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Topological phases and phase transitions in a two-dimensional fermionic lattice CRISTIANE MORAIS SMITH, WOUTER BEUGELING, Utrecht University, NATHAN GOLDMAN, Universite libre de Bruxelles — A topological state of matter is characterized by a topological invariant, which is protected against disorder effects. For the quantum Hall effect, the Hall conductivity is protected since it is carried by chiral edge states, induced by a magnetic field. Systems with large spin-orbit coupling exhibit the quantum spin Hall effect, where the protected quantity is the spin Hall conductivity, carried by helical edge states. In our theoretical study of a fermionic tight-binding model we show that the interplay between the magnetic field and the spin-orbit coupling generates spin-imbalanced chiral phases and exotic phase transitions between helical and chiral spin textures. We explore the experimental possibilities to observe these phase transitions in cold-atom systems, for which the necessary strengths of the magnetic field and spin-orbit coupling are accessible. As a second application, we investigate the spectrum of topological phases in HgTe quantum wells doped with Mn ions (in collaboration with Molenkamp's group). We show that this doping leads to interesting reentrant effects of both the Hall and spin Hall conductivities.

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