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Imaging the 3D flow around swimming Chlamydomonas reinhardtii using digital inline holographic microscopy KYLE WELCH, SANTOSH KUMAR, JIARONG HONG, XIANG CHENG, Univ of Minnesota - Twin Cities — Understanding the 3D flow induced by microswimmers is paramount to revealing how they interact with each other and their environment. While many studies have measured 2D projections of flow fields around single microorganisms, reliable 3D measurement remains elusive due to the difficulty in imaging fast 3D fluid flows at submicron spatial and millisecond temporal scales. Here, we present a precision measurement of the 3D flow field induced by motile planktonic algae cells, Chlamydomonas reinhardtii. We manually capture and hold stationary a single alga using a micropipette, while still allowing it to beat its flagella in the breastroke pattern characteristic to C. reinhardtii. The 3D flow field around the alga is then tracked by employing fast holographic imaging on 1 um tracer particles, which leads to a spatial resolution of 100 nm along the optical axis and 40 nm in the imaging plane normal to the optical axis. We image the flow around a single alga continuously through thousands of flagellar beat cycles and aggregate that data into a complete 3D flow field. Our study demonstrates the power of holography in imaging fast complex microscopic flow structures and provides crucial information for understanding the detailed locomotion of swimming microorganisms.

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