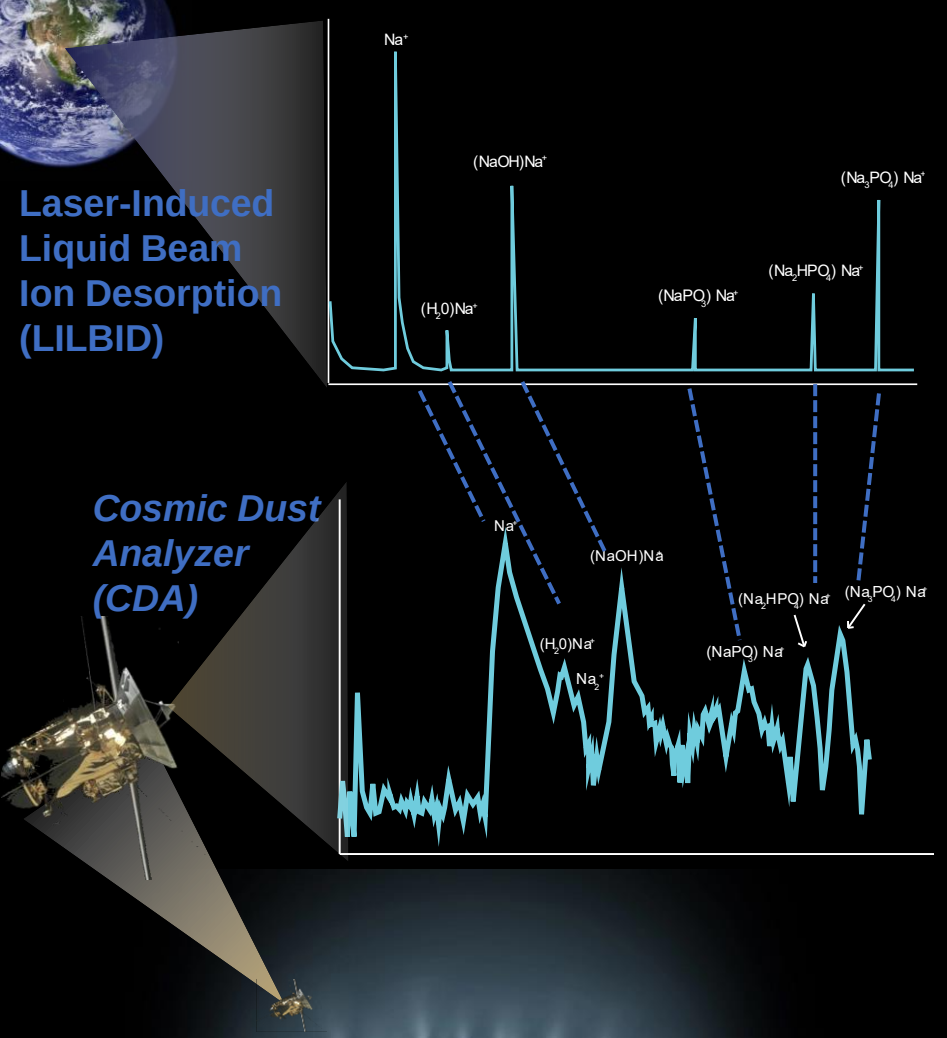
Detection of phosphates originating from Enceladus's ocean



Background: Enceladus, one of Saturn's small icy moons, is one of the most promising astrobiological targets in our solar system. Underneath its kilometers-thick icy crust lies a global ocean, thought to be capable of sustaining life. Previous studies from Cassini's analyses of plumes that erupt from the surface of Enceladus into space have found evidence of hydrogen gas and all the elements needed for life on Earth, except for phosphorus. If phosphorus were present, there would be sufficient chemical energy and the elemental inventory needed to sustain any life that may have taken hold in Enceladus. In this study, spectra from Cassini's Cosmic Dust Analyzer (CDA) are investigated to search for the presence of phosphorus, to complete the elemental inventory for life.

Experiments: A subset of data analyzed by Cassini's CDA that included grains with particularly high salt concentrations was further investigated for features of phosphorus, in the form of phosphates. 9 of the 345 particles analyzed yielded spectra that matched with known phosphate masses. To ground-truth the findings, back on Earth, different solutions of phosphates and their derivatives were used to generate ice grains in the lab for analysis via Laser Induced Beam Ion Desorption (LILBID) mass spectrometry in an attempt to generate similar spectra. The resulting spectra from a range of phosphate mixtures and concentrations were compared to Cassini's CDA data and used to estimate the concentration of phosphates in Enceladus's ocean. These findings enabled the team to model concentrations of phosphate in icy moons beyond and within the solar snowline.

Results & Significance: This study marks the first detection of phosphate in a non-Earth ocean. As one of the most challenging elemental requirements to meet for habitability, its presence on Enceladus is an excellent sign for the possibility of life on the moon. Based on these results, phosphate concentrations in Enceladus's ocean are 100 times higher than modern ocean concentrations. Modeling of the CO_2/PO_4 relationship also suggests that icy moons past the CO_2 snowline in the solar system would have similar amounts of phosphates, a good sign for the habitability of the other icy moons astrobiologists are interested in.

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