## Abstract

Magnetic skyrmion (Sk) is a topologically protected stable spin texture. It has created a promising impact on modern information technology because of its small size and low power consumption. In this thesis, we have studied 1) skyrmion's and its close cousins' such as antiskyrmion and meron profile of the direction of magnetization, 2) the dynamics of these quasiparticle like structures in the form of their Hall effect when electrical current is applied, and 3) we have proposed a model Hamiltonian for the exchange interaction and simulate it along with other relevant interactions to show that the model can potentially stabilize skyrmions even for thin films made with centrosymmetric materials.

Using Euler equation for the polar angle of magnetization, we obtain an approximate closed-form solution of a Sk and a meron in terms of their respective characteristic length scales. We show that the relevant length scale for these solutions primarily depend on the ratio of the strengths of the magnetic field and magnetic anisotropy with the Dzyaloshinskii-Moriya interaction (DMI) respectively. We have made an estimation of the radius of a Sk that shows an excellent agreement of its magnetic field dependence with experiments. An anisotropic DMI suitable for thin films made with $C_{nv}$ symmetric materials is found to stabilize antiskyrmion and antimeron, which are prototypical for $\mathcal{D}_{2d}$ symmetric systems, depending on the degree of anisotropy. We obtain phase diagram by comparing the energies of various collinear and non-collinear competing phases.

Based on our approximate above mentioned closed-form solution, we find by solving Thiele equation suitable for unchanged shape of the skyrmions that the Hall angle of a Sk or a meron does not depend on the relevant length scale and input current density. Due to their transverse motion arising from the skyrmion-Hall effect, they soon arrive at the boundary of a channel and their spin-textures get destroyed. We propose an experimental setup by which the transverse motion of a Sk can be restricted so that the Sk can only move longitudinally.

We introduce a *biquadratic* term with usual bilinear ferromagnetic nearest neighbor exchange interaction. In our model, the energy of the spin-wave mode minimizes at a finite wavevector for a vanishingly small DMI, supporting a ground state with spin spiral structure whose pitch length is unusually short as found in some of the experiments. We have performed Monte Carlo simulation of the model Hamiltonian and we find nanoscale Sks at vanishingly small DMI for the first time in a theoretical model. This model provides the nanoscale Sks of unit topological charge at zero magnetic field as well. We obtain a phase diagram for various noncolinear magnetic structures including isolated skyrmions, skyrmion lattice and meron lattice in the parameter space.



**Keywords**: Skyrmion, Antiskyrmion, Meron, Dzyalishinskii-Moriya Interaction, Biqudratic exchange interaction, Thiele equation, Monte Carlo simulation.