# Instabilities around a Spheroid Spinning in a Rotating Stratified Fluid

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To better predict Earth's climate evolution, the CO2 and heat fluxes between the oceans and the atmosphere must be taken into account. These fluxes are governed by the vertical mixing in the ocean. But the measured mixing rate is 10 times smaller than necessary to balance the energy budget of the oceans : this calls for new, local mechanisms of mixing. At the edge of meso-scale eddies, an horizontal layering is observed, corresponding to density steps [1]. This is a local signature of an increased vertical mixing. To quantify its influence we need to determine the origin of the underlying instability/ies. To model this geophysical flow, a solid ellipsoid differentially rotates anticyclonically in a rotating stratified medium. We numerically and experimentally study this setup to assess the intensity and the structures of instabilities around the ellipsoid in the different regions of the Rossby, Froude, Ekman, Prandtl and Schmidt numbers space.

The experimental apparatus uses salty water in a large rotating cylindrical tank of 1 m in diameter. Metrology includes Particle Image Velocimetry (PIV) in horizontal planes and Schlieren in the vertical ones. First the base flow is measured and compared to an analytical solution. This solution is derived for any aspect ratio of the rotating ellipsoid thanks to spheroidal coordinates. Then the unstable modes are observed experimentally and compared to a linear stability analysis conducted using the pseudo-spectral eigenvalue problem solver Dedalus[2]. Various types of instabilities are observed, including baroclinic, double diffusive, convective and centrifugal ones, see e.g. Fig. 1. Their efficiency and relevance to explain the observed mixing are systematically assessed.

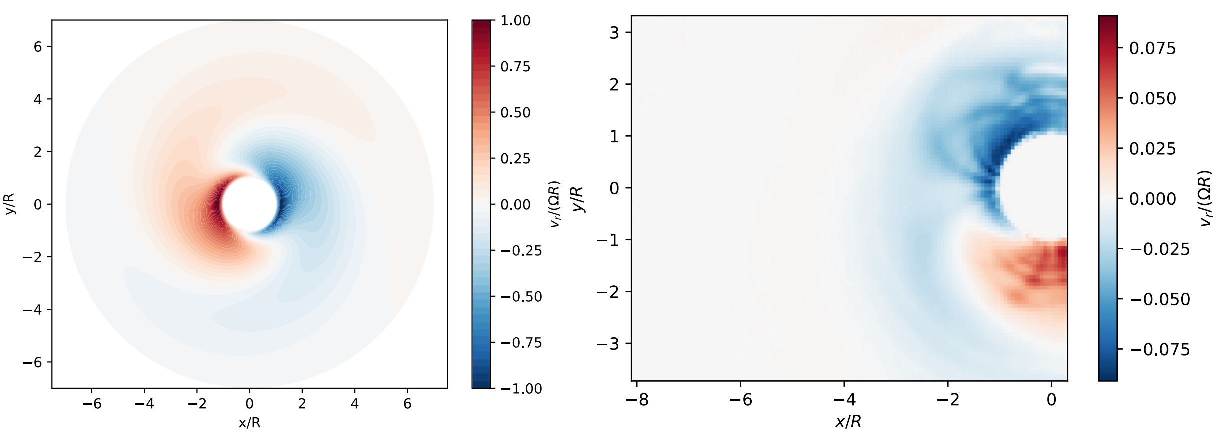


**Figure 1.** Left : Radial velocity map in the equatorial plane of a numerical eigenmode obtained using Dedalus. Right : Temporally filtered radial velocity map of an equatorial instability obtained by PIV

## Références

1. Hua et al, *Journal of Fluid Mechanics*, **731**(2013).
2. Burns et al, *Physical Review Research*, (2020).