Lunar Permanent Shadow Observed in The Far-IR: Doubley Shadowed Cold-traps, Water Ice, or Both?

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The northern floor and wall of Amundsen crater; near the lunar south pole; is a permanently shaded region. Previous work that includes this area shows spatial correlation between brighter NIR (1064nm) albedo; annual maximum surface temperatures low enough to enable persistence of surface water ice (~< 110K); and anomalous ultraviolet radiation. Using data from the Diviner instrument on Lunar Reconnaissance Orbiter; we quantify the differential far-IR emissivities (near the Planck peak for temperatures relevant in lunar polar permanent shadow) observed for permanently shaded and non-shadowed targets on the floor of Amundsen Crater. We find that features in far-IR emissivity (50-400 microns) could be attributed to either; or a combination; of two effects (i) differential regolith emissive behavior between permanently-shadowed temperature regimes and those of normally illuminated polar terrain; perhaps related to presence of water frost (as indicated in other studies); or (ii) high degrees of anisothermality within observation fields of view caused by doubly-shaded areas within the PSR target that are colder than observed brightness temperatures. The implications in both cases are compelling: The far-IR emissivity curve of lunar cold traps may provide a metric for the abundance of "micro" cold traps that are ultra-cool; i.e. shadowed also from secondary emission and scattered light; or for emissive properties consistent with the presence of surface water ice.