Research reveals hidden magnetism in superconductivity

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While studying a compound made of the elements cerium- rhodium-indium, researchers at Los Alamos National Laboratory and the University of Illinois at Urbana-Champaign have discovered that a magnetic state can coexist with superconductivity in a specific temperature and pressure range. The discovery is a step toward a deeper understanding of how Nature is organized in regimes ranging from the fabric of the cosmos to the most fundamental components of elementary particles.

In research published recently in the scientific journal *Nature*, Los Alamos scientists Tuson Park, Joe D. Thompson, and their colleagues describe the discovery of hidden magnetism in the $CeRhIn_5$ compound. In studying the compound, researchers found that a purely unconventional superconducting phase is separated from a phase of coexisting magnetism and unconventional superconductivity, with the boundary between these two phases controlled by the laws of quantum physics.

Unconventional superconductors are materials that exhibit superconductivity, a complete absence of electrical resistance under cold temperatures, but use exotic mechanisms. Conventional wisdom has long held that the magnetism is excluded as materials change phases, but the researchers now show that it is merely hidden by unconventional superconductivity and can be made to reappear in the presence of an applied magnetic field.

According to Thompson, "this discovery provides an exciting opportunity to better understand how magnetism and unconventional superconductivity are related in more-complex materials and may reveal more about the technologically important field of high temperature superconductors."

At low temperatures, electrons in a metal can pair with each other to create superconductivity, align in a magnetically ordered state, or do neither. Until recently, these mutually exclusive options for electrons were the norm, but the discovery of complex electronic materials like $CeRhIn_5$, which can sustain more exotic forms of superconductivity, now shows that electrons can participate simultaneously in magnetism and superconductivity.

Source: Los Alamos National Laboratory

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