Abstract Submitted
for the DFD19 Meeting of
The American Physical Society

Stability of Flow past a Freely-Rotatable Sprung Cylinder. KE DING, ARNE PEARLSTEIN, Department of Mechanical Science and Engineering, University of Illinois at Urbana-Champaign — Recent work (Tumkur *et al.*, *J. Fluid* Mech. **828**, 196-235, 2017; Blanchard *et al.*, *Phys. Rev. Fluids*, **4**, 054401, 2019) considers flow past a linearly-sprung circular cylinder whose transverse rectilinear motion is inertially coupled to linearly-damped rotational motion of an attached mass about the cylinder axis. (The rotating mass is either inside the cylinder or beyond the span of the flow, thus having no contact with the fluid.) That work reveals chaotic response at Reynolds numbers (Re) well below the fixed-cylinder critical value $Re_{fixed,c}$, and multiple unsteady long-time solutions for many combinations of the parameters. Here, we consider flow past a linearly-sprung circular cylinder with a nonaxisymmetric density distribution, which is free to rotate, and whose rotational motion is linearly damped. As for the case where the cylinder cannot rotate, a steady, symmetric, motionless-cylinder (SSMC) solution exists for all values of the parameters and all density distributions and orientations. We use a spectral-element technique to investigate the stability boundary in the space of Re and spring stiffness, and find that over a limited stiffness range, rotatability renders the SSMC solution stable for $Re > Re_{fixed,c}$. We also show that stability boundaries for different (initial) orientations of the density distribution are very similar to those for different (initial) orientations of an attached mass, suggesting that much of the complex dynamical behavior in the attached-mass case can be realized using a cylinder with nonuniform density, with no attached mass.

Arne Pearlstein
Dept of Mech Science and Engineering, Univ of Illinois at Urbana-Champaign

Date submitted: 01 Aug 2019 Electronic form version 1.4