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Low Reynolds number swimming in a stratified fluid AREZOO ARDEKANI, ROMAN STOCKER, Massachusetts Institute of Technology — Microorganisms live in aquatic environments that are often density-stratified, for example due to temperature or salinity gradients in oceans and lakes. Yet, the effect of stratification on low-Reynolds number swimming has not been investigated, in part because it is generally believed that the length scale of stratification is orders of magnitude larger than microorganisms. We show that this is incorrect and that typical stratifications can affect organisms as small as O(100 μm). By deriving fundamental singularity solutions (Stokeslet and stresslet) in a stratified fluid− which we call Stratlets− we demonstrate that the characteristic length scale of this problem, $L = (\mu\kappa/\gamma g)^{1/4}$, is one that combines buoyancy, diffusion and viscosity effects, where κ is the diffusivity of the stratifying agent, μ the dynamic viscosity, γ the background density gradient, and g the acceleration of gravity. The importance of stratification for a swimmer of size a, relative to diffusion, is measured by the Rayleigh number, $Ra = (a/L)^4$. Stratification dramatically changes the flow generated by a swimmer, creating recirculation cells that diminish in size with increasing Ra. Consequently, flow velocity decays with distance from the swimmer considerably faster than in homogeneous fluids. This suggests that stratification acts as a "silencer" for hydromechanical signals, for example reducing the perception abilities of microorganisms that rely on mechanosensing to detect prey.

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