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Chirality-induced bacterial rheotaxis in bulk shear flows[1] ANKE LINDNER, PMMH-ESPCI, Paris, France, GUANGYIN JING, School of Physics, Northwest University, China, ANDREAS ZÖTTL, Institute for Theoretical Physics, TU Wien, Austria, CLEMENT ERIC, PMMH-ESPCI, Paris, France — Interaction of swimming bacteria with flows controls their ability to explore complex environments, crucial to many societal and environmental challenges and relevant for microfluidic applications such as cell sorting. Combining experimental, numerical, and theoretical analysis, we present a comprehensive study of the transport of motile bacteria in shear flows. Experimentally, we obtain with high accuracy and, for a large range of flow rates, the spatially resolved velocity and orientation distributions. They are in excellent agreement with the simulations of a kinematic model accounting for stochastic and microhydrodynamic properties and, in particular, the flagella chirality. Theoretical analysis reveals the scaling laws behind the average rheotactic velocity at moderate shear rates using a chirality parameter and explains the reorientation dynamics leading to saturation at large shear rates from the marginal stability of a fixed point. Our findings constitute a full understanding of the physical mechanisms and relevant parameters of bacteria bulk rheotaxis.

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