THE SCIENCE OF THE LUNAR POLES. P.G. Lucey and G.J. Taylor, Hawaii Institute of Geophysics and Planetology, University of Hawaii at Manoa, 1680 East-West Road, Honolulu HI 96822, lucey@higp.hawaii.edu

Introduction: The Moon and the planet Mercury share a very small tilt of their rotation axis relative to the plane of their orbits. Near the poles this geometry allows declivities, of which the Moon and Mercury have an ample supply in the form of impact craters, to be permanently shaded from the Sun; there are lunar and mercurian polar surfaces that have not seen direct sunlight for billions of years. The natural consequence of this permanent night is that these surfaces achieve extremely low temperatures. Without an atmosphere to propagate heat, shaded polar surface temperatures are dominated by heat flow from the planets’ interiors, by small amounts of light reflected off nearby topographic highs, and by the background of space. While surface temperatures have not been directly measured, thermal models show maximum surface temperatures of 40 kelvins will be common, and 25 kelvins will be possible, enabling cold trapping of volatiles[1,2].

Polar Science: The lunar poles are usually discussed in the context of resources, where the near-continuous sunlight and potential source of water in the form of ice makes a polar site attractive to engineers. But scientific aspects of the poles makes them a compelling object of study beyond resource issues. While we know very little at present, the poles are undoubtedly a dynamic volatile system, with inputs from a variety of sources, a range of processes that can operate on and alter trapped volatiles while resident in the cold traps, and several loss mechanisms that can rob the poles of volatiles. These mass fluxes are conveyed through and constitute part of the lunar atmosphere that links the lunar surface to the rest of the solar system. However, there are almost no measurements that constrain these possibilities.

Potential sources of polar volatiles include the Moon itself, the Sun, the Earth, asteroids, comets, IDPs and giant molecular clouds [3]. Identifying material at the poles from any of these sources would provide new insights into the bodies that provide the volatile.

The Future As is typical in planetary science, a mix of orbital remote sensing, in situ measurements, and sample return are needed to understand the polar environment, as well as a contemporaneous modeling effort. The fleet of lunar remote sensing spacecraft presently in orbit and en route will make most of the useful measurements possible from orbit. If all are successful, we will have a detailed temperature and topographic map of the poles and improved constraints on the H abundance in the immediate polar vicinity. These missions are also equipped for possible detection of isolated patches of thick ice or surface frosts in permanent shadow, and for detection of organic or hydrated material if ejected from shadow into sunlit areas.