复旦大学物理系物质科学报告

Physics Department Colloquium

Exotic Spin Orders and Their Manipulation -The Theory and Mechanism

Prof. You-Quan Li

Zhejiang Institute of Modern Physics and Department of Physics,

Zhejiang University, Hangzhou 310027, China

Abstract: There has been spectacular progress in the study on multiferroics, which is expected to make a realistic step toward an electrical control of magnetism or four state memories. I will present our general spin order theory relating to this topics and propose a mechanism to pin skyrmions in chiral magnets. In our literature, the fiber bundle concept imagined by mathematicians becomes the "catwalk" for spins to show various exotic spin orders that were perceived in multiferroic materials. As a general scenario, the tilt SU(2) Heisenberg spin model is proposed, which is mathematically defined on a bundle whose base space and typical fiber are, respectively, lattice space and Bloch sphere, while the structure group that connects nearby fibers is the rotation group. For a deep understanding on macro-description, we show that the continuum limit of the model gives rise to the gauge Landau-Lifshitz equation which provides an unified description for various spin orders [1]. In our formulism, a spontaneous formation of "skyrmion fragments" was predicted [1], which has been observed in experiment [2]. A microscopic mechanism to understand the tilting field is also given [3]. We propose a mechanism to pin skyrmions in chiral magnets by introducing local maximum of magnetic exchange strength, which can be realized in chiral magnetic thin films by engineering the local density of itinerate electrons [4]. It is further shown that the position-dependent electric field can induce the Hall motion of the skyrmion with its velocity orthogonal to the field gradient [5]. We also find a rich variety of resonance modes excited by an ac electric field there [5].

References

[1] Y. Q. Li, Y. H. Liu, and Y. Zhou, Phys. Rev. B. 84, 205123 (2011).

[2] S. Heinze，K. Bergmann, M. Menzel J. Brede et al., Nat. Phys. 7, 713 (2011).

[3] S. Zhu and Y. Q. Li, preprint, arXiv:1308.1179 (J. Phys.: Condens. Matter. (2014) in press).

[4] Y. H. Liu, Y. Q. Li, and J. H. Han, Phys. Rev. B 87, 100402(R) (2013).

[5] Y. H. Liu and Y. Q. Li, J. Phys.: Condens. Matter 25, 076005 (2013).

Time：2:00pm, Tuesday, 09 Sept., 2014

Location：Physics Building, Room 221B

(Cookies and coffee will be served from 1:30 pm)