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Seeking constraints on lower mantle composition through nuclear resonance combined with computations

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How did the Earth form and how did it differentiate to form the core, mantle, and crust? Part of the answer to these questions resides in the composition of the present day lower mantle, where active discussions regarding how closely it approximates a chondritic composition are still ongoing. Comparison of laboratory measurements of elastic wave velocities of mantle minerals with seismic data constitutes one of the foundations upon which knowledge of the Earth's interior is based, yet it requires a precise knowledge of elastic wave velocities of the dominant lower mantle, bridgmanite, which have up until now been elusive. In situ measurements are important, because some transitions (for example, spin transitions) are not quenchable, and may influence the elastic properties of iron-containing minerals. Nuclear inelastic scattering offers the attractive possibility to determine elastic wave velocities of iron-containing minerals in the laser-heated diamond anvil cell through direct measurement of the partial density of states, although short range ordering and other effects can influence the results. We will present our measurements of elastic wave velocities in bridgmanite as a function of pressure, temperature and composition, and through comparison with ab initio calculations of the partial density of states, discuss the prospects for extracting knowledge regarding the composition and mineralogy of the present day lower mantle.

Keywords: nuclear resonance, elastic wave velocites, partial density of states, ab initio computations, bridgmanite, perovskite