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Laboratory measurements in support of radar studies of Titan seas

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Data from Cassini RADAR instrument observations of Titan's lakes and seas show tantalizing hints that in some locations the radar signals might penetrate the liquids, returning measurable reflections from the solid surfaces beneath. At the microwave frequencies used by the RADAR instrument, non-polar liquid alkanes such as methane, ethane, and propane are fairly transparent, supporting the possibility that propagation through the liquids at Titan occurs. But relatively small amounts of other species dissolved in a liquid can strongly influence its microwave absorption coefficient. The dissolution of small amounts of sodium chloride in water, which increases the absorption coefficient by orders of magnitude, illustrates the potential of this effect. At Titan it is almost certain that some of the organic materials observed on the surface, and possibly other species, would dissolve in the methane-ethane mixture thought to constitute the bulk of the seas and lakes. If the microwave propagation constants of the liquids were known, Cassini RADAR data could provide estimates of depth profiles for areas yielding lake-bottom returns, and lower limits to depth for those areas where returns are absent. But the effects of anticipated dissolved species on the microwave properties of liquid alkane mixtures are largely unknown.

Laboratory measurements could provide the key to inferring the lake-depth implications of Cassini RADAR results. There are multiple laboratory techniques available for measuring refractive indices and absorption coefficients of liquid samples at microwave frequencies. In the case of liquids relevant to Titan, the primary challenge is to maintain the samples and experimental apparatus at temperatures and pressures that keep the samples in the liquid phase, but this is not an impossible task. Other considerations include ensuring that the composition of a sample within the apparatus is well known. Notably, it is important that all surfaces in contact with the samples at any stage of the experiments do not affect the composition of the samples.

An opportunity might arise to conduct such measurements as an extension of a task recently funded by the NASA Astrobiology Institute. That task calls for measuring the solubility of expected Titan materials, including but not limited to species found in tholins, in liquid methane-ethane mixtures. If such solutions are to be generated for that task, it would be prudent to use them for microwave experiments also.

This presentation will describe candidate techniques for making these measurements and suggest possible applications to the Cassini data.

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