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Analysis of vortical flow with axial swirl and toroidal circulation
SUKALYAN BHATTACHARYA, Texas Tech University — Vortical flows with an axial swirl and a toroidal circulation can be observed in a wide range of fluid mechanical phenomena such as flow around rotary machines or natural vortices like tornadoes and hurricanes. These flows can be described by a general scalar equation if incompressible fluid and negligible viscous dissipation are assumed. We consider one of the simpler cases of this general formulation where the involved equation has a resemblance with the governing equation of the hydrogen problem. As a result, we obtain a quantization relation similar to the expression of quantized energies in an hydrogen atom. We solve the equation for two systems. First, we consider three- dimensional vortices confined between two parallel walls. Our examples include flows between two infinite plates, inside and outside of a vertical cylinder bounded at the ends by walls, and in an axially confined annular region. Then we also use our formulation to compute highly chaotic velocity fields with three-dimensional vortical structures which qualitatively mimic the features of physical flows. Hence, these solutions may be used in modeling of complicated flow systems.

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