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Derivative relations between electrical and thermoelectric quantum transport coefficients in graphene\(^1\) XINFEI LIU, Department of Physics and Astronomy, University of California, Riverside, ZHONGSHUI MA, School of Physics, Peking University, JING SHI, Department of Physics and Astronomy, University of California, Riverside — We find that the empirical relation between the longitudinal and Hall resistivities (i.e. \(R_{xx}\) and \(R_{xy}\)) and its counterpart between the Seebeck and Nernst coefficients (i.e. \(S_{xx}\) and \(S_{xy}\)), both originally discovered in conventional two-dimensional electron gases [1,2], hold surprisingly well for graphene in the quantum transport regime except near the Dirac point. These empirical relations can be described by the following equations:

\[
R_{xx} = \alpha_r \cdot \frac{B}{n} \frac{dR_{xy}}{dB}, \quad S_{yx} = \alpha_s \cdot \frac{B}{n} \frac{dS_{xx}}{dB}
\]

Here R and S are electrical resistivity and thermoelectric conductivity tensor respectively. The validity of the relations is cross-examined by independently varying the magnetic field and the carrier density in graphene. We demonstrate that the pre-factor, \(\alpha_s\), does not depend on carrier density in graphene. By tuning the carrier mobility therefore the degree of disorders, we find that the pre-factor stays unchanged. Our experimental results validate both derivative relations for massless Dirac fermions except near the Dirac point.


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