Sureshkumar, R.; **Smith, M. D.**; **Armstrong, R. C.**; **Brown, R. A.**

Linear stability and dynamics of viscoelastic flows using time-dependent numerical simulations. (English) Zbl 0968.76008

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The authors employ the finite element spatial discretization coupled with a semi-implicit θ-method for time integration to discuss linear and nonlinear dynamics of viscoelastic fluids. The linear stability analysis of plane Couette flow for upper convected Maxwell fluids shows that the eigenfunctions for the two most dangerous eigenvalues are non-orthogonal, and numerical integration shows an abnormal behaviour at intermediate times. There is a transient growth of disturbances at intermediate times, and this is valid also for Oldroyd-B type fluids. The amplification of transient growth is caused by the nonlinear coupling for nonorthogonal eigenfunctions. The authors extend the analysis to two-dimensional flow past a linear periodic array of cylinders in a channel, where the steady-state motion is known only from numerical study. The flow is shown to be stable over a range of Deborah number De for a single cylinder, or for widely separated cylinders in the channel. For closely spaced cylinders, the authors predict that the instability at a critical De appears as a family of two-dimensional vortices close to the channel wall. This instability is likely due to the interaction of shear mode (when De $\gg 1$) with periodic modulations caused by the presence of cylinders.

Reviewer: S.K.Lakshmana Rao (Bangalore)

MSC:

76A10 Viscoelastic fluids
76E05 Parallel shear flows in hydrodynamic stability
76M10 Finite element methods applied to problems in fluid mechanics

Keywords:

Oldroyd-B fluid; critical Deborah number; semi-implicit theta-method; periodic array of cylinders in channel; finite element spatial discretization; time integration; linear stability; plane Couette flow; upper convected Maxwell fluids; nonorthogonal eigenfunctions; vortices

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