Measuring hydrogen at high pressure: new approaches and recent results.

Paul LOUBEYRE
Universite' de Paris VI (Pierre et Marie Curie)
Departement de Physique des Milieux Condenses
Tour 13, E4, B77
4 Place Jussieu
75005 Paris, France

Abstract:

Hydrogen is considered the essential element to reveal quantum many-body effects of density, somehow similarly to the role played by helium in low temperature physics. The observation of metal hydrogen has been motivating the high pressure field for a long time. This goal should now be within the reach of the diamond anvil cell (DAC) apparatus. Indeed, the closure of the electronic gap of hydrogen in the visible has been measured by compressing solid hydrogen up to about 350 GPa in a DAC. In this talk, we will review how some of the interesting questions concerning the phase diagram of hydrogen can be experimentally addressed. In particular, we will discuss the importance of the coupling of the diamond anvil cell with large scale facilities. Recent results will be presented in more details: the structure of the Broken Symmetry Phase in deuterium; the isotopic shift on the equation of state of the hydrogen; the diffusion process in solid hydrogen; the properties of warm dense hydrogen, a state in between condensed matter physics and plasma physics.

References:

1) *Optical study of solid hydrogen to 320 GPa and evidence for black hydrogen. P.Loubeyre, F.Occelli and R.LeToullec,* ***Nature 416,*** *613 (2002).*
2) *Neutron and x-ray diffraction study of the broken symmetry phase transition in solid deuterium. I. Goncharenko and P.Loubeyre.* ***Nature 435,*** *1206 – 1209 (2005).*
3) *Coupling static and dynamic compressions with a laser shock in a diamond anvil cell and the properties of dense fluid hydrogen. P. Loubeyre et al,* ***High Pressure Research 24****, 25-31 (2004).*