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Chaos and threshold for irreversibility in sheared suspensions[1]
JERRY GOLLUB, Haverford College and UCSB, DAVID PINE, New York University and UCSB, JOHN BRADY, California Institute of Technology, ALEX LESHANSKY, Technion — Slowly sheared suspensions of solid particles are governed by time-reversible equations of motion. Here we report a precise experimental test showing that time-reversibility fails for slowly sheared suspensions. We study a dense suspension of PMMA particles (index and density matched to the fluid), at low Reynolds number in a Couette cell using oscillatory strain. We find that there is a concentration-dependent threshold strain amplitude beyond which particles do not return to their starting configurations after one or more cycles. Instead, their displacements follow the statistics of an anisotropic random walk. We determine the dependence of the effective diffusivities on strain amplitude, and the concentration dependence of the threshold. The experimental results are compared to numerical simulations, which demonstrate that the threshold strain amplitude is associated with a pronounced growth in the Lyapunov exponent for chaotic particle interactions. The comparison illuminates the connections between chaos, reversibility, and predictability.

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