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Anomalous magnetotransport in materials with strongly anisotropic Fermi surfaces

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Recent experiments probing the magnetic-field dependence of the resistivity $\rho(H)$ of selected charge-density-wave (CDW) materials including GdSi, Cr, $SrAl_4$, $NbSe_3$ and $(PO_2)_4(WO_3)_{2m}$ etc, revealed a linear-in-H variation of $\rho(H)$ at low fields and at temperatures below the CDW transition [1]. The classical theory of magnetoresistance (MR), based on Boltzmann's transport theory [2], however, predicts a quadratic-in-H variation of $\rho(H)$ at low fields. Attempts to adapt existing models involving, e.g., the linear dispersion of Dirac cones [3] failed to predict the observed $\rho(H)$ feature.

In this talk, we outline a simple 2D model which predicts the linear variation of $\rho(H)$ to arise from a strongly anisotropic Fermi surface [4] here assumed to consist of a rectangular cross section with rounded corners. This is an extension of Pippard's original model [2] where the corners are 90° angles. Our model considers that the corner regions may adopt light or heavy effective masses. While both variants of the model invariably reproduce the linear MR in low fields, the model predicts a saturating longitudinal MR and a nonzero Hall resistance for the "light-corner" variant but the opposite for the "heavy-corner" variant. New forthcoming experiments are expected to further improve the understanding of this intriguing feature of CDW materials.

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[2] A. B. Pippard, Magnetoresistance in metals, Vol. 2 (Cambridge University Press, Cambridge, 1989).
[3] A. A. Abrikosov, "Quantum linear magnetoresistance", Europhys. Lett. 49 789 (2000).
[4] L. Zou, S. Lederer, and T. Senthil, "Theory of anomalous magnetotransport from mass anisotropy", Phys. Rev. B 95 245135 (2017).

Position

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