Meeting: 1005, Newark, Delaware, SS 7A, Special Session on Frontiers on Complex Fluid Flows: Analytic and Computational Methods

1005-76-143 **Linda B Smolka*** (lsmolka@bucknell.edu), Department of Mathematics, Bucknell University, Lewisburg, PA 17837, **Andrew Belmonte** (belmonte@math.psu.edu), Department of Mathematics, Penn State Univeristy, State College, PA 16802, **Diane Henderson** (dmh@math.psu.edu), Department of Mathematics, Penn State University, State College, PA 16802, and **Thomas Witelski** (witelski@math.duke.edu), 121 Physics Building, Duke University, Durham, NC 27708. *Exact solution for the extensional flow of a viscoelastic filament.*

We solve the free boundary problem of an axisymmetric viscoelastic filament stretching in a gravity-driven extensional flow for the Upper Convected Maxwell and Oldroyd-B constitutive models. Assuming the axial stress in the filament has a spatial dependence provides the simplest coupling of viscoelastic effects to the filament's motion, and yields a closed system of ODEs with an exact solution for the stretch rate and filament thickness satisfied by both models. This viscoelastic solution, which is a generalization of the exact solution for Newtonian filaments, converges to the Newtonian power-law scaling as $t \to \infty$. Based on the exact solution, we identify two regimes of dynamical behavior called the weakly- and strongly-viscoelastic limits. We compare the viscoelastic solution to measurements of the thinning filament that forms behind a falling drop for several semi-dilute (strongly-viscoelastic) polymer solutions. The exact solution correctly predicts the time-dependence of the filament diameter in all the experiments. As $t \to \infty$, observations of the filament thickness follow the Newtonian scaling $1/\sqrt{t}$. The transition from viscoelastic to Newtonian scaling in the filament thickness is coupled to a stretch-to-coil transition of the polymer molecules. (Received February 06, 2005)