BUILDING A PLANETARY CHAMBER INSTRUMENT FOR ASTROCHEMICAL RESEARCH.

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Introduction: Sample return missions require extensive knowledge and testing of components and chemistries in order to make the decisions that best preserve the chemical information within extremely rare samples. In order to support these initiatives, a new 'Planetary Chamber' instrument is in progress that has a flexible parameter space to simulate a wide variety of planets encompassing both the Martian surface, the Lunar exosphere, and others.

Design Philosophy: The basic idea is that a flexible and modular instrumental design will develop exploratory data sets faster and more efficiently. When mapping pressures and temperatures for various planets, moons, and targets of interest, it was realized that with ultra-high vacuum (UHV) methods such as those utilized in molecular beam epitaxy for controlling pumping, gas flow, temperature and ultra-violet (UV) dose control, one could feasibly dial in the conditions and 'bring the planet to us' as needed. Therefore, a multi-parameter system is in progress that has pressure control from atmosphere to UHV to 10^{-7} torr or less, gas flow control from single gas to mixtures, UV illumination of rocky bodies or regolith, and low-temperature control is being established that can simulate surface temperature on planet as well as for example within lunar craters. The application of UHV, temperature control, and high purity gas mixtures aims to elucidate previously unknown chemistries, as well as provide a platform for materials testing, along with supporting the design of sample return mission protocols when combined with the sample regolith tests already in progress.

Experimental Evolution: The platform was started initially for the support of Martian surface analysis and some preliminary materials testing.[1] However along the way it was realized that the parameter space can be expanded to encompass not only the Martian surface but also Lunar and other targets of interest to NASA. The planetary chamber parameter space was broadened out before NASA turned the focus back to the Lunar surface and so having the flexibility to explore both the Mars and Lunar surface is in progress. The pressure differences between the Lunar surface and the Martian surface are significant, but not beyond the scope of standard instrumentation in the UHV systems.

Lunar and Mars Environments: The Lunar surface has an extremely low pressure atmosphere called an 'Exosphere'. The ions elucidated from the surface of the Moon from solar radiation are so sparse they don't typically collide, and can have an approximate density of 100 ions per cubic centimeter. Meanwhile the Martian atmosphere is much more dense, and primarily made of CO_2 (95.3%) at 6 millibar of pressure. Additionally, the application of wavelength selected UV Lamp surface dosing under UHV provides continued opportunity for materials testing and photochemistry explorations, while the low-temperature conditions provide a separate route for examining sample return storage methods and/or possibly permanently shadowed craters on the lunar surface.

Reference: [1] K. N. Davis, M. D. Fries, E. K. Lewis, A. S. Burton, A. J. Ross, T. G. Graff, K. K. John, R. Bhartia and L. Beegle; *Durability of Space Suit Materials Under Martian Conditions*, 49th Lunar and Planetary Science Conference 2018

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