Elastic properties of materials by Brillouin Scattering

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Mechanical and elastic properties are among the key properties investigated in Materials Science and in Earth sciences. Technological structural materials are designed for specific applications based on the details of their response to mechanical actions. In Geosciences, modeling of the mineral composition, the structure and the dynamic behavior of our planet is based on our precise knowledge of the compositional dependence of the elastic moduli of candidate minerals at the pressures and temperatures relevant for the different inner layers of the Earth.

Brillouin scattering is a non-destructive technique that allows us to determine the full elastic tensor of crystalline solids. This experimental method can furnish complete information about the elastic anisotropy of minerals, and it can be used even when the specimens have linear dimensions of few tens of micrometers. It is a method of choice for the study of materials that cannot be synthesized in large amounts, and, when carried out in conjunction with the diamond-anvil cell, it is an extremely effective technique for the study of the elastic properties of Earth materials at conditions relevant for the deep Earth.

Here we will introduce the principles of Brillouin scattering, the basics of Brillouin spectroscopy experimental setups. We will present a number of applications of this method to the study of the elastic properties of crystalline and amorphous solids and liquid Earth materials in a wide range of pressure and temperature conditions.

We will then present new perspectives and current challenges in the study of mantle minerals in-situ at the relevant pressures and temperatures of the Earth lower mantle by Brillouin scattering. In particular, we will report about recent progresses in sample preparation to extend the maximum pressure limits for single-crystal. We will discuss the combination of state-of-the-art characterization techniques with Brillouin scattering to improve our understanding of Brillouin scattering on polycrystals. Furthermore, different heating methods will be discussed. Finally, we will evaluate the potential impact of these advances on our understanding of the Earth deep interior.