WITHDRAWN: On the Taylor-Couette problem in the continuum limit

ITZCHAK FRANKEL, AVSHALOM MANELA, Faculty of Aerospace Engineering, Technion-Israel Institute of Technology, Haifa 32000, Israel — We study the Taylor-Couette problem for a perfect gas which is situated between a rotating inner cylinder and a concentric stationary cylinder, both of which are maintained at the same temperature. A linear temporal stability analysis is carried for small Knudsen numbers using a “slip-flow” model assuming axisymmetric perturbations. At small Mach numbers ($Ma$) the resulting neutral curve initially coincides with the critical-Reynolds-number ($Re$) curve ($Re \propto Ma/Kn$) obtained in the corresponding incompressible-flow problem. With increasing $Ma$, the neutral curve deviates to larger values of $Re$ demonstrating that, contrary to some statements in the literature, compressibility effects are stabilizing. Furthermore, our results indicate that there is an upper bound for the Knudsen number, $Kn_m$, above which the system is stable for all Mach numbers. Thus, owing to compressibility there also exists (for all $Kn < Kn_m$) an upper critical Mach number beyond which system stability is recovered. Occurrence of this upper bound is related to increasing viscous dissipation with increasing $Ma$. These predictions of the linear analysis are in agreement with results obtained from the direct simulation Monte Carlo method.

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