Possible Superconductivity Induced by Strong Spin-Orbit Coupling in Carrier Doped Iridium Oxides Insulators

KAZUTAKA NISHIGUCHI, RIKEN, CREST, TOMONORI SHIRAKAWA, RIKEN, RIKEN AICS, CREST, HIROSHI WATANABE, RIKEN CEMS, CREST, RYOTARO ARITA, Department of Applied Physics, The University of Tokyo, PRESTO, SEIJI YUNOKI, RIKEN, RIKEN CEMS, RIKEN AICS, CREST — 5d transition metal oxide Sr$_2$IrO$_4$ and its relevant Iridium oxides have attracted much interest because of exotic properties arising from highly entangled spin and orbital degrees of freedom due to strong spin-orbit coupling (SOC). Sr$_2$IrO$_4$ crystallizes in the layered perovskite structure, similar to cuprates. Five 5d electrons in Ir occupy its $t_{2g}$ orbitals which are split by strong SOC, locally inducing an effective total angular momentum $J_{\text{eff}} = 1/2$, analogous to a $S = 1/2$ state in cuprates. Because of the similarities to cuprates, the possibility of superconductivity (SC) in Iridium oxides has been expected theoretically once mobile carriers are introduced into the $J_{\text{eff}} = 1/2$ antiferromagnetic insulator [1]. To study theoretically possible SC in carrier doped Sr$_2$IrO$_4$, we investigate a three-orbital Hubbard model with SOC. By solving the Eliashberg equation in the random phase approximation, we find that $J_{\text{eff}} = 1/2$ antiferromagnetic fluctuations favor $d_{x^2-y^2}$-wave SC with a mixture of singlet and triplet Cooper pairings. We will also discuss the particle-hole asymmetry of the SC induced by electron and hole doping. [1] H. Watanabe, et. al., Phys. Rev. Lett. 110, 027002 (2013)