Abstract Submitted for the MAR16 Meeting of The American Physical Society

Non-monotonic size-dependent particle diffusion in active fluids¹ ALISON PATTESON, Univ of Pennsylvania, ARVIND GOPINATH, University of California, Merced, PAULO ARRATIA, University of Pennsylvania — We experimentally investigate the effect of particle size on the motion of passive polystyrene spheres in suspensions of Escherchia coli. Using particles covering a range of sizes from 0.6 to 39 microns, we probe particle dynamics at both short and long time scales. In all cases, the particles exhibit super-diffusive ballistic behavior at short times before eventually transitioning to diffusive behavior. Surprisingly, the longtime hydrodynamic effective diffusivity exhibits a peak in particle size; an anomalous response that is fundamentally different from classical thermal diffusion. Consistent with recent theory, we find that the active contribution to particle diffusion is controlled by a dimensionless parameter, the Peclet number. We propose a minimal model that allows us to predict the requirements for a peak in the diffusivity as well as the magnitude of the peak as a function of particle size and bacterial concentration. Our results have broad implications on characterizing active fluids using concepts drawn from classical thermodynamics.

¹NSF-DMR-1104705 and NSF-CBET-1437482

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Date submitted: 06 Nov 2015

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