Inelastic and Nuclear Resonant Scattering at Sector 3 and 30 at the APS

ABSTRACT

We are proposing to be a "Facility Member" of the NSF-EAR Funded Analytical Facilities, offering several unique techniques of nuclear resonant scattering. These techniques include Synchrotron Mössbauer Spectroscopy, SMS, and Nuclear Resonant Inelastic X-Ray Scattering, NRIXS. In addition, we will deliver two newer techniques, Nuclear Resonant Time Domain Interferometry, NR-TDI, and Mössbauer Microscopy, MM, with submicron resolution. All three of these techniques are combined with simultaneous X-Ray Diffraction.

Armed with these techniques, and with enhanced capabilities offered by upgrade of the APS, we can address several problems of critical interest to Earth Science community. For instance, constraining physical properties and phase diagrams of iron, iron alloys and iron-light compounds will allow determining Earth's core structure and composition, as well as Earth's magnetic field and the geodynamic behavior. Determining the valence and spin state of iron in Earth's mantle minerals as well as major phases Debye, shear and compression sound velocity is essential to the fine modeling Earth's mantle radial and lateral discontinuities, and electrical and thermal conductivity. The measurement of iron isotope fractionation during crystallization, its relation to oxygen fugacity allows for the development of new powerful oxythermobarometers.
.
The proposed facility will be located at 3-ID and partly at 30-ID beamlines, which are owned and operated by APS. In fact, 3-ID has been involved with COMPRES organization since 2005. Just in the last 5 years, there were 55 papers, and 4 PhD Theses were published, and 4 workshops and schools were organized for data analysis to train young researchers.

Our proposal includes new and expanded space for Earth Science experiments at 3-ID-C, a new micrometer level focusing mirror, combined SMS-NRIXS-XRD experiments under pressures exceeding 2 Mbar, and 3000 K. Furthermore, remote control of pressure application, pressure and temperature readout and data collection will be available.

In this proposal we present five (5) examples of scientific research performed at 3-ID-B and 30-ID-B stations, covering i) experiments that help us understand seismology of ultralow velocity zones, ii) development of a new proxy for isotope fractionation using ^{119}Sn nuclear resonance, iii) chemistry of iron and oxygen under deep Earth conditions, iv) looking into possible presence of phosphorus in the core, and v) biomineralization of ferritin to magnetite using mineral-based Mössbauer microscopic imaging.

New facilities will be accessible through General User Proposal (GUP) and Partner User Proposal (PUP) mechanisms.