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On the nonlinear stability of the circular Couette flow to viscous axisymmetric perturbations PUN WONG YAU, SHIXIAO WANG, University of Auckland, ZVI RUSAK, Rensselaer Polytechnic Institute — An axisymmetric viscous nonlinear stability analysis of the circular Couette flow to any finite amplitude perturbation is developed. The analysis is based on investigating the reduced Arnol'd energy-Casimir function A_{rd}, which consists of the sum of the total kinetic energy of the flow E and the Casimir circulation dependent function C_S, i.e. $A_{rd} = E + C_S$. In this case, ΔA_{rd} is used as a Lyapunov function, which represents the difference between the reduced Arnol'd function at a later time t and the corresponding base flow value. The requirement for the temporal decay of ΔA_{rd} leads to two novel conditions for the nonlinear stability of this steady flow against axisymmetric viscous perturbations of any finite amplitude. We also establish for the very first time a definite nonlinear stability region in terms of the operational parameters for the circular Couette flow. Once the flow is nonlinearly stable and stays axisymmetric, it always decays asymptotically to a unique steady state defined by the rotating cylinders. The results from this research shed a new fundamental physical insight into a classical flow problem that was studied for many decades.

Shixiao Wang
University of Auckland

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