Light-induced phenomena in condensed matter system from ab initio approach

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 Recent studies on light-matter interaction have attracted attention by showing unprecedented physical phenomena and the possibility of application devices. For example, light-induced topological phase transitions in WTe2 and ZrTe5 are experimentally demonstrated [1-2]. A follow-up theoretical study explained that this topological phase transition originates from the lattice distortion induced by exciting electronic structure [3]. Also, light-induced ferroelectric transitions in quantum paraelectric SrTiO3 are experimentally demonstrated by applying mid-infrared and terahertz lights [4-5]. It is theoretically proved that the unique property of the quantum paraelectric phase could lead to terahertz field-induced ferroelectricity [6]. These results indicate that light can control the phase of the material with various microscopic mechanisms and suggest the possibility of brand-new optical control devices. This seminar will introduce recent studies on light-induced phase transition in condensed matter systems and related microscopic mechanisms from *ab inito* approach.



Figure . Light-induced phenomena and their possible microscopic mechanism.

References

[1] Sie, E. J. *et al.* An ultrafast symmetry switch in a Weyl semimetal. *Nature* **565**, 61–66 (2019).

[2] Vaswani, C. *et al.* Light-Driven Raman Coherence as a Nonthermal Route to Ultrafast Topology Switching in a Dirac Semimetal. *Phys Rev X* **10**, 021013 (2020).

[3] Guan, M.-X., Wang, E., You, P.-W., Sun, J.-T. & Meng, S. Manipulating Weyl quasiparticles by orbital-selective photoexcitation in WTe2. *Nat Commun* **12**, 1885 (2021).

[4] Nova, T. F., Disa, A. S., Fechner, M. & Cavalleri, A. Metastable ferroelectricity in optically strained SrTiO3. *Science* **364**, 1075–1079 (2019).

[5] Li, X. *et al.* Terahertz field–induced ferroelectricity in quantum paraelectric SrTiO3. *Science* **364**, 1079–1082 (2019).

[6] Shin, D. *et al.* Simulating Terahertz Field-Induced Ferroelectricity in Quantum Paraelectric SrTiO3. *Phys Rev Lett* **129**, 167401 (2022).