SCIENCES SORBONNE UNIVERSITÉ

2019-2020

Master thesis proposal

Institut de Minéralogie, de Physique des Matériaux et de Cosmochimie

Campus Pierre et Marie Curie
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Director: Guillaume Fiquet

Title: Polymorphism and critical phenomena in liquid sulfur studied by Brillouin spectroscopy

Keywords: Liquid-liquid transition, critical phenomena, high-pressure techniques

Scientific description: First-order phase transitions separate two phases with distinct densities and entropies. They are common in the solid state but for a long time judged incompatible with the nature of the liquid state. About 20 years ago, such a liquid-liquid transition (LLT) was discovered in elemental phosphorus, which has had a large impact in the scientific community as it changed the way the liquid state was perceived. Since then, no other example of a LLT separating two thermodynamically stable liquid phases of a pure substance could be experimentally evidenced, until our recent discovery of a LLT in compressed liquid sulfur [L. Henry et al, under review]. Furthermore, our experiments have provided the first evidence for the existence of a critical point terminating the liquid-liquid transition line, which has been conjectured in other systems (water, silicon, phosphorus) but never observed. The pressure and temperature conditions of this critical point are easily accessible, making liquid sulfur an excellent system to study critical phenomena associated to LLTs.

This master project proposes to study the LLT in liquid sulfur at various pressure and temperature conditions using Brillouin spectroscopy. Brillouin spectroscopy enables to measure the sound velocity and attenuation in a material via the interaction between a light source and the thermal sound waves. The sound velocity is related to the compressibility of the material, and these experiments will first allow to obtain the difference in compressibility of the two liquid phases below the critical point. In a second step, the experimental investigation of the critical region will be performed.

Techniques/methods in use: Brillouin spectroscopy, high-pressure (diamond anvil) cell.
Applicant skills: Motivation for experimental physics. Good background in condensed-matter physics
Industrial partnership: No. This project is part of a collaboration with the European Synchrotron Radiation Facility (M. Mezouar, ID27 Beamline responsible).

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Possibility for a Doctoral thesis: Y