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Invited lecture - Session on Condensed Matter Physics

QED and quantum magnetism in (2+1)d

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The interplay of symmetry and topology has been at the forefront of recent progress in quantum matter. In this talk I will discuss an unexpected connection between band topology and competing orders in a quantum magnet. The key player is the two-dimensional Dirac spin liquid (DSL), which at low energies is described by an emergent Quantum Electrodynamics (QED) with massless Dirac fermions (a.k.a. spinons) coupled to a U(1) gauge field. A long-standing open question concerns the symmetry properties of the magnetic monopoles, an important class of critical degrees of freedom. I will show that the monopole properties can be determined from the topology of the underlying spinon band structure. In particular, the lattice momentum and angular momentum of monopoles can be determined from the charge (or Wannier) centers of the corresponding spinon insulators. I will then discuss the consequences of the monopole properties, such as the stability of the DSL on different lattices, universal (experimental and numerical) signatures of DSL, and competing symmetry-breaking phases near the DSL state.

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