Investigation of Normalization Methods using Plasma Parameters for Laser Induced Breakdown Spectroscopy (LIBS) under simulated Martian Conditions

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ABSTRACT: The LIBS technique has become an important method for the elemental analysis of rocks and soils on Mars [1]. The ChemCam instrument, that is part of the NASA mission Mars Science Laboratory applies LIBS at stand-off distances since 2012 ([2],[3]). Due to its achievements the follow up instrument SuperCam of the Mars 2020 mission will also use LIBS in combination with other spectroscopic methods [4]. Since LIBS measurements are influenced by matrix effects and varying experimental conditions the data needs to be normalized. This is especially important for LIBS applications in the field of planetary exploration, as the encountered geological samples show variations on different scales and the measurement parameters are not fixed like in a laboratory. Several normalization methods have been proposed in previous studies, such as using the total emission intensity [5], the emission intensity with continuous emission removed [6], the C(I) 247 nm peak [7] or the plasmas continuous emission [8]. It was shown that these approaches can work well under specific conditions, but do not provide a general normalization method. In this study we test an approach that uses plasma parameters, namely temperature and electron density, for the normalization under Martian conditions. In the work of [9] and [10] this method was applied to terrestrial laboratory LIBS data of glass and steel samples. Both observed reduced fluctuations in shot-to-shot measurements.

The LIBS set-up at DLR has an Echelle spectrometer (UV: 190-375 nm and NIR: 270-850 nm, Aryelle Butterfly, LTB), a simulation chamber, where pressure and atmospheric composition can be adjusted, a 1064 nm Nd:YAG laser (10 Hz repetition rate, 8 ns pulse length) and a time-gated intensified CCD camera. We investigated various geological samples relevant for Mars such as basalts and andesites to test which normalization is best suited for LIBS data taken under Martian atmospheric conditions. The influence on univariate and multivariate calibration will be analyzed. Moreover, we are testing combinations of different normalization methods and compare the results to the commonly applied methods. Advantages and drawbacks for different sample types will be discussed.

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