New cuprate superconductor may challenge classical wisdom

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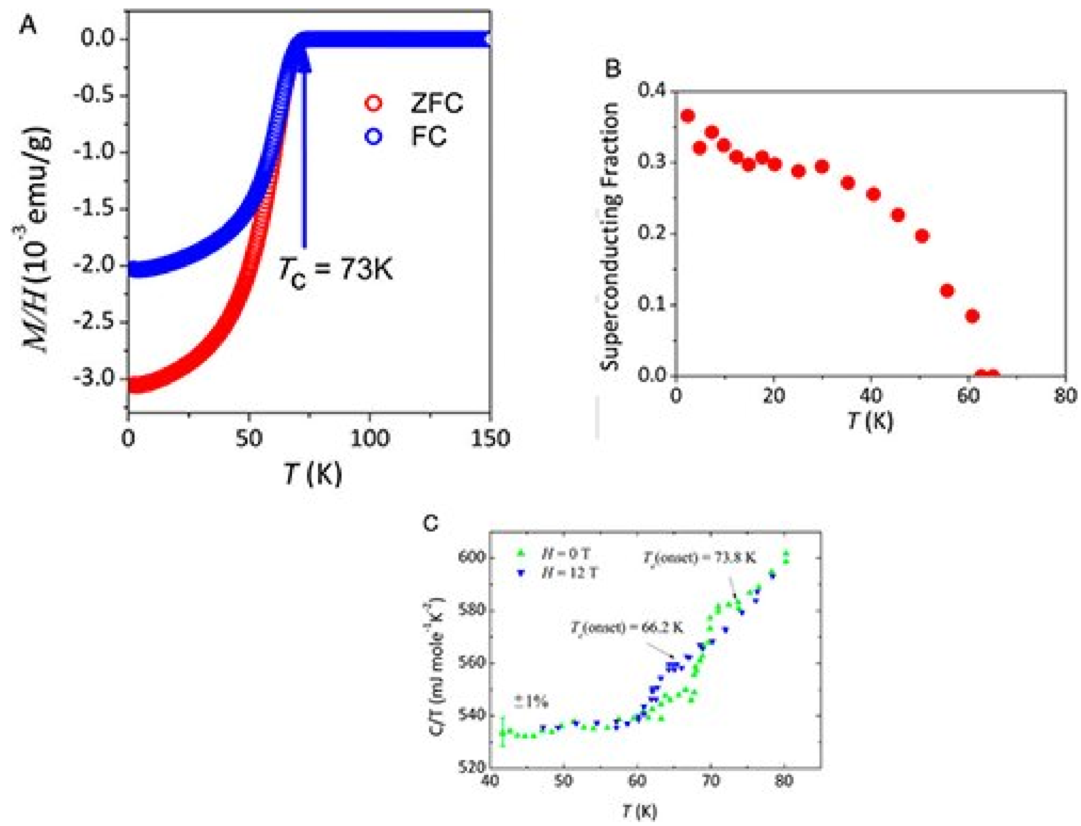

Fig.1. The superconducting transition of the sample showing Tc at 73K (A) The Meissner effects; (B) Superconducting volume fraction in terms of superfluid density estimated from μSR; (C) Specific heat measurement. Credit: Jin Changqing

Superconductivity is one of the most mysterious phenomena in nature in that materials can conduct electrical current without any resistance.

Cuprates hold the record high superconducting temperature at ambient pressure so far, but understanding their superconducting mechanism remains one of the great challenges of physical sciences listed as one of 125 quests announced by *Science*.

The recent discovery by Prof. Jin Changqing's team at Institute of Physics of the Chinese Academy of Sciences (IOPCAS) on a new high Tc superconductor $Ba_2CuO_{4-\delta}$ shows two unique features: an exceptionally compressed local octahedron and heavily over-doped hole carriers.

These two features are in sharp contrast to the favorable criteria for all previously known cuprate superconductors.

The compressed local octahedron results into a reversed orbital order with $3z^2$ lifted above $3dx^2$-y^2 leading to a strong multiband scenario, while the overdoped state violates the previous holding for a superconducting phase.

Impressively, the new material demonstrates superconducting transition temperature with Tc above 73 K, 30 K higher than that of the isostructural classical "conventional" superconductor based on La_2CuO_4.

Thus, the discovery of high Tc superconductivity in $Ba_2CuO_{4-\delta}$ calls into question the widely accepted scenario of superconductivity in the cuprates.

This discovery provides a totally new direction to search for further high Tc superconductors.

