A SPECTRAL VANISHING VISCOSITY METHOD FOR STABILIZING VISCOELASTIC FLOWS

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A new method for stabilizing viscoelastic flows is proposed suitable for high-order discretizations. It employs a mode-dependent diffusion operator that guarantees monotonicity while maintaining the formal accuracy of the discretization. Other features of the method are: a high-order time-splitting scheme, modal spectral element expansions on a single grid, and the use of a FENE-P model. The diffusion operator acts on the conformation tensor described by the model and is adjustable via two parameters, which are flow- and resolution-dependent.

The convergence of the method is established through analytic examples and benchmark problems in two- and three-dimensions.

The two-dimensional problem examined is the Stokes flow past a circular cylinder in a channel reaching a Weissenberg number of 2.0. Axial normal stress and drag results are reported. Another two-dimensional problem examined is the flow past a plate with rounded edges in a channel.

For the three-dimensional case the falling sphere problem in a tube is analyzed. Also, unsteady flow past a fully three-dimensional ellipsoid is studied at high Reynolds numbers (Re = 1,075 and 1,500) without axisymmetric-like formulations. Steady and unsteady results of the same geometry at lower Reynolds numbers are also reported. Drag reduction and corresponding turbulence suppression at the wake of the three-dimensional ellipsoid are obtained.

References

[1] X. Ma, V. Symeonidis, and G. E. Karniadakis, "A Spectral Vanishing Viscosity Method for Stabilizing Viscoelastic Flows ", *Journal of Non-Newtonian Fluid Mechanics* (to appear).