Encounter rates involving elongated marine microorganisms.

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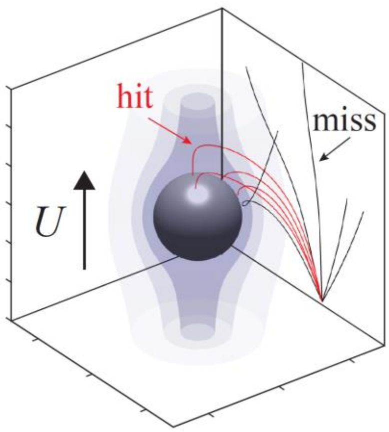

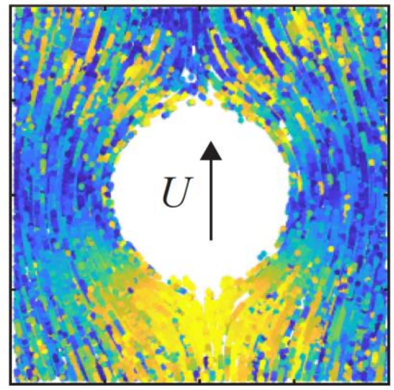

Abstract

Marine microorganisms control the global biogeochemistry of the oceans through interactions between individual cells and between cells and particles of organic matter. Prominent examples include marine snow formation by elongated phytoplankton following a phytoplankton bloom or bacterial degradation of marine snow responsible for carbon export from the upper ocean in the biological pump. A variety of physical mechanisms can drive these interactions, including diffusion, active swimming, gravitational settling and turbulent mixing, and the concept of encounter rates provide a unifying framework to describe them. However, the corresponding collision kernels, which map the physical mechanisms to the frequency of encounters, have been traditionally computed for spherical particles. Here, we first describe the impact of elongation on marine snow formation. We derive the collision kernels between identical and dissimilar rods settling in a quiescent fluid and show that marine snow formation by elongated phytoplakton can proceed efficiently even under quiescent conditions and that the resulting coagulation dynamics can lead to periodic bursts in the concentration of marine snow particles [1, 2]. Later, we describe the impact of elongation and fluid shear on the encounters between non-motile and motile bacteria and sinking particles of organic matter [3]. There, we find that the shape-shear coupling has a considerable effect on the encounter rate and encounter location through the mechanisms of hydrodynamic focusing and screening. Overall, our results demonstrate that elongation and fluid shear must be taken into account to accurately predict encounter rates at the microscale, which govern the large carbon flux in the ocean's biological pump.

References

[1] Słomka J & Stocker R. PNAS (accepted), 2020.
[2] Słomka J & Stocker R. in preparation, 2020.
[3] Słomka J et al. arXiv :1908.08376.