Contribution ID: **206** Type: **Poster**

A muon-spin relaxation study of type-I rhenium investigating time-reversal symmetry breaking in the superconducting state

Tuesday, 30 August 2022 18:40 (20 minutes)

Time-reversal symmetry breaking is a signature of unconventional superconductivity and can be observed from zero-field muon spin relaxation measurements as an increase of the muon relaxation rate through the superconducting transition temperature. Time-reversal symmetry breaking, although rare, has been observed in several noncentrosymmetric rhenium-based intermetallic superconductors [1].

Recent results indicate that elemental rhenium powder, exhibiting type-II superconductivity with a transition temperature of 2.7 K, also breaks time-reversal symmetry [2]. This suggests that the local electronic structure of rhenium may be intrinsically linked to the unconventional superconductivity in the rhenium-based materials. However, removing internal strain from the rhenium by melting or annealing reduces the transition temperature to 1.7 K and leads to type-I superconductivity.

In the present study, we have investigated the superconductivity in type-I rhenium using zero-field muon-spin relaxation measurements [3]. No unconventional behaviour is observed, and time-reversal symmetry is preserved in the superconducting state. Instead of the muons remaining stationary over their lifetime, we observe muon diffusion across the full temperature range studied, with muons quantum-mechanically hopping between interstitial sites. The hopping rate exhibits metallic behaviour in the normal state. In the superconducting state, the behaviour can be described qualitatively by including the presence of the superconducting energy gap and energy asymmetries between muon sites from crystallographic defects.

These results call into question the role the electronic structure of rhenium plays in the breaking of time-reversal symmetry in rhenium-based intermetallic superconductors and demonstrates that the behaviour of muon spectroscopy data can be governed by muon diffusion effects.

[1] S. K. Ghosh, *et al.*, J. Phys. Condens. Matter **33**, 033001 (2020).
[2] T. Shang, *et al.*, Phys. Rev. Lett. **121**, 257002 (2018).
[3] D. G. C. Jonas *et al.*, Phys. Rev. B **105**, L020503 (2022).

Primary author: Mr JONAS, David (University of Warwick)

Co-authors: Dr BISWAS, Pabitra (STFC / UKRI); Dr HILLIER, Adrian (STFC / UKRI); Dr MAYOH, Daniel (University of Warwick); Prof. LEES, Martin (University of Warwick)

Presenter: Mr JONAS, David (University of Warwick)

Session Classification: Posters

Track Classification: Superconductivity