A New Type of Superconductor


Materials made with iron (left) and copper (right) appear to achieve superconducting properties via different mechanisms. (Images courtesy of Amethyst Gallery. Click for larger image.)

The recent discovery of superconductivity in iron-based layered compounds known as iron oxypnictides has renewed interest in high-temperature superconductivity. These compounds, which transfer electric currents without resistance, may offer a low-cost option for electrical transmission, magnetic levitation and other applications.

For decades, only copper oxides were known to superconduct at relatively high temperatures. Then, in April 2008, researchers in Japan published an article in *Nature* announcing that they had made an iron-based oxide superconduct at 43 kelvin by applying pressure to the material. Soon after, the record was raised to 55 kelvin by a Chinese research group using another iron-based compound. These records ended the monopoly of copper oxides in the family of high-temperature superconductors, and provided a new direction in the study of high-temperature superconductivity.

Now, SLAC and Stanford researchers have furthered the quest to understand this iron compound. In a recent paper published in *Nature*, Stanford Synchrotron Radiation Laboratory scientist Donghui Lu, with colleagues in SSRL and Stanford, reported on the mechanism behind the superconductivity of a lanthanum-oxygen-iron-phosphorus compound, or LaOFeP, one of the new iron-based superconducting materials.

Superconductivity occurs when a material's electrons pair up and electrical resistance disappears. The precise mechanisms by which this happens are fairly well understood for conventional superconductors, but remain elusive for copper-based high-temperature superconductors. The new iron-based superconductors seem to be fundamentally different from both previous types, even though they operate at high temperatures like the copper oxide superconductors. Lu and colleagues took detailed measurements of the LaOFeP compound, which may lead to a deeper understanding of why the electrons pair up in iron superconductors. That, in turn, could also help to sort out the essential ingredients that are important to achieve high-temperature superconductivity.

Although this research suggests that the mechanism behind superconducting LaOFeP is likely different from that behind copper oxides, the same may not hold true for other iron-based oxide compounds. Lu and colleagues are now conducting experiments at SSRL using an iron-based compound that includes arsenic instead of phosphorus.

"This is an ongoing project," said Lu. "Overall, there is a lack of conclusive experimental information on these new superconductors. Surprises may come along the road. Part of the fun of scientific research is that there's always a surprise."

Although there are many other important issues to be resolved, this work serves as a starting point on the long journey toward unveiling how superconductivity works in this new family of high-temperature superconductors.

—Donghui Lu and Kelen Tuttle
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