Abstract Submitted
for the DFD19 Meeting of
The American Physical Society

Cross-stream migration of non-spherical particles in a second-order fluid SHIYAN WANG, CHENG-WEI TAI, VIVEK NARSIMHAN, Purdue University — Particle migration in viscoelastic suspensions is vital in many applications in the biomedical community and the chemical/oil industries. Despite previous studies on the motion of spherical particles in simple viscoelastic linear flows, the combined effect of more complex flow profiles and particle shapes is underexplored. Here, we study the dynamics of arbitrary-shaped particles in a second-order fluid, subject to a general quadratic flow field. For the two model constants $\psi 1$ and $\psi 2$ (first and second normal stress coefficients) we assume the relationship $\psi 1$=-2$\psi 2$. The assumption allows us apply a multipole expansion to derive analytical expressions for the polymeric force and torque of the particle. We apply the analytical solutions to track the translational and rotational trajectories of spheres, spheroids, and general ellipsoids in shear and pressure driven flows. In shear flows, we observe that prolate-like particles undergo a transition from tumbling to log-rolling motion (i.e., alignment along the vorticity direction) as the shear rate increases. At very large shear rates, the particles can reorient along the flow direction, but this state is metastable. In pressure driven flows, we find that particles migrate to the center of the flow, with the tumbling period increasing in time until the particle eventually aligns along the flow direction.

Shiyan Wang
Purdue University

Date submitted: 31 Jul 2019 Electronic form version 1.4