

Title: Unconventional superconductivity at non - centrosymmetric Ru_7B_3 .

Symmetry breaking is an important phenomena in physics. Gauge symmetry is broken in all superconductors due to electron pairing, however unconventional superconductors may also break other symmetries. Non-centrosymmetric compounds are particularly interesting as they lack an inversion centre which can lead to a mixture of spin-singlet and spin-triplets states. The non-centrosymmetric superconductor Ru_7B_3 was studied by muon spectroscopy on MUSR, at ISIS, on both polycrystalline and single crystal samples. Additionally a small angle neutron scattering (SANS) experiment was carried out on D22, at ILL. Ru_7B_3 crystallises at hexagonal Th_7Fe_3 structure with a space group $P6_3mc$, and enters a superconducting state below $T_C = 3.3$ K for a polycrystalline sample and $T_C = 2.8$ K for a single crystal. The lower critical temperature for a single crystal could be explained by a boron deficiency.[1]. Muon spin relaxation spectra for polycrystalline Ru_7B_3 indicate the presence of a small spontaneous magnetic field when the sample is in a superconducting state, at zero applied magnetic field. Hence time reversal symmetry is broken at Ru_7B_3 . Additionally, our muon spin rotation measurements of polycrystalline Ru_7B_3 showed a distinct beating at time dependence of asymmetry of muon polarisation, on top of the usual signal from a superconductor. This indicates two different frequencies of muon spin precession were observed at the same time which implies either anisotropy at the flux line lattice of Ru_7B_3 or the presence of a square vortex lattice in this material. [2, 3].

A single crystal of Ru_7B_3 displays different properties. Time reversal symmetry is preserved and at the muon polarization asymmetry spectra the beating is less prominent, although it is clearly noticeable again when a powdered single crystal sample was measured.

Recent SANS experiment provide evidence of anisotropic behaviour of the flux line lattice of Ru_7B_3 . However square vortex lattice was not observed.

References

- [1] N. Kase and J. Akimitsu. Superconducting state of the binary boride Ru_7B_3 with the noncentrosymmetric crystal structure. *J. Phys. Soc. Japan*, 78(4):044710, 2009.
- [2] E.H. Brandt and A. Seeger. Muon-spin rotation as a tool for investigating the diffusion of positive muons in type-II superconductors. *Advances in Physics*, 35(2):189–236, 1986.
- [3] A.D. Sidorenko, V.P. Smilga, and V.I. Fesenko. μ SR and determination of vortex lattice characteristics of anisotropic high- T_C superconductors. *Physica C*, 166(1–2):167 – 176, 1990.