Shear wave velocity of hot dense iron at Earth's inner core conditions

Presented by **Hong Yang (hyang777@stanford.edu)**
Department of geological sciences, Stanford University, Stanford, CA 94305

Co-lead: **Arianna Gleason (SLAC/Stanford)**

Collaborators:
Suzanne Ali (LLNL), Cindy Bolme (LANL), Amy Lazicki (LLNL), Jon Eggert (LLNL), Rodney Clifton (Brown University), Tonia Jiao(Brown University), Wendy Mao (Stanford), Raymond Jeanloz (UCB)

Determining the sound velocities of iron at core conditions is crucial for modelling the composition of the Earth's core, i.e., its iron content and the fraction of other light elements. However, such measurements pose challenges to static compression experiments due to technical difficulties especially at high temperature. Furthermore, in conventional shock-wave compression experiments, the sample interface is usually set vertical to the wave propagation direction, generating only compressional (longitudinal) waves passing the sample and leaving the shear modulus unconstrained. Previous studies that tried to resolve shear wave velocity were using indirect constrains either from bulk sound velocity or Debye sound velocity data. Here we show that by a special design of the precursor-sample geometry, shear wave velocity can be extracted from laser-induced dynamic loading. We will present the principles of such design, namely transverse-velocity interferometer (TVI), as well as our primary measurements of metallic iron at simultaneous high pressure and high temperature using the TVI. Data collected at the Jupiter Laser Facility, Janus Laser, Lawrence Livermore National Laboratory show we can independently validate the assumed melting point from earlier sound speed data (e.g., Brown and McQueen 1986). Using the established data and our TVI results allows us to compare the shear wave velocity of pure iron with the PREM model (Dziewonski and Anderson, 1981) at Earth's inner core conditions. Our analysis also implies the first direct evidence of shear wave softening at temperatures close to the melting point, and the following disappearance of the shear mode in the melt. Our preliminary data support shear wave velocity of solid iron is higher than PREM model and pure iron cannot be a candidate for Earth's inner core. The results here indicate the need for appropriate light element alloying in the inner core, or a partially molten inner core, to match the PREM velocity model (Dziewonski and Anderson, 1981).