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NonBoussinesq effects on vorticity and kinetic energy production
S. RAVICHANDRAN, TIFR Centre for Interdisciplinary Sciences, HARISH DIXIT, IIT Hyderabad, RAMA GOVINDARAJAN, TIFR Centre for Interdisciplinary Sciences — The Boussinesq approximation, commonly employed in weakly compressible or incompressible flows, neglects changes in inertia due to changes in the density. However, the nonBoussinesq terms can lead to a kind of centrifugal instability for small but sharp density variations, and therefore cannot be neglected under such circumstances (see, e.g., DIXIT & GOVINDARAJAN, JFM , 2010, 415). Here, we study the evolution of a light-cored Gaussian vortex and find that the nonBoussinesq terms can lead to significant changes in how vortices evolve. The problem is governed by three nondimensional numbers—Reynolds number (i.e. viscosity), Atwood number, and a ratio of gravitational and centrifugal Froude numbers. We find that the production of kinetic energy and vorticity in a light-cored Gaussian vortex are affected significantly by the nonBoussinesq terms, and varies non-monotonically with the parameters of the problem. In general, these nonBoussinesq effects depend both on the strength of gravity and on the Reynolds number associated with the initial vortex.

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