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The geometry and fluid dynamics of two- and three-dimensional maneuvers of burrowing and swimming C. elegans JERZY BLAWZDZIEWICZ, ALEJANDRO BILBAO, AMAR PATEL, Department of Mechanical Engineering, Texas Tech University, MIZANUR RAHMAN, SIVA A. VANAPALLI, Department of Chemical Engineering, Texas Tech University — In its natural environment, which is decomposing organic matter and water, *C. elegans* swims and burrows in 3D complex media. Yet quantitative investigations of *C. elegans* locomotion have been limited to 2D motion. Recently [Phys. Fluids 25, 081902 (2013)] we have provided a quantitative analysis of turning maneuvers of crawling and swimming nematodes on flat surfaces and in 2D fluid layers. Here, we follow with the first full 3D description of how *C. elegans* moves in complex 3D environments. We show that the nematode can explore 3D space by combining 2D turns with roll maneuvers that result in rotation of the undulation plane around the direction of motion. Roll motion is achieved by superposing a 2D curvature wave with nonzero body torsion; 2D turns (within the current undulation plane) are attained by variation of undulation wave parameters. Our results indicate that while hydrodynamic interactions reduce angles of 2D turns, the roll efficiency is significantly enhanced. This hydrodynamic effect explains the rapid nematode reorientation observed in 3D swimming.

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