

DEVELOPMENT OF THE MARS MICROBEAM RAMAN SPECTROMETER (MMRS)

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Abstract: Raman spectroscopy is a powerful tool for mineral characterization and for detection of water and organic and inorganic forms of carbon. The Mars Microbeam Raman Spectrometer (MMRS) is designed for close-up analysis of rocks and soils in planetary surface exploration. The MMRS consists of a probe (in a flight unit to be deployed by a robotic arm) and a spectrograph, laser source, and electronics (in a flight unit to reside on a rover or lander). The Raman probe has a scanning optical bench that enables a one-centimeter linear traverse across a target rock or soil, both on target materials as encountered and on fresh surfaces of rocks exposed by abrasion or coring. From these spectra one can identify major, minor, and trace minerals and obtain their approximate relative proportions, and determine chemical features (e.g., Mg/Fe ratio) and rock textural features (e.g., mineral clusters, amygdular fill, veins). One can also detect and identify organic species, graphitic carbon, and water-bearing phases. Extensive performance tests have been done on a brassboard model of the MMRS using a variety of geological materials (minerals, rocks, Martian meteorites, etc.). These tests show that a Raman spectrometer can be built that is suitably miniaturized, sufficiently robust, and low enough in power usage to serve as an on-surface planetary instrument, yet the spectrometer can retain high detection sensitivity and yield near laboratory quality spectra over a broad wavelength range. These features are essential to provide definitive mineralogy in a planetary exploration.