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Laser shock compression studies of MgO-SiO_2 systems at high pressures

Three decades of exoplanet discoveries brought the physics of planetary interiors among the topics of broad and current interests. 3700 exoplanet candidates have been confirmed up to date with a large variety of radii and masses, with rocky planets with sizes similar to the Earth being the most abundant. In order to understand planetary formation, evolution and dynamics, one of the key ingredient is the knowledge of the equation of states, phase diagram and physical properties of planetary constituents.

MgO, $MgSiO_3$ and Mg_2SiO_4, that are among the most abundant components of rocky planet mantles, have been recently investigated at high pressure ($P > 200$ GPa) with laser driven shock compression. These studies provide a first picture of the phase diagrams and properties of these materials at extreme pressure and temperature. In this talk, I will review those of these experiments that have been crucial in providing our actual knowledge of the high pressure phase diagram of MgO, $MgSiO_3$ and Mg_2SiO_4.

Then I will present a time-resolved X-ray absorption near edge spectroscopy (XANES) study of warm dense MgO. At LULI2000 (Ecole Polytechnique, FR), a high power nanosecond laser beam has been used to drive a strong uniform shock wave in the sample and a picosecond pulse to generate a spectrally flat broadband x-ray source near the Mg K edge. XANES spectra have been obtained in a large region of the phase diagram spanning density up to 5.5 g/cc and temperatures up to 30000K. With the support of quantum molecular dynamic simulations, this study evidences the MgO band gap closure mechanism and the local structural properties of liquid MgO.