

Fermiology-Driven Skyrmions in Centrosymmetric Magnets Revealed by ARPES

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Magnetic skyrmions are topologically nontrivial spin textures that have become one of the central themes because of their emergent phenomena and potential for spintronic applications. In non-centrosymmetric magnets, their formation is well understood through the Dzyaloshinskii-Moriya interaction, which stabilizes skyrmion lattices tens to hundreds of nanometers in size. In contrast, the discovery of nanometric skyrmions (<4 nm) in centrosymmetric magnets such as Gd_2PdSi_3 and GdRu_2Si_2 [1,2] has fundamentally challenged this paradigm. In the absence of DMI, proposed mechanisms include geometrical or orbital frustration, dipolar coupling, and itinerant electron mediated Ruderman–Kittel–Kasuya–Yosida (RKKY) interactions linked to Fermi-surface nesting. Yet despite extensive theoretical and experimental studies, the microscopic origin of skyrmion formation in centrosymmetric systems remains elusive.

Here, we report high-resolution angle-resolved photoemission spectroscopy (ARPES) measurements on Gd_2PdSi_3 and GdRu_2Si_2 [3], which directly reveal Fermi surface nesting as the driving instability behind skyrmion formation. Both compounds exhibit strong nesting features, whose wave vectors coincide with the magnetic modulation vectors observed by resonant X-ray and neutron scattering. In GdRu_2Si_2 , we further observe a domain-dependent pseudogap (~ 100 meV) at the nested regions, reconstructing the Fermi surface into twofold-symmetric arcs. The pseudogap evolves with temperature and disappears above the Néel temperature, establishing its direct connection to magnetic ordering. These results provide spectroscopic evidence that nesting-driven RKKY interactions stabilize the screw-type spin modulations responsible for skyrmion formation in centrosymmetric Gd compounds and highlight their tunable magnetism as a foundation for reconfigurable spintronic architectures.

[1] T. Kurumaji et al., *Science* **365**, 914-918 (2019).

[2] N. D. Khanh et al., *Nat. Nanotechnol.* **15**, 444-449 (2020).

[3] Y. Dong et al., *Phys. Rev. Lett.* **133**, 016401 (2024); *Science* **388**, 624630 (2025).