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Anomalous swimming behavior of bacteria in nematic liquid crystals[1] ANDREY SOKOLOV, Materials Science Division, Argonne National Laboratory, Illinois 60439, USA, SHUANG ZHOU, OLEG LAVRENTOVICH, Liquid Crystal Institute, Kent State University, Kent, Ohio 44242, USA, IGOR ARANSON, Materials Science Division, Argonne National Laboratory, Illinois 60439, USA
— Flagellated bacteria stop swimming in isotropic media of viscosity higher than $0.06\text{kgm}^{-1}\text{s}^{-1}$. However, Bacillus Subtilis slows down by only about 30% in a nematic chromonic liquid crystal (CLC, 14wt% DSCG in water), where the anisotropic viscosity can be as high as $6\text{kgm}^{-1}\text{s}^{-1}$. The bacteria velocity (V_b) is linear with the flagella rotation frequency. The phase velocity of the flagella $V_f \approx 2V_b$ in LC, as compared to $V_f \approx 10V_b$ in water. The flow generated by the bacteria is localized along the bacterial body axis, decaying slowly over tens of micrometers along, but rapidly over a few micrometers across this axis. The concentrated flow grants the bacteria new ability to carry cargo particles in LC, ability not seen in their habitat isotropic media. We attribute these anomalous features to the anisotropy of viscosity of the CLC, namely, the viscosities of splay and twist is hundreds times higher than that of bend deformation, which provides extra boost of swimming efficiency and enables the bacteria swim at considerable speed in a viscous medium. Our findings can potentially lead to applications such as particle transportation in microfluidic devices.

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