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PRIDE – Passive Radio Ice Depth Experiment - An Instrument to Measure Outer Planet Lunar Ice Depths from Orbit using EHE Neutrinos

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We describe a potential confluence between EeV neutrino detection and planetary science: a concept for an instrument to measure the thickness of the ice shell on a planetary body, such as Jupiter's moon Europa or Saturn's moon Enceladus, by making use of the Askaryan Effect RF signal from EHE neutrinos observed from an orbiting spacecraft. Unlike a large high powered active device, i.e., an ice-penetrating radar, this instrument is a passive receiver of the naturally occurring signal generated by interactions of deep penetrating cosmic ray neutrinos in the extremely thick, cold ice layer encasing outer solar system moons. It is therefore potentially less massive and requires less power, making it very attractive for interplanetary missions. Measuring the ice sheet thickness on such moons is a first step toward exploring potential oceans below, and is a very high scientific priority for outer planet missions, so new and economical approaches to this measurement are of great interest. We discuss the basic concept, including the correlations of event rate and direction distribution with ice sheet thickness, and consider the instrument design requirements from the perspective of a NASA Outer Planet Orbiter Mission. We show results [1] of simulations, compare signal-to-noise estimates, and examine possible components and configurations for the antenna, receiver, and electronics. We note some options that can be used to reduce mass and power. Finally, we identify issues that would need further study to produce a more concrete design.
[1] Miller, T., Schaefer, R.K., and Sequeira, H.B., Icarus, 220, 877-888, 2012.

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