

IR SPECTROSCOPY AND TWO-STEP LASER DESORPTION/IONIZATION TIME-OF-FLIGHT MASS SPECTROMETRY AS A BIOSIGNATURE IDENTIFICATION INSTRUMENT SUITE. K. Uckert¹, S. A. Getty², N. Chanover¹, A. Grubisic³, X. Li⁴, W. Brinckerhoff², T. Cornish⁵, D. Voelz⁶, X. Xiao⁶, ¹New Mexico State University (Department of Astronomy, Las Cruces, New Mexico 88003; kuckert@astronomy.nmsu.edu), ²NASA Goddard Space Flight Center (8800 Greenbelt Road, Mailstop 699, Greenbelt, MD 20771), ³University of Maryland (Department of Astronomy, College Park, MD 20742), ⁴University of Maryland, Baltimore County (1000 Hilltop Cir, Baltimore, MD 21250), ⁵C & E Research, Inc. (9194 Red Branch Rd., Suite L, Columbia, MD 21045) ⁶New Mexico State University (Klipsch School of Electrical and Computer Engineering, Las Cruces, New Mexico 88003)

Introduction: The detection of organics on other planetary surfaces provides insight into the chemical and geologic evolution of a Solar System body, and can inform our understanding of its potential habitability. In this study, we explore the analytical advantages offered by coupling into vibrational resonances of molecules and minerals with two instrument prototypes: infrared (IR) reflectance spectroscopy based on an acousto-optic tunable filter [1,2] and advanced two-step laser desorption/ionization (LDI) time-of-flight mass spectrometry (L2MS), which uses an IR desorption laser pulse, followed at a delay by an ultraviolet (UV) ionization pulse. L2MS in particular can be used to target certain high-priority classes of organic molecules, such as polycyclic aromatic hydrocarbons, organic acids, amino acids, and nucleobases, in planetary surface materials of high astrobiological interest [3,4]. We emphasize the astrobiological potential of these instrument techniques, specifically the implementation of IR spectroscopy to optimize the detection of organic signatures with mass spectrometry, and explore the desorption laser wavelength dependence on the L2MS organic detection sensitivity in an effort to optimize instrument sensitivity of species with high molecular weight (>100 Da) mass spectral signatures.

Preliminary Results: Desorption of analyte in L2MS is strongly dependent on the ability of the IR laser to couple to the molecular vibrational modes, which can be independently inferred from IR spectra. In Figure 1 (top), IR reflectance as a function of excitation wavelength reveals a vibrational resonance of tryptophan near 2935 nm. A desorption wavelength-resolved series of mass spectra of an epsomite + 0.1 wt% tryptophan mixture demonstrates the dramatic increase in signal corresponding to this IR resonance feature of the tryptophan molecule. We will present L2MS and IR spectroscopy results of minerals doped with organic standards to demonstrate the analytical performance of resonance-enhanced desorption in L2MS analysis of planetary analog samples.

Conclusions: IR spectroscopy and mass spectrometry are well suited to *in situ* analysis of the elemental, organic, and mineralogical composition of planetary surfaces. We present the unique organic detection capabilities of resonance L2MS and IR spectroscopy, and

demonstrate the value of using these techniques in a complementary manner to optimize the detection of organics on other planetary bodies.

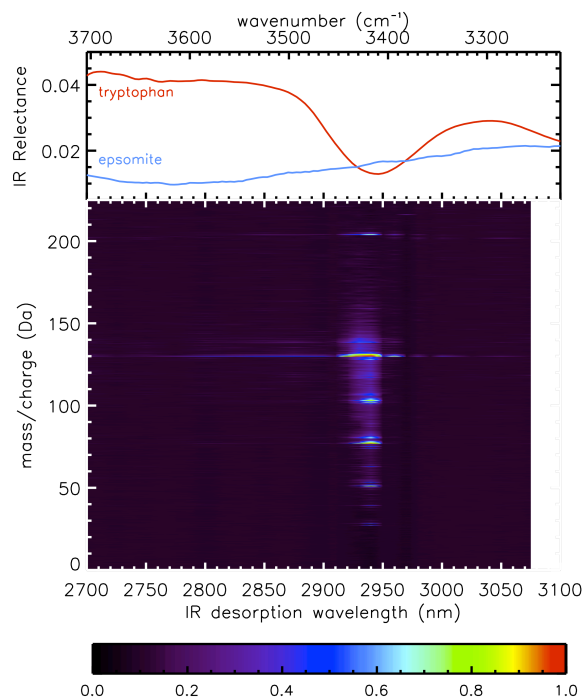


Figure 1: Absorption features in the IR spectrum correspond to an increased signal in the IR-resolved L2MS mass spectrum.

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