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Periplasmal Physics: The Rotational Dynamics of Spirochetal Flagella

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Spirochetes are distinguished by the location of their flagella, which reside within the periplasm: the tiny space between the bacterial cell wall and the outer membrane. In *Borrelia burgdorferi* (the causative agent of Lyme Disease), rotation of the flagella leads to cellular undulations that drive swimming. Exactly how these shape changes arise due to the forces and torques acting between the flagella and the cell body is unknown. By applying low-Reynolds number hydrodynamic theory to the motion of an elastic flagellum rotating in the periplasm, we show that the flagella are most likely separated from the bacterial cell wall by a lubricating layer of fluid. We obtain analytical solutions for the force and torque on the rotating flagellum through lubrication analysis, as well as through scaling analysis, and find results are in close agreement numerical simulations. (Joint work with J. Yang and C.W. Wolgemuth.)