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Interactions and Topology in Quantum Matter: From frustrated magnets to fractional topological insulators

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In this talk I will review the origin of various intriguing phenomena such as fractionalization in two traditionally distinct settings: geometrically frustrated magnets and in the fractional quantum Hall system. A common feature in these systems is the occurrence of flat bands which frustrate the interaction between the constituent particles and thereby suppress the tendency towards conventional (local) order. Especially interesting are flat bands characterized by non-trivial topological invariants, and I will argue that combining the ingredients of geometrical frustration and spin-orbit coupling is particularly promising in this regard. In fact, at fractional band filling such systems may host lattice generalizations of fractional quantum Hall states. Contrary to their continuum analogues, these states do not require an external magnetic field and may potentially persist at room temperature. This makes these systems very attractive for possible applications such as topological quantum computation. Moreover, this class of systems include new types of fractional topological insulators with no previously known counterparts.