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Characterization of gyrotactic swimmers using digital holographic microscopy MICHAEL BARRY, MIT, Dept. of Mechanical Engineering, WILLIAM M. DURHAM, University of Oxford, Dept. of Zoology, ANWAR CHENGALA, University of Minnesota, Dept. of Civil Engineering, JIAN SHENG, Texas Technical University, Dept. of Mechanical Engineering, ROMAN STOCKER, MIT, Dept. of Civil and Environmental Engineering — Observations from the ocean reveal that motility can exert a strong influence on the spatial distribution of phytoplankton at multiple scales, from thin layers and harmful algal blooms to Kolmogorov-scale accumulations in turbulence. Aside from a few model organisms, however, little is known about the fundamental motility characteristics of marine phytoplankton species, in particular their stability and the noise in their swimming orientation. In the absence of fluid flow, a phytoplankter's swimming direction is governed by the competition between an intrinsic stabilizing torque and stochastic fluctuations resulting from noise in the flagellar beat. These two processes can be parameterized by a gyrotactic reorientation time scale and an effective rotational diffusivity, respectively. Here we obtain measurements of these two parameters by using digital holographic microscopy to capture three-dimensional trajectories of phytoplankton. Novel inverse techniques are applied to individual tracks, which are analyzed for noise in the swimming direction and the rate of reorientation to the vertical. This approach can easily be extended to other species, promising to improve our understanding of how the interaction of motility and flow affects the distribution of phytoplankton communities.

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