

Semiconductor-Metal Transitions in Fluid Hydrogen, Nitrogen, and Oxygen at Megabar Pressures

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Hydrogen, nitrogen, oxygen, rubidium, and cesium undergo SCM transitions in the fluid phase at a few 1000 K. The diatomics require \sim megabar pressures; the alkalis require \sim 100 bar to hold them stably near their critical points. The dynamic and static experimental techniques will be described. All these fluids have the same values of electrical conductivity around their SCM transitions. The disordered metallic phases are at the Ioffe-Regal limit where the electron mean free paths are \sim the average distances between atoms. The density dependences of the semiconductivities essentially scale with the radial extents of the electronic charge density distributions of the respective atoms.

The disordered metallic phases are at the Ioffe-Regal limit, that is, the electron mean free path is \sim the average distance between atoms. In the metallic phases, temperatures T are small compared to Fermi temperatures T_F . In the case of the low- Z fluids, the pressures of these transitions are \sim 100 GPa (106 bar). These extreme conditions are achieved with adiabatic multiple-shock compression. In the case of the alkalis, pressures of only \sim 0.01 GPa (102 bar) are required to observe this transition. These conditions are achieved with isothermal static heating which is sufficiently high to drive these fluids into the subcritical regime where Rb and Cs semiconduct. Static pressure is then applied to drive the alkali fluids up to the critical point, where they become metallic.