Abstract Submitted
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Nonlinear dynamics of clustering in particle-laden turbulent flows[1] MAHDI ESMAILY, ALI MANI, Stanford University — Heavy inertial particles in spatially and temporally varying flows can form clusters if their relaxation time is on the order of the dissipation time scale of the flow. This regime, identified by $\mathrm{St} = \mathcal{O}(\infty)$, is investigated in this study using analytical tools. We show that the nonlinear variation of segregation versus St can be explained by considering a one-dimensional canonical setting where particles are subjected to an oscillatory velocity gradient that is constant in space. Our analysis shows that the Lyapunov exponent, as a measure of particle segregation, reaches a minimum at $\mathrm{St} = \mathcal{O}(\infty)$ and becomes positive at $\mathrm{St} \gg 1$ and approaches zero as $\mathrm{St} \to 0$ or ∞. These predictions, which are corroborated by the numerical results, are directly linked and compared against measurements of the dispersion and segregation in three-dimensional turbulence. Our analysis reveals a strongly nonlinear behavior of the Lyapunov exponents in the straining regimes of strong oscillations.

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