Chez Pierre

Presents ...

Monday, March 27, 2023

12:00 pm -1:00 pm

Duboc Room – 4-331

Chez Pierre Seminar

Su-Yang Xu, *Harvard University*

"Axion optical control of antiferromagnetic order".

Using circularly-polarized light to control quantum matter is a highly intriguing topic in physics, chemistry and biology. Previous studies have demonstrated helicity-dependent optical control of spatial chirality and magnetization *M*. The former is central for asymmetric synthesis in chemistry and homochirality in bio-molecules, while the latter is of great interest for ferromagnetic spintronics. We report the surprising observation of helicity-dependent optical control of fully-compensated antiferromagnetic (AFM) order in 2D even-layered $MnBi_2Te_4$, a topological Axion insulator with neither chirality nor *M*. We demonstrated helicity-dependent optical creation of AFM domain walls by double induction beams and the direct reversal of AFM domains by ultrafast pulses. The control and reversal of AFM domains and domain walls by light helicity have never been achieved in any fully-compensated AFM. To understand this optical control, we studied an AFM circular dichroism (CD) proportional to the AFM order, which only appears in reflection but is absent in transmission. We showed that the optical control and CD both arise from the optical Axion electrodynamics. The Axion induction provides the possibility to optically control a family of *PT*-symmetric AFMs such as Cr_2O_3, even-layered CrI_3 and possibly pseudo-gap state in cuprates. If time allows, I will also briefly discuss a new nonlinear Hall effect induced by the quantum metric in the same system, the Axion insulator state of even-layered

$MnBi_2Te_4$.

Reference: J. Qiu, et al."Axion optical induction of antiferromagnetic order" Nature Materials s41563-023-01493-5 (2023).

Bio: Suyang Xu received PhD in the Physics Department of Princeton University under the supervision of Prof. M. Zahid Hasan. During his phd, Xu experimentally realized a wide range of new topological phases of matter, including the discovery of the Weyl semimetal in the TaAs class of material, which was selected as a top10 breakthrough in physics in 2015. In 2016, Xu moved to MIT Physics for postdoc under the supervision of Prof. Nuh Gedik. There, Xu pioneered in nonlinear optical studies of topological materials including photocurrents, nonlinear Hall and second-harmonic generation. In 2020, Xu started his independent career in the department of Chemistry and Chemical Biology at Harvard as an assistant professor.