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Bacterial diodes: Rectified transport of swimming cells in porous media flow JEFFREY GUASTO, NICOLAS WAISBORD, Tufts University — Directed motility enables swimming microbes to navigate their porous habitats for resources, where self-propulsion competes with fluid flow to affect processes ranging from disease transmission and bioremediation. Despite this broad importance, how directed motility affects the self-transport and dispersion of microswimmers in flow through constricted pores remains unknown. Focusing on magnetotactic bacteria in a microfluidic porous medium, we show that upstream oriented cells, directed by a magnetic field, are localized and trapped in vortical orbits at a constriction. Vortical cell localization results in three distinct regimes of rectified bacterial conductivity through a throat, akin to a 'bacterial diode', whereby cells swim upstream, become trapped within a pore, or are advected downstream with increasing flow speed. Langevin simulations reveal that the trapping regime results in near-complete transport suppression, while ephemoral trapping in the downstream regime enhances dispersion. We also show that vortical cell localization persists in three-dimensional flow through a packed microfluidic bed, emphasizing the relevance of this phenomenon in realistic hydraulic networks.

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