Emergent run-and-tumble in a simple model of Chlamydomonas

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The green alga *Chlamydomonas* has two flagella which beat in synchrony with a breaststroke like motion. I consider a simple hydrodynamic model consisting of three spheres, shown in figure1, from which we see interesting features in the synchronization behaviour. The flagella need to have a phase dependent beat pattern during forward motion in order to synchronize. Rapid synchronization occurs from the hydrodynamic friction due to cell rotation, while hydrodynamic interactions are only a second order effect. Some beat patterns lead to synchronization and others do not [1]; this enables the model to produce run-and-tumble behaviour when we add intrinsic noise [2], in agreement with experimental observations [3]. Figure 2 shows an example of a run-and-tumble trajectory produced by the model. Some beat patterns may or may not lead to synchronization, depending on the initial conditions. The model is simple, yet provides a wide range of different types of behaviour, giving the possibility of using the model to study other features in the motion of *Chlamydomonas*.

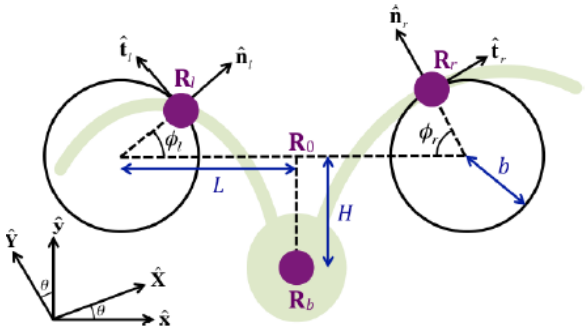

Figure 1: The three-sphere model. The two beads on the left and right represent the flagella and move around circular trajectories. The cell body is represented by a third bead. The green underlay shows a schematic of a Chlamydomonas cell.

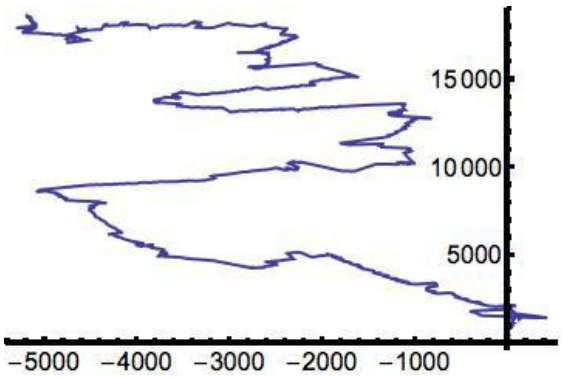

Figure 2: Run-and-tumble trajectory over ~ 1000 beat periods.

[1] Bennett, R. R. and Golestanian, R., New J. Phys. 15 (2013) 075028
[2] Bennett, R. R. and Golestanian, R., Phys. Rev. Lett. 110 (2013) 148102
[3] Polin, M., Tuval, I., Drescher, K., Gollub, J., and Goldstein, R. E., Science 325 (2009) 487