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Cooper pairs in superconductivity in a generalized BEC theory

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The generalized Bose-Einstein condensation (GBEC) theory subsumes as special cases both BCS and BEC, among other theories. It hinges on three separate new ingredients: i) treating Cooper pairs (CPs) as *actual* bosons as distinct from BCS pairs which strictly speaking are not bosons; ii) inclusion of two-hole Cooper pairs (2hCPs) on an equal footing with the usual two-electron ones (2eCPs); and iii) incorporating in the resulting ideal *ternary* boson-fermion (BF) gas specific vertex interactions that drive formation/dis-integration processes of both kinds of CPs. Here we extend the BCS-Bose crossover theory by *explicitly* including 2hCPs. This leads to a phase diagram with two pure phases, one with 2eCPs and the other with 2hCPs, plus a mixed phase with arbitrary proportions of both. The special-case phase with a 50-50 mixture of both 2e/2hCPs gives the usual *unextended* BCS-Bose crossover theory. Furthermore, if T_c and T_F are respectively the critical and the Fermi temperatures, it predicts T_c/T_F values for the elemental superconductors Al, In, Sn, Pb, Hg, and Nb comparing quite well with experiment and notably much better than BCS predictions. Also shown is a phase diagram of the dimensionless energy gap at zero-temperature $\Delta(0)/E_F$ *vs* n/n_f, where $E_F=k_BT_F$ is the Fermi energy. We do this for the 50-50 case as well as for the pure 2eCPs and 2hCPs cases separately. It is thus unequivocally shown that if one ignores 2hCPs the energy gap lies substantially below the 50-50 case which already roughly reproduces the data.

Biography

I Chávez MS and BS have completed his Doctoral degree in the Material Sciences and Engineering Research Graduate Program at the National Autonomous University of Mexico (UNAM, in Spanish) with the thesis titled "*A new dimensionless coupling constant in superconductivity.*" He is also a Laboratory Assistant at the School of Sciences at UNAM.

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