New material raises questions about theoretical models of superconductivity

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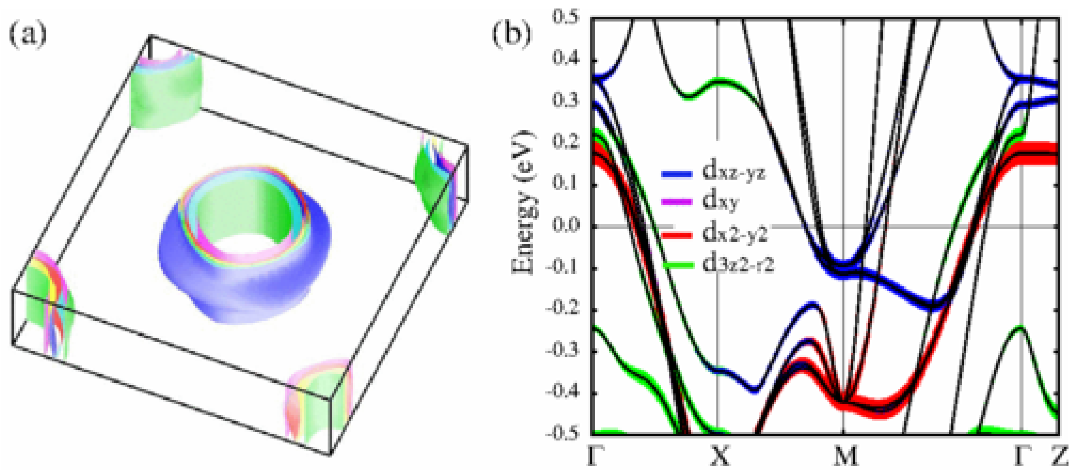

The calculated 3D Fermi surface of $CaKFe_4As_4$, a material notable for having a high superconducting temperature of 35K in its pure state. Credit: Ames Laboratory

The U.S. Department of Energy's Ames Laboratory has successfully created the first pure, single-crystal sample of a new iron arsenide superconductor, $CaKFe_4As_4$, and studies of this material have called into question some long-standing theoretical models of superconductivity.

The material is notable for having the high superconducting temperature of 35K without the need for small amounts of additional elements (such as cobalt or nickel), called dopants.

"That is important because dopants, that were previously used to induce superconductivity, also interfere with superconductivity and other important physical properties of materials" said Adam Kaminski, Ames Laboratory scientist and professor in the Department of Physics and Astronomy at Iowa State University. "This material gave us an excellent opportunity to study superconductivity in pristine samples without the interference of dopants."

Using high resolution angle resolved photoemission spectroscopy and density functional theory, researchers were able to measure the superconducting gap in areas of the momentum space that were previously inaccessible in other materials, and found that their results contradicted the widely accepted antiferromagnetic fluctuation model.

"Our data obtained from samples of pristine iron-arsenic superconductor represents a big deviation from previous studies of doped samples and questions some well-established theories," said Kaminski. "It means that the predictions of previous models are at only partly valid, and there many aspects that are not completely understood. What our work has achieved is to create a new clean avenue of research, towards finding a general model to explain the behavior of these novel superconductors."

More information: Daixiang Mou et al. Enhancement of the Superconducting Gap by Nesting in: A New High Temperature Superconductor, *Physical Review Letters* (2016). DOI: 10.1103/PhysRevLett.117.277001

Provided by Ames Laboratory

superconductivity.html