

Exploration of Titan's Seas

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Saturn's moon Titan has extensive lakes and seas of liquid hydrocarbons that are a priority target of future exploration. The largest of these seas, Ligeia Mare and Kraken Mare, are ~400km and ~1000km in extent, respectively, and are composed of liquid methane and ethane at 94K, with likely traces of hundreds of other organic compounds. Titan's seas represent a laboratory for air-sea exchange and other hydrological and oceanographic processes, as well as a site of astrobiological interest.

Observations from the Cassini spacecraft, in particular its radar instrument, have measured the depth of Ligeia Mare to be ~160m, consistent with terrestrial basins of similar size. The tidal amplitudes have been predicted to be some tens of centimeters, and as surface windspeeds grow to 1-2m/s as we approach northern summer in 2017, waves are expected to form. Cassini observations of sunglint and with radar and radio generally show the sea surface to be flat up to now, but some time-variable patches of reflectivity show that dynamic processes are active, and perhaps that waves are just beginning to form. Further Cassini observations are eagerly anticipated.

Several proposals have considered future missions to Titan's seas. Of these, the most detailed work was for a NASA Discovery Phase A study, the Titan Mare Explorer, TiME. This envisaged a radioisotope-powered capsule in Ligeia Mare in 2023, which it would traverse over several weeks blown by the wind. Detailed designs and operations plans were developed, and prototype instrument systems (e.g. sonar transducers, liquid sampling inlets) tested in cryogenic conditions; scale model splashdown testing was also performed.

More recently, the NASA Institute for Advanced Concepts has sponsored a study of a robot submarine to explore Titan's seas circa 2040. This study has addressed some unique challenges such as the reconciliation of hydrodynamic design drivers with the need to accommodate a large data relay antenna.

Whether these vehicles, or other systems such as airplanes or balloons, explore Titan next, it is clear that Titan's seas offer tremendous scientific potential and public engagement.

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