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Modeling of low-temperature plasmas generated using laser-induced breakdown spectroscopy: the ChemCam diagnostic tool on the Mars Science Laboratory Rover[1]

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We report on efforts to model the low-temperature plasmas generated using laser-induced breakdown spectroscopy (LIBS). LIBS is a minimally invasive technique that can quickly and efficiently determine the elemental composition of a target and is employed in an extremely wide range of applications due to its ease of use and fast turnaround. In particular, LIBS is the diagnostic tool used by the ChemCam instrument on the Mars Science Laboratory rover *Curiosity*. In this talk, we report on the use of the Los Alamos plasma modeling code ATOMIC to simulate LIBS plasmas, which are typically at temperatures of order 1 eV and electron densities of order 10^{16-17} cm^{-3}. At such conditions, these plasmas are usually in local-thermodynamic equilibrium (LTE) and normally contain neutral and singly ionized species only, which then requires that modeling must use accurate atomic structure data for the element under investigation. Since LIBS devices are often employed in a very wide range of applications, it is therefore desirable to have accurate data for most of the elements in the periodic table, ideally including actinides. Here, we discuss some recent applications of our modeling using ATOMIC that have explored the plasma physics aspects of LIBS generated plasmas, and in particular discuss the modeling of a plasma formed from a basalt sample used as a ChemCam standard[1]. We also highlight some of the more general atomic physics challenges that are encountered when attempting to model low-temperature plasmas. The Los Alamos National Laboratory is operated by Los Alamos National Security, LLC for the National Nuclear Security Administration of the U.S. Department of Energy under Contract No. DE-AC5206NA25396. [1] J. Colgan, E. J. Judge, H. M. Johns, D. P. Kilcrease, J. E. Barefield II, R. McInroy, P. Hakel, R. C. Wiens, and S. M. Clegg, Spectrochimica Acta B **110**, 20–30 (2015).

[1]Work performed in conjunction with D. P. Kilcrease, H. M. Johns, E. J. Judge, J. E. Barefield, R. C. Wiens, S. M. Clegg