Exotic magnetic phenomenon observed in metal

EPS - 1003897
RII: Louisiana Alliance for Simulation-Guided Materials Applications (LA-SiGMA)
Louisiana **2010-2015**
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Louisiana State University students using a magnetometer to test the properties of experimental magnetic materials.

Credit: Dr. Shane Stadler, Louisiana State University.

What is the outcome or accomplishment?
Researchers worldwide are performing experiments on ferromagnetic materials, changing different variables such as pressure and impurities to observe the changes in the electron interactions and magnetization. In certain rare scenarios where the competing physical phenomena clash, ferromagnetic materials will exhibit unconventional behaviors, like extreme drops in resistance and superconductor levitation.

A team of researchers led by Dr. Shane Stadler at Louisiana State University observed a rare, exotic interaction, called an “anisotropic Kondo effect,” in a ferromagnetic alloy. The lattice effect forms as a result of electrons "screening" the magnetic behavior of the atoms in the material. The electrons move to positions around the magnetic atoms in the material, effectively canceling the magnetic effect of those atoms. The Kondo effect is observed more commonly in rare earth materials, and it is unusual to observe this behavior in a metal alloy.

What is the impact?
The behavior of these materials cannot be explained by the understanding of the individual atoms alone. Each additional variable, like applied pressure, magnetic field, or the addition of new atoms adds an enormous level of complexity that produces entirely new properties. Observing and measuring exotic phenomena like this at the quantum level gives us a fundamental understanding of the physics at play. The next step will be to research how to manipulate these properties to produce the desired effects for the development of commercially important applications like nanoscale computer circuits and the next generation of media storage.

What explanation/background does the lay reader need to understand the significance of this outcome?
Magnets, also known as ferromagnetic materials, have been around since ancient times. From basic iron to more complex alloys, ferromagnetic materials have been widely used in our daily life for a long time. The strength of magnets has improved exponentially since the early 20th century, and many important modern technologies depend on magnetic materials, such as MRI devices, sensors, and the data storage devices in our computers. The magnetic phenomena occurring inside these materials can be explained by quantum physics.