Use of Lasers and FemtoSats to Explore the Lunar Permanently Shadowed Regions

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The Permanently Shadowed Regions (PSR) on the Moon are thought to hold vast reserves of water-ice that would be critical for future propellant production and sustaining a future human base. The previous LCROSS mission impacted into a PSR region, providing data to further strengthen this water-ice hypothesis. Future surface missions are needed to provide in-situ measurements of PSRs. However, the PSRs pose unique challenges because they are some of the coldest environments in the solar system, while being in perpetual darkness. As part of the NASA BIG Challenge, a team led by Colorado School Mines, in partnership with University of Arizona's SpaceTREx Laboratory and University of Colorado, Colorado Springs, propose to develop a laser emitter-receiver system to pave the way for lunar PSR exploration. The system consists of a turret mounted on a CLPS lunar lander that will emit a laser beam onto a receiver deployed from the lander. The receivers will be ballistically launched using a spring deployment system. The laser beam will be used to power and communicate with the receivers. It is envisioned that these receivers are SunCube FemtoSats. The SunCube FemtoSats are miniature spacecraft that are low-cost, in the order of few hundred dollars each, have a mass of 35, 70 or 100 grams, disposable and can be sent in groups to perform exploration and networking studies. The FemtoSats could potentially light-up the PSR surface using LEDs of different wavelength for spectroscopic studies, obtain close-up picture of the regolith surface and characterize the surface topology and material from their impact. Considering the lunar PSRs are an unknown environment, it is logical to deploy low-cost disposable devices to get a closer look at it first. This technology demonstration will pave the way for powering and communicating with more sophisticated instruments and vehicles inside the PSRs using lasers deployed on areas of high illumination. The proposed mission is expected to last one lunar day (12 earth days).