FAST BREAKING PAPERS - 2009

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Hong Ding talks with *ScienceWatch.com* and answers a few questions about this month's Fast Breaking Paper in the field of Physics. The author has also sent along an image of his work.

Article Title: Observation of Fermi-surface-dependent nodeless superconducting gaps in Ba0.6K0.4Fe2As2

Authors: Ding, H;Richard, P;Nakayama, K;Sugawara, K;Arakane, T;Sekiba, Y;Takayama, A;Souma, S;Sato, T;Takahashi, T;Wang, Z;Dai, X;Fang, Z;Chen, GF;Luo, JL;Wang, NL

Journal: EPL, Volume: 83, Issue: 4, Page: art., Year: no.-47001 2008

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SW: Why do you think your paper is highly cited?

This paper provided the first convincing experimental evidence of a new type of s-wave pairing symmetry for the newly discovered iron-based high temperature superconductors by observing the Fermi-surface-dependent nodeless superconducting gaps in an optimally doped pnictide using angle-resolved photoelectron spectroscopy (ARPES).

Pairing symmetry consists of the momentum information of the amplitude and phase of the superconducting energy gap, which represents the energy needed to break the pairs of electrons (Cooper pairs) apart and destroy the superconductivity along each direction.

Thus, knowing the pairing symmetry is a crucial step in understanding the superconducting mechanism of a superconductor. In the case of high-temperature copper-based superconductors, the determination of a d-wave pairing symmetry is arguably the most important achievement of the intensive research efforts which have taken place over a period of 23 years.

SW: Does it describe a new discovery, methodology, or synthesis of knowledge?

This paper describes the discovery of a new class of superconducting gap which is isotropic along any given Fermi surface, yet varies strongly among different Fermi surfaces.

SW: Would you summarize the significance of your paper in layman's terms?

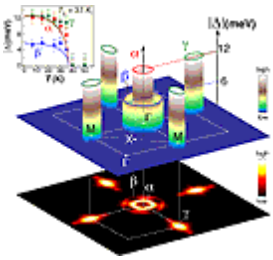
Understanding how a material completely loses its electrical resistance is of great importance from both the fundamental and applied sides of superconductors. Electrons in a superconductor form pairs, and lock into a single phase of motion, similar to the example that many downhill skiers hold their hands together, and are thus able to

overcome small bumps or resistance along their way.

In a quantum world, a very small resistance is quantized into an absolute zero resistance. Crucial information of how strong is the binding force for the pairs and what is the preferred direction of this binding is reflected from the pairing symmetry of a superconductor.

The surprising discovery of high-temperature superconductivity (as high as 55K) in many iron-based compounds has opened a new route in searching for new high-performance superconductors, and the understanding of their pairing symmetry may shine a light on this new direction.

Figure 1 [+] details



ARPES directly probes the superconducting gap in single crystals...

SW: How did you become involved in this research, and were there any problems along the way?

I have been doing research in understanding novel superconductors over the past 17 years, and I've made important contributions in measuring the pairing symmetry and other electronic properties of copper-based superconductors.

The combination of ultrahigh resolution of ARPES and the high quality of single crystals has enabled us to clearly observe superconducting energy gaps and to accurately determine their magnitudes on different Fermi surfaces in iron-based superconductors. The biggest challenge we encountered in our experiment was to find a way to prepare clean sample surfaces for ARPES measurements.

SW: Where do you see your research leading in the future?

We are continuing to do research towards achieving a full understanding of the superconducting mechanism of iron-based superconductors, and have made significant progress since the publication of this paper.

We have accumulated much experimental evidence for inter-Fermi-surface interactions being a driving force for electron pairing in these superconductors. Our research on iron-based superconductors may also lead to a better understanding of copper-based high-temperature superconductors, since both materials have many of the same properties in common. In the meantime, we hope that our research in this fundamental area can one day lead to better applications of superconducting technology.

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Figure 1:

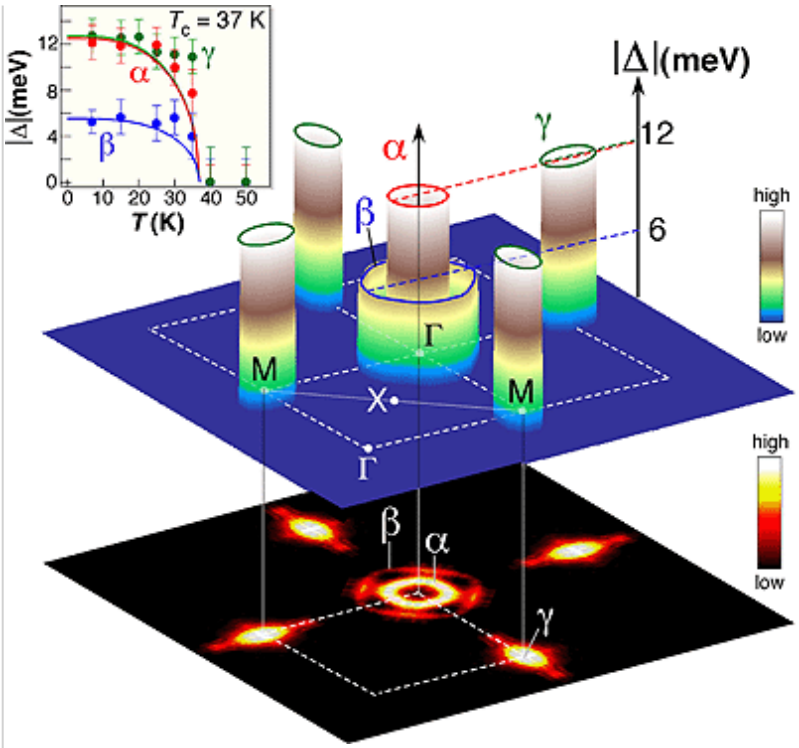

Figure 1:

ARPES directly probes the superconducting gap in single crystals $Ba_{0.6}K_{0.4}Fe_2As_2$ (T_c = 37 K). Two nodeless and nearly isotropic superconducting gaps are observed around their respective Fermi surface sheets: a large gap (D ~ 12 meV) on the small hole-like and electron-like FS sheets, and a small gap (~ 6 meV) on the large hole-like FS. Both gaps close simultaneously at the bulk T_c (inset). (Adapted from H. Ding *et al.*, *EPL* 83, 47001, 2008.).

KEYWORDS: IRON-BASED HIGH-TEMPERATURE SUPERCONDUCTORS; ANGLE-RESOLVED PHOTOELECTRON SPECTROSCOPY; ARPES MEASUREMENTS; COOPER PAIRS; HIGH-TEMPERATURE COPPER-BASED SUPERCONDUCTORS; D-WAVE PAIRING SYMMETRY; INTER-FERMI-SURFACE INTERACTIONS; ELECTRON PAIRING.

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Research Front Map from the special top of High-Temperature Superconductors: *"Iron-Based Layered Superconductors."*

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