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Falling-Ball Rheometry of Magnetized Ferrofluids in the Presence of Magnetic Particle Threads[1] A.F. CALI, A.D. TRUBATCH, P.A. YECKO, Montclair State University — To probe the rheology of magnetized ferrofluid on a millimeter scale, we examine the paths of glass spheres (500 micrometer diameter) falling in a bulk ferrofluid under a uniform magnetic field, applied at a fixed angle with respect to the horizontal. Visualization of the ball trajectories is accomplished by the capture of high-resolution, X-ray phase-contrast images on high-speed, digital video. The drag on each sphere is determined by measurement of its terminal velocity. The effective viscosity of the ferrofluid is observed to be anisotropic: the terminal velocity of a sphere depends on the angle of the applied magnetic field. Specifically, the drag is greater when the applied field is normal to the vertical path of the falling sphere than when parallel. We propose that this effect is due the field-induced formation of magnetic particle "threads" having diameter of a few microns (∼1000 nanoparticles) and lengths that span the container (a few millimeters). These threads form a dense parallel array aligned with the applied magnetic field and are visible in phase-contrast images of the bulk ferrofluid. We model the drag experienced by the falling ball as originating from the falling-ball Stokes flow through a fixed array of rigid threads with an inter-penetrating fluid.

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