Crystal structure in a non-centrosymmetric pressure-induced superconductor $CeRhSi_3$

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Coexistence between magnetism and superconductivity is the central issue in condensed matter physics. Recently non-centrosymmetric heavy-fermion superconductor $CePt_3Si$ [1] and UIr [2] were reported. From the fundamental point of view of symmetry, the discovery of these materials are very surprising because there are two basic symmetries which are considered indispensable to form Cooper pair: time reversal symmetry and parity. The former is important for Cooper pairing in any case while the latter is mandatory for pairing in the triplet channel. Thus there is no right picture for the non-centrosymmetric superconductivity at present.

Kimura *et al.* [3] discovered another non-centrosymmetric superconductor $CeRhSi_3$. Its crystal structure is the $BaNiSn_3$-type belonging to space group *I*4*mm* (No. 107) without an inversion center. [4] $CeRhSi_3$ exhibits the antiferromagnetic (AFM) ordering below T_N = 1.6 K at ambient pressure. By increasing the pressure, T_N shows a maximum around 0.7 GPa, then gradually decreases. Superconductivity appears in a wide pressure range from 1.2 to 2.3 GPa (and more). To determine the magnetic structure of the AFM state, we performed the neutron diffraction measurements using single crystals $CeRhSi_3$, proving that the longitudinal spin-density wave state with the incommensurate wave vector $Q \sim (0.215, 0, 0.5)$ is realized below T_N with a small magnetic moment of 0.16(10) m_B/f.u., which indicates that this material is located in the vicinity of quantum critial point (QCP). [5] On the other hand, as far as we know, there is no information on the lattice parameters and atomic position at low temperature in this material. Therefore there is no band structure calculations suggesting the nesting vector which directly connects with the SDW structure.

To determine the crystal structure in $CeRhSi_3$ at low temperature, we performed the powder neutron diffraction measurements at the HERMES in JRR-3/JAEA. Figure 1 shows the typical power pattern in $CeRhSi_3$ at 1.1 K (below T_N). The red solid lines are the obtained data and the blue broken lines are the calculations. Since the magnetic moment is small, no incommensurate magnetic peak is observed. Futhermore we, unexpectedly, found the unknown second phase in the powder. These features are seen in the previous neutron powder diffraction measurments. [6] Then unfortunately we can not determine the crystal structure in $CeRhSi_3$ at low temperature.

References

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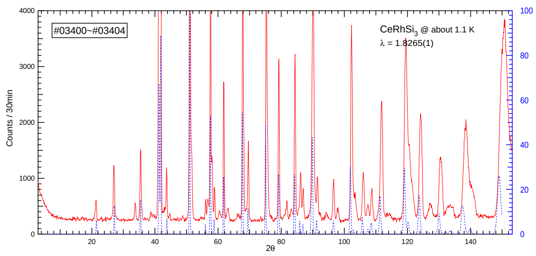

Fig. 1. Neutron power pattern in $CeRhSi_3$ at 1.1 K (below T_N).