**Project ESPRESSO: Optical Constants for Quantitative Spectral Analysis and Exploration Roles of Field LIBS and Raman.**

M. H. Yant[1], S.M. Hörst[1], K. Lewis[1], A.H. Parker[2], S. Protopapa[2], K. Nowicki[3], C.A. Thomas[3], J. Hanley[4], and W.M. Grundy[4], and the Project ESPRESSO Team. [1]Department of Earth and Planetary Sciences, Johns Hopkins University, Baltimore, MD 21218. [2]Space Sciences division, Southwest Research Institute, Boulder, CO 80302. [3]Northern Arizona University, Department of Physics & Astronomy, Flagstaff, AZ 86001. [4]Lowell Observatory, Flagstaff, AZ 86001. (marcella.yant@jhu.edu).

**Introduction:** In order to accurately and quantitatively assess a surface's composition from remote reflectance spectroscopy in the presence of material mixtures, a complete set of optical constants for potential constituent materials must be available over the wavelength ranges of interest. However, for many key materials, accurate optical constants have not yet been measured in the laboratory, making truly quantitative assessments of some target body compositions from remote spectroscopy impossible. This often leads to the use of more limited spectral analysis methods. The necessity of measuring optical constants of a broad range of minerals in order to recover compositions of the resource-rich C- and M-type asteroids is stated in [1] the "Mineralogy and Surface Composition of Asteroids" chapter of *Asteroids IV.*

Furthermore, there is a need to assess the role and performance of hand-held LIBS and Raman devices in the context of human space exploration, as these instruments are now commercially available. Their fast data acquisition and simple sample prep requirements make them extremely attractive as candidate tools for future astronauts to use for geochemical mapping, resource prospecting, sample selection, and hazard identification.

The Project ESPRESSO[1] (Project for Exploration Science Pathfinder Research for Enhancing Solar System Observations) node of the SSERVI program is currently measuring optical constants of lunar and asteroid constituent materials for quantitative remote compositional analysis of these target bodies, as well as conducting joint field LIBS and Raman measurements while specifically targeting questions of geologic interest at field analog sites.

**Methods:** At Johns Hopkins University, our team is implementing a facility to provide SSERVI and the planetary community with reliable access to rapid, responsive measurements of optical constants over a wavelength range of 0.175–28.5 μm, well-matched to several current and upcoming telescopic facilities including JWST. The facility's primary instruments are two spectrophotometers that together cover 0.175–28.5 μm. There is a region of overlap between the two spectrophotometers' wavelength ranges (1.2–3.3 μm), where optical constants can be computed from spectral measurements acquired with *both* devices and all available methods for calibration and cross validation purposes will be applied.

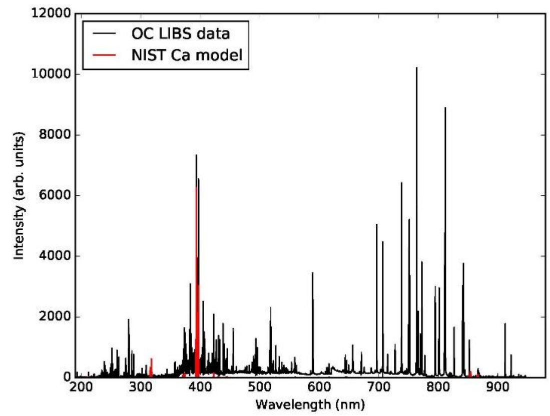


**Figure 1:** Point spectrum of an ordinary chondrite obtained with our handheld LIBS device.

For the field exploration, we are utilizing handheld SciAps Z-300 LIBS spectrometer and Inspector 300 Raman spectrometer. The handheld LIBS offers elemental microanalysis in the field over the range of 190-950 nm (**Figure 1**). It is equipped with an integrated argon purge which allows for an increase in signal for the deep UV (190 – 300 nm), permitting analysis of all atomic species from Hydrogen to Uranium. The handheld Raman utilizes a 785nm excitation wavelength, and contains an integrated data processing unit that delivers real-time mineral identification. Used in concert, these two devices can provide a powerful means of performing sample selection and triage, enabling future human explorers to identify and collect highly optimized rock and mineral samples with minimal effort and risk. Project ESPRESSO is conducting the first trials of these instruments operating in this role in spring of 2018.

**References:** [1] Reddy, V., et al. (2015) *Asteroids IV*, pages 43–63.

[1] https://www.espresso.institute