Nernst Effect in Ultraquantum Bismuth

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Introduction

The aim of this project was to study the thermoelectric response of a clean bulk metal beyond the quantum limit. A previous study detected giant quantum oscillations of the Nernst coefficient in elemental bismuth[1]. This experiment was set to probe any further anomaly at higher fields.

Experimental

We built a miniature probe to measure Nernst effect and used a He^3 refrigerator inside a resistive magnet yielding 33 T. Thermal conductivity in bismuth is field-independent. Therefore, a constant heat current yielded a constant temperature gradient along the sample. The signal-to-noise ratio in our DC voltage measurement was very satisfactory.

Results and Discussion

We resolved three new anomalies in the field dependence of the Nernst coefficient beyond the quantum limit (see the figure). These anomalies occur in the ultraquantum limit. They appear to be beyond the one-particle picture which successfully describes the low-field peaks associated with quantum oscillations. They may constitute the first detected signatures of electron fractionalization in a bulk metal.

Conclusions

The results were published in Science [2]. We intend to pursue this investigation by studying the Nernst response of bismuth in the hybrid magnet up to 45 T next January.

Acknowledgements

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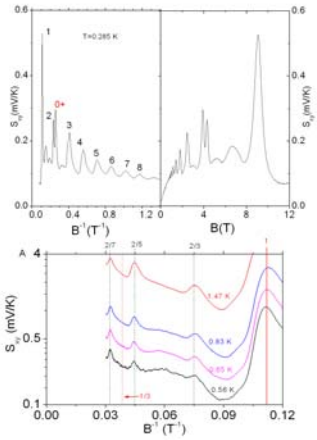

Fig. 1: Nernst effect as a function of field below (upper panel) and above (lower panel) the quantum limit. Note the three additional peaks.

References

[1] K. Behnia, M. -A. Méasson, Y. Kopelevich, Phys. Rev. Lett. **98**, 166602 (2007).
[2] K. Behnia, L. Balicas, Y. Kopelevich, Science **317**, 1729 (2007)