凝縮系物理学ゼミナール

Condensed Matter Seminar

Location: **Room 413**, School of Science Bldg. 5 (理学 5 号館 413 号室)

Date: **13:30-15:00**, Wednesday, 16 May 2018

"Control of Magnetic and Topological Orders with a DC Electric Field"

Speaker:

Kazuaki Takasan (Condensed Matter Theory Group)

Abstract:

In recent years, the control of solid states with external electric fields has been intensively studied. While plenty of interesting scenarios with AC electromagnetic fields or laser light has been proposed [1], the control with low-frequency or DC (static) electromagnetic fields has been also studied (e.g. electric-field-controlled magnetism in multiferroics [2] and dielectric breakdown in Mott insulators [3]). However, varieties of DC-field driven phenomena have been still limited compared with AC-field studies. In contrast, recent experimental techniques of generating strong DC fields and low-frequency AC fields (e.g. Tera Hz laser) have been rapidly developed [5]. Therefore, now is the best time to theoretically propose novel scenarios for DC- or low-frequency AC-driven phenomena.

In this talk, we present our theoretical proposal which provides a new route to control magnetic and topological orders in a broad class of insulating magnets with a DC electric field [6]. We show from the strong-coupling expansion that magnetic exchange interactions along the electric-field direction are generally enhanced in Mott insulators. It indicates that we can control the spatial structure of the interactions in magnets with a DC electric field. To illustrate this idea, we particularly focus on two kinds of magnets, frustrated magnets and quasi-one-dimensional magnets, and obtain phase diagrams including several magnetic or topological ordered phases such as quantum spin liquids and Haldane-gap states. Our proposal is effective especially for weak Mott insulators and magnets in the vicinity of quantum critical points, and would also be applicable for magnets under low-frequency AC electric fields such as terahertz laser pulses. In this talk, we give several candidate materials and experimental setups for our scheme. Our result would pave a promising way to control the exotic states of matter in magnets.

References:

[1] For example, J. H. Mentink, et al., Nat. Comm. 6, 6708 (2015).
[2] H. Katsura, et al. Phys. Rev. Lett. 95, 057205 (2005).
[3] T. Oka, et al., Phys. Rev. Lett. 91, 066406 (2005).
[4] K. Ueno, et al., J. Phys. Soc. Jpn., 83, 032001 (2014).
[5] P. J. Hsu et al. Nat. Nano. 12, 123-126 (2017).
[6] K. Takasan and M. Sato, arXiv:1802.04311.