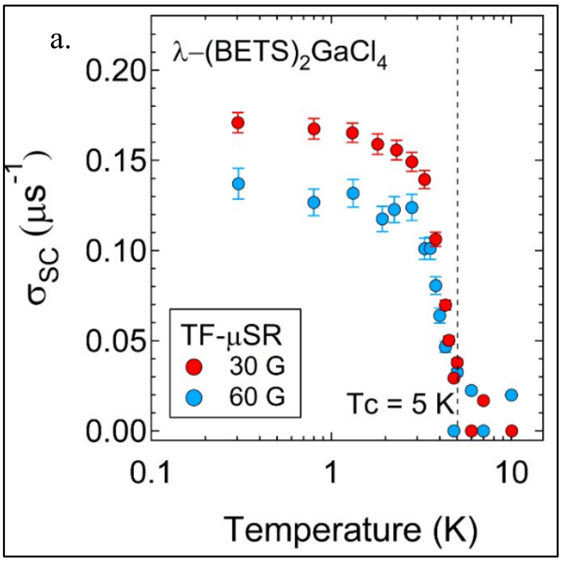
Superconducting Pairing Symmetry of Organic Superconductor λ-(BETS)$_2$GaCl$_4$ Studied by μSR

Dita Puspita Sari[1,2), Retno Asih[1,2), Koichi Hiraki[3), Yasuyuki Ishii[4), Adrian Hillier [5), Toshihiro Takahashi[3), Isao Watanabe[1,2,6), Takehito Nakano[2), and Yasuo Nozue[2)

[1]RIKEN Nishina Center, [2]Osaka U., [3]Gakushuin U., [4]Shibaura Institute of Technology, [5]ISIS-STFC, [6]Hokkaido University

The quasi two-dimensional organic superconductor, λ-(BETS)$_2$GaCl$_4$, (BGC), is composed of conductive BETS and insulating GaCl$_4$ layers which are alternatively stacked. It is expected that the low-dimensional crystal structure and the hybridization of the 3*d* character on the Fermi surface would cause an exotic superconducting state in BGC. The magnetic phase diagram has similarities to that of HTSC Cuprates and the Fe based superconductor when we gradually change the insulating layer to be FeCl$_4$, (BFC) [1-2]. A study of the superconducting state of BGC is important in order to reveal the presence of unconventional superconductivity. Muon spin rotation (μSR) is an ideal tool for such investigation.

We have carried out muon-spin-relaxation (μSR) measurements in the zero-field (ZF) and transverse-field (TF = 30 and 60 G) conditions at the RIKEN-RAL Muon Facility in the UK. We investigated the Cooper pairing symmetry in the superconducting state of BGC from the muon-spin relaxation behavior. The relaxation rate of the muon-spin polarization in ZF was independent of temperature below Tc. This result would reject a possibility to break the time-reversal symmetry of the Cooper pair. The temperature dependence of the damping rate of the muon-spin rotation in TF increased with decreasing temperature below Tc and seemed to keep gradually decreasing down to 0.3 K (Figure 1 a.). In order to understand our results, we calculated the Fermi surface by means of the density functional theory (DFT) calculation as shown in Fig. 1 b. We are going to present the experimental analysis in conjunction with DFT calculations to discuss the superconducting state.



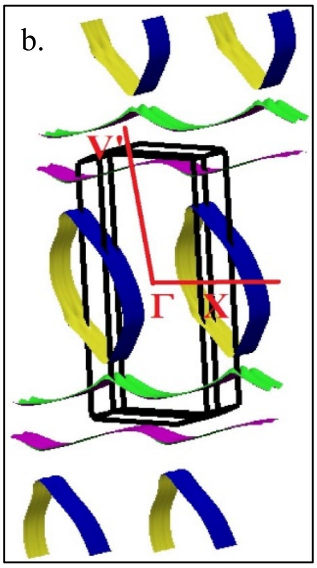


Figure 1 a. Temperature dependence of damping rate of TF-μSR
b. 3D image of Fermi surface of λ-(BETS)$_2$GaCl$_4$ in the Brilluoin zone calculated at the room temperature. Γ = (0, 0, 0); X = (0.5, 0, 0); V' = (-0.5, 0, 0.5)

References:

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2. S. Uji and J. Brooks, J. Phys. Soc. Jpn., **75,** 051014 (2006).