

Coupled Crystal Field, Spin and Orbital Physics in Altermagnets

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Altermagnets, magnetic materials with zero magnetization and spin split band structure, have gained tremendous attention recently for its rich physics and potential applications. However, many theoretical predictions rely on simple effective models that may not represent realistic materials or capture altermagnetism in its full complexity. In this talk, I introduce a tight-binding model that provides a microscopic

understanding on how altermagnetism emerges from the interplay between sublattice, orbital and spin degrees of freedom and local crystal field effects. Our design is general, and we apply it to both d-wave and g-wave altermagnets. For d-wave altermagnets, we find that the orbital and spin degrees of freedom are coupled, which gives rise to a momentum-dependent and spin-selective optical absorption [1]. This promotes the controlled optical excitation of up or down spins depending on the polarization direction of linearly polarized light. Beyond simple models, our tight-binding formalism can also capture the key fingerprints of altermagnetism of the recently measured altermagnet CoNb_4Se_8 [2]. Based on the insights provided by these models, I will also show how we can engineer altermagnetism in twin boundaries and multiferroic domain walls in systems that are not altermagnets in their bulk form [3]. In summary, our findings not only demonstrate unique optical manipulation of orbitals and spins in altermagnets but also clarify the fundamental role of crystal field in these novel magnetic materials.

References

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