

# Magnetism observed in gas for the first time

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(PhysOrg.com) -- For the first time, MIT scientists have observed ferromagnetism in an atomic gas, addressing the decades-old question of whether gases could show properties similar to a magnet made of iron or nickel. Specifically, the team observed the ferromagnetic behavior in a gas of lithium atoms cooled to 150 billionth of 1 Kelvin above absolute zero (-273 degrees C or -459 degrees F).

Team members used the lithium-6 isotope, which consists of three protons, three neutrons and three electrons. Since the number of constituents is odd, lithium-6 is a fermion — a class of exotic particles that have a half-integral spin — and has properties similar to an electron. Therefore, [lithium](#) atoms can be used to simulate the behavior of electrons.

For decades, scientists have debated whether it is in principle possible for a [gas](#) or liquid of fermions, which are not in a periodic crystal, to become ferromagnetic.

The MIT research appears to provide a compelling affirmative answer to this question.

"One thing is certain: We have made an important discovery, which will advance our understanding of magnetism," said Ketterle, an MIT physics professor and the corresponding author on the paper. More broadly, magnetic materials have important applications in [data storage](#), nanotechnology and medical diagnostics.

The MIT team trapped a cloud of ultracold lithium atoms in the focus of an infrared [laser beam](#). When they gradually increased the repulsive forces between the atoms, they observed several features indicating that the gas has become ferromagnetic.

The cloud first became bigger and then suddenly shrunk. When the atoms were released from the trap, they suddenly expanded faster. This and other observations agreed with theoretical predictions for a phase transition to a ferromagnetic state.

If confirmed, the MIT result may enter the textbooks on magnetism, showing that a gas of fermions does not need a [crystalline structure](#) to be ferromagnetic.

"The evidence is pretty strong," said David E. Pritchard, an MIT physics professor and one of the study's authors. "But it is not yet a slam dunk. We were not able to study how the atoms would all point in the same direction. They started to form molecules and may not have had enough time to align themselves."

More information: "Itinerant Ferromagnetism in a Fermi Gas of Ultracold Atoms," Gyu-Boong Jo, Wolfgang Ketterle, et al., *Science*, Sept. 18, 2009

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