Topological Solitons in Chiral Magnets

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Abstract

Topological solitons such as domain walls or vortices are ubiquitous in condensed matter as well as high energy physics and are responsible for many emergent phenomena. Recently a new mesoscopic spin texture called skyrmion was discovered experimentally in helimagnets. Skyrmions are vortex-like swirling spin textures, characterized by a topological winding number. It is now believed to exist in superconductors, Bose-Einstein condensates, 2D quantum hall systems, nematic liquid crystals among many other systems. These non-homogeneous magnetization structures exhibit unusual topological and dynamic properties such as emergent electromagnetism, which is interesting not only for fundamental studies but also for applications. The formation of nano-scale skyrmions has been demonstrated in non-centrosymmetric crystals and in ultrathin ferromagnets deposited on a heavy metal substrate. They are stabilized by the Dzyaloshinskii-Moriya interaction (DMI) arising from a lack of inversion symmetry and a strong spin-orbit coupling of the compound. So far, they have only been observed at low temperatures. But recently, they have demonstrated in a room-temperature magnet by several research groups [1-4], making their promise for future technologies more realistic. In this presentation I will first attempt to summarize the overview on skyrmions and recent progresses. Then I will demonstrate novel nucleation ways of isolated skyrmions in ultrathin nanomagnets driven by a magnetic field pulse [5-6]. Micromagnetic simulations in real time and analytic approaches show the generation of magnetic skyrmions in CoPt, stabilized by magnetic dipole-dipole interactions, in the absence of DMI. Finally, I will explore the current driven skyrmions dynamics for building of a new concept of non-volatile memories or logic gates which can split or merge leading to the formation of magnetic monopoles and anti-monopoles connected by a Dirac string.

Keywords: *condensed matter physics, topology, magnetism, spintronics*

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Biography

Changhoon Heo is condensed matter physicist. He received the B.S. degree in physics from Korea University, Seoul, Korea, in 2006, and the M.S. degrees in physics from École polytechnique, Palaiseau, France, in 2011. He holds PhD in physics from Radboud University Nijmegen, Netherlands in 2015. He had been worked at Research Center Jülich as a Marie Curie research fellow and recently he joined IMEC, Leuven, Belgium where he is working on device physics since 2018.