

New fermionic superfluid state

We introduce a new fermionic variational wavefunction, suitable for interacting multi-species systems of spinful fermions. This wavefunction sustains superfluidity. In this frame, we also introduce a new quantum index, which is related to the internal structure of the quantum state. Applications include quark matter, neutron stars, cold atoms and the high temperature superconductors. Spin up and down fermions are, in principle, inequivalent. Due to the inclusion of adequate 2-fermion correlations, a wider class of Hamiltonians than sheer Bardeen-Cooper-Schrieffer (BCS) type, comprising interaction and hybridization between different fermion species, can be treated "exactly", as in the well known manner of BCS theory. We present the finite temperature version of the theory, and we discuss the appearance of charge and spin density wave order.