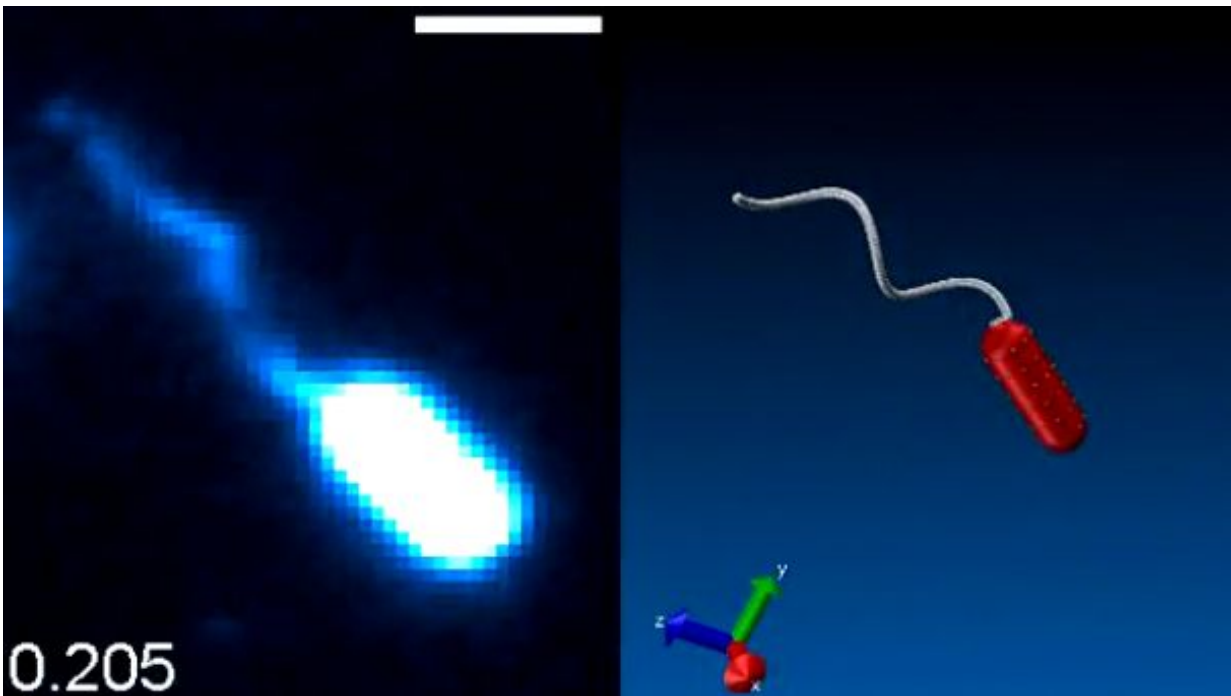


# First direct visualization of archaeella's rotation using cross-kymography

October 27 2016

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Microorganisms have sophisticated motility mechanisms that enable them to move in response to changes in the environment. These mechanisms are well characterized in bacteria, which use flagella to propel themselves. In contrast, little is known about how archaea swim. In a study published recently by Yoshiaki Kinosita and co-authors in *Nature Microbiology*, researchers at Gakushuin University and Tohoku

University clarified how the swimming model archaeon *Halobacterium salinarum* produces motility by using its rotary archaella filaments.

Archaella have protein sequences and structures similar to non-rotary bacterial type IV pili. However, archaella rotate, and this rotation drives swimming motility. In their study, "Direct observation of rotation and steps of the archaellum in the swimming halophilic archaeon *Halobacterium salinarum*", Kinoshita et al. used 3-D tracking of cell-surface quantum dots to reveal the archaeon's left-handed corkscrewing. The authors then used their newly devised "cross-kymography" technique under a total internal reflection fluorescence microscope (TIRFM) and revealed the archaella's right-handed helicity and rotation speed.

Using these and additional parameters revealed by cross-kymography, the authors succeeded in developing a hydrodynamic model that reproduced the archaeon's swimming features. This approach also made it possible to calculate the archaella's motor torque for swimming motility. Tethered-cell assays revealed stepwise rotation of the archaellum for the first time. The authors speculated that the intermittent pauses during the archaella's rotation may be unitary steps that consume a single ATP molecule, and suggested that the efficiency of the motor may be ~6-10%. They note that "the exploration of this fascinating rotary motor, especially in microscopic detail, has just begun", and they plan next to tackle questions including "How are helical filaments generated?" and "How do archaella change the direction of rotation?".

Regarding other applications, the authors note that the advantage of their cross-kymography method under TIRFM is that "an observer can simultaneously judge two parameters, rotational direction and the structural helicity handedness, with no assumptions, and immediately detect their switching without time delay". Lead author Yoshiaki Kinoshita, a graduate student at Gakushuin University, wrote recently in

an email interview that "One successful application of our experimental set-up is the simultaneous quantification of polymorphism and/or rotation switching of flagellated bacteria. Additionally, there are a large number of bacterial species that employ helical patterns to realize their swimming motility, and our method is applicable to them. The structure of the archaellum is similar to that of the type IV pilus in pathogenic bacteria such as *Pseudomonas aeruginosa* and *Neisseria gonorrhoeae*, and our techniques are applicable to labeling and visualizing these pili, and may allow real-time imaging of the interaction between the host cells and bacteria".

**More information:** Yoshiaki Kinosita et al, Direct observation of rotation and steps of the archaellum in the swimming halophilic archaeon *Halobacterium salinarum*, *Nature Microbiology* (2016). [DOI: 10.1038/NMICROBIOL.2016.148](https://doi.org/10.1038/NMICROBIOL.2016.148)

Provided by Gakushuin University

Citation: First direct visualization of archaella's rotation using cross-kymography (2016, October 27) retrieved 31 August 2024 from <https://phys.org/news/2016-10-visualization-archaella-rotation-cross-kymography.html>

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