Physics of Spin Triplet Superconductivity under Magnetic Field

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We have investigated the pairing mechanism of the superconductivity in the strongly correlated electron systems on the basis of the perturbation theory. We can easily extend this method into the superconducting state. Study of the superconducting state on the microscopic method was performed only for a d-wave spin-singlet state on the fluctuation-exchange approximation (FLEX), but not for the spin-triplet state. The FLEX succeeded to describe the normal and the superconducting states near the antiferromagnetic critical point. However, it has not rightly described the spin-triplet state in Sr_2RuO_4. This is because the γ band, which does not indicate the strong magnetic fluctuation, triggers the superconductivity in Sr_2RuO_4. In addition, the FLEX overestimates the spin fluctuation and the depairing effect. On the contrary, the 3rd order perturbation theory rightly predicted the spin triplet state. Thus, the perturbation theory has an advantage in investigating the superconductivity in Sr_2RuO_4.

The remaining questions in Sr_2RuO_4 are to understand the Knight shift in the NMR experiment, which does not decrease in any direction, and the multi-phase diagram under the magnetic field. In order to clarify these phenomena, we are planning to investigate the superconducting state in Sr_2RuO_4 by developing the perturbation theory into the superconducting state. First of all, considering the spin-orbit interaction, we discuss behavior of the magnetic susceptibility and the physics concerning the internal degree of freedom of d-vector. Finally, we extend the microscopic theory into the superconductivity under the magnetic field, and evaluate the Knight shift itself.