



## Observation of the dynamical Axion quasiparticle by ultrafast coherent control of Berry curvature in 2D $\text{MnBi}_2\text{Te}_4$

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Su-Yang Xu studied in the Peking University, China, the Princeton University, and Massachusetts Institute of Technology (MIT). He is now an assistant professor of the Department of Chemistry and Chemical Biology at Harvard University. His research focuses on the design and discovery of new quantum materials and to understand their physical and chemical properties.



**4:00 ~ 5:30 pm Wednesday, June 19**

The Axion is an elusive elementary particle that can solve multiple fundamental questions including the strong CP problem in QCD and the dark matter. This particle is a boson defined by the coherent oscillation of the theta field in QCD. Similar theta has been introduced to condensed matter and so far studied as a static value, quantized value to characterize topology. But the dynamical oscillation of theta in condensed matter is proposed to lead to new physics directly analogous to the high energy Axion, the dynamical Axion quasiparticle. In this talk, I present the observation of the dynamical Axion quasiparticle. By combining 2D electronic device with ultrafast pump-probe optics, we manage to measure the magnetoelectric coupling  $\alpha$  of 2D  $\text{MnBi}_2\text{Te}_4$  with ultrafast fs time-resolution ( $\alpha$  is proportional to theta). This allows us to visualize a coherent oscillation of theta at 44 GHz in real time, which is uniquely coupled to the optical antiferromagnetic magnon. Interestingly, in 2D  $\text{MnBi}_2\text{Te}_4$ , the dynamical Axion quasiparticle arises from the magnon-induced ultrafast coherent modulation of Berry curvature. Our results enable novel Axion physics and coherent antiferromagnetic spintronic phenomena. The observed dynamical Axion quasiparticle can be used to detect dark matter Axion in the critically-lacking sub-THz regime. If time allows, I will also briefly talk about our recent discovery of the topological Luttinger ferrimagnet, UOTe.

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