Bismuth Beyond the Quantum Limit

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Introduction

The aim of this project is to study the instabilities of a three-dimensional electron gas beyond the quantum limit. Elemental bismuth is one of the rare cases in which such an exploration can be done with currently available magnetic fields. In 2007, we detected unexpected anomalies in the Nernst response of elemental bismuth beyond 9 T, the quantum limit when the field is applied across the trigonal axis [1].

Experimental

We studied the Nernst effect in the hybrid magnet up to 45 T and performed angular-dependent resistivity and Hall measurements in a resistive magnet. Experiments were performed in He^3 cryostats. A miniature two-thermometer-one-heater set-up was used to measure the Nernst effect.

Results and Discussion

In addition to the previous anomalies, a new high-field anomaly in the Nernst response was resolved. The ultraquantum anomalies in transport properties present a sharp angular dependence as previously reported in the case of torque magnetization anomalies [2]. The analysis of the results is still under way. One striking finding is the observation of Hall plateaus for particular orientations of a magnetic field over a finite field window (Fig. 1). The plateaus rapidly vanish when the field is tilted off these magic angles [3].

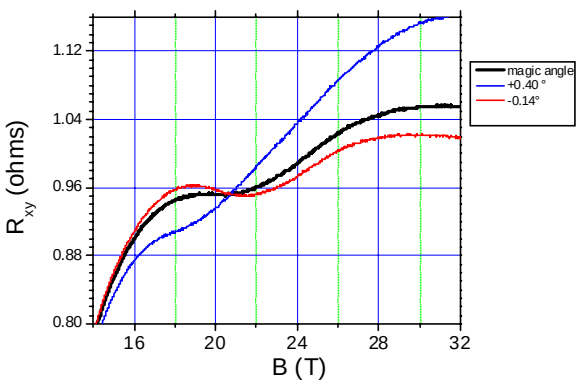

Fig.1: When the field is oriented along a particular orientation, the Hall response in bismuth presents a plateau, which rapidly vanishes as the field is tilted.

Conclusions

There is a lot of interesting unexplored physics in elemental bismuth beyond the quantum limit.

Acknowledgements

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References

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