METALLIC HYDROGEN AND ITS QUANTUM ORDERINGS*

N.W. ASHCROFT
Cornell University
Laboratory of Atomic and Solid State Physics
& Cornell Center for Materials Research
615 Clark Hall
Ithaca, N.Y. 14853-2501
U.SA.

Abstract:

The recently reported existence of a melting point maximum in sodium and subsequent rapid decline in its melting curve raises the prospect of similar behavior in the lighter Group I elements, lithium and hydrogen. For the latter the effective proton-proton interactions are notably state dependent, and over a range of density their structural consequences are weakened to the point where corresponding static lattice energy differences are small when compared to the ensuing zero-point energies. This situation, familiar from the physics of the condensed phases of helium under normal conditions, has promoted a view that at least in a constrained density range metallic hydrogen might also adopt a liquid state at low temperatures. As in helium there is then the prospect of further orderings but now in quantum-liquid-metals, for example the dual Fermion system represented by electrons and protons and in the mixed Fermion-Boson system represented by electrons and deuterons (spin 1). The physical arguments leading to these conclusions will be reviewed along with the ambit of possible off-diagonal-long-range-orderings, and also some novel states that might occcur in the presence of magnetic fields and in rotating frames.

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