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Looking at bare transport coefficients in fluctuating hydrodynamics

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It is well established that fluid motions at the macroscopic scale are governed by the celebrated Navier-Stokes equation. However, in mesoscopic regimes where fluctuations become significant, the governing equations must incorporate fluctuation terms, leading to the framework of "fluctuating hydrodynamics" [1]. A central feature of this framework is the presence of noise terms and associated transport coefficients, referred to as bare transport coefficients. These coefficients characterize dissipation and transport at the mesoscopic scale and differ from the macroscopic transport coefficients of the deterministic Navier-Stokes equation, which govern macroscopic fluid phenomena. Particularly in two-dimensional (2D) fluids, this distinction between the bare and macroscopic transport coefficients is crucial [2]. The macroscopic coefficients depend on system size and diverge logarithmically as the system size increases, while the bare coefficients are expected to remain finite constants determined by microscopic details such as atomic structure, temperature, and pressure (or density). However, directly measuring the bare transport coefficients has proven challenging because standard observations typically yield only the macroscopic ones. In our recent paper [3], we address this challenge. We show how bare transport coefficients manifest in measurable physical quantities and propose practical methodologies for their determination. In this presentation, we will explain our results, presenting both numerical simulation results and theoretical calculations. [1] L. D. Landau and E. M. Lifshitz, Fluid Mechanics: Volume 6 (Elsevier, 1959) [2] D. Forster, D. R. Nelson, and M. J. Stephen, Physical review. A 16, 732 (1977). [3] H. Nakano, Y. Minami, and K. Saito, arXiv:2502.15241 (2025).

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