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Sailing On Diffusion MICHAEL ALLSHOUSE, MIT, MIKE BARAD, Stanford, THOMAS PEACOCK, MIT — When a density-stratified fluid encounters a sloping boundary, diffusion alters the fluid density adjacent to the boundary, producing spontaneous along-slope flow. Since stratified fluids are ubiquitous in nature, this phenomenon plays a vital role in environmental transport processes, including salt transport in rock fissures and ocean-boundary mixing. Here we show that diffusion-driven flow can be harnessed as a remarkable means of propulsion, acting as a diffusion-engine that extracts energy from microscale diffusive processes to propel macroscale objects. Like a sailboat tacking into the wind, forward motion results from fluid flow around an object, creating a region of low pressure at the front relative to the rear. In this case, however, the flow is driven by molecular diffusion and the pressure variations arise due to the resulting small changes in the fluid density. This mechanism has implications for a number of important systems, including environmental and biological transport processes at locations of strong stratification, such as pycnoclines in oceans and lakes. There is also a strong connection with other prevalent buoyancy-driven flows, such as valley and glacier winds, significantly broadening the scope of these results and opening up a new avenue for propulsion research.

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