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Hydrodynamic Transport Properties of Dirac Materials in the Quantum Limit MATTHEW GOCHAN, KEVIN BEDELL, Boston College —
Dirac materials are a versatile class of materials in which an abundance of unique physical phenomena can be observed. Such materials are found in all dimensions, with the shared property that their low-energy fermionic excitations behave as massless Dirac fermions and are therefore governed by the Dirac equation. The most popular Dirac material, its two dimensional version in graphene, is the focus of this work. We seek a deeper understanding of the interactions in the quantum limit within graphene. Specifically, we derive hydrodynamic and transport properties, such as the conductivity, viscosity, and spin diffusion, in the low temperature regime where electron-electron scattering is dominant. To conclude, we look at the so-called universal lower bound conjectured by the anti-de Sitter/conformal field theory (AdS/CFT) correspondence for the ratio of shear viscosity to entropy density ratio. The lower bound, given by $\eta/s \geq \hbar/(4\pi k_B)$, is supposedly obeyed by all quantum fluids. This leads us to ask whether or not graphene can be considered a quantum fluid and perhaps a "nearly perfect fluid"(NPF); if this is the case, is it possible to find a violation of this bound at low temperatures.

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