NASA MUREP Space Technology Artemis Research (M-STAR) Implementation Awards

Title: Raman Cube Rover (R3R) for Enabling Lunar Science and Exploration: Integrating Technology Development with STEM Engagement
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Summary:
Howard University (HU), a leading Historically Black College and University (HBCU), proposes to develop an efficient optical telescope system for in situ standoff Raman spectroscopy for a CubeRover lunar payload. HU will partner in this effort with the University of Maryland (UMD), National Aeronautics and Space Administration (NASA) Goddard Space Flight Center (GSFC), and the developers of the CubeRover technology, Astrobotic Technology. State-of-the-art standoff Raman systems, e.g., SuperCam on Mars 2020, are limited in range (~7 m) due to the telescope aperture signal collection area. Our Raman CubeRover (R3R) technology development proposal will significantly improve the instrument range, potentially up to 500 m, depending on the divergence of the returned collimated beam to the stationary lander. A high fidelity time-resolved Raman instrumentation system shared on a rover (optical head) and lander (excitation pulsed laser, spectrograph and camera), can work in tandem via relay optics, on a future NASA mission that will enable (i) lunar regolith science measurements and help better understand near-surface processes, such as dust-lifting and the diurnal water cycle; and (ii) in situ resource utilization (ISRU) measurements that will help identify water, other volatiles and mineralogical species present in the regolith. The versatility and range of use of Raman spectroscopy offers a distinct advantage in the study of minerals in planetary regolith exploration, as it allows for less ambiguous detection, even in the presence of mixtures. In this proposed Minority University Research and Education Project (MUREP) Space Technology Artemis Research (M-STAR) effort, HU plans to demonstrate two key technology components, namely the Raman light collection telescope and the steering mirror that will relay the signal back to a stationary lander. HU will demonstrate a proof-of-concept of this technology on the benchtop in the laboratory. The proof-of-concept of the proposed standoff Raman optical collection system will be demonstrated by a seasoned and experienced team of researchers and education specialists, spearheaded by Howard University, and with collaborators from NASA GSFC, UMD and Astrobotic. The project is designed to augment Science, Technology, Engineering, and Mathematics (STEM) skills of undergraduate and graduate students and enhance faculty expertise at HU, with direct relevance to planetary science exploration programs. A primary goal of the project is to develop a viable and sustainable education program that aligns with the NASA Space Technology Mission Directorate (STMD) goals and objectives around vehicle platform technologies for lunar science and exploration. A central objective of the proposed effort with the Moon as a target is to stimulate interest and enhanced expertise in planetary exploration research at HU within the Department of Physics & Astronomy, and subsequent expansion to engage the wider university community. Howard University, as a higher-education HBCU, is committed to increasing underrepresented minority participation in the NASA STEM enterprise. In addition to developing the proposed Raman optical system for standoff distances, HU would like to build on the existing relationships between students and

faculty with UMD and NASA GSFC. The proposed Raman CubeRover (R3R) project will draw and engage undergraduate and graduate students and faculty in STEM disciplines. A long-term goal of the effort is to extend collaborations across multiple departments and with other neighboring institutions, besides NASA GSFC and UMCP (e.g. with Morgan State University, Bowie State University, and University of Maryland Baltimore County), for enhanced STEM engagement and planetary science exploration.