UH Manoa Team to Lead NASA Mission Technology Study To Identifty Ice Deposits on the Moon

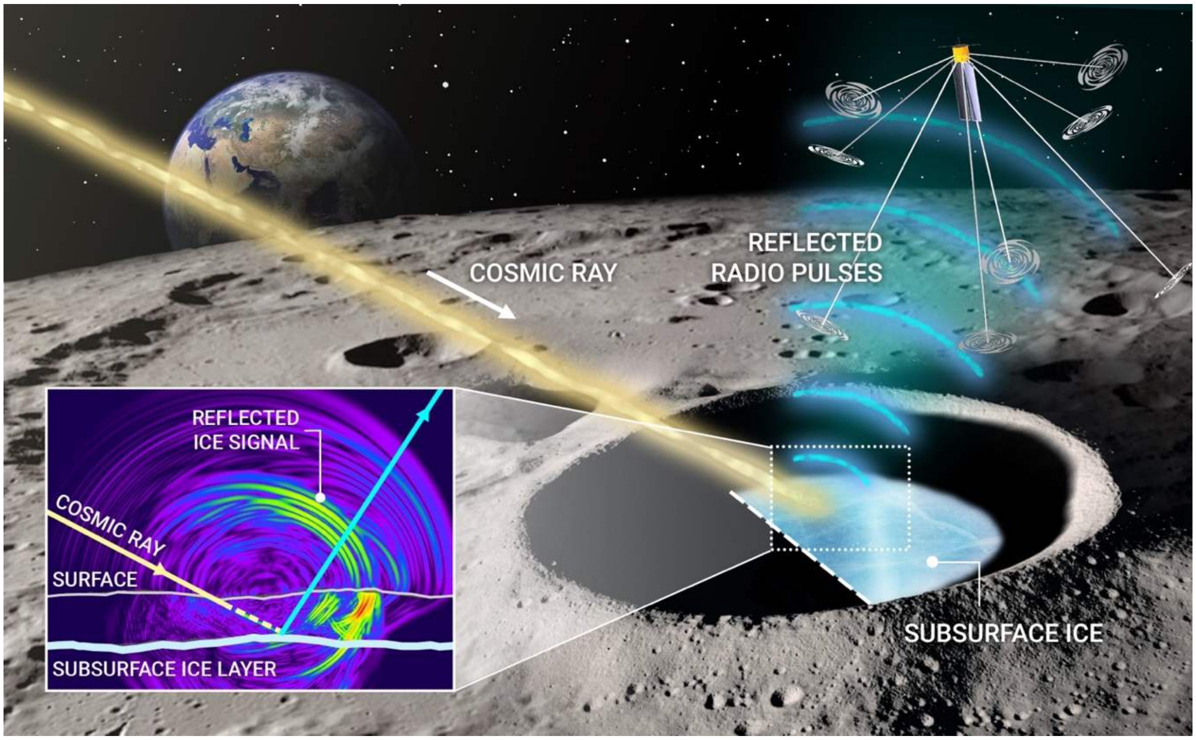

Figure 1: Artists concept of CoRaLS mission. Credit: A. Romero-Wolf, JPL.

Five UH Manoa scientists in the Department of Physics & Astronomy and Hawaii Institute of Geophysics and Planetology have been awarded almost $3M in a 3-year project to develop technology for the NASA Cosmic Ray Lunar Sounder (CoRaLS) mission, initiated by a joint effort between UH Manoa and NASA's Jet Propulsion Lab. CoRaLS is a new spacecraft concept for detecting extensive water ice deposits in the lunar regolith using the radio signals produced by ultra-high energy cosmic ray particles incident on the surface of the Moon. No other mission has yet been proposed that can detect subsurface ice below the first meter, so CoRaLS has a unique opportunity to further lunar science and identify crucial resources for future manned and unmanned mission to the Moon.

Extensive ice deposits have been found in the permanently shadowed regions (PSRs) of Mercury, but so far only traces of water ice have been found on the surface of lunar PSRs, and active radar measurements sensitive to the top meter or so of regolith show no clear signal yet from extensive deposits. Given expectations from the way meteor impacts change the surface of a planetary body, the extensive ice deposits on the surface of Mercury are expected to be less than 10 million years old, suggesting that their source is sudden and voluminous. These considerations leave the possibility for relic extensive ice deposits below the first meter of lunar regolith provided that a sudden and voluminous source, similar to Mercury, emplaced ice within the last billion years. If Mercury-like ice deposits exist on the moon, they will have been emplaced and disrupted by random impact events. Because of their largely random evolution, in order to find large subsurface ice deposits, we must be able to probe deeply and across a large area.

