Temperature-Dependent Rxx in Untra-Quantum Limit of Bismuth Along Binary

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Introduction

Beyond quantum limit of bismuth along binary, a transition from semimetal to semiconductor was proposed and "observed" with far-infrared radiation measurement[1]. The transition field is important to determine the parameters for the first principle calculation, band parameters and the low-field analysis. The measurement was up to 120T within 18 micro seconds with an explosive magnet. The non-destructive magnet is exact suitable for the measurement by measuring magnetoresitance along the binary in bismuth.

Experimental

We carried out a temperature-dependent Rxx along binary. The Rxx is showed in Fig.1. The sudden drop at 40T related to the quantum limit of hole pocket in bismuth. But at 88T, no obvious transition is observed. Instead, we observed a weak hump around 77 T. The temperature-dependent magnetoresistance in whole range beyond 40T is metal-like instead of the semiconductor-like which would increase with temperature lowered.

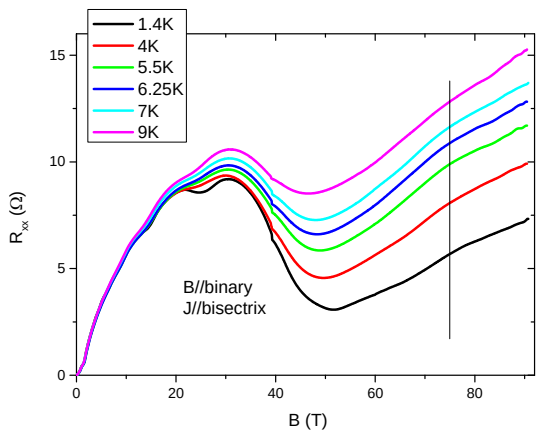

Fig.1 temperature-dependent in-plane Rxx in the pulsed field up to 90T. The weak hump is observed at 77T. No transition is observed at 88T.

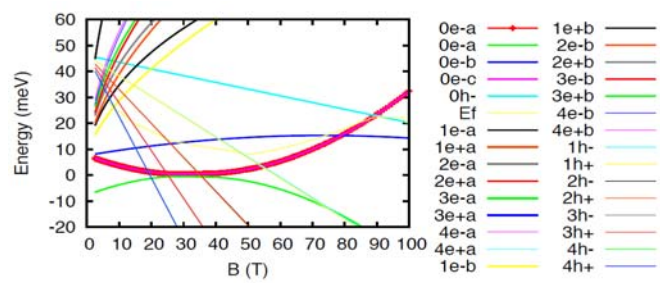

Fig.2 the theoretical calculation when the field is along binary up to 100T.

Results and Discussion

Between 20T and 33T, Fermi energy E_f is proximity to 2h. Between 33T and 50T, Fermi energy E_f pins to 0e-b, and crosses the 1h at 43T, The Fermi energy E_f leave 0e-b at 50T. When the field is large than 50T, Ef pins to 0e-a and crosses 0e-b at 80T again. The theoretical calculation might explain the observation.

Conclusions

We performed temperature-dependent Rxx measurement. A Theoretical calculation was carried out for the observation. The semimetal-semiconductor transition might occur at higher field according to our new calculation.

Acknowledgements

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Reference

[1] N. Miura, K. Hiruma, G. Kido, and S. Chikazumi, Physical Review Letters **49**, 1339 (1982).