

Unbounded hydrodynamics in nodal-line semimetals

The ratio between the shear viscosity and the entropy η/s is considered a universal measure of the strength of interactions in quantum systems. This quantity was conjectured to have a universal lower bound $(1/4\pi)\hbar/k_B$, which indicates a very strongly correlated quantum fluid. After a general overview on quantum hydrodynamics, which describes the long wavelength deviations of local thermal equilibrium, I will address the quantum kinetic theory for a nodal-line semimetal in the hydrodynamic regime. I will show that the ratio between the shear viscosity and the entropy is unbounded, scaling towards zero with decreasing temperature in the perturbative limit. Due to the large unscreened Fermi surface represented by the nodal-line, the phase space for collisions is greatly enhanced compared to either conventional relativistic systems and metals, resulting in a short hydrodynamic scattering time that is nearly temperature independent (up to logarithmic scaling corrections) and set by the radius of the nodal line. I suggest that the lower bound criteria should be modified to account for unscreened relativistic systems with a Fermi surface.