The beauty of quantum transport in graphene grown on SiC

Benoit Jouault

Laboratoire Charles Coulomb (L2C), UMR 5221 CNRS-Université de Montpellier, Montpellier, France

The famous integer quantum Hall effect (QHE), discovered in 1980, is one of the most fascinating quantum effects existing in condensed matter physics. It appears in a strong transverse magnetic field, as the Hall resistivity of a two dimensional electron gas (2DEG) develops plateaus at values quantized in units of h/e^2. Because of this unique relation between electrical resistance and fundamental physical constants, the QHE in GaAs heterostructures is used in modern metrology to define electrical resistance standards. The discovery of the QHE in graphene a few years ago sparked an immediate interest. In graphene, the massless nature of the charge carriers leads to a Landau level spectrum with an energy gap between the first adjacent levels which is five times larger than that in GaAs for magnetic fields around 10 T and twenty times larger around 1 T. This implies that the QHE in graphene can be observed at much reduced magnetic fields or at much higher temperatures. The QHE is therefore expected to be more robust in graphene. This has been confirmed by recent experimental works, where QHE was observed in monolayer graphene on SiC with homogeneous carrier concentration, low carrier densities and high mobility - three prerequisites for metrology.

Motivated by these perspectives, we will show some of our recent results obtained with graphene grown on SiC substrates. We have shown that in these samples, little changes in temperature during the growth can trigger the carrier concentration [1]. Monolayer graphene films are obtained, homogeneous at the centimeter scale, allowing precise transport measurements. The study of the quantum corrections at low magnetic fields reveals that various scattering mechanisms are at play in these devices [2]. At higher fields, the stability of the quantum Hall plateaus with respect to current, temperature and magnetic field is remarkable and extends over more than 70 T. This stability is probably linked with both charge transfer and/or some specific disorder. Finally, we will present the best metrological results obtained with these samples [3]. They show exceptionally good metrological properties, with relative accuracies of the quantized resistance of the order of 10^{-9}.

References

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