P_074 Spectroradiometric calibration of the dedicated LIBS spectrometer for space research application

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2012 has opened the space era for the atomic emission spectroscopy of laser-induced plasmas with the ChemCam microimager & LIBS instrument on board of the NASA's Mars Space Laboratory Rover Curiosity. The development of LIBS-based instruments for in-situ robotic exploration of solar system bodies, including originally proposed to the ESA`s Exomars mission combined LIBS-Raman instrument, has triggered investigation of feasibility of LIBS science at specific conditions on inner and outer planets, moons and asteroids. While simulation of planetary conditions is achievable world-wide in research laboratories, only a few prototype LIBS instruments, specially designed for specific space missions will be available. In order to study the influence of extraterrestrial conditions on operation of LIBS spectrometers as well as for building dedicated data bases, it is important to transfer measurement results obtained by laboratory available LIBS spectrometers into those expected for operation of a flight LIBS instrument. This goal can be achieved by absolute radiometric calibration of spectrometers including their spectral response to calibration optical sources.

We report the results of spectroradiometric calibration of the commercial LIBS spectrometer Aryelle Batterfly from Lasertechnik Berlin adapted for measurements at simulated planetary conditions. Spectral responsivity and quantum efficiency of the spectrometer ICCD camera (Andor), efficiency of the LI plasma light collection into the spectrometer and atmospheric losses have been taken into account. Different halogen gas-filled tungsten lamps and a deuterium lamp with a known irradiance covering the ultraviolet to infrared light spectrum (200 to 2500 nm) have been used as emission sources for the calibration. A 99% diffusely reflecting standardized Spectralon® panel (Labspere) was placed in the focus of the light collection optics, i.e. where an investigated sample is usually located. The calibration product is an apparatus function of the spectrometer allowing conversion of intensity in the LIBS spectrum in CCD counts into spectral irradiance ($W/cm^2/nm$) or spectral photon flux density ($photons/cm^2/s/nm$). The obtained optical throughput, relative to total irradiance power of the source, is dominated mainly by optical loss on the spectrometer entrance slit and peaks about 2%, that is very high value even if compared with other commercial LIBS spectrometers with lower spectral resolution. Note here that necessity of high spectral resolution is favourable for space application of LIBS instruments working at low pressure conditions where the reduction of pressure broadening offers identification of many minor elements in complex rock samples not feasible or not unmistakable at Earth ambient atmosphere conditions due to their overlapping.

The performed spectroradiometric calibration enables accurate transfer of results from the lab LIBS spectrometers to those expected for the designed space instruments as well as comparison between different prototypes and flight LIBS instruments.