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Dynamics of a fluid inside a precessing cylinder ROMAIN LAGRANGE, PATRICE MEUNIER, CHRISTOPHE ELOY, IRPHE, FRANÇOIS NADAL, CEA/CESTA — The instability of a fluid inside a precessing cylinder is studied theoretically and experimentally, motivated by aeronautical and geophysical applications. Precessional motion forces hydrodynamic waves called Kelvin modes whose structure and amplitude are predicted by a linear inviscid theory. When a forced Kelvin mode is resonant, its amplitude diverges (and saturates due to viscous effects), which makes the flow unstable for sufficiently high Reynolds numbers. A linear stability analysis based on a triadic resonance between a forced Kelvin mode and two free modes has been carried out. The precessing angle for which the flow becomes unstable is predicted and compared successfully to experimental measurements. A weakly nonlinear theory was developed and allowed to show that the bifurcation of the instability of precession is subcritical. It also showed that, depending on the Reynolds number, the unstable flow can be steady or intermittent. Finally, this weakly nonlinear theory allowed to predict, with a good agreement with experiments, the mean flow in the cylinder; even if it is turbulent.

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