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Thermoelectric power in graphene and quark–gluon plasma systems

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The thermoelectric power or Seebeck coefficient of graphene and quark gluon plasma (QGP) produced in the relativistic heavy ion collision experiment exhibits significant deviation compared to the conventional Mott relation. This deviation highlights the unique transport properties and strongly interacting quantum fluid behaviors of both the graphene and QGP cases. Near the charge neutrality point, the Seebeck coefficient approaches the hydrodynamic limit, showing an enhanced value at high temperatures. In this study, we investigate the Seebeck coefficient of a clean graphene monolayer using a kinetic theory-based relaxation time approximation (RTA) calculation, incorporating the fluid-like collective dynamics of charge carriers. By assuming an energy-independent relaxation time, we demonstrate that the Seebeck coefficient derived from a quasiparticle description of the electron-hole plasma with linear dispersion provides a good agreement with experimental observations. Similarly, for QGP, we observe the thermoelectric power by using the kinetic theory-based RTA calculation. The comparative study of graphene and QGP thus provides deep insights into the transport characteristics for high-energy physics and nanoscale thermoelectrics.

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Author: Mrs NAYAK, Subhalaxmi (IIT BHILAI)

Co-authors: Dr DEY, Jayanta (JINR,DUBNA,RUSSIA); Dr GHOSH, Sabyasachi (IIT BHILAI); Dr VEMPATI, Sesha (IIT BHILAI)

Presenter: Mrs NAYAK, Subhalaxmi (IIT BHILAI)

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