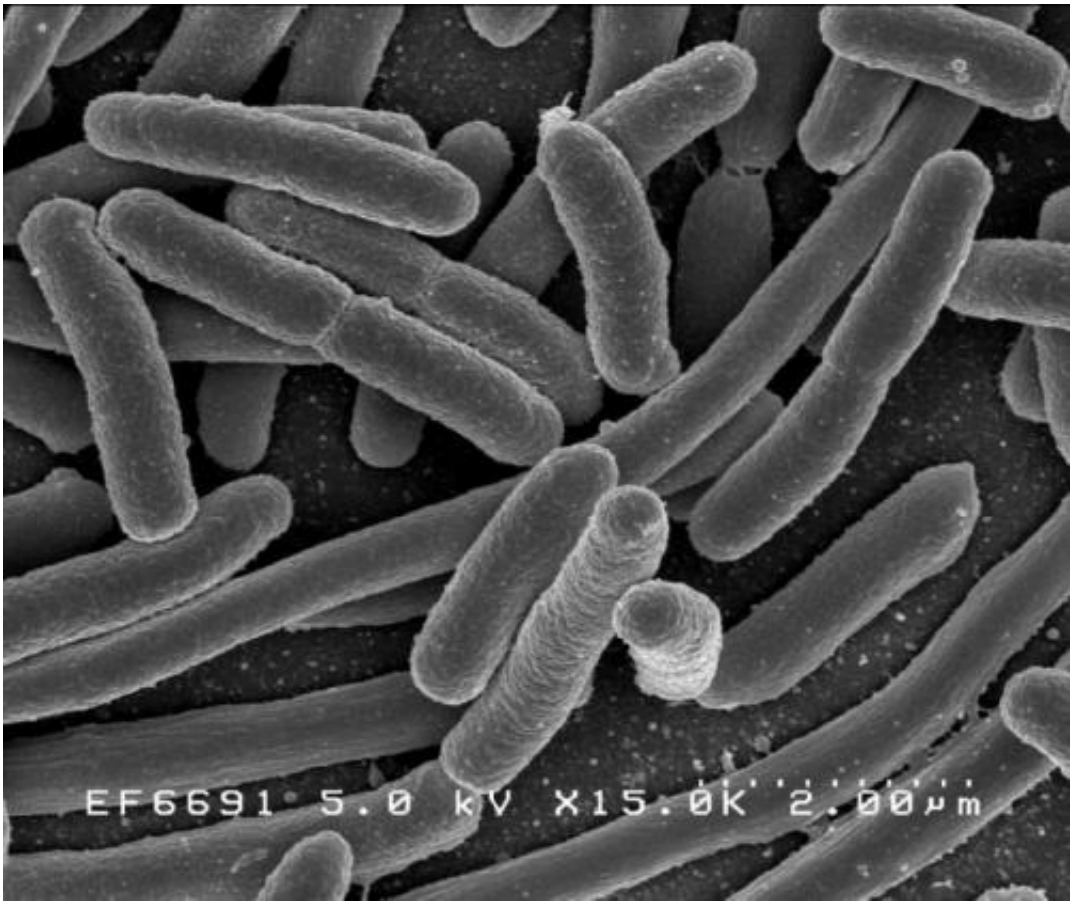
Bacteria used to create superfluids

July 13 2015, by Bob Yirka



Escherichia coli. Credit: Rocky Mountain Laboratories, NIAID, NIH

(Phys.org)—A team of researchers with Université Paris-Sud and Université P.M. Curie/Université Paris-Diderot, both in France, has discovered that putting certain types of bacteria into an ordinary fluid, can cause it to become a superfluid. In their paper published in the

journal *Physical Review Letters,* the team describes how they modified an old rheometer to conduct the tests, their readings and their ideas on why the bacteria caused a change in viscosity.

A fluid's viscosity is its state of thickness as can be demonstrated when it is poured out—water will run out much faster than oil, for example. Viscosity comes about due to friction among the ingredients that make up the fluid. Scientists have suspected for a number of years that bacteria in a fluid can cause a change in its viscosity, but until now, it has not been proven. To do so, the researchers pulled out a rheometer (a device used to measure viscosity) that was built several decades ago—they modified it to allow for connecting to a computer.

They then added various amounts of *E. Coli* to a water/nutrient solution and then tested its viscosity at different rotation speeds. Their modified instrument showed that the bacteria did indeed cause a change in viscosity, it lowered it. Adding more bacteria led to a viscosity reading of zero, and then to negative viscosity. They also proved that their results were due to some action on the part of the bacteria rather than their mere presence causing the change—when the *E. Coli* were killed, the viscosity readings did not go down. Fluids with no viscosity are called superfluids because they flow with no friction whatsoever.

The team explains that they had to modify the old rheometer because modern devices are only capable of measuring high viscosity, which means using a high spin rate. They also suggest that it is likely the bacteria caused changes to viscosity by the movement of their tails against the current. They note that it might be possible to somehow harness the viscosity lowering ability of bacteria by inserting tiny rotors into a fluid that would be dragged around, perhaps powering a small device.

More information: Turning Bacteria Suspensions into Superfluids,

Phys. Rev. Lett. 115, 028301 – Published 7 July 2015.
dx.doi.org/10.1103/PhysRevLett.115.028301 . On *Arxiv*:
arxiv.org/abs/1503.05511

ABSTRACT
The rheological response under simple shear of an active suspension of Escherichia coli is determined in a large range of shear rates and concentrations. The effective viscosity and the time scales characterizing the bacterial organization under shear are obtained. In the dilute regime, we bring evidence for a low-shear Newtonian plateau characterized by a shear viscosity decreasing with concentration. In the semidilute regime, for particularly active bacteria, the suspension displays a "superfluidlike" transition where the viscous resistance to shear vanishes, thus showing that, macroscopically, the activity of pusher swimmers organized by shear is able to fully overcome the dissipative effects due to viscous loss.

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