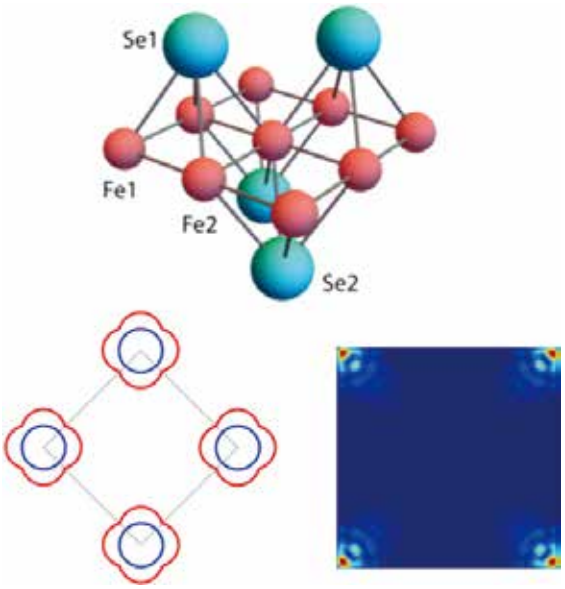
Basic Research

Revealing the Pairing Nature by Topology in Iron-based Superconductors

Unconventional high-temperature superconductivity is a jewel in the crown of condensed-matter physics, but its underlying mechanisms remains elusive. Some clues may lie in the formation of electron pairs in iron-based superconductors. In particular, iron chalcogenides, because of their special electronic structures, have greatly challenged traditional viewpoints. However, despite great efforts in the past decade, no consensus has been reached on how their electrons pair up. Dr. QIN Shengshan, Prof. FANG Chen, Prof. ZHANG Fuchun and Prof. HU Jiangping from the Institute of Physics, Chinese Academy of Sciences recently demonstrated that the pairing nature of the iron chalcogenides can be distinguished by their topological characters, properties that are robust to perturbations and give rise to many exotic electronic behaviors.

Iron-based superconductors are perfect platforms for studies on the combined effects of lattice structure, electronic structure, and superconductivity. The researchers observed in the special lattice structure of iron-based superconductors a one-to-one correspondence between the way in which the electrons pair up and their topological properties. They mathematically proved that the "sign-changed *s*-wave pairing state" — one of the candidate pairing states in the iron chalcogenides — is an intrinsic type of topological superconducting state. This state hosts Majorana modes — one of the most important and long-sought-after features of topological superconductors. Protected by the crystalline symmetries, it can be detected by scanning tunneling spectroscopy.

The study provides an idea for classifying the topological superconductors that has not been considered in previous studies and may lead to a full class of topological superconductors in the future.



The lattice structure of FeSe layer, the Fermi surface and the sign distribution of the superconducting order parameter in the topological s-wave state and the corner Majorana states.

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