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Pertrurbation theory for dynamic behavior of a sphere settling in a viscoelastic fluid MATTHEW NICK MOORE, Courant Institute of Mathematical Sciences, BIN LIU, Brown University School of Engineering, JUN ZHANG, New York University Department of Physics, Courant Institute, MICHAEL J. SHELLEY, Courant Institute of Mathematical Sciences, APPLIED MATHEMATICS LABORATORY, COURANT INSITUTE TEAM — We present a new perturbation theory for the motion of a rigid sphere settling in a viscoelastic Oldroyd-B fluid that can be generalized to other scenarios of viscoelastic fluid-structure interaction. In contrast to previous perturbation theories, the perturbative expansion variable is not the Weissenberg number, but instead it is a parameter measuring the feedback of the viscoelastic stress into the fluid momentum. This allows for accurate calculations at large Weissenberg numbers. Previous experiments, including our own, have documented that a sphere overshoots its terminal velocity on a transient timescale comparable to the fluid relaxation time. Our theory predicts this behavior as well as a non-trivial dependence of the drag on the Weissenberg number. I will also discuss experiments in which periodic forcing is applied to a body moving through a viscoelastic fluid, and the perturbation theory is used as a predictive tool.

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