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NONLINEAR DYNAMICS AND BIFURCATIONS IN EQUILIBRIUM STATE OF A SPHEROIDAL PARTICLE SUSPENDED IN SHEAR FLOW

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The study of a single particle suspended in simple flow fields can reveal fundamental knowledge on the properties of dispersed particle flows, which we encounter for example in material processes or geophysical and biomedical flows. Here, we report on the rotational behavior of a prolate spheroidal particle in a linear shear flow, which has been studied using a lattice Boltzmann method with external boundary forcing. This system is surprisingly rich in terms of dynamical states. Transitions between rotational states have been observed as a consequence of a competition between fluid and particle inertial effects. The transitions will be described in detail and compared with some simple dynamical models. Typically, the particle behaves like a damped driven pendulum when in a planar rotation (particle symmetry axis perpendicular to vorticity axis), and like the unfolding of a double zero eigenvalue in a nonlinear system with odd symmetry when in a non-planar rotation (particle is close to aligned with the vorticity direction). Furthermore, how the solutions change due to particle aspect ratio and density is discussed. Understanding this behavior can give valuable predictions about the behavior of dilute suspensions with prolate spheroids.

REFERENCES

[1] T. Rosén, F. Lundell and C. K. Aidun. Effect of fluid inertia on the dynamics and scaling of neutrally buoyant particles in shear flow. *J. Fluid Mech.*, Accepted, 2013.