Quantum Hall Effect in Molecular Dirac fermion systems

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First bulk (multilayered) two-dimensional (2D) zero-gap state with massless Dirac particles was realized in an organic conductor α-(BEDT-TTF)$_2$I$_3$ under pressure [1-3]. The Shubnikov-de Haas oscillations (SdHO) or the quantum Hall effect (QHE) originated from the Dirac particle, however, have not been observed yet until now because Fermi level always locates at the Dirac point. Thus, we have succeeded in detecting the zero-mode Landau level and its spin-split levels in this system probed by inter-layer magnetoresistance [3]. Quite recently, we made a breakthrough in the detection of SdHO and QHE in this system [4]. The hole-doping was successful by only fixing a crystal on a substrate weakly negatively charged by contact electrification. The QHE plateaux for ν= 6, 10, (14 and 18) were detected in the magnetic field up to 7 T at the temperature below 2 K. Those steps are essence of 2D Dirac fermion systems.

In this work, SdHO and QHE were investigated in the magnetic field up to 14 T. We succeeded in detecting the QHE plateau for ν=4 which is the spin-splitting state of N=1 Landau level. In this state, the ν=4 quantum Hall ferromagnetic state is anticipated. This multilayered Dirac fermion system is characterized further from the detection of SdHO and QHE and its interpretation.

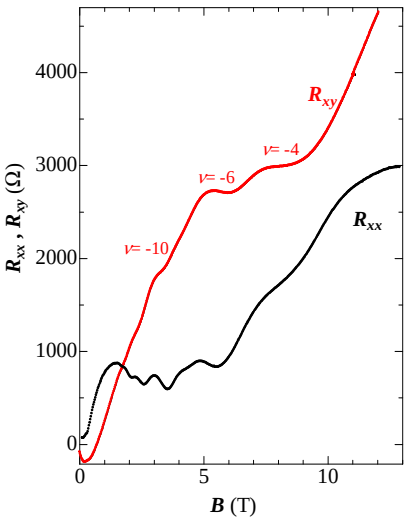

Fig.1. SdHO and QHE

[1] S. Katayama, et al., J. Phys. Soc. Jpn. **75**, 054705 (2006).
[2] N. Tajima, et al., EPL **80**, 47002 (2007).
[3] N. Tajima, et al., Phys. Rev. Lett. **102**, 176403 (2009).
[4] N. Tajima, et al., to be submitted.