Geophysical application of inelastic neutron scattering at high pressures and high temperatures

Tomoo Katsura[1]

[1] ISEI, Okayama Univ.

In Materials and Life Science Facility of J-PARC, the proposal of high P-T beam line has been approved. At present, the neutron diffraction studies at high P-T conditions using a large volume press is planned at this beam line. However, it could be also possible to conduct inelastic neutron scattering experiment at high P-T conditions in a large-volume press because of the recent progress in collimation technology of neutron beam. Inelastic neutron scattering is the most powerful technique to study the dispersion relation and density of state of phonon. Here, I would like to discuss possible application of inelastic neutron scattering to geophysics.

The most direct application of inelastic neutron scattering is determination of elastic wave velocity by extrapolating the phonon dispersion curve. I would like to emphasize the sound velocity measurement for liquid phases in the Earth. The reason is that the sound velocity measurement for liquid phases at high P-T condition is very difficult by the ultrasonic method. The important liquid phases in the Earth are molten iron alloy, silicate melt and water fluid. Measurement of the sound velocities of these materials could help to solve the following important geophysical problems.

The first issue is the composition of the outer core. The outer core is believed to be composed of molten iron-nickel alloy. The comparison of density suggests that the outer core may contain 10% of light elements. However, the estimation of the density distribution the Earth is not so reliable. The most reliable information on the outer core is obtained by seismology. By comparing the sound velocity of molten iron-nickel alloy containing light elements with the seismic wave velocity profile, we could constrain the composition of the outer core.

The second one is the origin of the low velocity zone at the top of the asthenosphere. One possibility of the origin is the partial melting. In order to examine this hypothesis, the sound velocity of silicate melt should be measured at the P-T conditions of the top of the asthenosphere.

The third one is the seismicity of the lower crust. The presence of water fluid may cause the seismic activity in the lower crust. In order to examine this hypothesis, the presence of water fluid has to be detected by the seismic tomography. The sound velocity measurement of water fluid at the P-T conditions of the lower crust is desired for this purpose.

Thus, high P-T inelastic neutron scattering could make significant contribution for our understanding of the Earth's interior.