Thermoelectric Transport Coefficients for Massless Dirac Electrons in Quantum Limit

Igor Proskurin and Masao Ogata

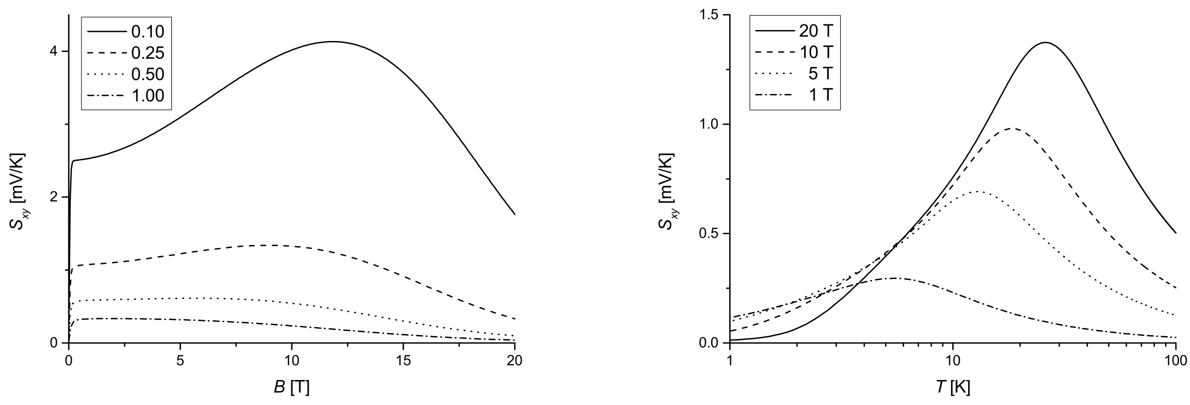
Department of Physics, The University of Tokyo, Hongo 7-3-1, Bunkyo-ku Tokyo 113-0033

email: iprosk@hosi.phys.s.u-tokyo.ac.jp

Unusual thermoelectric properties of graphene have recently attracted considerable interest. In quantizing magnetic field, when chemical potential μ is close to zero, Nernst and Seebeck coefficients in graphene show anomalous behaviour, while for large μ their behaviour is consistent with early theoretical predictions for non-relativistic two-dimensional electron gas [1].

While the μ-dependence of thermoelectric coefficients for massless Dirac electrons is now rather well understood [2,3], the magnetic field and temperature dependences in quantum limit are less studied. The aim of the present work is to clarify the magnetic field and temperature dependencies for the Nernst coefficient in quantum limit for the case when μ is close to the Dirac point. For this purpose we perform an analytical calculation of the thermoelectric coefficients for massless Dirac fermions using the approach based on the Kubo–Středa formula and generalized Mott's relation. In the case when the broadening of Landau levels due to the impurity scattering, Γ, is weak in comparison with temperature broadening, we obtain an analytic formulae which can be useful for qualitative analysis. In order to compare our results with recent experiments in α-(BEDT-TTF)$_2$I$_3$ organic conductor [4], we also include Zeeman splitting of Landau level which is important for understanding of experimental data in quantizing magnetic fields.

The figure shows calculated magnetic field (a) and temperature (b) dependencies for the Nernst coefficient at $\mu = 0$ for Fermi velocity $v_F = 0.5 \times 10^5$ m/s and g-factor $g = 2$.



(a) Magnetic field dependence of the Nernst coefficient for different Γ at 1.5 K

(b) Temperature dependence of the Nernst coefficient at different magnetic fields.

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