Internship offered in M2

2018-2019

Responsible for internship

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Group: MP^3

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Internship topic: Sound velocity and density measurements on Fe-rich minerals at high pressure: Experimental constraints on the composition of the mantle of Mars

Here we propose a master project to be developed within the InSight NASA Discovery program mission (http://insight.jpl.nasa.gov/home.cfm) and the ERC-funded project PICKLE (Planetary Interiors Constrained by Key Laboratory Experiments, PI D. Antonangeli).

Characterizing the effect of pressure (P) and temperature (T) on the propagation of elastic waves in solids is very important for understanding elasticity, mechanical stability, material strength, interatomic interactions and phase transition mechanisms, with applications in materials and engineering science. Sound velocity measurements at high P-T conditions are also fundamental to produce accurate planetary models. The InSight mission, whose landing on Mars is scheduled for November 26th, 2018, will deploy a seismometer to study the interior of the "red planet". On apart the Apollo records on the Moon, InSight will collect the first seismic observation of a planetary body other than Earth. However, the full exploitation of InSight data will rely on laboratory measurements of the propagation of acoustic waves across relevant minerals at pertinent P-T conditions, which will provide the necessary guidance to the interpretation of the seismic data and the necessary link between seismic observations and planetary models. Classic techniques such as pulse-echo ultrasonics and Brillouin spectroscopy cannot be employed, either because limited in the achievable pressure range (ultrasonics), either because cannot be applied to opaque samples (Brillouin spectroscopy) as the case of Fe-rich minerals of Mars (Fe amount about twice than on the Earth's minerals). Accordingly, here we propose to use a novel and unique experimental setup, recently developed at IMPMC, which combines pump-probe laser and diamond anvil cell techniques, to probe sound wave propagation in Fe-rich mantle minerals up to ~30 GPa (i.e. spanning the entire pressure range of Martian mantle). When necessary, x-ray diffraction measurements will be performed to determine sample density. The obtained results will be discussed in view of their physics interest (effects of Fe inclusion on elasticity and equation of state) and in view of the interest in planetary science (mineralogy of Martian mantle, interpretation of Mars seismic records).

Techniques involved: Pump-probe laser acoustics, x-ray diffraction, diamond anvil cell

Paid internship: Yes

Can this internship be continued for a PhD? Yes

If yes, type of PhD funding envisaged is: CNES and ERC funding already allocated