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A Model for the Viscous Synchronization of Bacterial Flagella QIAN BIAN, LEILA SETAYESHGAR, THOMAS R. POWERS, KENNETH BREUER, Brown University — Many flagellated bacteria propel themselves by rotating several helical flagella. The motors that rotate these filaments operate in a constant torque mode, and can alternate between counter-clockwise and clockwise motion. Although they reverse direction independently and randomly, the filaments are observed to coordinate and form a bundle during the run phase of the cell motion. We bring both experimental and theoretical tools to study a model problem which considers rotating paddles rather than helical filaments. The paddles are simpler both to construct and to model, and exhibit stronger viscous interactions than thin helices. Experimentally, we find that the paddles coordinate in about 15 rotations, and stay in synchronized motion with a phase difference of $\pi/2$, although this phase difference increases if there is a torque mismatch between the two motors. The synchronization is observed to persist indefinitely. However, as the paddle separation increases, the synchronization is weaker, and can exhibit instabilities. Theoretical models based on the long-range hydrodynamic interaction of Stokes flow are compared with the experimental results.

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