Superconductivity in Electron-doped Fullerenes

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Recent experiments revealed that the C_{60} solid has surprisingly high superconducting temperatures T_c up to 117 K upon ionizing the C_{60} molecular layers in the field-effect transistor devices. Various behavior in electronic structures indicates that the C_{60} solids are in the strongly interacting regime where the intramolecular interactions such as Coulomb interaction, electron-phonon coupling and Hund's rule couplings are crucial to understanding of the superconductivity. We investigate the superconducting behavior of the well-studied electron-doped C_{60} based on a model Hamiltonian with the electronic hopping, Coulomb interaction, electron-phonon coupling and Hund's rule coupling within the dynamical mean field theory with quantum Monte Carlo technique. The Jahn-Teller H_g phonons turn out to be crucial for the superconductivity due to their insensitivity to the electronic screening as opposed to the non-Jahn-Teller A_g phonons. In addition, in the strongly correlated regime, the low-spin ground state structure of the Jahn-Teller coupling stabilizes the local singlet electron pairs and makes the superconductivity possible even for large Coulomb interactions. We also show the interesting doping dependency of T_c near the Mott transition. Strong Jahn-Teller coupling at the even number fillings drives the system towards insulators at filling 2 and 4 with the maximum T_c at filling 3. Competition of Hund's rule coupling with the electron-phonon interaction for superconductivity is discussed.