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Mechanics of swimming at the small scale in complex fluids

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Recent experiments with bacteria in liquid crystalline solutions have revealed that nematic order affects the swimming behavior of bacteria. Motivated by these observations, we study a simple model of low-Reynolds-number swimming in an anisotropic fluid, that of an infinitely long two-dimensional sheet deforming via propagating transverse or longitudinal waves and immersed in a hexatic or a nematic liquid crystal. The liquid crystal is categorized by the dimensionless Ericksen number Er, which compares viscous and elastic effects. Paying special attention to the anchoring strength at the interface of the liquid crystal and the swimmer, we calculate how swimming speed depends on Er for small amplitude waves. We study both the sinusoidal steady-state problem as well as the startup problem in which the swimmer starts from rest.