

Superconductivity as a problem in chemical physics.

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Superconductivity as a fundamental problem in quantum mechanics is now more than 100 years old. While the Bardeen-Cooper-Schrieffer (BCS) theory [1] gave a successful explanation of the so-called low critical temperature (low T_c) superconductivity, for more than 25 years now, since the discovery of high T_c superconductivity in the layered cuprates, it has become clear that there exists a different, and perhaps more complete theory of superconductivity that applies broadly to all systems with strong repulsive interactions between electrons. In spite of enormous collective effort by condensed matter physicists, such a theory has not been reached yet. This talk will present an approach to this problem from a perspective that has its roots in chemical physics. The condensed matter physics community recognized at the outset that the most important characteristic of correlated-electron superconductivity is that this phase is proximate to antiferromagnetism. We will begin by pointing out that there exists yet another feature that is shared by all correlated-electron superconductors, viz., superconductivity in these is limited to specific chemical stoichiometries where a particular carrier concentration is reached [2, 3, 4]. We posit that at this carrier concentration mobile electron-pairs with physical dimensions close to that in molecules occur. Superconductivity is due to the condensation of these mobile pseudomolecules, as was suggested by Schafroth a few years prior to the advent of the the BCS theory [5]. Examples will be given mostly from, but will not be limited to, carbon-based superconductors including organic charge-transfer solids, fullerides, and metal-intercalated phenacene hydrocarbons (A_3 phenanthrene, A_3 picene and A_3 dibenzopentacene, $A = K, Rb$).

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