Abstract Submitted
for the DFD10 Meeting of
The American Physical Society

The dynamics of a lipid vesicle in shear flow HONG ZHAO, ERIC S.G. SHAQFEH, Stanford University — The dynamics of a lipid vesicle in a simple shear flow, where the lipid membrane is modeled as a two dimensional incompressible fluid with bending stiffness, is solved by a high-fidelity spectral boundary integral formulation. We combine our direct numerical simulation (DNS) with a linear stability analysis to solve the exact critical internal/external viscosity ratio for the transition from the steady tank-treading motion to the unsteady trembling/tumbling motions at different shear rates. It is demonstrated that a fourth (and higher) order spherical harmonic expansion of the vesicle shape is necessary for obtaining quantitatively correct transition boundaries. The particle stresslets in different flow regimes are calculated, and the consequences for the rheology of a dilute suspension is discussed. In addition, our DNS reveals a family of time-periodic and out-of-shear-plane vesicle motion patterns, where the orientation of principle axes follow orbits that resemble but are fundamentally different from the classical Jeffery orbits of rigid particles due to the vesicle's deformability. The effect of wall boundaries on the vesicle motion is then investigated within our DNS by using the known Green's function for a no-slip walls at zero Reynolds number. It is demonstrated that wall interactions have a strong effect on the dynamic phase boundaries and stresslet. We finish by discussing the effect of thermal fluctuations and strategies of performing Brownian dynamics for the vesicle system.

Hong Zhao
Stanford University

Date submitted: 05 Aug 2010 Electronic form version 1.4