Researchers explain the flagellar synchronisation of swimming algae

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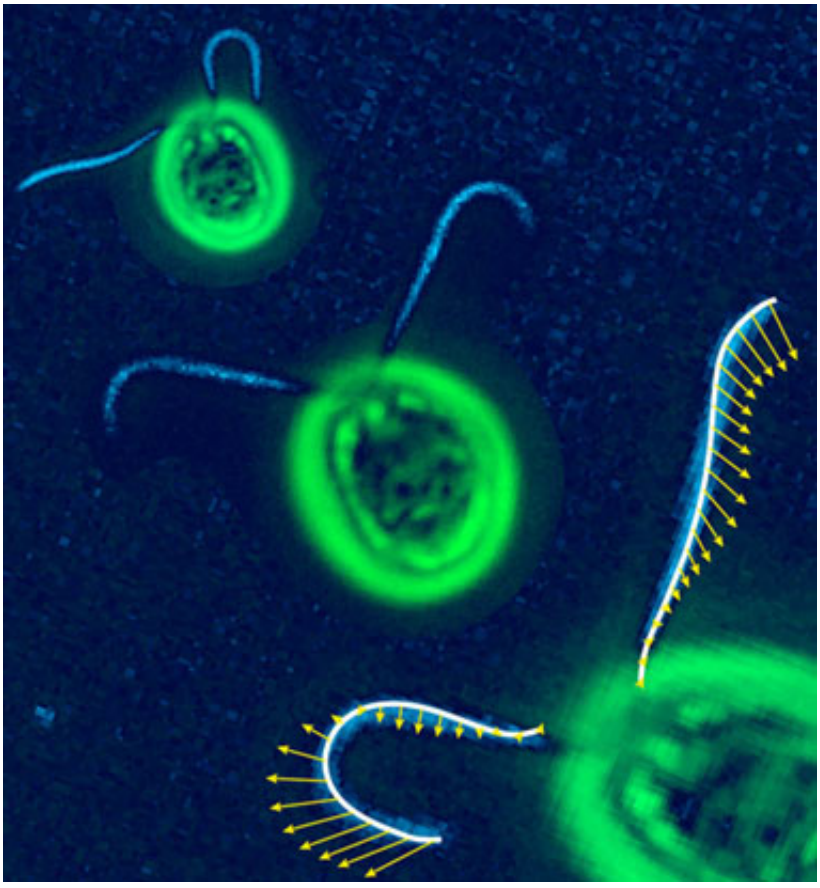

The green alga is a microscopic breaststroke swimmer. The movements of its two flagella are synchronised by mechanical forces: its swimming strokes slow down or accelerate, depending on how the cell rocks while swimming. Credit: MPI-CBG, Dresden

The beating of flagella is one of the basic principles of movement in the cellular cosmos. However, up to now, scientists were unsure as to how the movements of several of these small cellular appendages are synchronised. Dresden-based researchers from the Max Planck Institute of Molecular Cell Biology and Genetics and the MPI for the Physics of Complex Systems have now succeeded in demonstrating how the green alga *Chlamydomonas* synchronises the movements of its two flagella using a resourceful rocking movement. To do this, the researchers started by developing a theoretical model which they were then able to substantiate in experiments with the microscopic breaststroke swimmers: when the two flagella lose their rhythm, the cell begins to rock. This causes the swimming movements to slow down or accelerate. The resulting synchronisation mechanism is based solely on the coupling of the two movements of the body and the flagella; no special sensors or chemical signals are needed.

"An alga is a wonderful model for investigating our research question because, with its two flagella, it shows us very clearly how several of these appendage-like structures are synchronised using mechanical forces alone," says Benjamin Friedrich from the Max Planck Institute for the Physics of Complex Systems who headed the studies. How tens of thousands of molecular engines work together to set flagella in motion and synchronise them is a matter of great interest, as this mechanism underlies numerous processes: "The tiny cellular appendages are one of nature's greatest hits: they drive sperm and form big conveyor belts in the fallopian tubes and airways," explains Friedrich.

The cellular extensions, which are a mere ten micrometres long, beat around 30 times per second. In a flat observation chamber, the researchers allowed the single-celled green algae *Chlamydomonas* to swim around under their microscope lenses and then evaluated the swimming and bending movements on the microscope films: "From these films, we are able to reconstruct all of the mechanical forces at

work in detail," says Friedrich. When the load increases, the flagellum beats more slowly – just like a car engine that has to negotiate an incline. The strength and speed of the beat are linked to the movement of the body. This load dependency synchronises the beats of the two flagella and thus eliminates the need for special sensors or chemical signals.

More information: Veikko F. Geyer, Frank Jülicher, Jonathon Howard, Benjamin M. Friedrich, Cell-body rocking is a dominant mechanism for flagellar synchronization in a swimming alga, *PNAS*, 21 October 2013

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