**A Combined Raman, Laser-Induced Fluorescence and Laser-Induced Breakdown Spectroscopy System for Planetary Exploration**

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There is currently great interest in standoff detection of surface minerals and biomarkers for NASA’s exploration programs, particularly as applied to Mars, Venus, and icy satellite Europa. Recent scientific observations have steadily advanced our understanding of the nature and abundance of water on Mars, and there is growing recognition of the abundant hydrous alteration that has taken place on its surface. Stand-off active spectroscopic techniques such as Raman, laser-induced fluorescence (LIF) and laser-induced breakdown spectroscopy (LIBS) are highly synergistic analytical techniques and are well suited for planetary missions. Raman spectroscopy is sensitive to the molecular structure of the sample from which one can definitively determine mineralogy, and identify organic and biogenic materials. In the time-resolved (TR) mode LINF spectra allow measurement of fluorescence from trace rare-earths and transition-metal ions in minerals with high sensitivity, and also assist in differentiating between abiogenic minerals from organic and biogenic materials based on their fluorescence lifetime. Time-resolved LIBS allows measurements of chemical compositions from standoff distances. At the University of Hawaii, we have developed a combined TR Raman, LINF and LIBS spectroscopic instrument suitable for remotely exploring planetary surfaces during daytime and nighttime. The fluorescence spectrograph is capable of measuring TR- laser-induced fluorescence excited with 355 nm laser in the spectral range 380-800 nm spectral range. Biological materials are also identified from their characteristic short-lived (<10 ns) laser-induced fluorescence lifetime. Biomarkers such as chlorophyll-*a*, and carotenes can be identified from their characteristic fluorescence and resonance Raman spectra, respectively. The combined TR Raman-LIBS spectrograph allows measurements of LIBS spectra for elemental analysis of surface minerals. The role of these combined active spectroscopic instruments in the upcoming NASA’s Mars 2020 rover mission, and in future planetary exploration will be discussed.