

RICE QUANTUM GROUP MEETING SEMINAR SERIES



<u>Presenter:</u>	Andrey Baydin
Research Group:	Prof. Junichiro Kono's group
Date:	December 09, 2022, Friday
Time:	4PM - 5PM
Venue:	SST 300

Magnetic Manipulation of Electronic Topology with Chiral Phonons

Abstract:

Chiral phonons arise in crystals with broken mirror symmetries. In a magnetic field, the circular motion of lattice ions in a chiral phonon leads to a finite magnetic moment, even when the host material is purely nonmagnetic. Further, via electron-lattice and spin-orbit interactions, chiral phonons are predicted to induce novel topological phases of matter. To explore such hitherto-unobserved phenomena, here we study $\text{Pb}_{1-x}\text{Sn}_x\text{Te}$, which is a narrow-bandgap semiconductor that exhibits a topological phase transition as a function of Sn composition, x – from a trivial insulator ($x < 0.32$) to a topological crystalline insulator ($x > 0.32$). In addition, this material system possesses soft optical phonons (in the terahertz frequency range) and exhibits ferroelectric instabilities. First, I will describe our observations of novel magnetic phenomena associated with chiral phonons in PbTe [1]: magnetic circular dichroism, a Zeeman splitting, and a diamagnetic shift. I will show that these observations are results of magnetic field-induced morphic changes in the crystal symmetries through the Lorentz force exerted on the lattice ions. Second, for films in the topological crystalline insulator phase, we observed phonon magnetic moment values that are larger than those for topologically trivial films by two orders of magnitude [2]. Furthermore, the sign of the effective g -factor was opposite in the two phases. These results strongly hint at the existence of interplay between the magnetic properties of chiral phonons and the topology of electronic band structure. Lastly, I will discuss initial results of our attempt to observe topological polariton ground states through ultrastrong coupling of chiral phonons in PbTe with quantum vacuum fluctuations in small mode-volume terahertz cavities.

[1] A. Baydin et al., "Magnetic Control of Soft Chiral Phonons in PbTe," Phys. Rev. Lett. 128, 075901 (2022)

[2] F. G. G. Hernandez, A. Baydin, et al., "Chiral Phonons with Giant Magnetic Moments in a Topological Crystalline Insulator," arXiv:2208.12235 (2022)

Short Bio:

Dr. Andrey Baydin joined the Kono group as a postdoctoral researcher in September 2019. He graduated from Department of Theoretical Physics at Perm State University and received his M.S. and Ph.D. degrees in Physics at University of Louisville and Vanderbilt University in 2013 and 2018, respectively. His current research interests include light-matter interaction in the ultrastrong coupling regime and ultrafast spectroscopy of quantum materials.

Note: Snacks and Coffee will be served during the event Wine & cheese will be served after the talk. Everyone is welcome to stay around after the seminar for further informal discussions.