Tilted Dirac Cone Effect on Interlayer Magnetoresistance in α-$(BEDT\text{-}TTF)_2I_3$

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Usually electrons in a conductor are well described by a non-relativistic Schrödinger equation. Because the Fermi velocity is much less than the velocity of the light. However, if the electronic band structure has a linear dispersion then the dynamics of the electrons are described by a relativistic Dirac equation with the velocity of the light replaced by the Fermi velocity. Graphene is a well-known example as reviewed in Ref.[1].

The Dirac fermion energy spectrum is also realized in the layered organic compound α-$(BEDT\text{-}TTF)_2I_3$. Under pressure above 2GPa, the electron correlation that leads to charge ordering under ambient pressure is suppressed and the system shows behaviors expected in a Dirac fermion system: The carrier density shows T^2 behavior[2] and the negative interlayer magnetoresistance is observed[3] which is consistent with the zero energy Landau level of the Dirac fermions[4].

Theoretically the Dirac fermion spectrum in α-$(BEDT\text{-}TTF)_2I_3$ is not a simple Dirac cone but a tilted Dirac cone as suggested in Ref.[5]. The tilt of the Dirac cone leads to an azimuthal angle dependence of the interlayer magnetoresistance[6]. We discuss applications of the formula in Ref.[6] to experiments. In particular we argue that discrepancies between the experiments[3] and theoretical formula[4] are associated with the tilt effect. In the presence of the tilt, non-zero interlayer hopping matrix elements appear between different Landau levels. We discuss a unified picture connecting the negative magnetoresistance regime with the positive magnetoresistance regime.

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