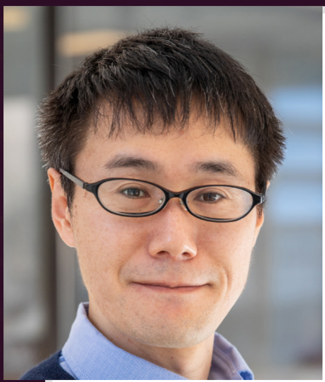
Oral Session B3 (Wednesday, February 14)

Chair: Maria A. H. Vozmediano,
Instituto de Ciencia de Materiales de Madrid (ICMM - CSIC)

Special Session Talk



14: 00 - 14 : 40

Shinsei Ryu

Department of Physics, Princeton University

Topological phenomena out of equilibrium and time-reversal symmetry

Time reversal symmetry plays a crucial role in topological phenomena in many-body quantum physics. One of the prime examples include topological insulators that have been studied extensively in modern condensed matter physics. Recent investigations have expanded the scope to include non-equilibrium settings, such as driven (Floquet) systems, and topological phenomena in open quantum systems. In this talk, I will discuss the implication of time-reversal symmetry in out-of-equilibrium quantum many-body systems. In particular, we discuss the so-called Kubo-Martin-Schwinger (KMS) symmetry, and the role it plays in drive/open quantum many-body systems. Specifically, we discuss topological phenomena protected by the KMS symmetry and quantum anomalies associated to the KMS symmetry with applications to the Lieb-Schultz-Mattis type theorem.

References

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[2] Kohei Kawabata, Anish Kulkarni, Jiachen Li, Tokiro Numasawa, and Shinsei Ryu, "Symmetry of Open Quantum Systems: Classification of Dissipative Quantum Chaos", PRX Quantum 4, 030328 (2023)
[3] Kohei Kawabata, Ramanjit Sohal and Shinsei Ryu, "Lieb-Schultz-Mattis Theorem in Open Quantum Systems", arXiv:2305.16496

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Special Session Talk

14: 40 - 15 : 20

Takashi Oka

The Institute for Solid State Physics (ISSP), The University of Tokyo

Heterodyne Hall effect in oscillating magnetic fields

Floquet engineering [1] introduces new dynamical functions within quantum materials. The process of heterodyning, a signal processing technique, produces output signals by combining an input signal with the dynamics of a designated multiplier [2]. This multiplier operates as a Floquet system, which is periodically influenced by an external drive over time [2, 3]. By designating electrons in oscillating magnetic fields as this multiplier, the Heterodyne Hall effect can be achieved [2]. We have recently broadened this concept to encompass 2D Dirac electrons, leading to the discovery of Floquet Landau levels and an effect reminiscent of the chiral magnetic effect [4].

References

[1] T. Oka and S. Kitamura, Annu. Rev. Condens. Matter Phys. 10, 387 (2019).
[2] T. Oka, L. Bucciantini, Phys. Rev. B 94, 155133 (2016).
[3] A. Kumer, M. Rodriguez-Vega, T. Pereg-Barnea, B. Seradjeh, Phys. Rev. B 101, 174314 (2020).
[4] S. Kitamura, T. Oka, in preparation.

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Contributed Oral

15: 20 - 15 : 40

Nonlinear optical responses in α-type organic salt

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Nonlinear optical responses, such as shift current, have been extensively explored from the perspectives of both fundamental science and electronic applications. However, nonperturbative effects in multiband systems are not well understood.

In this talk, we investigate the shift current induced by linearly polarized light in α-(BEDT-TTF)$_2$I$_3$ [see Fig. (a)] [1]. In our previous studies, we have theoretically predicted various photoinduced topological phase transitions in this material [2-5]. By applying the perturbation theory, we determine the dependencies of the shift current on the frequency of light. Notably, we discover that the direction of the shift current strongly depends on the frequency of light, and this unique dependence is attributed to multiband effects. Furthermore, we explore the nonperturbative effects of the shift current using the Floquet Hamiltonian [see Fig. (b)]. Our findings reveal a sign change in this response, a phenomenon not observable when considering only the second-order response. We discuss the limitations of both the equation derived by the perturbation theory and the one derived by Morimoto and Nagaosa [6] when the light intensity is large.

References

[1] K. Kitayama and M. Ogata, arXiv:2311.07176 (2023).
[2] K. Kitayama and M. Mochizuki, Phys. Rev. Research 2, 023229 (2020).
[3] K. Kitayama, M. Mochizuki, Y. Tanaka, and M. Ogata, Phys. Rev. B 104, 075127 (2021).
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[5] K. Kitayama, M. Ogata, M. Mochizuki, and Y. Tanaka, J. Phys. Soc. Jpn. 91, 104704 (2021).
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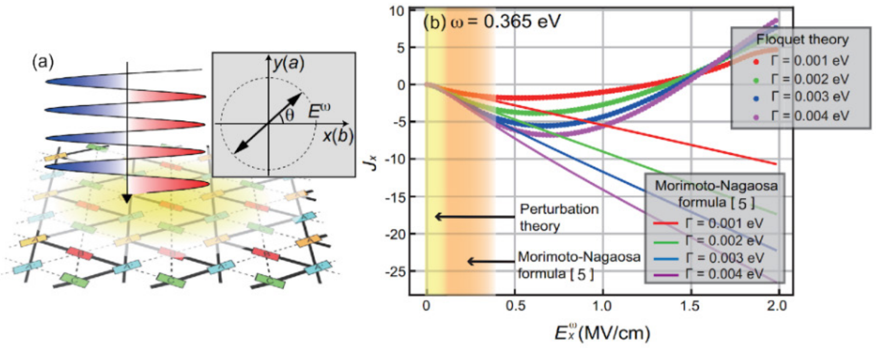

Fig. (a) Schematic illustration of α-(BEDT-TTF)$_2$I$_3$ irradiated with linearly polarized light. (b) Nonlinear optical responses in photodriven α-(BEDT-TTF)$_2$I$_3$.