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High-pressure investigations of Earth's interior

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In the first half of the talk, the electronic structure of iron in ferromagnesium silicate perovskite will be discussed. Knowledge of iron valences and spin states in silicate perovskite is relevant to our understanding of the physical and chemical properties of Earth's lower mantle such as transport properties, mechanical behavior, and element partitioning. In this study, we have measured the electronic structure of the iron component of an aluminous Fe-bearing silicate perovskite sample, $(Mg_{0.88}Fe_{0.09})(Si_{0.94}Al_{0.10})O_3$, close to a pyrolite composition, using synchrotron Mössbauer spectroscopy (SMS) and laser heated diamond anvil cells at high-pressure and temperatures at beamline 3-ID of the Advanced Photon Source. Evaluation of the spectra provided the isomer shift and the quadrupole splitting of the iron component in silicate perovskite, which gives information on valence and spin states under lower mantle conditions. In the second half of the talk, experiments on the melting curve of iron at high-pressures will be presented. Seismological observations indicate that Earth's iron-dominated core consists of a solid inner region surrounded by a liquid outer core. Previously, melting studies of iron metal at high-pressures and temperatures were performed by shock-compression, resistive- and laser-heating in diamond anvil cells using visual observations or synchrotron x-ray diffraction and theoretical methods. However, the melting curve of iron is still controversial. Here, we will present a new method of detecting the solid-liquid phase boundary of iron at high-pressure using ^{57}Fe SMS. The characteristic SMS time signature is observed by fast detectors and vanishes suddenly when melting occurs. This process is described by the Lamb-Mössbauer factor $f = \exp(-k^2 <x^2>)$, where k is the wave number of the resonant x-rays and $<x^2>$ is the mean-square displacement of the iron atoms.