Heavy Spheroidal Particles as a Model for Phytoplancton Cells

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Micro and nano phytoplanctonic cells show an extreme variety of morphologies, which, in most cases, are rather different from the spherical shape. They also are generally heavier than the water in which they live, therefore any turbulence or large-scale motion in the fluid affects their ecology in a crucial way.

Several results are known about the settling of spherical particles in fluids subject to either turbulent or laminar motion (e.g. [2]). Here we investigate the dynamics of heavy of spheroidal particles (both oblate and prolate) with numerical solutions of the equations proposed by Maxey [1], valid for very small particle Reynolds number. In particular, we compute the distribution of suspension times of spheroidal particles in cellular and other simple flows. We also discuss the separation of nearby particles: while spheres separate exponentially, the distance between two spheroids, for small separations and short time intervals, grows linearly, at a rate dependent on the mutual orientation between the particles.

We conclude with some considerations on the ecological and evolutionary significance of our findings.

References

[1] M. R. Maxey, "On the advection of spherical and non-spherical particles in a non-uniform flow," Philosophical Transactions: Physical Sciences and Engineering 333, no. 1631 (1990): 289–307.

[2] 1. Claudia Pasquero, Antonello Provenzale, and Edward Spiegel, "Suspension and Fall of Heavy Particles in Random Two-Dimensional Flow," Physical Review Letters 91, no. 5 (8, 2003).