Spin- and Orbital Monopoles in Chiral Semimetals

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The term chirality is derived from the Greek word for ‘hand’ χειρ (kheir) and describes objects that are distinct from their mirror image. It is long known that chirality plays a crucial role in nature, providing powerful functionality to chiral molecules in living organisms. By extending this concept from the molecular to the solid state, my group aims to uncover new chirality-enabled phenomena that could form the basis for new technologies.

The focus of my talk will be on chiral topological semimetals, an emerging class of quantum materials at the intersection of structural and electronic chirality. These materials can host new fermionic quasiparticles without analogue in high-energy physics [1–4], which carry large and controllable topological charges [5]. We have recently demonstrated that these quasiparticles realize a monopole-like Weyl-spin-momentum locking that can be considered the natural counterpart of Rashba spin-orbit coupling [6]. Moreover, I will present fingerprints of controllable orbital angular momentum monopoles in these materials [7], which could be exploited in memory devices for field-free switching of magnets with perpendicular magnetic anisotropy.

Time-permitting, I will also present our latest discovery of an Octdong Fermi-surfaces in a Kramers-nodal line metal [8], which is formed by a family of 2D Dirac-cones, which could extend the physics of Graphene to bulk materials. I may also talk about signatures of topological edge states in a high-temperature superconductor.

References

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Figures

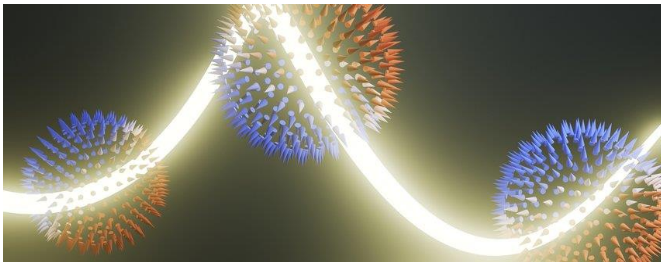

Figure 1: Artistic illustration of spin- and orbital-monopoles enabled by structural chirality
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