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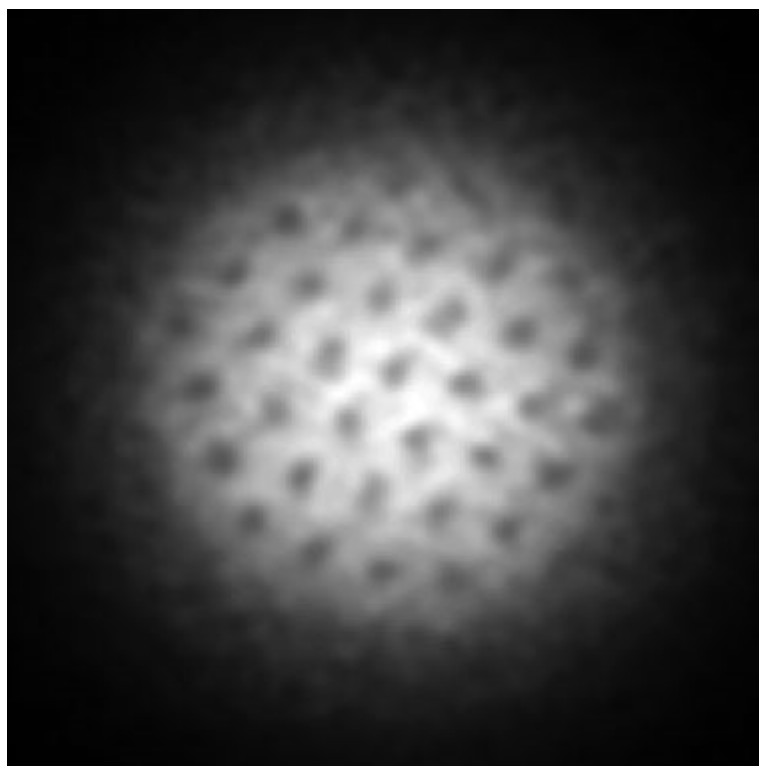
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22 June 2005

Ultracold Atoms Turn a Cool Trick

In recent years, physicists have been racing to prove that ultracold atoms can pair up and flow like the freely flowing electrons in a superconductor. Now, subtle swirls in a cloud of atoms provide proof positive that researchers have reached that elusive goal.



Smoking gun. Array of vortices proves paired atoms form a superfluid.

CREDIT: Andre Schirotzek/MIT

do so, they must form pairs, as the electrons do in a superconductor. The pairs join together to form the superfluid.

Or so the theory goes. Researchers have been striving to produce such a superfluid, and last year, they finally coaxed ultracold atoms into pairing (*ScienceNOW*, 28 January, 2004). But experimenters had not proved that the

For more than a decade, physicists have used laser beams and magnetic fields to chill gases of atoms to within billionths of a degree of absolute zero, producing a variety of weird quantum effects. Atoms of some isotopes can crowd into a single quantum wave, or "state," to create a Bose-Einstein condensate, or BEC. First produced in 1995, a BEC is a "superfluid," a weird quantum soup that flows without any resistance and refuses to rotate. Atoms of other isotopes cannot squeeze into a single quantum state because of the way they spin. However, physicists have long expected that such atoms can still form a superfluid, although in a more complicated way. To

paired-up "Fermi condensate" was a superfluid.

To clinch the case, physicists Martin Zwierlein, Wolfgang Ketterle, and colleagues at the Massachusetts Institute of Technology in Cambridge tried to rotate a Fermi condensate of the isotope lithium-6 by tickling it with a laser, much as one might set a golf ball spinning by brushing around its circumference with a feather. Had the lithium-6 been an ordinary fluid, the cloud would have rotated as a whole, like water in a slowly turning drinking glass. A superfluid resists rotation, however, because it is a quantum wave that can possess only quantized amounts of rotation. Turn its container fast enough, and a superfluid admits one quantum of rotation in the form of a tiny whirlpool, or vortex. Turn faster still, and the vortices proliferate and form a triangular array, which is what Zwierlein and Ketterle observed in the cloud of atoms, as they report 23 June in *Nature*.

The results leave no doubt that a Fermi condensate is a superfluid, says Rudolf Grimm, an experimental physicist at the University of Innsbruck, Austria. "Everybody was waiting for the smoking gun," he says, "and there it is."

--ADRIAN CHO

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