Seminar

Kagome Flatband Superconductor $LaRu_3Si_2$ and Superconductivity in MgB_2 Revisited

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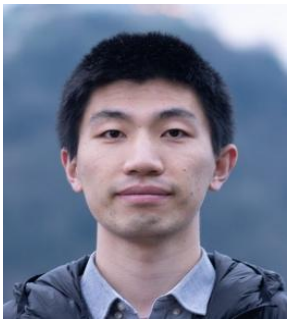

Time: 10:30 am, July.4, 2025 (Friday)

时间：2025年7月4日（周五）上午10:30

Venue: Room w563, Physics building, Peking University

地点：北京大学物理楼，西563会议室

Abstract

Electron–phonon coupling (EPC) is central to conventional superconductivity. In this talk, we present recent insights into two distinct superconducting systems—$LaRu_3Si_2$ and MgB_2—with a focus on how lattice symmetry, flat-band physics, and quantum geometry govern their superconducting properties.

$LaRu_3Si_2$ (Tc=7.8K) is a kagome metal recently reported to exhibit charge density wave (CDW) order above room temperature. Our findings reveal that the EPC in $LaRu_3Si_2$ is highly mode-selective, dominated by the strong interactions between Ru-B_{3u} phonons and Ru-A_g electrons within the kagome lattice. Light hole doping significantly enhances the superconducting critical temperature Tc by 50%, whereas heavy doping triggers structural instability and ferromagnetism. Furthermore, we perform high-throughput screening and identify 3063 stable materials in the kagome 1:3:2 family, of which 428 are predicted to exhibit superconductivity with Tc > 1 K and the highest Tc reaching 15 K.

MgB_2, a well-established superconductor with Tc=39K, is revisited from a symmetry-driven perspective. We demonstrate that its electronic, phononic, and electron-phonon properties can be understood with minimal inputs from *ab initio*. The obstructed sp^2 bonds generate a compact σ Fermi surface with large quantum geometry, naturally favoring strong EPC. We further show that electron doping raises the Fermi level toward the degenerate nodal point of this Fermi surface, enhancing Tc despite a reduced density of states—highlighting the pivotal role of quantum geometry in optimizing superconductivity.

[1] Deng J, Jiang Y, Cerqueira T F T, et al. Theory of Superconductivity in LaRu3Si2 and Predictions of New Kagome Flat Band Superconductors[J]. arXiv preprint arXiv:2503.20867 (2025)

About the speaker

Dr. Yi Jiang is a postdoctoral researcher at the Donostia International Physics Center under the supervision of Prof. Andrei Bernevig. He earned his Ph.D. from the Institute of Physics, Chinese Academy of Sciences, in 2023. His work combines computational and theoretical approaches to explore quantum materials, focusing on their topological, magnetic, superconducting, and moiré properties.