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On the instability of radially sheared and axially stratified vortex flows

Gabriel Meletti de Oliveira (1), Isabelle Raspo (2), Torsten Seelig (1), Stephane Viazzo (2), Anthony Randriamampianina (2), Stephane Abide (3), Andreas Krebs (1), and Uwe Harlander (1)

(1) Brandenburg University of Technology (BTU) Cottbus, Aerodynamics and Fluid Mechanics, Cottbus, Germany (haruwe@b-tu.de), (2) Laboratoire M2P2, UMR 7340 CNRS, AMU, Centrale Marseille, France, (3) LAMPS Laboratory of Mathematics and Physics, Université de Perpignan, France

The stability of rotating stratified vortices has been the subject of a large amount of studies as it concerns fluid mechanics in general but geo- and astophysical fluid dynamics in particular. Simple inviscid stability criteria have been obtained for homogeneous axisymmetric rotating vortices characterized by their velocity profile. These criteria address centrifugal but also shear instability. Adding linear stratification with respect to the rotation axis does not affect these criteria but gives rise to a new type of instability, the so called stratorotational instability. Using a thermally stratified Taylor-Couette experiment and two numerical codes applying either the Boussinesq (BA) or the low Mach number approximation (LMA) we study this instability for different azimuthal flow profiles (ranging from quasigalactic, Keplerian to Taylor-Couette type flows) and axial temperature gradients. The new experiments confirm earlier theoretical findings but also show interesting deviations due to the fact that the small gap approximation does not hold for the used experimental design. We also address the question whether for axial temperature differences of about 10K and larger the Boussinesq approximation still holds. For this purpose we compare solutions performed with the BA and the LMA. In the future we plan to do more detailed numerical simulations using massively parallel computing.