

Physical Colloquium

„Persistent spin texture as a universal property of nonmagnetic crystals“

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Physical colloquium on

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Crystal symmetries significantly impact the behavior of electrons in solids, including how their spins align and evolve. A particularly important consequence is spin-momentum locking, which defines how an electron's spin orientation is tied to its momentum. The spin-momentum locking determines a range of effects relevant to spintronics – technology that aims to harness both the charge and spin of electrons.

In this talk, I will focus on a special type of spin-momentum locking known as persistent spin texture (PST), where the spin orientation remains fixed over extended regions of the Brillouin zone, independently of the momentum. This unidirectional spin configuration enables spin helix states that can live much longer than usual, significantly enhancing spin coherence and boosting charge-to-spin conversion efficiency—both crucial for future spin-based devices.

Until recently, PST was thought to be rare, confined to carefully engineered quantum wells or a few exotic materials. However, we show that PST is not a rare exception but a universal feature of all nonmagnetic crystals lacking inversion symmetry. Using symmetry analysis based on group theory - tools widely used for topological properties and classification - we establish general criteria for the existence of symmetry-protected PST. Our work provides a complete classification of such textures across all crystal symmetries, revealing that PST regions can often align with the Fermi surface and therefore play a direct role in charge-to-spin conversion and spin transport.

Supported by first-principles simulations, this framework opens new avenues for identifying and designing materials with robust PST - bringing it into the realm of experimental exploration and potential spintronic applications.

Host: Prof. Dr. Christopher Gies

