# **Planetary Exploration with ChemCam, SuperCam, SHERLOC and VEMCam.**

Samuel M. Clegg

Physical Chemistry and Applied Spectroscopy Group, Chemistry Division

Los Alamos National Laboratory

Remote laser-based spectroscopic techniques have made significant impacts on the future of planetary investigations. The ChemCam instrument on the NASA Curiosity rover has been exploring Mars since landing on August 5, 2012. The ChemCam instrument is the integration of a remote Laser-Induced Breakdown Spectrometer (LIBS) and a Remote Micro-Imager (RMI). The ChemCam LIBS instrument focuses a 1064 nm laser on rocks and soils up to 7 m from the rover mast. This focused laser ablates material from these targets generating a plasma containing electronically excited atoms, ions and small molecules. A telescope is used to collect some of the emission as these excited species relax to lower electronic states. The ChemCam laser has been fired over 600,000 time, each laser shot produces a quantifiable LIBS spectrum.

The Mars 2020 rover is currently under construction and will start to explore Jezero crater in February 2021. The Mars 2020 rover includes several instruments capable of microscale geologic analysis including SuperCam and Scanning Habitable Environments with Raman & Luminescence for Organics and Chemicals (SHERLOC). SuperCam contains an integrated suite of remote LIBS, 532 nm (green) Raman Spectroscopy, Time-Resolved Luminescence Spectroscopy (TRLS), Visible and Infrared Spectroscopy (VISIR), color RMI, and a microphone. The SHERLOC instrument is an arm mounted ultraviolet Raman and Fluorescence Spectrometer designed to detect organic and biological materials in Jezero crater.

Finally, the Venus Elemental and Mineralogical Camera (VEMCam) is currently under development as a potential instrument for future explorations of the Venus surface. VEMCam is the integration of LIBS, 532 nm Raman Spectroscopy, Time-Resolved Luminescence Spectroscopy (TRLS), and color imagers. The Venus atmosphere at the surface consists of approximately 92 atm of supercritical CO2 at approximately 740 K. Landers tend to survive in this atmosphere for only hours and rapid analyses are required. The VEMCam instrument is capable of recording more than 1000 LIBS, Raman, and TRLS spectra within the first hour on the surface from within the safety of the lander.

In this presentation, I will focus on the ChemCam, SuperCam, SHERLOC, and VEMCam instrument physics. I will also discuss the Curiosity and Mars 2020 mission goals and the contributions these instruments make to realize these goals.