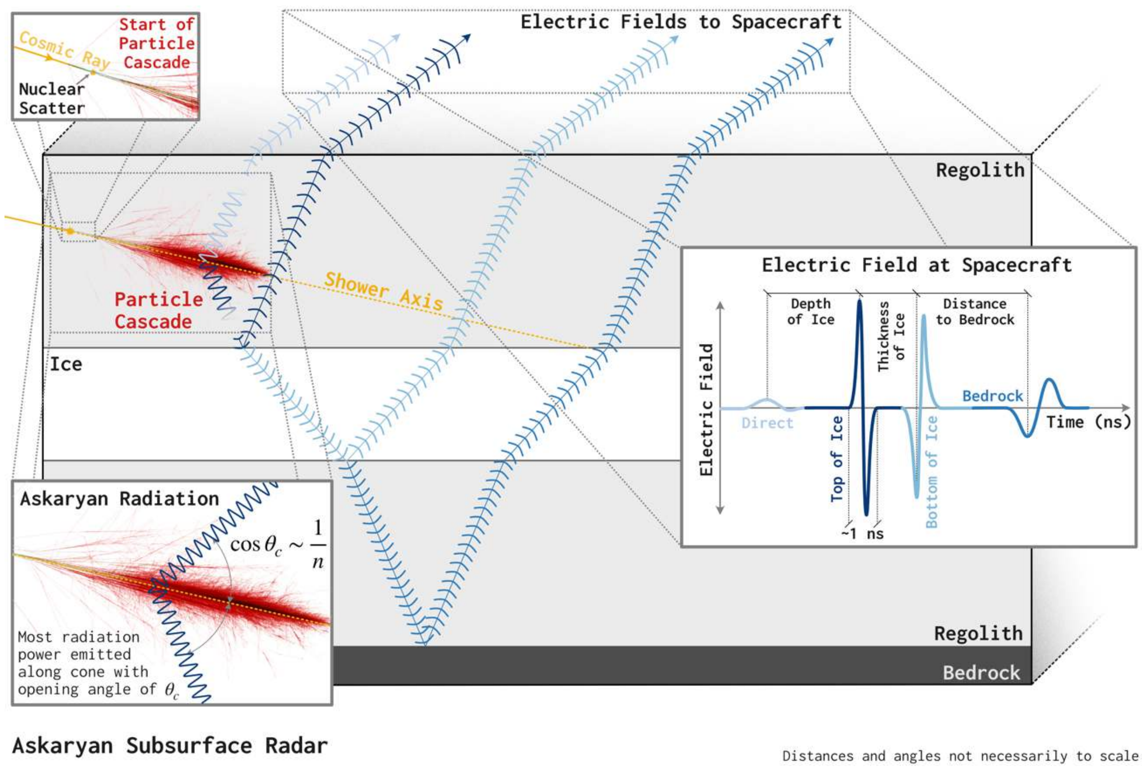

Figure 2: Overview of the process by which cosmic rays produce radio signals that reflect from subsurface ice. Credit: R. Prechelt

The CoRaLS mission will probe tens of meters into the regolith using a known source of coherent radio impulses that are effectively implanted into the regolith by the interactions of cosmic ray particles, which are mainly high energy protons and heavier nuclei of cosmic origin. The lunar regolith is continually bombarded by cosmic rays, and the most energetic of these produce strong secondary particle cascades within the regolith, extending for up to 10 meters. These particle cascades are somewhat analogous to bolts of compact lightning within the lunar soil, and provide a natural radio signal that can be exploited to search for extensive ice deposits within the first 10-20 m of the lunar subsurface. Due to the lack of a lunar atmosphere, the cosmic-ray particles enter the regolith unimpeded with their full energy, providing a unique opportunity for an orbiting spacecraft observatory to use their radio emission as a natural subsurface probe. According to Dr. Emily Costello of HIGP, one of the lead investigators on the project, “CoRaLS is the best and only way to probe for ice deeply and widely enough to conclusively discover or deny the existence of buried coherent ice deposits on the Moon."

