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Skyrmions and Hopfions in frustrated ferromagnets

Magnetic skyrmion is a two-dimensional 'hedgehog-like' spin texture, characterized by non-zero topological number. Stability of skyrmions is topologically
protected, therefore they can be potentially used as information carriers
in magnetic memory devices.

Skyrmions have been experimentally observed in several materials,
such as chiral magnets and thin magnetic films with long-range dipolar
interaction.
Recent theoretical works [1,2] proposed frustrated ferromagnets (FFM) on
triangular lattice as new skyrmion materials, that can host isolated
skyrmions, skyrmion lattice and other exotic magnetic phases.

In the present work we show that stable skyrmions can exist in the FFM on
the simple square lattice with spin anisotropy.
This finding broadly enhances the scope of possible skyrmion materials.
We also found attraction of skyrmions with opposite helicity, that leads to
existence of stable skyrmions with very high topological numbers.

Hopfion is a three-dimensional topological object, which is similar to
torroidal vortex. Hopfions have been predicted in various physical systems
such as Bose-Einstein condensates [3], liquid He^3 [4], and vortex-like
dynamical spin precession in a collinear uniaxial ferromagnet [5].
Extending our skyrmion work and
considering 3D FFM on simple cubic lattice, we for the first time
predict existence of a static magnetic hopfion.

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Primary author(s) : Mr KHARKOV, Yaroslav (UNSW)

Co-author(s) : Prof. MOSTOVOY, Maxim (Zernike Institute for Advanced Materials, University of Groningen, Nijenborgh 4, 9747 AG Groningen, Netherlands); Prof. SUSHKOV, Oleg (University of New South Wales)

Presenter(s) : Mr KHARKOV, Yaroslav (UNSW)