Does Magnetic Field Break the Interlayer Coherence?

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The extremely high anisotropy characteristic of many organic metals brings into question the coherence of the interlayer charge transport in them. While the temperature dependence of the interlayer resistivity $\rho_c(T)$ in most cases remains metallic, at least, at low T, the estimated interlayer hopping time often exceeds the quasiparticle scattering time. This obviously makes the classical three-dimensional (3D) transport description inappropriate. Indeed, distinct anomalies of ρ_c observed on some compounds in magnetic fields [1-3] have been attributed to a breakdown of the interlayer coherence. Various scenarios were proposed to explain violations of the classical 3D theory (see, e.g. [4,5]); however, the situation remains controversial.

To elucidate the problem, we have performed a detailed study of the anomalous interlayer magnetoresistance, taking α-(BEDT-TTF)$_2$KHg(SCN)$_4$ under pressure (in the normal metallic state) as a model object. We have found that the anomalous behavior is inconsistent with the earlier proposed field-induced confinement (FIC) model [4]. On the other hand, it can be nicely described by parallel contribution of two conduction channels, providing, respectively, coherent and incoherent interlayer charge transfers. A strong magnetic field changes the relative contributions of the channels, thus causing an apparent dimensional crossover. However, by contrast to the FIC scenario, this crossover does not imply a change in the dynamic properties of charge carriers. We discuss the possible mechanism of the incoherent conduction channel and show how the proposed model can be applied to other layered metals situated in the transient region between the fully coherent and incoherent transport regimes.

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