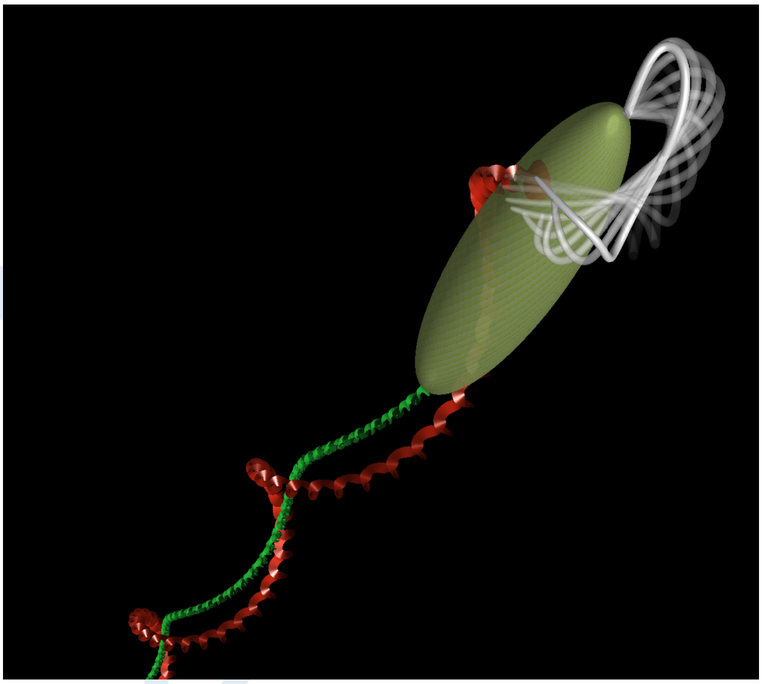
PRESS RELEASE

The sky in a pond



Cells, like the planets, travel through orbits described by classical mechanics

Applying the law of classical mechanics to biology, new research has illustrated for the first time euglenoid cellular movement in three dimensions. This has interesting applications in the microrobotic field

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It was like finding the laws that govern the movement of planets inside a pond. Because that is where *Euglena gracilis* lives, a unicellular organism, which has allowed a group of scientists of *mathLab* and of *Sensing and Moving Bioinspired Artifacts laboratory* (SAMBA) at SISSA, in association with the National Institute of Oceanography and Experimental Geophysics – OGS, to rebuild **the motion in three dimensions** of single cells, using a very original approach, which looks to Space.
In the research, just published on *Proceedings of the National Academy of Sciences* (PNAS), scientists have reconstructed the motion of *Euglena* starting from images gathered under the microscope and subsequently analysed through the **laws of classical mechanics, following an approach similar to that applied to the study of the motion of celestial bodies**.

In addition to the important implications within the scope of biology and physics, this research opens up interesting perspectives in the field of biomimetics, a branch of science, which gets inspired by nature to invent new technological applications. In particular, the study of the motion of these organisms could be used to produce miniature robots for use in medicine.

Discovering *Euglena*

Euglena lives in ponds and uses a flagellum to move, an external appendage which allows the cells to proceed in water as if it were a swimmer with a single limb. We are talking about a special way of swimming, which is complicated and still little explored. Until today, the world of these microorganisms had only been investigated in two dimensions, because they are visible through the lenses of a conventional optical microscope.

Euglena has one flagellum which beats asymmetrically and periodically. "The asymmetry made it so difficult to reconstruct the motion of the flagellum that we had to reconstruct a three-dimensional image starting from just two-dimensional images", stated Antonio De Simone, one of the professors at SISSA of Trieste responsible for the research.

The images of the microscope, recorded at high frequency, and the mathematical modelling of the cellular motion have made it possible to reconstruct the trajectory followed by the alga and the orientation of its body in all phases of movement. To the eyes of the researchers, the alga rotating on itself as it moved forward, looked like the Earth would appear to an observer sitting on the Sun. The combination of the two motions, the translation and rotation on itself, have led to the reconstruction of cell motion in three dimensions, as also the structure and the movement of the flagellum.

Only this multi-disciplinary approach has allowed us to solve the enigma of the movement of the *Euglena* flagellum" commented Alfred Beran, biologist at the National Institute of Oceanography and Experimental Geophysics -OGS.

Applications of the research

What emerged from this research expresses a valid law to describe the motion of any unicellular flagellate organism in a fluid. The propulsion mechanism of *Euglena* is shared by many microorganisms. Consequently, its interest in the biological field can be easily understood.

The motion of these organisms can be useful to classify them and to understand which physical microscopic structures are involved in their movement. This discovery marks an important step forward for physics, while dealing with living beings that, unlike planets, move actively. The flagellum can therefore be equated with an internal engine which makes the system move.

The observations on *Euglena* could be used in engineering terms to produce robots able to adapt and proceed into indefinite areas. This is a goal which would represent a great step forward and true discontinuity with respect to the already widely diffused robots, such as those used for industrial purposes, which move in a predetermined setting.

De Simone concludes: "This work, which has taken three years, was prompted within the context of an important effort, that of setting up an innovative laboratory for the combination of different disciplines at SISSA. It is also the result of mathematics which looks to the world and tries to interpret with its laws what is observed in Nature. But it is also a wonderful example of how to perceive the existence of a universal law based on microscope observations", concluded De

Simone.

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http://www.pnas.org/content/114/50/13085.abstract

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