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Why are Entry Probes Essential to Ice Giant Planet Exploration?

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The overarching goal of any outer planet mission is to understand the origin and evolution of the planet and its atmosphere. This goal is best achieved by synergistic observations from orbiting spacecraft and entry probes. This was the philosophy that guided the Galileo mission to Jupiter, which consisted of an orbiter and a probe, and is the rationale behind Saturn probe as a mission candidate in NASA's New Frontiers Program in order to provide the missing pieces of the puzzle after the Cassini orbiter remote sensing observations. Unlike the gas giants, the ice giant planets, Uranus and Neptune, have been explored only marginally, by Voyager flybys in 1986 and 1989. Any future missions to the ice giants should also include both orbiter and probe elements. Though entry probes add some cost and complexity to the mission architecture, they are the only means of obtaining the measurements that are critical to constraining the models of planetary formation and the origin of the atmosphere, in addition to providing a window into the workings of the planet's interior. For the ice giant planets, the abundances of noble gases, He, Ne, Ar, Kr and Xe, together with their isotope ratios are key. They are expected to be uniform over the planet, unaffected by dynamics or meteorology. Only entry probes can make these measurements. Probes will also yield complementary data on certain other heavy elements (mass >He) and isotopes (D/H, 13C/12C, etc.), while remote sensing in the microwave may be better suited for ammonia and water (N and O), as at Jupiter by Juno. Alternatively, or in addition, radio measurements from the Earth using instruments such as the enhanced VLA hold much promise for sensing deep water, ammonia and hydrogen sulfide abundances (hence O, N and S) of the ice giant planets. This is possible from the ground because these planets, unlike Jupiter, lack synchrotron radiation. This presentation will focus on the unique science only the probes can deliver.