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Gyrotactic trapping: a bifurcation in vertical motility triggers formation of thin phytoplankton layers[1] WILLIAM DURHAM, MIT, JOHN KESSLER, Univ. of Arizona, ROMAN STOCKER, MIT — Characterized by spikes in cell concentration orders of magnitude above ambient, thin layers of phytoplankton are recurrent features of the coastal ocean, yet the mechanism of their formation remains unclear. We propose that cell motility in combination with depth-variable fluid shear can form thin layers via a mechanism we call "gyrotactic trapping." The swimming direction of many motile phytoplankton is set by a balance between a gravitational torque (caused by cell asymmetry) and a viscous torque (caused by shear). Local peaks in shear disrupt this torque balance, producing a gradient in vertical cell flux and leading to intense cell accumulation. We tested gyrotactic trapping using two species of phytoplankton exposed to a lid-driven cavity flow, observing strong thin layers for both. The experimental layers closely matched results from individual-based simulations. Furthermore, an advection-diffusion model reveals that gyrotactic trapping can generate thin phytoplankton layers under realistic conditions in the ocean, where vertical distances are on the order of meters and layers are subject to dissipation by turbulence.

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