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論文題目: μSR Study on Superconducting Gap Symmetry in Organic Superconductor λ-$(BETS)_2GaCl_4$

（有機超伝導体 λ-$(BETS)_2GaCl_4$ の超伝導ギャップ対称性に関する μSR 研究）

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概要： The superconducting gap symmetry is important to understand the mechanism of the Cooper pairing in superconductors. Among superconductors, organic-molecular based superconductors (OM SCs) are uniquely important because they tend to have the low dimensionality in electronic states and its dimensionality is tunable by chemical substitutions and the external pressure. Clean samples with fixed stoichiometry can be synthesized in OM SCs, resulting in deducing electronic states to be in simple and ideal physics models.

My target system studied in my Ph.D. research is one of OM SCs, λ-$(BETS)_2GaCl_4$ (BETS = bis(ethylene)dithio tetraselenafulvalene). This system is metallic and undergoes a superconducting state at T_C ~ 5.5 K at ambient pressure. One interesting issue of this system is that the superconducting state links to that of the isostructural relative λ-$(BETS)_2FeCl_4$ which shows the superconductivity under magnetic fields higher than about 17 T. However, the superconducting gap symmetry of λ-$(BETS)_2GaCl_4$ is not yet well agreed due to debated experimental and theoretical results and is still an open question to be carefully studied.

In order to determine the superconducting gap symmetry and the magnetic penetration depth of λ-$(BETS)_2GaCl_4$, I have performed the zero-field (ZF) and transverse-field (TF) muon spin relaxation (μSR) experiments down to 0.3 K at the ISIS and RIKEN-RAL Muon Facilities. Randomly aligned crystals were used for my measurements. I determined superconducting parameters T_C, H_{c1} and H_{c2} to be 5.3(1) K, 11(1) Oe and 63(1) kOe, respectively. I found that the superconducting gap symmetry of λ-$(BETS)_2GaCl_4$ is the mixture of the *s*–wave and *d*–wave symmetries. The *s*–wave symmetry is the major component with more than 70 % weight. I carried out density functional theory (DFT) calculations with my collaborators to discuss the superconducting gap symmetry from the theoretical viewpoint, assuming that λ-$(BETS)_2GaCl_4$ is a spin-fluctuation mediated superconductor in the spin singlet channel. I concluded that theoretical calculation result well supported our experimental results and that a new type of superconducting pairing symmetry, *s+d*–wave symmetry, appeared in λ-$(BETS)_2GaCl_4$.