Nodal-line superconductivity in chiral crystals

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Structural handedness is a defining characteristic of *chiral crystals*, which are known to exhibit exotic quantum phenomena resulting from the interaction of band topology, spin-orbit coupling (SOC) and electronic correlations. Due to the limited availability of suitable chiral-crystal materials, their unconventional superconductivity (SC) has remained largely unexplored.

Here, we report the discovery of *unconventional superconductivity* in the La(Rh,Ir)Si family of materials by combining muon-spin spectroscopy, band-structure calculations and perturbation theory. This family, characterized by a double-helix chiral structure, hosts exotic multifold fermions, which are absent in other topological chiral crystals. While LaRhSi behaves as a fully gapped superconductor, substituting $4d$-Rh with $5d$-Ir significantly enhances the SOC, leading to topological nodal-line SC in LaIrSi. Our newly developed model shows that the nodal-line SC arises from an isotropic SOC with a specific strength. This exotic mechanism extends our conventional understanding of materials that can exhibit unconventional SC, as these typically rely on significantly anisotropic SOC to promote triplet pairing. Our work establishes a new type of phase diagram that provides a *comprehensive roadmap* for identifying and engineering unconventional superconductivity in chiral crystals.

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[2] T. Shang et al., *Adv. Matter* **37**, e11385 (2025).
[3] T. Shang, T. Shiroka, *Front. Phys.* **9**, 270 (2021).