Abstract Submitted
for the DFD14 Meeting of
The American Physical Society

Numerical Simulations of the Mechanics of Vitrectomy ETHAN YOUNG, JEFF D. ELDREDGE, JEAN-PIERRE HUBSCHMAN, University of California, Los Angeles — Filling the cavity between the lens and retina in the eye is a clear, gel-like substance known as vitreous humor. The treatment of certain eye abnormalities necessitates the removal of this substance, in a surgical procedure called a vitrectomy, using a device called a vitreous cutter. Understanding the behavior of this viscoelastic biofluid during operations is essential to improving the effectiveness of the procedure. In this work, a three-dimensional computational model of a vitreous cutter is investigated using an immersed boundary method and a viscoelastic constitutive model. The solver uses a fractional-step method to satisfy continuity and traction boundary conditions to simulate the applied suction. The Giesekus constitutive equation is used to model the vitreous, as it captures both elastic and shear-thinning effects. Rheological parameters were obtained from the work of Sharif-Kashani et al. [Retina, 2013]. These simulations were used to quantify both the average and time-varying flow rate through the device during different stages in the cutting cycle. Characteristics of the flow field illustrate how surgical variables like cutting speed, duty cycle, and aspiration pressure affect overall flow rate and suggest targets for improving cutter efficacy.

Ethan Young
University of California, Los Angeles

Date submitted: 01 Aug 2014 Electronic form version 1.4