# Pengcheng Dai Named JIAM Chair of Excellence

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Professor Pengcheng Dai was recently honored with a Chair of Excellence for his many contributions to superconductivity, just as his latest paper on the subject was working its way through the editorial process at *Nature Materials*.

In a special colloquium on September 17, Dai was named a Joint Institute for Advanced Materials (JIAM) Chair of Excellence “for his pioneering work in elucidating the origin of the novel functionality in correlated electron materials using neutron scattering,” as the citation read. Distinguished Professor Ward Plummer, who recruited Dai to the University of Tennessee, made the presentation. He pointed out that UTK is not the only place where Dai’s work has been appreciated; his most-cited paper has been referenced 243 times and this year alone he has had 12 papers published, with three more accepted including the *Nature Materials* paper and two papers in *Phys. Rev. Lett.* Plummer said he was confident of even greater achievements in the future.

“I expect unbelievable success,” he said.

Dai’s talk, entitled “Strike While the Iron is Hot,” explained some of the history behind and latest discoveries in superconductivity, an area where much of his research is focused. Discovered nearly 100 years ago, superconductivity is the phenomenon where electrons form pairs to carry electric current with no resistance. Early superconductors, however, only worked at temperatures far too low to be practical (mercury, for example, has zero resistance at 4.2 Kelvin, or -277.2°C).

By the mid-1980s, scientists had discovered that compounds made of copper and oxygen (termed “cuprates”) could become superconductors at much higher transition temperatures ($T_c$), although they were still far below room temperature (about 300 Kelvin). Complicating matters was that no one knows exactly what causes electron pairing in these materials. In conventional, old-school superconductors, electrons and phonons interact, causing the electrons to pair up. With the so-called High-$T_c$ superconductors, researchers have differing ideas about the origins of electron pairing. Some accredit it to the presence of copper, while others, like Dai, propose that magnetism is the key factor. A recent development in the superconductivity story might provide some answers.

This past spring, scientists in Japan serendipitously put together iron and arsenic and in the process created a new class of superconducting materials. Dai and his research group have been working with the new compounds since May and are encouraged by the results. They published a paper in *Nature* where they showed how doping iron-arsenic compounds can suppress static magnetism and usher in superconductivity—the same approach that works in cuprates, only without the copper.

Dai says that for 20 years, scientists have been “beating their heads again the cuprates,” as understanding how they work has eluded definitive explanation and getting higher transition temperatures to make them practical has stalled. He said the new class of iron-arsenic superconductors represents “a new playground.” He is optimistic that the more that is understood about superconductivity, the better the chances are that one day scientists can actually design materials for specific purposes—including solving energy problems. Up to now, he said, “most superconductors are discovered by experimentalists doing something else.”

In the October 26 issue of *Nature Materials*, Dai’s group, with graduate student Jun Zhao as lead author, published a new paper entitled: “Structural and magnetic phase diagram of $CeFeAsO_{1-x}F_x$ and its relationship to high-temperature superconductivity.” In this work, they started with a parent compound of cerium (a rare earth element), iron, arsenic, and oxygen. When they doped the system with fluorine, they discovered it has an electronic phase diagram remarkably similar to that of the cuprates. While the cuprates have been around for two decades, the new iron-arsenic compounds are only a few months old and consequently require much more study. However, comparing them with their copper-based predecessors will, scientists hope, take some of the mystery out of what makes superconductors work. Steven A. Kivelson and Hong Yao of Stanford University chose the paper as the subject for their News & Views article in the December 2008 issue of *Nature Materials*. This is exactly the sort of work championed by the Joint Institute for Advanced Materials—a University of Tennessee-Oak Ridge National Laboratory (ORNL) partnership that capitalizes on the considerable strengths of both institutions in areas like nanophase materials, high-performance computing, and—Dai’s expertise—neutron scattering.

In Dai's preferred experimental method, a beam of neutrons is fired at a sample to determine that sample's nuclear and magnetic structure based on how the neutrons scatter. His group has traditionally ordered samples from other labs across the globe, but with the addition of new postdoc Chenglin Zhang, who just obtained his Ph. D degree from Rutgers University, they will be able to grow their own single crystals in their UTK campus laboratory. They also use the Spallation Neutron Source at ORNL.

Dai said the success of his group is mostly due to the hard work of his talented graduate students and postdocs; that without them none of this would have been possible. He said graduate students Jun Zhao and Songxue Chi and postdocs Clarina de la Cruz and Shiliang Li have played a very important role in the work on the new iron arsenic based superconductors and are really the champions of their success.

Dai earned a bachelor's degree in physics from Zhengzhou University and went on to complete the Ph.D. at the University of Missouri. He was a postdoc and staff member at ORNL before joining the physics faculty in 2001. In 2003 he was recognized as an outstanding young researcher by the Overseas Chinese Physics Association and this past spring he was honored with a Chancellor's Award for Research and Creative Achievement in recognition of his contributions to the understanding of high-temperature superconductors. As a new JIAM Chair of Excellence, he joins fellow Physics Professor Hanno Weitering and Civil and Environmental Engineering Professor Dayakar Penumadu, both of whom were named JIAM Chairs in 2006.