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Shape and shear guide sperm cells spiraling upstream VASILY KANTSLER, Skolkovo Institute of Science and Technology, Russia; Department of Physics, University of Warwick, UK, JORN DUNKEL, Department of Mathematics, Massachusetts Institute of Technology, RAYMOND E. GOLDSTEIN, DAMTP, University of Cambridge, UK — A major puzzle in biology is how mammalian sperm determine and maintain the correct swimming direction during the various phases of the sexual reproduction process. Currently debated mechanisms for sperm long range travel vary from peristaltic pumping to temperature sensing (thermotaxis) and direct response to fluid flow (rheotaxis), but little is known quantitatively about their relative importance. Here, we report the first quantitative experimental study of mammalian sperm rheotaxis. Using microfluidic devices, we investigate systematically the swimming behavior of human and bull sperm over a wide range of physiologically relevant shear rates and viscosities. Our measurements show that the interplay of fluid shear, steric surface-interactions and chirality of the flagellar beat leads to a stable upstream spiraling motion of sperm cells, thus providing a generic and robust rectification mechanism to support mammalian fertilization. To rationalize these findings, we identify a minimal mathematical model that is capable of describing quantitatively the experimental observations.

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