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Contribution of cell body to the thrust production of flagellate bacteria BIN LIU, School of Engineering, Brown University, THOMAS R. POWERS, School of Engineering and Department of Physics, Brown University, KENNETH S. BREUER, School of Engineering, Brown University — We trace individual motile microorganisms using a digital 3D tracking microscope in which the microscope stage follows the motion of the target. Using this technology, we not only trace a single cell over extended duration but also obtain the cell kinematics with high spatial and temporal resolution. We apply this tracking microscope to a study of Caulobacter crescentus, a bacterium that moves up to 100 microns (or 50 body lengths) per second and reverses its direction of motion by switching the rotation direction of its single helical flagellum. We show that when the cell reverses the rotation direction of the right-handed flagellum, e.g., switching from CW (a pusher) to CCW (a puller), its cell-kinematics is not completely reversible. In case of a puller, the cell almost spins along its long axis. However, in case of a pusher, besides spinning, the cell body precesses along its swimming direction, following a helical trajectory. These two types of cell-kinematics contribute to different cell motilities: the pusher rotates slower for the same swimming speed. We present a resistive force theory to account for this behavior, and by computing the torque on the cell body, we show that the finite precession angle of the bacterial pusher is optimized for swimming with fixed torque.

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