

Setting up of a refrigerator for vortex lattice measurements at SANS-U

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Small-angle neutron scattering (SANS) is the ideal technique for observing the magnetic flux lattice in the mixed state of Type II superconductors. To perform such experiments, it is necessary to operate a cryostat equipped with a horizontal magnet and a window that does not obstruct the neutron beam traveling in the forward direction. In our laboratory, we tried to set up a system equipped with a dilution refrigerator for flux lattice measurements down to 100 mK using SANS-U on JRR-3.

The dilution refrigerator owned by our team is from CryoConcept and the outer wall of the refrigerator needs to be cooled down to 4 K before the gas circulation of the system can start. On the other hand, the magnet used in the system is a small one with split-type coils and we use the Orange cryostat with a bore diameter of 10 cm to cool it down to 1.3 K by feeding 4He gas. Namely, we put the small 3 T magnet and the dilution refrigerator insert together into the sample space of the Orange cryostat and cooled down them to 1.3 K by feeding 4He gas.

For this year, we continued the operation test. It was confirmed that the sample space in the orange cryostat reached the lowest temperature of approximately 1.3 K, which allowed us to start operating the dilution system. However, the gas-circulation in the dilution refrigerator was not stable at the lowest temperature, and we had to attribute it to the dilution refrigerator being clogged. This problem should be solved by cleaning the IVC well by vacuuming and installing exchange gas before starting pre-cooling.

For this time, anyway, we could test the magnet operation through the observation of the magnetic flux of Nb superconductor, and it was confirmed that an external magnetic field of approximately 2010 G was established by a current of 6 A (Fig. 1).

In summary, in the experiment, the individual parts of the system were passably driven. This made us believe that measurement experiments on each of the topics can be carried out from next year onwards.

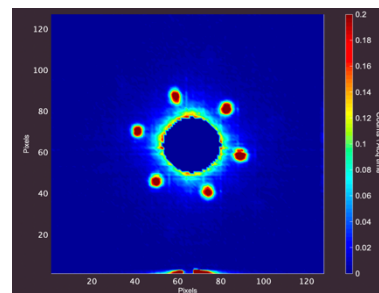


Fig. 1. Magnetic flux lattice pattern of Nb. ($\Lambda=7\text{\AA}$, PSD=16m, $H=2010\text{G}$)