Abstract Submitted
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Chaotic Orbits of Tumbling Ellipsoids in Viscous and Inviscid Fluids[1] ERICH ESSMANN, PRASHANT VALLURI, School of Engineering, University of Edinburgh, STEPHANE POPINET, Sorbonne Universite, Institut Jean le Rond d'Alembert, RAMA GOVINDARAJAN, ICTS-TIFR, Bangalore — It was shown that the equations of motions of an immersed tri-axial ellipsoid become non-integrable under certain inviscid conditions, (Kozlov and Onishchenko, 1982). Non-integrability is a necessary condition for chaotic dynamics. We used analytical and numerical methods to determine occurrence and conditions of chaotic orbits in viscous and inviscid environments for both tri-axial and prolate ellipsoids. Our numerical work uses Gerris (Popinet et al, 2003) augmented with a fully-coupled solver for fluid-solid interaction with 6 degrees-of-freedom (6DOF). For inviscid conditions, our numerical results agree with the solution of Kirchhoffs equations. Using recurrence quantification (Marwan et al, 2007) methods, we also characterise chaos and identify regime shifts from being periodic to chaotic. For inviscid systems, we observe chaotic behaviour only in the tri-axial systems and that chaos is a strong function of density ratio and the initial energy ratio. In viscous systems, we have noted evidence of chaotic orbits for symmetric ellipsoids. Due to vortex shedding behaviour in this context breaking the symmetry of the system. We show how chaos can be exploited under viscous environments to promote mixing.

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