Theoretical Study of 3D Superconducting Gap Structure in Iron Based Superconductors

TETUSRO SAITO, SEIICHIRO ONARI, HIROSHI KONTANI, Nagoya University — The mechanism and symmetry of the superconducting (SC) gap in Fe-based superconductors have been studied actively, and both the spin fluctuation-mediated $s_{\pm}$-wave SC state and orbital fluctuation-mediated $s_{\pm\pm}$-wave SC state had been proposed. To obtain important information on the pairing mechanism, we analyze the Eliashberg gap equation using the 3-dimensional 10-orbital model. When we perform the RPA by considering only the Coulomb interaction, only the spin fluctuations develop, and the SC gap of $z^2$-orbital dominant part on the hole pockets is almost zero. The resultant horizontal node is inconsistent with several measurements. However, the orbital fluctuations develop by introducing the quadrupole interaction $g$ (due to the vertex correction) and it is found that (i) the horizontal node disappears and (ii) the crossover from $s_{\pm}$-state to $s_{\pm\pm}$-state is realized. During the crossover, we obtained the loop-node structures on the electron pockets, which are actually observed by ARPES measurements in BaFe$_2$(As,P)$_2$. We expect that optimally doped BaFe$_2$(As,P)$_2$ is in the crossover regime between $s_{\pm\pm}$-state and $s_{\pm}$-state.