Small-angle neutron scattering about abnormal metal state of Sr_2RuO_4

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Sr_2RuO_4 is isostructural with the high-Tc cuprate $La_{2-x}Sr_xCuO_4$. Also, it was predicted to be a spin-triplet superconductor by the data of NMR knight shift measurements and polarized neutron scattering measurements [1][2]. However, recent work has raised new questions on whether Sr_2RuO_4 is indeed a spin-triplet superconductor [3].

In this experiment, we attempted to confirm whether or not strong Pauli-paramagnetic effect in Sr_2RuO_4 would change the position of vortices in magnetic field. The transition of the position would support the opinion that Sr_2RuO_4 is a d-wave superconductor because of its similarity with $CeCoIn_5$, which also shows d-wave superconductivity [4]. This experiment would useful for deciding the pairing symmetry of the material. The purpose of the experiment is the measurement of vortices. Thus, it was carried out at SANS-U.

Before the irradiation on Sr_2RuO_4, we tried to adjust the setting of the magnet by use of Nb. It is a representative material that is easy to observe vortices. The critical temperature and upper critical magnetic field of Nb is 9.25K and 0.24T. Fig.1 is the contour-plot when we applied an electrical current of 4A to the magnet (the theoretical value of the magnetic field that the magnet generates is 2T per 45A). There are two spots which appear to be vortices in Fig.1 vertically symmetrically. However, considering the position of the spots, it was suspicious that they were caused by vortices because the sample was rotated horizontally. To figure out whether or not the spots are related to vortices, we carried out measurements in other strength of magnetic field. The contour-plots that we observed at a current of 8A and 0A showed same spots as the plot at a current of 4A. Therefore, it is valid to consider that the signals in Fig.1 are not caused by vortices. Although we analyzed plot areas other than the signals to confirm the existence of peaks that cannot be seen visually, no peaks were found.

Next, we changed the diameter of the beam from 15mm to 5mm. That is because there is a possibility that the spots were caused by the irradiation on the edge of Nb. The contour-plot in this measurement showed same spots as them in Fig.1. Thus, we considered that the signals were not related to the edge of Nb.

As we reached the last day of the experiment at this time, we could not carry out the measurement of Sr_2RuO_4.

We could not observe vortices of Nb in this experiment. After the beam time, we examined the magnet and found that it generates no magnetic field. As the cause of the two spots is still unknown, we hope to make clear this problem.

[1] K. Ishida *et al*., Nature. **396**, 658
[2] J A Duffy *et al.,* PhysRevLett. **85**, 5412
[3] A. Pustogow *et al*., Nature. **574**, 72
[4] Andrea D. Bianchi *et al*., Sience. **319**, 5860

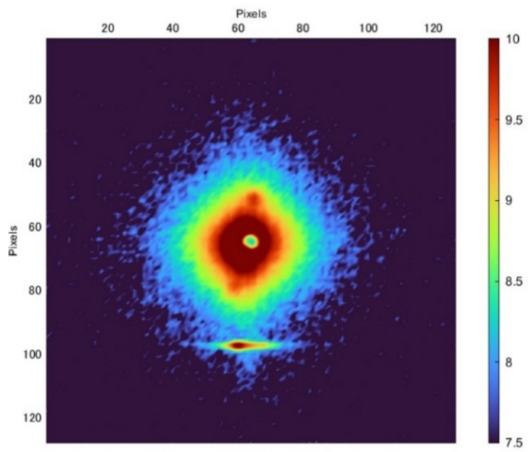

Fig. 1. Contour-plot of the data from irradiation on Nb at a current of 4A. The wave length used for the measurement was 7 Å and the temperature was 4K.