Self-Propelled Oceanic Titan Rover (SPOTR)

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Abstract

Titan, Saturn’s biggest moon, is considered one of the best candidates to study life (Johns Hopkins University Applied Physics Laboratory, n.d.a). To do so, The Self-Propelled Oceanic Titan Rover, or SPOTR, will go to Titan. Its objectives are to spot possible signs of past or present life, study prebiotic chemistry on Titan’s seas to determine how life first came about on Earth, and perform atmospheric and oceanic analysis. As a Space-Based Planetary Exploration, SPOTR will fly over to Titan for seven years, then collect data for an additional 14, totaling 21 years. Its significant subject matter, the origins of life, will help biologists discover breakthroughs and further biotechnology. Additionally, NASA and other space agencies will use rover designs and procedures to further their own aerospace technology. SPOTR will primarily use the Meteorology and Physical Properties Package (MP3) to conduct studies. However, SPOTR is limited by its design and instrumentation.

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Of all the places in the Solar System to explore, Saturn’s biggest moon, Titan, is one of the most promising. This is because of Titan’s unique characteristics, such as “complex organic material,” liquid formations such as rivers and seas, and the presence of liquid water (Johns Hopkins University Applied Physics Laboratory, n.d.a). With this in mind, the Self-Propelled Oceanic Titan Rover, or SPOTR, will go to Titan.

SPOTR’s objectives are: (1) spot possible signs of past or present life, (2) study prebiotic chemistry on Titan’s seas to determine how life first came about on Earth, and (3) perform measurements on the seas including chemistry, depth, weather, and atmosphere. Titan is uniquely suited for these science goals because of its methane and nitrogen atmosphere. It is the only “moon in our solar system with a dense atmosphere” (Johns Hopkins University Applied Physics Laboratory, n.d.a). These chemicals, methane, and nitrogen, beak when exposed to ultraviolet light, where the resulting elements can form into complicated organic compounds. Another reason Titan best supports these goals is that Titan has, like Earth, weather such as clouds and rain that support habitability. Its combination of abundant organic compounds and liquid water makes it the best cosmic body to explore to understand life as we know it (Johns Hopkins University Applied Physics Laboratory, n.d.a).

This mission is important because it studies the nature of life itself. We still do not know how life came into existence (Blais, n.d.). Titan presents itself as similar to Earth before life occurred. It may reveal “the kinds of chemical interactions that occurred” before life came about on Earth (Johns Hopkins University Applied Physics Laboratory, n.d.a). With this knowledge, we may be able to further our understanding of where life came from and under what circumstances it would flourish.

The SPOTR mission is a Space-Based Planetary Exploration. During the seven-year trip, SPOTR will not collect any fly-by data.

Mission users include NASA, the medical community, the biotechnology industry, biology as a whole, and other space agencies. NASA is especially interested in the idea of “potential habitability, examining prebiotic chemistry, and searching for signs of life,” which is exactly what SPOTR plants to do (Johns Hopkins University Applied Physics Laboratory, n.d.a). The medical community may use this knowledge to improve medical practices; the biotechnology industry may gain new insight into how life works of a fundamental level, helping improve CRISPR and other life-related procedures. There is no way of telling what would happen if SPOTR found another piece of the evolutionary puzzle. Additionally, other space agencies may use the launch, data collection, rover design, or another part of the mission to improve upon their old designs.

This mission will last for a total of at least 21 years. This is because the trip to Titan takes about seven years (NASA, 2018). The operational lifespan of the battery used, the Multi-Mission Radioisotope Thermoelectric Generator (MMRTG), would provide a lifespan of at least 14 years, similar to the Curiosity rover on Mars (Johns Hopkins University Applied Physics Laboratory, n.d.a).

SPOTR will start its journey to Titan in 2028. During 2026 through 2035, Titan will be behind Saturn, with no way of communicating with Earth (JHU Applied Physics Laboratory, 2011). However, SPOTR will reach Titan’s second-biggest body of liquid, the Ligeia Mare, by 2035, the year where Titan will be in line with Earth again (Hadhazy, 2011). Several instruments will support SPOTR on its mission. First, SPOTR would have to have a high-gain antenna to communicate directly with Earth. If there were communication errors, then the rover could not send back data (Johns Hopkins University Applied Physics Laboratory, n.d.b). Secondly, the rover would need atmospheric and ocean data. For this, SPOTR will use the Meteorology and Physical Properties Package (MP3). With the MP3 instruments, SPOTR will be able to determine the chemical composition of the sea and atmosphere. It will also be able to determine the depth of Titan’s seas and track weather patterns over time (Proxemy Research et al., 2012). The rover will have propulsion as well. As proposed by the European Planetary Science Congress, the rotors on each side of SPOTR will be corkscrew, much like an Archimedes screw (European Planetary Science Congress, 2012). Lastly, it will require durable cameras to withstand the harsh Titan environment (Johns Hopkins University Applied Physics Laboratory, n.d.a).

The design stage on SPOTR will begin in 2020, preparing for a launch in 2028. In 2026, the construction will begin. Once SPOTR has successfully lifted off, it will head towards Titan for 7 years, until 2035. SPOTR will land in the Ligeia Mare on Titan in 2035. From the to 2049 or more, SPOTR will move throughout the Ligeia Mare, recording depths, weather patterns, the chemical composition of the sea and air, and possible signs of life. It will do so all while transmitting back information to Earth.

There are several constraints that arose during the proposal of SPOTR. One such constraint is a lack of fly-by instruments. The sheer amount of instruments on the rover itself and the equipment to get the rover to the correct landing zone do not allow for more data collection on the seven-year trip to Titan. Although the rover will be sent past many points of interest, no fly-by instruments can be fitted on the rover. The SPOTR mission is also constrained by its design. In order to study the oceans, a rover must be on the surface of the lake to collect chemical data. Unfortunately, SPOTR only has access to the liquid seas of Titan.

In conclusion, the Self-Propelled Oceanic Titan Rover (SPOTR) will search for life signatures and record oceanic and atmospheric data of Titan over a period of 14 years. It’s important to send this rover because of the possible implications of new life. How life began has been one of our greatest mysteries and sending SPOTR out might help us learn something new about ourselves and the organisms around us (Blais, n.d.). NASA, other space agencies, and the biology field will benefit from the knowledge gleaned from this mission. The payload will fly for seven years to Titan, then disengage. SPOTR will then explore Titan’s Ligeia Mare for an operational life of at least 14 years. It will launch in 2028 and contain the Meteorology and Physical Properties Package (MP3), corkscrew propulsion, and durable cameras. Once it reaches Titan in 2035, it will continue to gather data for 14 years. The sheer amount of instrumentation constrains this mission. Because there is so much of it, no fly-by data can be collected. Of all the places in our solar system to harbor life, Titan and its oceans may be our best hope.

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