A semi-analytic approach to the viscous flow between a rotating and a stationary disk

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The steady axisymmetric flow of a viscous incompressible fluid between two coaxial disks, one rotating and the other stationary, is discussed. Similarity solutions of Navier–Stokes equations are obtained for small and moderately large Reynolds numbers. We propose a double series expansion for the perturbation series. The recurrence relation derived allows the generation of large numbers of universal coefficients, in small Reynolds number perturbation series of the solution function by computer. The convergence of this computer-extended series is found to be limited by a simple pole at $R^2=-593.8091$ for the case of non-dimensional pressure gradient. Using Euler transformation, the series is recast into a new form whose region of validity is enlarged, resulting in analytic continuation of the series solution. In addition, Padé approximants, via continued fraction representation, provide results that are in excellent agreement with the pure numerical studies of Mellor et al.

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