Evidence for the axial anomaly in a quasi-two-dimensional metal

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The axial anomaly leads to the violation of separate number conservation laws for left- and right-handed massless chiral (or Weyl-) fermions. For a certain class of gapless semiconductors, for which the low-energy band structure is described in terms of Weyl-fermions, the application of a magnetic field parallel to the electrical current is predicted to induce a large suppression of the electrical resistivity. To date, there is no concrete experimental realization of a Weyl semi-metal or unambiguous evidence for this field-induced phenomenon. Here, we report the observation of a very large negative *longitudinal* magnetoresistance in the extremely clean quasi-two-dimensional metal $PdCoO_2$ for fields along the inter-planar direction [1] . We observe this pronounced negative magnetoresistivity also for fields away from the *c*-axis when it overcomes the extremely large orbital one. It is not observed for fields aligned along an Yamaji angle, where the inter-planar transfer integral is effectively renormalized to zero, thus suggesting that it is intrinsically correlated with a finite inter-planar dispersion. We argue[1,2] that our experimental study provides strong support for a scenario where this unconventional response results from the axial anomaly of field-induced quasi-one-dimensional conduction channels. The observation of this effect in $PdCoO_2$ would demonstrate that the axial anomaly would be a general feature of the longitudinal magnetotransport of clean and weakly correlated three-dimensional metals.

[1] N. Kikugawa, P. Goswami, A. Kiswandhi, E. S. Choi, D. Graf, R. E. Baumbach, J. S. Brooks, K. Sugii, Y. Iida, M. Nishio, S. Uji, T. Terashima, P. M. C. Rourke, N. E. Hussey, H. Takatsu, S. Yonezawa, Y. Maeno, L. Balicas. arXiv:1412.5168 (2014).
[2] P. Goswami, J. Pixley, and S. Das Sarma (to be published).