First Observation of Angle-Dependent Stark Cyclotron Resonance in Bulk Crystals: High-Electric-Field Interlayer Magnetotransport in a Layered Organic Conductor

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We report novel angle-dependent magnetotransport phenomena in quasi-two-dimensional layered conductors under interlayer electric fields. Interlayer conduction shows the Stark cyclotron resonance (SCR) when electron orbital motion becomes periodic in **k**-space. SCR amplitude oscillates depending on magnetic field orientations. The conventional angle-dependent magnetoresistance oscillation (AMRO) switches to this angle-dependent SCR in high electric fields.

We predict angle-dependent SCR by employing the Boltzmann semiclassical magnetotransport theory based on coherent electron orbital motion. Although SCR has already observed in artificial semiconductor superlattices with incoherent interlayer coupling, it has been ascribed not to bulk orbital effect but to local tunneling effect assisted by phonons. In this sense, the present SCR with orbital origin is quite different. Moreover, there has been no observation of SCR in bulk crystals.

In order to demonstrate angle-dependent SCR in a bulk layered crystal with coherent interlayer coupling, we chose an organic conductor α-(BEDT-TTF)$_2$NH$_4$Hg(SCN)$_4$, which has large interlayer spacing among bulk crystals. As shown in the figure, we have successfully observed the expected switching from conventional AMRO to angle-dependent SCR in high electric fields. This is the first observation of SCR in a bulk crystal. In addition, the present result implies the possibility of SCR as a new experimental tool to estimate effective mass only from transport measurement.

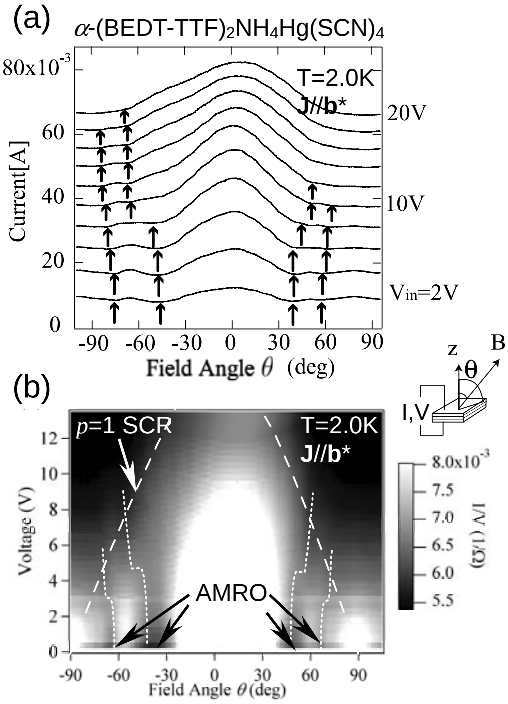

Fig.1 (a) Angle-dependence of interlayer current for several voltages when the magnetic field is rotated. (b) Density plot of current per voltage as a function of angle and voltage.