Coherent signal transfer along skyrmion strings

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Magnetic skyrmion, a topological soliton characterized by swirling spin texture appearing in two-dimensional system, has recently attracted attention as a stable particle-like object. In the three-dimensional system, skyrmion forms a string structure in analogy with the vortex-line in superconductors / superfluids and cosmic string in the universe, whose unique topology and symmetry may also host nontrivial response functions. In this talk, we discuss the propagation character of spin excitations on skyrmion strings. We find that this propagation is directionally non-reciprocal, and the degree of non-reciprocity, as well as the associated group velocity and decay length, are strongly dependent on the character of the excitation modes. Our theoretical calculation establishes the corresponding dispersion relationship, which well reproduces the experimentally observed features. Notably, these spin excitations can propagate over a distance exceeding 10^3 times the skyrmion diameter, demonstrating the excellent long-range nature of the excitation propagation on the skyrmion strings. The present results offer a comprehensive picture of the propagation dynamics of skyrmion string excitations, and suggest the possibility of unidirectional information transfer along such topologically-protected strings.

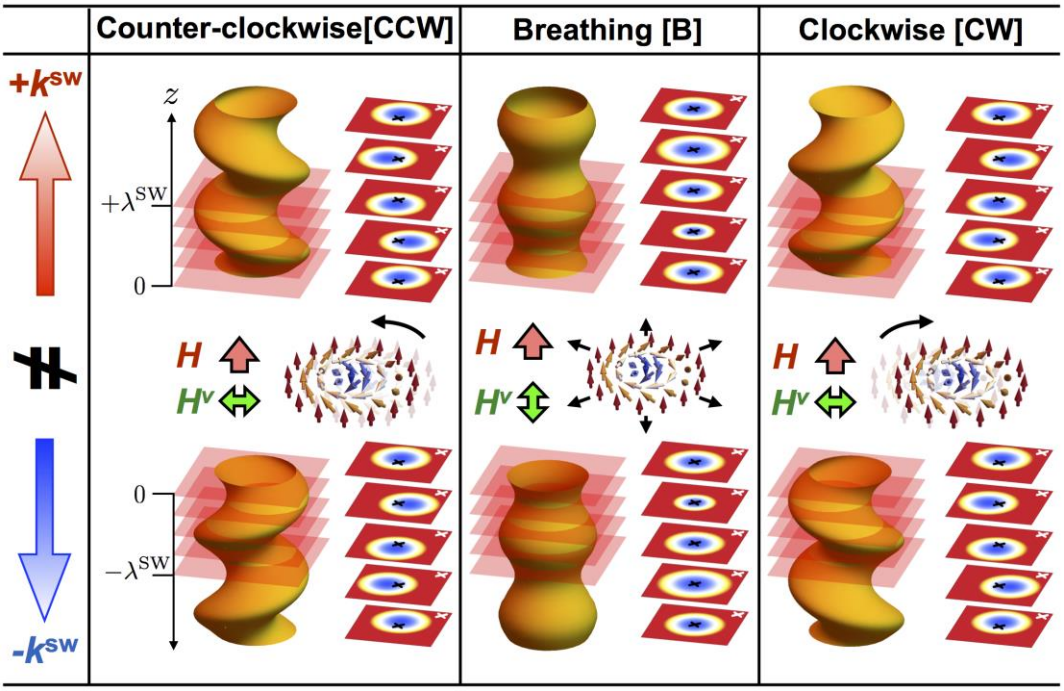

Figure 1. Schematic illustration of spin excitation propagating along skyrmion strings.

Reference

1) S. Seki, X. Z. Yu, S. Ishiwata, and Y. Tokura, Science **336**, 198 (2012).
2) S. Seki, M. Garst, J. Waizner, R. Takagi, Y. Okamura, K. Kondou, F. Kagawa, Y. Otani, Y. Tokura, arXiv:1902.10302.