**DISTINCTIVE LOW-AND HIGH-TEMPERATURE DEPENDENCES OF THE MAGNETIC PENETRATION DEPTH IN ORGANIC AND HIGH-**$T\_{c}$ **CUPRATE SUPERCONDUCTORS: EVIDENCE FOR THE GAPPED AND GAPLESS BOSE-LIQUID SUPERCONDUCTIVITY**

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One of the challenging problems discovered from experimental studies of high-$T\_{c}$ cuprate superconductors is the presence of low-energy and gapless excitations in them [1,2]. The anomalous temperature dependence of the London penetration depth $λ\_{L}\left(T\right)$ is observed in organic superconductors and high-$T\_{c}$cuprates both below the critical temperature of the superconducting transition $T\_{c}$ and at low temperatures $T\ll T\_{c}$. Since discovery of superconductivity in these materials, the question of whether the mechanism of superconductivity in these systems is of the conventional Bardeen-Cooper Schrieffer (BCS)-type or not has attracted great interest [1,2,3].

We examine the validity of a new alternative (Bose-liquid) approach that has an advantage over Fermi-liquid (BCS-like) approaches to unconventional superconductivity in organic and high-$T\_{c}$ cuprate superconductors. We argue that the organic materials and doped high-$T\_{c}$ cuprates can be regarded as the bosonic superconductors in which tightly-bound (polaronic) Cooper pairs behave like composite bosons just like He4 atoms and condense into two distinct Bose superfluids below the superconducting transition temperature $T\_{c}$. We show that the unconventional (Bose-liquid) superconductivity in organic compounds and doped cuprates results from the pair and single-particle condensations of attracting bosons into two Bose superfluids below two characteristic temperatures. We analyze the experimental data on the London penetration depths $λ\_{L}\left(T\right)$ in organic and high-$T\_{c}$ cuprate superconductors in terms of the theory of a three-dimensional (3D) Bose-liquid superconductivity. By comparing the predictions of this theory for the temperature dependences of $λ\_{L}\left(T\right)$ with the measured temperature dependences of $λ\_{L}\left(T\right)$ in the organic superconductor $k-(BEDT-TTF)\_{2}Cu(NCS)\_{2}$ and in the different Y-based high-$T\_{c}$ cuprate superconductors, we found that the temperature dependences of the new superconducting order parameter and the magnetic field penetration depths in these superconductors are anomalous and have pronounced kink-like features near a certain characteristic temperature lower than $T\_{c}$. We predicted the existence of two different gapped and gapless regimes of 3D Bose-liquid superconductivity in organic and high-$T\_{c} $cuprate superconductors resulting in: (i) the exponential temperature dependence of $λ\_{L}\left(T\right)$ in some temperature range below $T\_{c}$ and (ii) the power-law temperature dependence of $λ\_{L}\left(T\right)$ at low temperatures. Our theoretical results for the low- and high- temperature dependences of ${λ\_{L}\left(T\right) }/{λ\_{L}\left(0\right) }$ and ${λ\_{L}^{2}(0)}/{λ\_{L}^{2}(T)}$ are in good quantitative agreement with the experimental findings in these superconductors.

**References**

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