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Numerical Analysis of Vesicle Dynamics in Linear Shear Flow[1]
ALIREZA YAZDANI, PROSENJIT BAGCHI, Rutgers University — There has been an ongoing debate in the vesicle research community with regard to the dependence of the vesicle dynamics on the controlling parameters, namely, the shear rate, viscosity ratio, and vesicle excess area. Theoretical works by Misbah and coworkers [e.g., Kaoui et al, Phys Rev E, **80**, 061905 (2009)] predict that the dynamics depends on all three parameters, whereas experimental works by Steinberg's group [e.g., Zabusky et al, Phys Fluids, **23**, 041905 (2011)] suggest only two parameters. In order to provide further insight, we consider 3D numerical simulations using a front-tracking method. We model the membrane bending resistance using the Helfrich formulation [Zhong-can & Helfrich, Phys Rev A, **39**, 5280 (1989)], and the area dilatation using the strain energy function developed by Skalak et al [Biophys J. **13**, 245, (1973)]. The simulations successfully predict three different dynamical regimes, namely, the tank-treading, vascillating-breathing, and tumbling. Quantitative comparisons are made with the theoretical results as well as the experimental data. We find that the tank-treading inclination angle and the tank-treading-to-tumbling transition threshold is weakly dependent on the shear rate. We further provide phase diagrams, and discuss the role of the controlling parameters on the transition.

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