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Subsurface Migration of H2O at Lunar Cold Traps

N. Schorghofer (1) and G.J. Taylor (2)

(1) Institute for Astronomy, University of Hawaii, Honolulu (norbert@hawaii.edu), (2) Hawaii Institute of Geophysics and Planetology, University of Hawaii, Honolulu

Permanently shaded areas near the poles of the Moon may harbor water ice, which accumulates by the Watson-Murray-Brown mechanism, unless the water is destroyed by space weathering. But a small fraction of water molecules delivered to permanently cold areas diffuses into the regolith where it is protected from space weathering. We quantify this migration process and discover two new pathways that lead to accumulation of H2O. At constant temperature, diffusive migration produces up to one molecular layer of volatile H2O on regolith grains. A second pathway is pumping by diurnal temperature oscillations from a transient ice cover that may have formed during a large comet impact. Both types of subsurface charging mechanism are most efficient, not in the coldest areas, but for temperatures typical of permanently shaded areas with sunlit surfaces in their field of view.