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Is room-temperature superconductivity with phonons possible?

MANUEL DE LLANO, Instituto de Investigaciones en Materiales, UNAM, Mexico City — By recognizing the vital importance of two-hole Cooper pairs in addition to the usual two-electron ones in a strongly-interacting many-electron system, the concept of Cooper pairing was re-examined with striking conclusions, namely gapped and linearly-dispersive resonances with a finite lifetime. Based on this, Bose-Einstein condensation (BEC) theory has been generalized to include not boson-boson interactions (also neglected in BCS theory) but rather boson-fermion interaction vertices reminiscent of the Froehlich electron-phonon interaction in metals. Instead of phonons, the bosons in the generalized BEC (GBEC) theory are now both particle and hole Cooper pairs. Each kind is responsible for half the condensation energy. The GBEC reduces to all the old known statistical theories as special cases—including the so-called "BCS-Bose crossover" picture which in turn generalizes BCS theory. With no adjustable parameters, the GBEC theory yields superconducting transition temperatures substantially higher than the BCS limitation of around 45K [including room-temperature superconductivity (RTSC)] without relying on non-phononic dynamics involving excitons, plasmons, magnons or otherwise purely-electronic mechanisms. The results are expected to shed light in the experimental search for RTSCs.

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