The Lunar Volatiles Orbiter: A Lunar Discovery Mission Concept. P. G. Lucey[1], N. Petro[2] D. Hurley[3], W. Farrell[2], X. Sun[2], R. Green[4], R. Greenberger[4], and D. Cameron[4] [1]University of Hawaii at Manoa, 1680 East-West Rd, Honolulu, HI 96822, lucey@higp.hawaii.edu, [2]NASA/Goddard Space Flight Center, Greenbelt, MD 20771, [3]The Johns Hopkins Applied Physics Laboratory, Laurel, MD 20723, [4]Jet Propulsion Laboratory, Pasadena CA 91109.

Introduction: The Lunar Volatiles Orbiter (LVO) is a Discovery-class mission concept which leverages the spacecraft design and operations experience of the Lunar Reconnaissance Orbiter. LVO is aimed at understanding the current state of volatiles on the Moon with an emphasis on current dynamics. The mission will carry both surface and atmospheric composition instruments that will definitely answer questions regarding volatile flows to and from the Moon, and their propagation in the lunar environment. A particular emphasis is to use the Moon as a natural laboratory to understand volatile interactions of all airless bodies.

All planetary bodies are exposed to and interact with the solar wind and continuous infall of meteorites. The surfaces of those without atmospheres are directly exposed to this flow and diverse evidence shows can respond differently to this stimulus. Most of the inferences regarding the influence of exposure to space are indirect and researchers invoke differential response of known inputs to explain often conflicting observations. The Moon offers the opportunity to fully understand the response of an airless body to these inputs, providing insights into the general process of space-surface interaction applicable from Mercury to exoplanets. Despite the wealth of sample and remotely obtained data the response of the lunar surface to the solar wind and mass infall of volatiles is only partly understood. A single mission can provide the linkages necessary to form a coherent understanding of the interaction of the Moon and its volatile rich sources.

LVO plans six instruments to address its science objectives: 1) Spectroscopic Infrared Reflectance LIDAR (SpIRRL), a laser spectrometer developed by Goddard Space Flight Center operating in the 3 micron region; 2) the Lunar Volatiles Imaging Spectrometer (LVIS), an infrared imaging spectrometer operating in the 3 micron region; 3) Surface Water Mapper (SWAM), an infrared spectrometer operating at 6 microns; 4,5) Ion and neutral Mass Spectrometers (IMS, NMS), developed by Goddard Space Flight Center aimed at detection of water and other species in the lunar atmosphere; and 6) Gamma-Ray/Neutron Spectrometer (GRNS) by APL for high spatial resolution measurement of the abundance and distribution of hydrogen in the polar regions and other proposed hydrogen-rich regions.

Mission and Science Objectives: The objective of the LVO mission is to determine how volatile elements and compounds are distributed, transported, and sequestered in near-surface environments on the surface of the Moon. The mission will determine the current state of surface volatiles including whether the Moon is in net loss or accumulation, and address issues related to interior water with a powerful remote sensing suite.

The first science objective is to inventory the surface and subsurface volatile content, and determine the extent of dynamic changes to this inventory. LVO instrumentation can definitively separate water from hydroxyl, and distinguish the various forms of water and hydroxyl in ice, minerals and glasses. The instrument suite is also sensitive to organics as has been suggested to be present at locally high abundances on Mercury. The second science objective is to globally characterize the lunar atmosphere, detect vertical and horizontal flows, and determine if the present day Moon is in equilbrium, loss or accumulation. The third objective is to characterize interior water with targeted observations of known water related anomalies using the extensive spectroscopic capabilities of the mission. Low altitude GRNS passes will characterize huydrogen contents to about 1-m depth. The fourth objective is to identify flows of volatiles from low latitudes to the polar region and determine if the polar inventory is consistent with modern or ancient deposition. The fifth objective is to characterize how the Moon reacts to brief high intensity volatile sources including solar storms and meteorites, and how these contribute to the overall volatile inventory and cycle.

Relevance to Exploration: LVO contributes to resolving several Strategic Knowledge Gaps including: The Composition, Form and Distribution of Polar Volatiles; Temporal Variability and Movement Dynamics of Surface- Correlated OH and H2O deposits towards PSR retention; and Composition, Volume/Distribution and form of pyroclastic/dark antle deposits and characteristics of associated volatiles.