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Estimation of Internal Power Distribution in Sperm Flagella from Measurements of Beat Patterns ASHWIN NANDAGIRI, IITB-Monash Research Academy, India, AVINASH GAIKWAD, School of Biological Sciences, Monash University, Australia, DAVID POTTER, Monash Microscopy Institute, Monash University, Australia, JULIO SORIA, Department of Mechanical & Aerospace Engineering, Monash University, Australia, MOIRA OBRYAN, School of Biological Sciences, Monash University, Australia, SAMEER JADHAV, Department of Chemical Engineering, Indian Institute of Technology Bombay, India, RANGANATHAN PRABHAKAR, Department of Mechanical & Aerospace Engineering, Monash University, Australia — Sperm flagella are internally-driven flexible filaments that display complex beating patterns. We estimate energetics of the internal driving from measurements of beat patterns. A large number of beat cycles (40) of mouse sperm tethered at their heads are recorded using high-speed, high-resolution microscopy. Flagellar centrelines are digitally extracted using image processing techniques. Proper Orthogonal Decomposition (POD) is used to represent the beat cycle data in a compact form and obtain an average representative beat cycle. The Kirchhoff theory for inextensible, elastic, rods is adapted to account for internal driving and combined with the Resistive Force Theory for hydrodynamic forces to compute the spatiotemporal power distribution of the internal forces exerted by protein motors in the sperm axoneme. Representative beat patterns and internal power distributions are computed for a large number of sperm samples from mutant mice deficient in a family of proteins that regulate calcium ion flux in the flagellum. Clear differences in beat patterns are observed which are found to be correlated with the active power distribution.

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