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Stochastic and Deterministic Flagellar Dynamics Provide a Mechanism for Eukaryotic Swimming Reorientation MARCO POLIN, IDAN TUVAL, KNUT DRESCHER, RAYMOND GOLDSTEIN, DAMTP, University of Cambridge — The biflagellated alga *Chlamydomonas reinhardtii* is a good model organism to study the origin of flagellar synchronization. Here we employ high-speed imaging to study the beating of the two flagella of *Chlamydomonas*, and show that a single cell can alternate between two distinct dynamical regimes: asynchronous and synchronous. The asynchronous state is characterized by a large interflagellar frequency difference. In the synchronous state, the flagella beat in phase for lengthy periods, interrupted episodically by an extra beat of either flagellum. The statistics of these events are consistent with a model of hydrodynamically coupled noisy oscillators. Previous observations have suggested that the two flagella have well separated intrinsic beat frequencies, and are synchronized by their mutual coupling. Our analysis shows instead that the synchronized state is incompatible with coupling-induced synchronization of flagella with those intrinsic frequencies. This suggests that the beat frequencies themselves are under the control of the cell. Moreover, high-resolution three-dimensional tracking of swimming cells provides strong evidence that these dynamical states are related to non-phototactic reorientation events in the trajectories, yielding a eukaryotic equivalent of the "run and tumble" motion of peritrichously flagellated bacteria.

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