Doppler shift picture of the Dzyaloshinskii-Moriya interaction and light propagation in systems with broken inversion symmetry

Gen Tatara[1]

[1] *RIKEN Center for Emergent Matter Science (CEMS), 2-1 Hirosawa, Wako, Saitama, 351-0198 Japan*

We present a physical picture for the emergence of the Dzyaloshinskii-Moriya (DM) interaction based on the idea of the Doppler shift by an intrinsic spin current induced by spin-orbit interaction under broken inversion symmetry such as the case with Rashba interaction[1]. The picture is confirmed by a rigorous effective Hamiltonian theory, which reveals that the DM coefficient is given by the magnitude of the intrinsic spin current. The expression is directly applicable to first principles calculations and clarifies the relation between the interaction and the electronic band structures. Quantitative agreement with experimental results is obtained for the skyrmion compounds $Mn_{1-x}Fe_xGe$ and $Fe_{1-x}Co_xGe$. The Doppler shift occurs for incoming electromagnetic wave, too, when the Rashba interaction and magnetization are present, resulting in directional dichroism[2,3]. The effective Hamiltonian for the electromagnetic field is shown to the vector type, $\boldsymbol{u}\cdot(\boldsymbol{E}\times\boldsymbol{B})$, where $\boldsymbol{u}$ corresponds to the intrinsic velocity due to the troidal moment[3].

References:

[1] T. Kikuchi, T. Koretsune, R. Arita, G. Tatara, Phys. Rev. Lett., **116**, 247201 (2016).
[2] J. Shibata, A. Takeuchi, H. Kohno and G. Tatara, J. Phys. Soc. Japan, **85**, 033701 (2016).
[3] H. Kawaguchi and G. Tatara, Phys. Rev. B **94**, 235148 (2016).