Poster-2-5

Benchmark solution of the continuum model for metallic hydrogen, using the full energy- and momentum-dependent Eliashberg formalism

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The superconductivity of highly pressurized metallic hydrogen was predicted long ago [1, 2]. The model underlying these predictions is a continuum description featuring homogeneous gases of electrons and protons—the electron or proton density being the model unique parameter. The Coulomb interaction between charges is screened using an approximate dielectric function, yielding a retarded interaction between the electrons. It turns out that the superconducting critical temperature T_c derived from that model at a given density depends dramatically on the approximation used, ranging from thousands of Kelvin to tens of milliKelvin [3]. We have solved the full energy- and momentum-dependent Eliashberg equations, both for the normal and pairing self-energies, and obtained a maximum T_c of ~ 0.13 K at a density $\sim 1.3 \times 10^{21}$ cm^{-3}. The computation is surprisingly heavy given the simplicity of the model and reveals that insufficient numerical convergence can also lead to wide variations in the calculated T_c. Our results question the standard method for calculating T_c of real materials, where the momentum dependence of the Eliashberg theory and the normal self-energy are ignored.

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