Abstract Submitted
for the DFD20 Meeting of
The American Physical Society

Sedimentation of elastic circular microfibres[1]

RADOST WASZKIEWICZ, PIOTR SZYMCZAK, MACIEJ LISICKI, University of Warsaw, Institute of Theoretical Physics — We study the gravitational sedimentation of a thin, flexible filament bent into the shape of a loop in a viscous fluid depending on its stiffness. In the Stokesian regime, with a vanishing Reynolds number elastic forces, gravity, and hydrodynamic drag on the filament balance out to zero. We account for hydrodynamic interactions using the local slender-body theory (resistive-force theory), in which the local velocity is linearly related to the local hydrodynamic drag force. We model the elastic forces according to the Euler-Bernoulli beam theory. Depending on the relative strength of gravity and stiffness of the loop, we observe various regimes of motion. We analyse the stability of a circular solution known for an infinitely stiff loops when increasing the fibre elasticity. By linear stability analysis, we identify a single dimensionless parameter (stiffness vs gravity) that controls the dynamics and find the threshold value determining the stability of a sedimenting loop. We verify this stability criterion in simulations and analyse the transition towards the unstable region. Our results give intuitive grounding to the preference for horizontal orientation seen in sedimenting red blood cells and in DNA loops which break at locations corresponding to large stress in our model.

[1]The work of ML and RW was supported by the National Science Centre of Poland grant Sonata to ML no. 2018/31/D/ST3/02408. PS was supported by the National Science Centre (Poland) under research grant 2015/19/D/ST8/03199.

Radost Waszkiewicz
University of Warsaw, Institute of Theoretical Physics

Date submitted: 29 Jul 2020 Electronic form version 1.4