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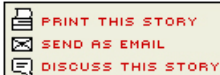
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MIT researchers spin superfluid gas

[Nicolas Mokhoff](#)
[EE Times](#)

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MANHASSET, NY — A team of MIT scientists has created atomic gas exhibiting high-temperature superfluidity.

The MIT work is closely related to the superconductivity of electrons in metals. Observing superfluids may help solve lingering questions about high-temperature superconductivity, which has widespread applications for magnets, sensors and energy-efficient transport of electricity.

The team, led by Wolfgang Ketterle, a Nobel laureate and the John D. MacArthur Professor of Physics at MIT, observed many vortices emanating from the gas — a sure sign that the gas is superfluid.

Normal gas rotates like an ordinary object, but a superfluid gas can only rotate when it forms vortices similar to mini-tornadoes. This gives a rotating superfluid the appearance of Swiss cheese, where the holes represent the tornadoes' core.

"When we saw the first picture of the vortices appear on the computer screen, it was simply breathtaking," said research team member [Martin Zwierlein](#). The team worked nearly a year on creating nearly round magnetic fields and laser beams used to rotate the gas. "It was like sanding the bumps off of a wheel to make it perfectly round," Zwierlein explained.

"In superfluids, as well as in superconductors, particles move in lockstep. They form one big quantum-mechanical wave," explained Ketterle. Such a movement allows superconductors to carry electrical currents without resistance.

The team observed fermionic superfluidity in a lithium-6 isotope consisting of three protons, three neutrons and three electrons. Using laser and evaporative cooling techniques, gas was cooled to absolute zero. The team then trapped the gas in the focus of an infrared laser beam. The electric and magnetic fields of the infrared light held the atoms in place.

The last step involved spinning a green laser beam around the gas to initiate rotation. A shadow picture of the cloud showed its superfluid behavior: a cloud pierced by a regular array of vortices, each about the same size.

The work is based on the MIT group's earlier creation of [Bose-Einstein condensates](#), a form of matter in which condensed particles act as a big wave. Albert Einstein predicted this phenomenon in 1925. Scientists later realized that

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
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Bose-Einstein condensation and superfluidity are intimately related. While earlier work at MIT and other university research centers have observed Bose-Einstein condensation, their's were not the same as observing superfluidity.

The superfluid Fermi gas can also serve as an easily controlled model system to study the properties of much denser forms of fermionic matter such as solid superconductors, neutron stars or the quark-gluon plasma that existed at the beginning of the universe.

Members of the research team included MIT graduate students Zwierlein, Andre Schirrotzek, and Christian Schunck, all of whom are members of the Center for Ultracold Atoms, as well as former graduate student Jamil Abo-Shaeer.

The MIT research will be reported in the June 23 issue of *Nature*, and is supported by the National Science Foundation, the Office of Naval Research, NASA and the Army Research Office.

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