Solving the Inverse Problem of Couette Viscometry

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ABSTRACT

The accurate characterization of the flow properties of non-Newtonian fluids is a major ongoing activity in industrial rheology which stimulates a demand for improved instrumentation and algorithms. The recovery of such information from Couette rheometry measurements involves the solution of a quite simple first kind Volterra integral equation with a discontinuous kernel. The current methods require the explicit numerical differentiation of the measured angular velocity data. A new family of parameterized representations for the solution of the Couette integral equation has recently been derived. By exploiting the flexibility inherent in the parameterization, two new classes of approximation have been constructed. The first class is a family of finite difference formulas, which do not involve a direct numerical differentiation of the observational data. The second defines a framework for the construction of imporved power law approximations.

In addition, a new implementation of regularization has been proposed. It involves the direct regularization of the observational equations through the construction of basis functions that exploit the mathematical structure in the integral equation. The proposed implementation is first derived for a general first kind integral equation and then applied to the Couette rheometer equation. For the regularization of this problem, the basis functions take on a form similar to that for B-splines.

This talk is based on joint research with Frank de Hoog which has been submitted for publication in the Journal of Integral Equations and Applications and the Bulletin of the Australian Mathematical Society.