The University of Texas at San Antonio

UTSA Physics and Astronomy

Qualifying Exam

Caleb Gimar

Date: **Friday, September 23, 2022**

Time: **1:00pm/CT**

Advisor: **Dr. Ujjwal Raut**

Abstract

Laboratory investigations of cold-trapped volatiles at the Moon and Charon

Recent spacecraft observations have revealed small Solar System bodies such as our Moon and Pluto's moon Charon to host volatiles like water and methane in the condensed phase. Permanently shaded regions (PSRs) on the Moon and Charon's winter polar region experience ultralow temperatures (< 25 K) resulting from permanent or century-long darkness and can act as cold-trap sites for these volatiles. Understanding the nature (abundance, physical state, evolution following interaction with the environment) of these polar volatiles through interpretation of spacecraft data often require robust laboratory-based experiments. Proposed here are two such experimental thrusts as applied to the Moon and Charon. The first set of experiments examine the far-ultraviolet reflectance spectra of dry and water-infused lunar simulants and Apollo-era soils in conditions similar to the lunar PSRs. The results of these experiments will improve constraints on the PSR water ice abundance, as well as the dayside lunar hydration and its diurnal variability as observed by the Lunar Reconnaissance Orbiter (LRO) Lyman-alpha Mapping Project (LAMP). A second set of experiments will measure the effects of keV proton radiation mimicking solar wind on the visible and near-IR reflectance spectra of several hydrocarbon ices—ethane, acetylene, ethylene, and propane—relevant to Charon. Methane frost cold-trapped onto Charon's winter polar regions is photolyzed by the interplanetary medium Lyman-α during the century-long dark winter, generating more complex hydrocarbons like ethane. Our recent investigations have shown that photolytic ethane being colorless cannot contribute to Charon's polar reddening. Solar wind (SW) processing of the photolyzed hydrocarbon frost with the onset of spring sunrise may contribute the reddish albedo of Charon's north polar region as observed by New Horizons. These experiments will enable us to estimate the contribution of such SW radiolytic processing to Charon's colorful polar landscape.

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