Prof. Dr. S. Hollands
Prof. Dr. J. Meijer

UNIVERSITÄT LEIPZIG

Fakultät für Physik und Geowissenschaften

Physik-Kolloquium

Dienstag, den 01.07.2014, 16.00 Uhr

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Transformations at megabar pressures

Under megabar pressures solids can be strongly compressed: volume of solid hydrogen decreases in >20 times, even diamond is 1.5 fold compressed at achievable pressures of ~400 GPa. This dramatically changes interatomic distances in materials eventually leading to electrical conductivity, metallization and superconductivity in a number of presenting elements: B, Xe, nitrogen, Li. A special case is Na – simple metal – it becomes transparent at pressures of ≈200 GPa transforming into ionic- electride-like state[1]. Ammonia transforms to ionic state[2].

The main focus of the presentation is hydrogen. At ambient pressures and low temperatures hydrogen forms a molecular crystal which is expected to display metallic properties under megabar pressures. This metal is predicted to be superconducting with a very high critical temperature T_c of 200–400 K. The superconductor may potentially be recovered metastably at ambient pressures, and it may acquire a new quantum state as a metallic superfluid and a superconducting superfluid. Previous experiments performed at low temperatures T <100 K showed that at record pressures of 300 GPa, hydrogen remains in the molecular state and is an insulator with a band gap of ~2 eV.

We have found that at room temperature and already at pressures >220 GPa, a new opaque and conductive phase IV appeared. Above 280 GPa, in the next phase V, hydrogen resistance is nearly temperature-independent over a wide temperature range, down to 30 K[3]. Our recent data and theoretical works further support the conclusions[3] that hydrogen is semiconductor in phase IV and most likely metal (semimetal) in phase V. We will present new data on phase diagram of hydrogen determined in P, T domain up to 300 GPa and 350 K.

1 Ma, Y. *et al.* Transparent Dense Sodium. *Nature* 458, 182-185 (2009).
2 Palasyuk, T. *et al.* Ammonia as a case study for the spontaneous ionization of a simple hydrogen-bonded compound. *Nature Communications* 5, 3460 (2014).
3 Eremets, M. I. & Troyan, I. A. Conductive dense hydrogen. *Nature Materials* 10, 927-931 (2011).

Ort: Hörsaal für Theoretische Physik, Linnéstraße 5

Alle Teilnehmer sind ab 15.30 Uhr zu Kaffee vor dem Hörsaal eingeladen.