Because the cosmic rays hit the Moon's surface at random locations, an orbiting spacecraft can detect the resulting radio signals and make an unbiased map of the subsurface reflectivity at discrete locations spread out over the entire Moon. Since subsurface ice layers are much more reflective than other materials, ice deposits in the polar PSRs will show up as a strong enhancement of the number of signals detected there. Characteristics of those signals, such as the phase, polarization, and intensity, will yield even more details about the ice – its depth, and its purity are among the most pressing questions.

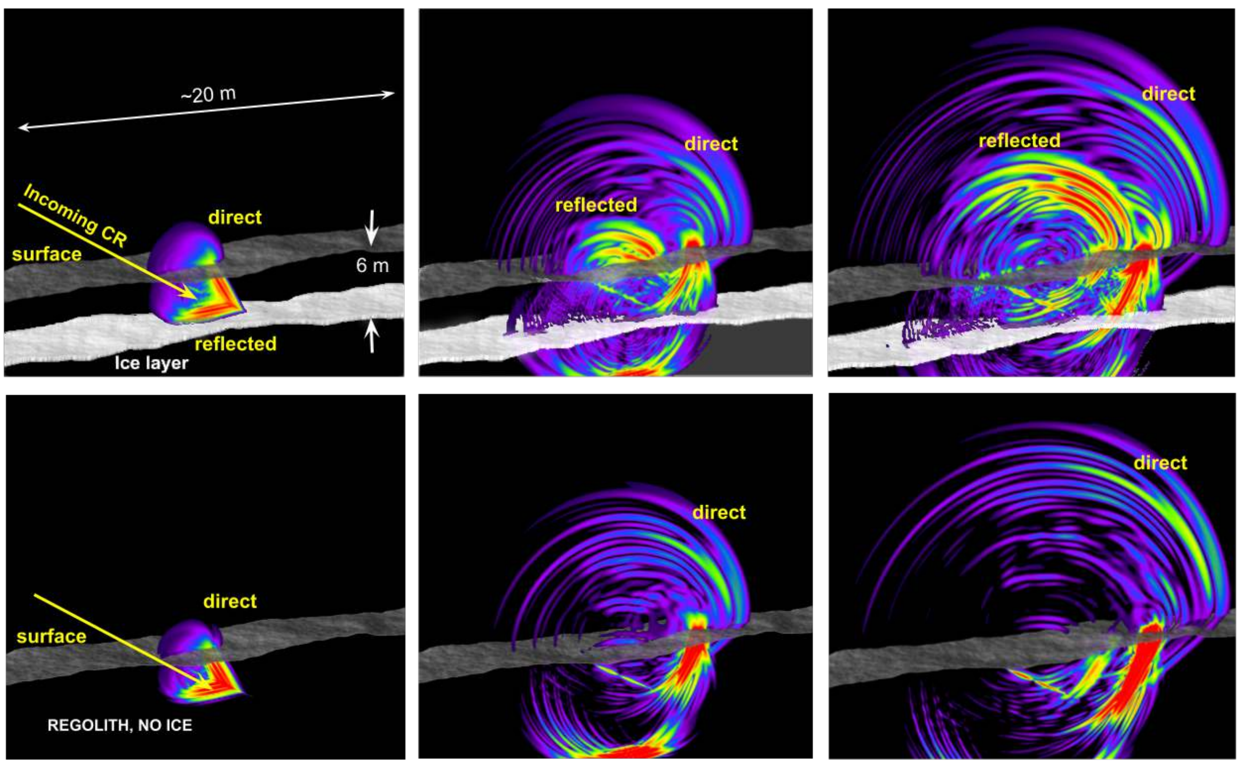

Figure 3: Detailed simulations of the radio emission from cosmic rays in the lunar regolith, with (top row) and without (bottom row) an embedded ice layer. The color scale runs from weak (indigo) to very strong (red). Credit P. Gorham, R. Prechelt.

The UH team will work with colleagues from the NASA Jet Propulsion Lab, the University of Chicago and Ohio State University on the project, which is slated to begin later this year. The $1M per year funding will be focused on developing and testing new antennas and radio receiver systems that are optimized for the expected signals that CoRaLS will encounter, and which are ruggedized to survive the harsh radiation environments the spacecraft will encounter in lunar orbit.