# High Magnetic Field Measurements of a Kondo Semiconductor

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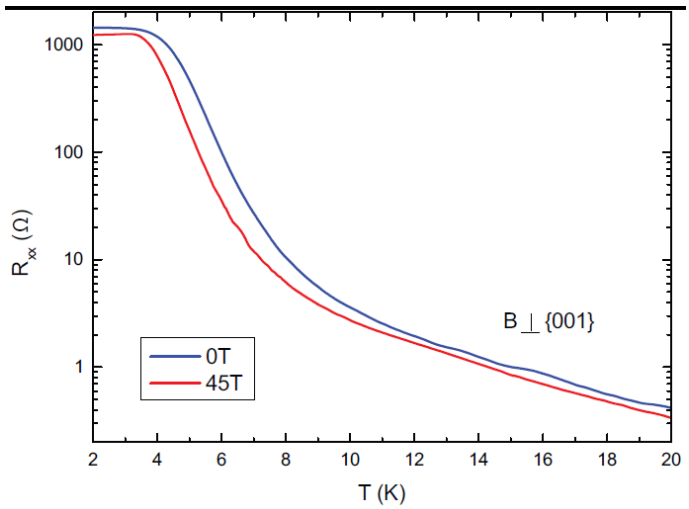
## Introduction

Measurements of electrical transport, infrared conductivity, heat capacity, and others have revealed $SmB_6$ to be a bulk Kondo semiconductor, with an activation gap of the order of 30 K [1]. While recent interest has focussed on this material due to the identification of a surface conductance layer that is potentially topological [2,3], the focus of the present study is the bulk rather than the surface of $SmB_6$.




## Experimental

Single crystals of $SmB_6$ used in the present study were grown by the image furnace technique in order to avoid potential effects of extraneous flux such as Aluminium. Special care was taken to further purify as-grown crystals to remove potential effects of strain or other impurity effects. Single crystals with the highest inverse resistance ratios higher than 105 between $T$ = 1:8 K and $T$ = 300 K were selected for measurement; a measure of the inverse resistance ratio has been shown to characterise crystal quality with the introduction of point defects for example by radiation damage, or by off-stoichiometry having been shown to result in a decrease in low temperature resistance and an increase in high temperature resistance.

Fig. 1 shows the resistance of a $SmB_6$ single crystal measured as a function of temperature at zero magnetic field and in an applied DC magnetic field of 45 T. Perhaps surprisingly, very little magnetoresistance is observed, with the resistance as a function of temperature at 45 T remaining very similar to that at 0 T. Activated resistance behaviour is thus observed to persist up to high magnetic fields. Furthermore, the non-magnetic ground state of $SmB_6$ is evidenced by a small value of linear magnetic susceptibility up to 60 T.

Magnetic torque on $SmB_6$ is measured in magnetic fields up to 40 T down to 0.4 K. Non-monotonic features are observed in the magnetic torque at the lowest temperatures. The observed features are likely associated with the bulk of the sample, given that the observed features show very little angular dependence

## Results and Discussion

Magnetoresistance and magnetic torque measurements will be pursed to dilution fridge temperatures to investigate the magnetoresistance to lower temperatures, and the temperature dependence of observed nonmonotonic features observed in magnetic torque.

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## References

[1] Nickerson, J. C. et al. Phys. Rev. B **3**, 2030 (1971).
[2] Wolgast, S. et al., Phys. Rev. B **88**, 180405(R) (2013).
[3] Phelan, W. A. et al., Phys. Rev. X **4**, 031012 (2014).