CHEMCAM

Laser-Induced Remote Sensing for Chemistry and Micro-Imaging

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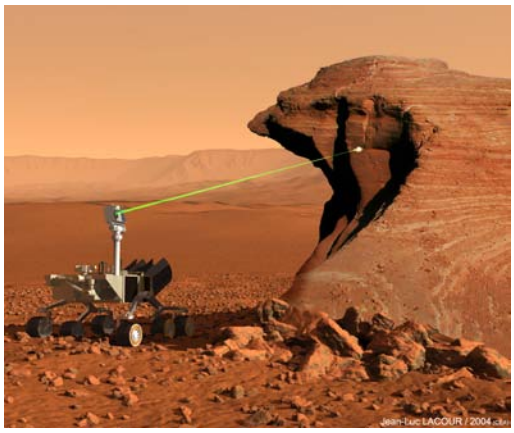

General Description: ChemCam is being built for NASA's 2011 Mars Science Laboratory (MSL) rover. ChemCam combines laser-induced breakdown spectroscopy (LIBS) with a remote micro-imager (RMI) that provides images of the target. It provides elemental analysis of spatially resolved solid samples (<0.5 mm diameter) at distances of 1-7 m. ChemCam's primary objective is to quantitatively determine the chemical composition of rocks and regolith in order to characterize the materials in the vicinity of the rover. ChemCam's small LIBS spot size enables chemical stratigraphy of fine layers and measurement of small-scale features such as "blueberries". Since LIBS removes dust and weathering layers using multiple laser shots, contamination from Martian soils does not deter ChemCam results.

LIBS: Brief, 5 ns pulses from a 30 mJ Nd:KGW laser at 1067 nm create light-emitting plasmas from the materials ablated from the sample. The emission spectra consist of spectrally narrow atomic and first-ionized emission lines from the elements contained in the sample. ChemCam's spectral range covers 240-860 nm in 3 spectrometers with resolutions between 0.15 and 0.65 nm FWHM. LIBS detects nearly all elements, including H, C, N, O, with most elements displaying multiple emission lines. Sensitivity to alkali elements is very high, with detection limits close to 10 ppm for Li. LIBS yields major element compositions at ±10% relative accuracy and precision.

RMI: The Remote Micro-Imager provides high resolution (100 μRad) images over a 20 mRad field of view. Its primary purpose is to provide close-up context images of the LIBS analysis spots, but it can operate at any distance from 1.2 m to infinity. It will be the highest resolution long-range camera on Mars.

Operations: A typical LIBS analysis consists of 50 laser shots at 3 Hz. Forty-five (50 minus the first five cleaning) spectra are usually averaged together for better statistics, but can be analyzed separately, as in weathering rind analyses. A single ChemCam analysis requires only ~2 W-hr, including both LIBS and RMI. Whole rock analyses require multiple analysis spots on the same rock. Remote depth profiling into rocks to≥1 mm will be done with ~1000 lase r shots. Multivariate analysis is used to simultaneously analyze spectra for abundances of a number of different elements. The MSL operations team is planning an average of ~15 ChemCam analyses per sol, as it is used on all sol types. In addition to undertaking its own scientific investigations, ChemCam will be able to rapidly assess an outcrop and identify high priority sampling locations for the analytical laboratory instruments. The MSL Slow Motion and Fast Motion Field Tests employ large numbers of ChemCam analyses on every sol due to its capability to provide both close-up imaging and chemical analyses while using very low resources. The ChemCam science team consists of experts in Mars geochemistry, imaging, and spectroscopy from France and the US (including from JPL, Ames, and USGS).

Management and Current Status: The PI is Dr. Roger Wiens at Los Alamos National Laboratory. Los Alamos built the Body Unit, consisting of the spectrometers, an optical demultiplexer, and the data processing unit. The LANL budget is $13M for Phases A-D. The deputy PI, Dr. Sylvestre Maurice, is leading the Mast Unit, including the laser, telescope, and RMI. The Mast Unit is contributed by the French Space Agency (CNES) (Phase A-D cost of $23M) and was built by CESR in Toulouse, France. Optical fiber and electrical cables between the two units were provided by JPL. The flight instrument was delivered to JPL in the summer of 2010. Launch is scheduled for late 2011, with arrival at Mars in 2012. Operation on Mars is planned for one full Mars year, which is approximately two Earth years.