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Transition state theory and the lifetimes of topologically protected magnetic structures

It is believed that the stability of some quasi-two-dimensional localized magnetic systems with respect to thermal fluctuations and external perturbations is of a topological nature. However, in real magnetic systems, where magnetic moments are localized at the nodes of the crystal lattice, there is no strict topological protection. Instead, topological states are separated from each other and from the trivial (i.e., homogeneous) state by energy barriers of finite size that determine their stability. How topological protection is formed as the lattice constant decreases compared to the typical size of the structure and the system approaches the continuous limit will be discussed using the example of skyrmionic states. The theoretical approach is based on the transition state theory for magnetic degrees of freedom. It involves the analysis of multidimensional energy surfaces of magnetic systems, the construction of minimum energy paths between locally stable states and the calculation of energy barriers between these states. In the harmonic approximation for the shape of the energy surface at minima and saddle points, one can obtain a formally analytical expression for the lifetimes of states corresponding to the Arrhenius law. The evolution of the activation barrier and pre-exponential factor will be discussed as the dimensionality of the energy surface increases (up to several millions) and transition to a continuous model.

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