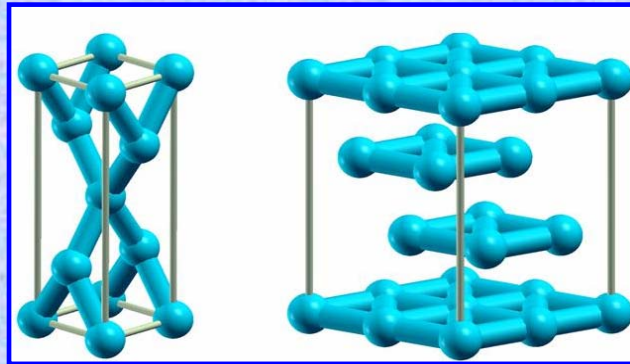


Harvard University Department of Physics Colloquium

April 4, 2011, Monday
Jefferson 250 @ 4:15 pm



“Hydrogen and Helium at High Pressure as Revealed by Simulations”

David Ceperley

University of Illinois, Urbana-Champaign

Hydrogen and helium account for much of the visible mass in the universe. Their properties are important for understanding the giant planets, Jupiter and Saturn, but calculating their properties remain a challenge. It has long been an open question how hydrogen makes a transition from a molecular insulating state to an atomic metallic state. We have developed new simulation methods starting from “first principles” to treat such systems and using them, have studied molecular dissociation in liquid hydrogen. We have performed a “random structure search” using to determine the ground-state crystal structures of atomic metallic hydrogen from 500 GPa to 5 TPa. We have observed clear evidence of an “extra” liquid-liquid phase transition for temperatures $600\text{K} < T < 1500\text{K}$. We also examined hydrogen–helium mixtures at Mbar pressures and high temperatures (4000 to 10000 K) and determined the temperature, at a given pressure, when helium becomes insoluble in dense metallic hydrogen: this could explain some of the observed differences between Jupiter and Saturn.

For more information please go to our website: <http://www.physics.harvard.edu>