Theoretical Analysis on Cooperation of Coulomb and Electron-Phonon Interactions for Fulleride Superconductors

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Alkali metal (A) doped fullerides (A₃C₆₀) show not only superconductivity (SC) with high transition temperature Tₐ up to about 40K, but also antiferromagnetism (AF) with A=Cs [1]. In view of nearby presence of the AF state, the Coulomb repulsion should play a significant role in the SC state. However, it has been believed that the SC state of A₃C₆₀ is driven mainly by the electron-phonon interaction because various experimental evidences point to a fully symmetric s-wave SC state being realized. In the conventional theory, the s-wave state is unfavorable in the presence of Coulomb repulsion. Then it is an open question why the Tₐ in fullerides is so high. In our previous study, we found that the s-wave pair can be formed even in the purely repulsive interaction model because of the characteristic band structure of fullerides [2]. The Kohn-Luttinger type interaction provides the attraction by Coulomb interaction. In this contribution, we demonstrate cooperation, rather than competition, between electron-phonon interaction and Coulomb repulsion for the s-wave pairing. We solve the gap equation with an effective interaction which include both Coulomb and electron-phonon interactions, and determine the most stable SC state. According to our result, we propose that the high Tₐ in actual fullerides comes from the cooperation between Coulomb repulsion and electron-phonon interaction.

References