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Passive control of a sphere by complex-shaped appendages SHERVIN BAGHERI, UGIS LACIS, Linne Flow Centre, KTH Mechanics, Stockholm, STEFANO OLIVIERI, ANDREA MAZZINO, DICCA, University of Genova, Italy — Appendages of various shapes and sizes (e.g. plumes, barbs, tails, feathers, hairs, fins) play an important role in dispersion and locomotion. In our previous work (Lacis, U. et al. Passive appendages generate drift through symmetry breaking. Nat. Commun. 5:5310, doi: 10.1038/ncomms6310, 2014), we showed that a free-falling cylinder with a splitter plate turns and drifts due to a symmetry-breaking instability (called inverted-pendulum instability or IPL). In other words, in a separated flow, the straight position of a short splitter plate is unstable and as a consequence a side force and a torque are induced on the cylinder. In this work, we seek the three-dimensional (3D) appendage shape (on a sphere at Re=200) that induces the largest drift of the sphere. We find that highly non-trivial shapes of appendages on a sphere increase the side force significantly compared to trivial shapes (such as an elliptic sheet). We also find that appendages may be designed to generate drift in either direction, that is, a free-falling sphere can drift either in the direction in which appendage is tilted or in the opposite direction depending on the particular geometry of the appendage. We discuss the physical mechanisms behind these optimal appendage shapes in the context of the IPL instability.

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