Topology in Magnetism. Spin textures, topological numbers, topological insulators, topological spin liquids

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The 2016 Nobel prize in physics was awarded to Thoules, Kosterlitz and Haldane for introducing the notion of topological phase transitions and topological phases of matter. Their work considered magnetic model systems in 2D and 1D, but the concepts have now spread to diverse fields of condensed matter physics including the quantum Hall effect, topological insulators and superconductors, majorana chains etc. Simple geometric topology, such as the difference between an apple, a doughnut (one hole) and a pretzel (three holes) are easy and intuitive. Similarly can we consider topological invariances in smooth classical magnetization patterns, such as the 2D XY model, where Kosterlitz and Thoules demonstrated that the binding of vortices lead to a topological phase transition. I will discuss this Kosterlitz Thoules transition and its experimental implications. More recently another topological magnetization pattern, namely skyrmions, have attracted significant attention and will be the topic of my second lecture. Quantum systems can host less intuitive topological properties, such as the spin 1 Heisenberg 1D chain, where Haldane showed that an energy gap to excitations occur due to a ground state protected by topological invariance in the ground state. Such novel topological states have since been found in various systems also beyond magnetism. I will describe Haldane's conjecture and how it was experimentally investigated in quasi one-dimensional S=1 magnets.

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