NSYSU physics 學生研討會

Student Seminar

NATIONAL SUN YAT-SEN UNIVERSITY

Why Do Spins Form Spirals? Understanding Magnetism in Weyl Semimetals

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Abstract

Magnetism is commonly understood through ferromagnetic and antiferromagnetic arrangements, where neighboring atomic spins align parallel or antiparallel to each other. However, some materials exhibit more complex magnetic structures in which spins gradually rotate across the crystal, forming spiral patterns. What determines the formation of these spirals, their periodicity, and the orientation of the rotating spins? Understanding these questions requires examining the microscopic interactions between magnetic moments and their connection to the electronic structure of materials.

In this talk, we will explore the origin of spiral magnetism in Weyl semimetals, a class of quantum materials with unusual electronic properties. Focusing on SmAlSi and related rare-earth compounds, we combine first-principles electronic-structure calculations with theoretical spin models to investigate the mechanisms governing their magnetic order. Our studies reveal how competing exchange interactions select the magnetic ordering wave vector, while magnetic anisotropy and Dzyaloshinskii–Moriya interactions influence the orientation and handedness of the spiral. Comparisons across related compounds illustrate how different magnetic interactions give rise to distinct magnetic ground states. We will also discuss how the fixed-length constraint of atomic spins affects theoretical predictions of spiral structures, providing a broader understanding of the microscopic origins of complex magnetism in quantum materials.





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