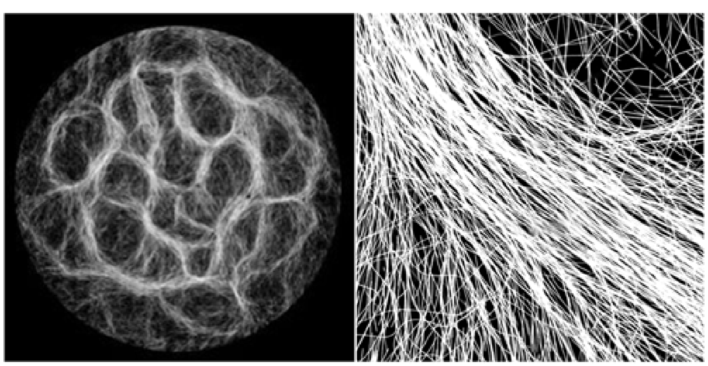
Collective Organization of Spaghetti-like Bacteria

Lab experiments and theoretical models elucidate how chains of light-harvesting bacteria assemble into various density-dependent structures.

By **Charles Day**

Cyanobacteria were Earth's first photosynthetic organisms, and they remain important members of the planet's ecosystem. Like flocks of birds and schools of fish, they are also natural examples of a type of out-of-equilibrium ensemble known to physicists as active matter. Mixon Faluweki of Nottingham Trent University in the UK and his colleagues have now applied the tools and concepts of statistical physics to investigate how members of one cyanobacteria species congregate [**1**]. The researchers found that a minimal model can account for the variety of structures they observed.

The study of active matter began in the 1990s when researchers modeled systems of self-propelled, interacting point particles. Since then, ever-more complex systems have come under scrutiny, including long, flexible biological particles such as the *Oscillatoria lutea* cyanobacteria studied by Faluweki and his colleagues.



Credit: M. K. Faluweki *et al.* [**1**]

In its natural, freshwater setting, *O. lutea* forms flexible filaments, 1–2 mm long, each comprising hundreds of individual cyanobacteria. Those filaments slide over each other in bundles that aggregate into net-like configurations. To investigate this behavior, Faluweki and his colleagues first monitored lab-grown colonies of *O. lutea* under a confocal microscope. Their measurements informed the next step: creating a model with a modest number of parameters to describe the aggregation of *O. lutea*. The model reproduced the variety of density-dependent structures that the researchers observed. It also yielded a physical explanation for the characteristic length of the web-like patterns emerging from the chains' movement in terms of the relative importance of advective and diffusive transport.

The team's work could help elucidate the self-organization of other multicellular filamentary organisms, such as fossilized archaea and the cyanobacteria that are cultured in modern algal bioreactors.

Charles Day is a Senior Editor for ***Physics Magazine***.

REFERENCES

1. M. K. Faluweki *et al.*, "Active spaghetti: Collective organization in cyanobacteria," **Phys. Rev. Lett. 131, 158303 (2023).**