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Physical limits to gradient sensing by swimming cells NICHOLAS LICATA, University of Michigan-Dearborn — The chemotactic motion of cells relies on their ability to infer the location of a chemical source from the random arrival of molecules at chemical receptors on the cell surface. Small organisms like bacterial cells generally employ a temporal sensing mechanism to measure spatial gradients in concentration. For example, the bacterium Escherichia coli compares concentrations in time as it swims, and modulates its swimming behavior accordingly to swim up the concentration gradient. Slightly larger eukaryotic cells are able to directly sense spatial gradients of chemicals across their surface. Previous studies have demonstrated that the physical process of diffusion sets a fundamental limit to the accuracy with which cells can sense spatial gradients. However, most of these studies neglect the intrinsic coupling between the sensory task and the behavioral response of swimming. The swimming cell stirs the surrounding fluid, which in turn affects the arrival location of molecules at the cell surface, and hence the inferred spatial gradient. By considering the appropriate advection-diffusion equation for the arrival of molecules at the cell surface, we determine the fundamental physical limit to the accuracy of direct gradient sensing by swimming cells.

Nicholas Licata
University of Michigan-Dearborn

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