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An exponential mapping for the conformation tensor for flow of viscoelastic fluids; application in turbulent channels K. HOUSIADAS, A. BERIS, Univ. of Delaware — The conformation tensor, a quantity that describes the internal microstructure of polymer molecules, is usually being used as the primary variable in viscoelastic flow calculations. Its main property is that is a positive definite, second order, tensor. Unless special care is taken, the conformation tensor may lose this property resulting to instabilities during the calculations and finally either to break-up of the simulations or to non-physical results. This situation is greatly intensified under turbulent flow conditions. In order to resolve these problems we have expressed the conformation tensor, 'c', as the exponential of another tensor 'a', c=exp(a), and we solve for 'a' instead of 'c'. By construction, the positive definite property of 'c' is always preserved since its eigenvalues are the exponential of the eigenvalues of 'a'. The method is illustrated for viscoelastic turbulent channel flow. Direct Numerical Simulations are being performed using spectral spatial approximations and a stabilizing artificial diffusion term in the viscoelastic constitutive model. That term is needed to smooth the solution to be resolvable with the mesh size used due to the very fine scales that are being created in chaotic flow fields. The FENE-P constitutive model is used to represent the effect of polymer molecules in solution. We will offer a comparison of the results, for exactly the same flow, viscoelastic and numerical parameters, using the old and the new formulation of the constitutive model in terms of the conformation tensor and the exponential tensor, respectively.

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