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Topological order, topological insulators, and the search for the Majorana fermion

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In condensed matter physics complex order often emerges from simple interactions. Recent experiments show that topological order, previously seen only in 2D electron systems in high magnetic field, can exist in zero field and even in bulk 3D materials called topological insulators, in which spin-orbit coupling induces the topological order. Topologically ordered phases can support new kinds of emergent particles, such as the Majorana fermion. Current experiments in condensed matter, in both fractional quantum Hall systems and strong spin-orbit materials, are probing the physics of Majorana fermions, which may eventually enable a topological approach to quantum computing.