Titan's atmosphere is four times denser, making atmospheric activity much more "sluggish" than on Earth, and gravity is about 1/7th of what we experience.

When exposed to sunlight, the methane and nitrogen molecules in Titan's atmosphere are split apart by ultraviolet light and recombine to form a variety of complex organic compounds. Organic molecules are the building blocks for life, and their presence on Titan adds to its intrigue—what compounds are on Titan, and what might they form?

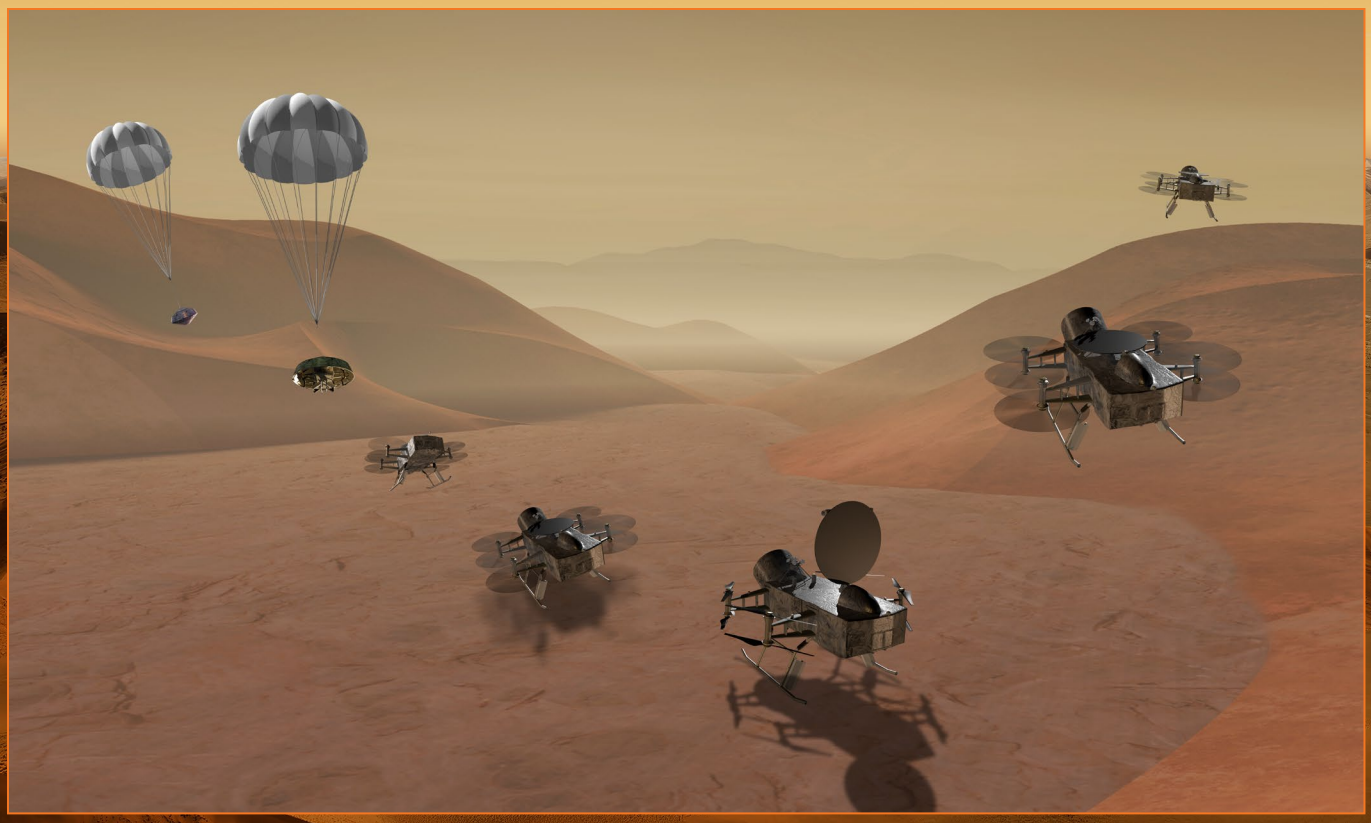
Titan is in many ways the most Earthlike world in the solar system. Larger than the planet Mercury and covered with a thick nitrogen atmosphere laden with organic smog, Titan's surface is partially hidden from view. Far from the Sun, Titan is cold enough that methane plays the active role that water plays on Earth, serving as a condensable greenhouse gas, forming clouds and rain, and pooling on the surface as lakes and seas. Titan's carbon-rich surface is shaped not only by winds that sculpt drifts of aromatic organics into long linear dunes but also by methane rivers and possible eruptions of liquid water ("cryovolcanism").

Ocean Worlds

NASA's Ocean Worlds mission theme focuses on characterizing potential habitability, prebiotic chemistry, and even the search for signs of life. Titan's unique combination of abundant, complex, carbon-rich chemistry on its water-ice-dominated surface is ideal for the study of prebiotic chemistry and habitability of an extraterrestrial environment.



Infrared view of Titan from the Cassini spacecraft (NASA/ESA/ASI)



The Dragonfly mission concept (APL)

Powered Flight

Launching in 2025 and reaching Titan in 2034, the Dragonfly dual-quadcopter would fly to dozens of different sites, tens to hundreds of miles/kilometers apart. Titan's dense, calm atmosphere and low gravity make flying an ideal way to travel. With one Dragonfly flight per Titan day (16 Earth days), the rotorcraft could travel from its initial landing site to explore areas several hundred kilometers away, although the quadcopter would spend most of its mission making science measurements on the ground.

Dragonfly would use a Multi-Mission Radioisotope Thermoelectric Generator (MMRTG) like the Curiosity rover on Mars.

Critical Science

Dragonfly would carry science instruments that enable a range of surface and atmospheric measurements:

- Sampling surface material with a mass spectrometer to identify chemical components available and processes at work to produce biologically relevant compounds
- Measuring bulk elemental surface composition with a neutron-activated gamma-ray spectrometer
- Monitoring atmospheric and surface conditions with meteorology sensors
- Characterizing geologic features via imaging
- Performing seismic studies to detect subsurface activity

In flight, Dragonfly would make atmospheric profile measurements and image the surface to examine geology, provide context for ground measurements, and scout potential landing sites of interest.

An Experienced Team

Led by the Johns Hopkins University Applied Physics Laboratory, Dragonfly is a finalist to become the next mission in NASA's New Frontiers planetary science program. Key mission partners include Penn State University, NASA (Goddard Space Flight Center, Ames Research Center, Langley Research Center, Jet Propulsion Laboratory), Honeybee Robotics, and Malin Space Science Systems. New Frontiers is managed by the Planetary Missions Program Office at NASA's Marshall Space Flight Center in Huntsville, Alabama, for the agency's Planetary Science Division in Washington.

Learn More About Dragonfly:

http://dragonfly.jhuapl.edu

APL_BCC3_18-01334