Abstract Submitted
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Azimuthal instability of vortex rings generated by an oscillating disk[1] JIAN DENG, Department of Mechanics, Zhejiang University, Hangzhou 310027, P R China, C. P. CAULFIELD, BP Institute, University of Cambridge, Madingley Road, Cambridge CB3 0EZ, UK — We report the instabilities of vortex rings generated by an oscillating disk. Assuming sinusoidal variation in the azimuthal direction with mode number, m, a Floquet linear stability analysis is performed. We study the dynamics for a range of the two control parameters, the Keulegan-Carpenter number $KC = 2\pi A/c$ and the Stokes number $\beta = fc^2/\nu$, where A is the amplitude of oscillation, f is the frequency of oscillation, c is the diameter of the disk, and ν is the kinematic viscosity of the fluid. We observe two distinctive flow regions in the (KC, β) parameter space. First, in the low β region, the flow breaks its symmetry with a single wavenumber mode getting a positive growth rate. Second, in the high β region, high-order unstable modes emerge, with the highest mode number $m = 9$ recorded. Furthermore, we carry out Direct Numerical Simulations (DNS) on the fully three-dimensional Navier-stokes equations. The results reproduce the main features of the high-order unstable modes predicted by the Floquet analysis, exhibiting the highest mode number $m = 6$. We conjecture that the inconsistence in the highest mode number between the Floquet linear stability analysis and the DNS implies the non-linear characteristic of the current problem.

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Jian Deng
Zhejiang Univ

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