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Anomalous Drag Reduction and Hydrodynamic Interactions of Nanoparticles in Polymer Nanocomposite Thin Films JAYDEEP BASU, NAFISA BEGAM, Department of Physics, Indian Institute of Science, Bangalore, India, SIVASURENDER CHANDRAN, Department of Physics, Albert Ludwigs University of Freiburg, Germany, MICHAEL SPRUNG, PETRA-III, DESY, Germany — One of the central dogma of fluid physics is the no-slip boundary condition whose validity has come under intense scrutiny, especially in the fields of micro and nanofluidics. Although various studies show the violation of the no-slip condition its effect on flow of colloidal particles in viscous media has been rarely explored. Here we report unusually large reduction of effective drag experienced by polymer grafted nanoparticles moving through a highly viscous film of polymer, well above its glass transition temperature. The extent of drag reduction increases with decreasing temperature and polymer film thickness. We also observe apparent divergence of the wave vector dependent hydrodynamic interaction function of these nanoparticles with an anomalous power law exponent of ~ 2 at the lowest temperatures and film thickness. Such strong hydrodynamic interactions are not expected in polymer melts where these interactions are known to be screened to molecular dimensions. We provide evidence for the presence of large hydrodynamic slip at the nanoparticle-polymer interface and demonstrate its tunability with temperature and confinement. Our study suggests novel physics emerging in dynamics nanoparticles due to confinement and interface wettability in thin films of polymer nanocomposites.

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