Bose-Einstein condensation of collective Cooper pairs

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In this work, we present a new evidence to support the view point that the superconductivity could be a Bose-Einstein condensation (BEC). It is well known that the Cooper pairs are not true bosons[1] and then, we introduce the concept of collective Cooper pairs (CCP) through a unitary transformation of Cooper pairs[2]. We further prove that they accomplish bosonic commutation relations at the dilute limit[3], being able to accumulate many of them at a single quantum state, in contrast to the standard Cooper pairs. Next, we rewrite the Bardeen-Cooper-Schrieffer (BCS) Hamiltonian and its ground state in terms of collective Cooper pairs. An exact solution of all single-pair eigenstates is found by means of a multishell model and an analytical freedom-degree reduction technique. In particular, this solution becomes analytical at the thermodynamic limit and the obtained energy spectrum is used to determine the BEC temperature of CCP.

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