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Quasiparticles in Topological Quantum Systems

We are used to that particles can be divided into two types, namely bosons and fermions. Nevertheless, it turns out that if one puts many bosons or many fermions together, it is possible, under certain conditions, to form quasiparticles that are neither fermions, nor bosons, but anyons. Anyons have strange properties. They can, e.g., have a charge that is only a fraction of the elementary charge, and if one exchanges two anyons, the wavefunction of the system changes either by a phase factor or is transformed into a different state. Surprisingly, the change is robust against local noise. Anyons have been created in the fractional quantum Hall effect in solid state systems, but realizing them in ultracold atoms in optical lattices would give new tools to study them in detail. We therefore discuss possibilities for constructing families of fractional quantum Hall models in lattices with and without anyons, and we compute the size, shape, charge and exchange properties of the anyons.

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