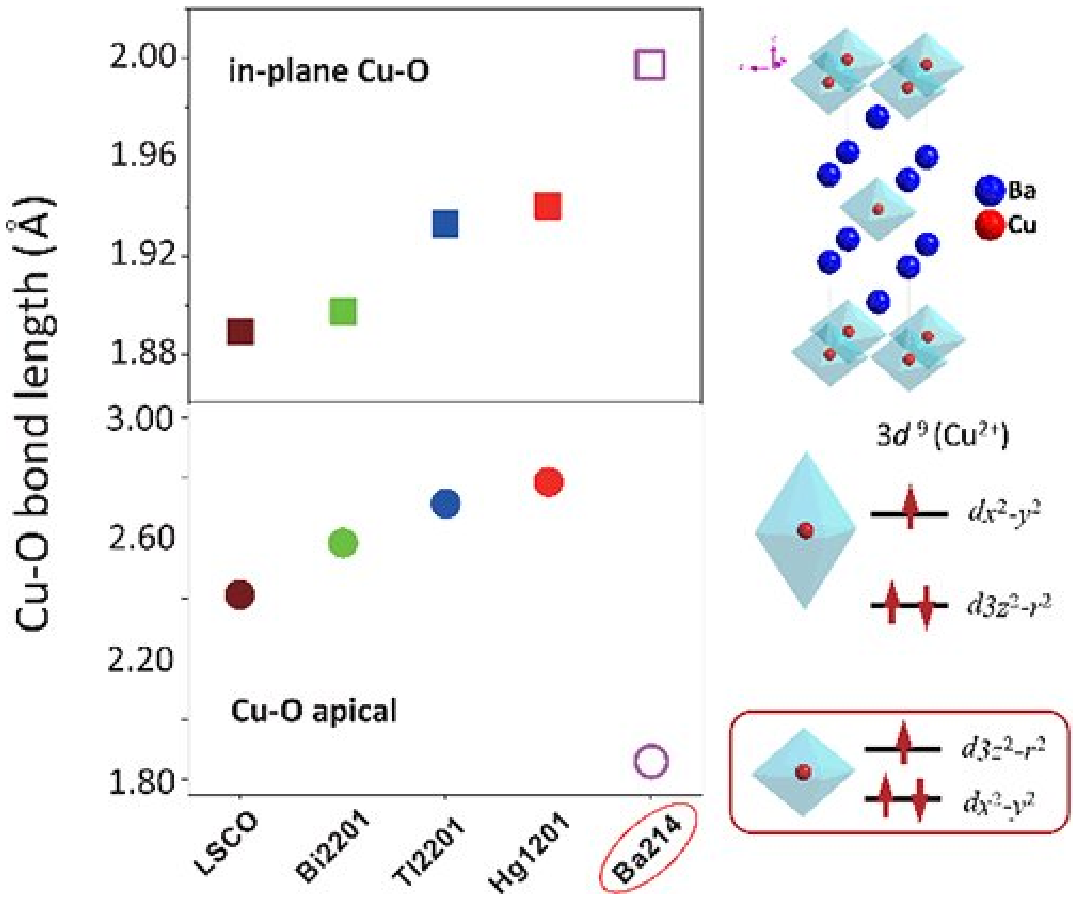

Fig.2. The in-plane Cu-O and apical Cu-O bond length showing the unique compressed local octahedron coordination that leads to the orbital reversal in cuprate superconductors. Credit: Jin Changqing

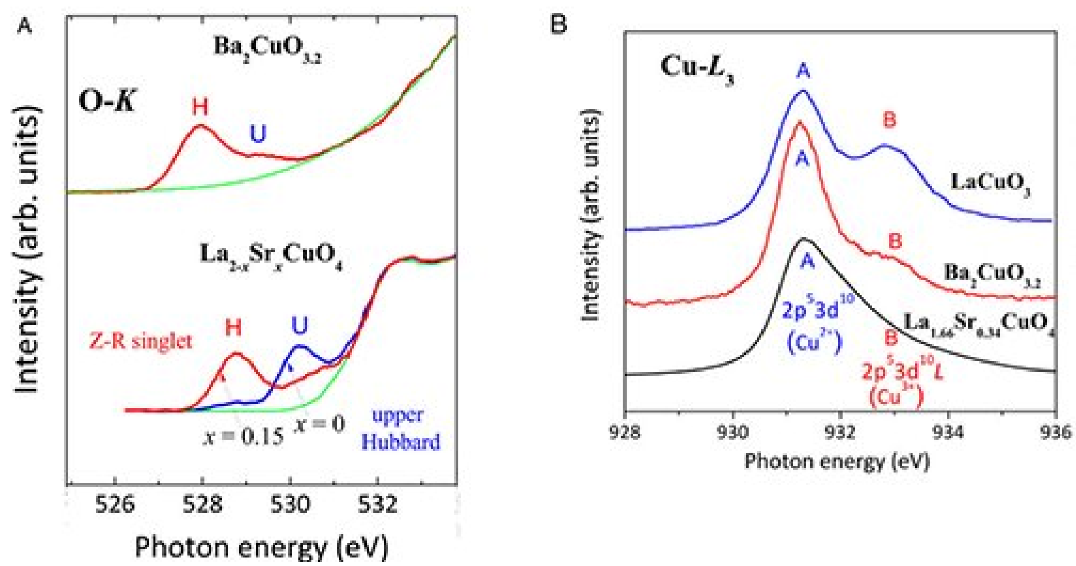

Fig. 3. XAS measurements (A) O-K edge. (B) Cu-L3 edge showing the extremely overdoping state. Credit: Jin Changqing

More information: W. M. Li et al, Superconductivity in a unique type of copper oxide, *Proceedings of the National Academy of Sciences* (2019). DOI: 10.1073/pnas.1900908116

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