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Topological Quantum Numbers and their Importance for Precise Measurements

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Various physical quantities can be related to topological invariants. The simplest exampled is the circulation of a superfluid round a circular pipe which is related to the change of the phase of the condensate wave function round the pipe. The Josephson frequency-voltage relation is another example, where the voltage across a weak superconducting link is proportional to the frequency of the alternating current across the link, with very high precision. A more complicated example was provided by the experimental discovery of the quantum Hall effect, where the topological invariant turned out to to a winding over the surface of a torus, rather than around a single loop. Attention in recent years has shifted to topological insulators, but theory and experiment have not yet converged as neatly as they did for the quantum Hall effect.