Gapped momentum states and shear viscosity limit in strongly coupled mesoscopic systems

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Shear viscosity is the property to resist and diagnose the strength of the interaction between condensed matter constituents. There is a paradox that the low shear viscosity indicates a significant interaction strength [1]. There is estimation of fundamental lower limit $\eta/s = \hbar/(4\pi k_B)$ (universal lower bound). Existence of viscosity limit is related to gapped momentum states (GMS) in open dissipative systems. GMS emerge in liquid viscoelasticity revealing k_g-gaps in dispersion relations with applications in turbulence and non-ideal (dusty) plasma as interplay between propagation, dissipation effects and relaxation time [2]. This corresponds to Fraenkel definition of liquid as condensed matter state retaining structural features of solid and corresponding set of internal (thermodynamic) variables. Structural image of k_g-gap can be introduced as localized shears corresponding to coordinated movement of molecules in elastic field of shear stresses. Statistical thermodynamics of microshear ensemble established criticality type (structural-scaling transition) leading to generation collective modes (solitary and blow-up) as mechanism of k_g-gap related to new spatial and temporal scales. Critical dynamics of microshears collective modes provides anomaly of energy absorption and self-similarity of momentum transfer with power law viscosity asymptotic limits. This asymptotic was supported experimentally at steady state wave fronts in shocked liquids [3].

[1] Fortov V E and Mintsev V B 2013 *Phys. Rev. Lett.* **111** 125003
[2] Baggioli M, Vasin M, Brazhkin V and Tkachenko K 2020 *Phys. Rep.* **865** 1–44
[3] Naimark O B 2016 *Phys. Mesomech.* (3) 19