Abstract Submitted
for the MAR14 Meeting of
The American Physical Society

The sedimentation of flexible filaments SAVERIO SPAGNOLIE, LEI LI, University of Wisconsin-Madison, HARISHANKAR MANIKANTAN, DAVID SAINTILLAN, University of Illinois at Urbana-Champaign — The dynamics of a flexible filament sedimenting in a viscous fluid are explored analytically and numerically. Compared with the well-studied case of sedimenting rigid rods, the introduction of filament compliance is shown to cause a significant alteration in the long-time sedimentation orientation and filament geometry. A model is developed by balancing viscous, elastic and gravitational forces in a slender-body theory for zero-Reynolds-number flows, and the filament dynamics are characterized by a dimensionless elasto-gravitation number. In the weakly flexible regime, a multiple-scale asymptotic expansion is used to obtain expressions for filament translations, rotations and shapes which match excellently with full numerical simulations. Furthermore, we show that trajectories of sedimenting flexible filaments, unlike their rigid counterparts, are restricted to a cloud whose envelope is determined by the elasto-gravitation number. In the highly flexible regime we show that a filament sedimenting along its long axis is susceptible to a buckling instability. A linear stability analysis provides a dispersion relation, illustrating clearly the competing effects of the compressive stress and the restoring elastic force in the buckling process.

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Date submitted: 15 Nov 2013 Electronic form version 1.4