Spin Pairing Mechanism in High-Temperature Superconductors

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Abstract

The aim of these lectures is to present an overview about the essential physics of high-temperature superconductors, focusing in particular on their pairing mechanism. After a short introduction about "conventional" superconductors and the BCS phonon-mediated pairing mechanism, I will present one of the models which is commonly used to describe the physics of these materials, namely, the Hubbard model. Here, I will show how the Pauli principle naturally leads to the superexchange mechanism, i. e. to an antiferromagnetic coupling between spins of neighboring orbitals. In undoped compounds this coupling leads to an insulating antiferromagnetic phase. Upon doping, charge carriers (holes) are introduced into the copper-oxide layers and destroy long-range antiferromagnetism which is replaced by short-range antiferromagnetic fluctuations. In the last part of these lectures I will show how these magnetic fluctuations lead to an effective attraction between charge carriers and to pairing. Finally, I will discuss the competition between pairing strength and superconducting phase fluctuations occurring in these materials.