TcSUH Bi-Weekly Seminar

Ultrafast Atom Dynamics + Magnetism in Low Dimensions

Prof. Byron Freelon

Department of Physics, University of Houston, Houston, TX 77204
TcSUH Welch Professor, Texas Center for Superconductivity at the University of Houston

Thursday, April 4, 2024

In Person – Room 102, Houston Science Center, 12:00 p.m. – 1:00 p.m
Sandwiches will be provided on a first-come, first-served basis.

ABSTRACT: A revolution in materials physics is currently underway to explain the wide range of phenomena that have been uncovered in low-dimensional (low-D) van der Waals crystals. The production of graphene-inspired materials has led to a huge number of discoveries in fundamental condensed matter science. In fact, our theoretical understanding of electron physics in 2 dimensions has been constantly re-adjusted as topological behaviors are found to be applicable. In midst of this intellectual shift, quests to observe magnetism in 2D, graphene-like materials were launched; the result was the identification of magnetic order in low-D, chromium-based van der Waals crystals in 2017. We have explored such a 2D magnet CrSBr. It is a highly versatile, technologically promising material with many exciting properties due to the strong coupling between magnetism, lattice deformation and charge arrangement. Ultrafast atomic dynamics have been observed to be intimately coupled to the magnetic ordering state. Femtosecond pump-probe experiments reveal that the coherent motion of atoms is affected by the presence of antiferromagnetism. The collective atomic motion turns out to be coherent acoustic phonons (elastic waves) that mediate apparent structural deformations in the 2D magnetic crystal. We propose that magnetic ordering can influence the collective motion of atoms on an ultrafast time scale. Further, CrSBr may provide an example of a system in which non-equilibrium-induced acoustic phonons are robust with clear anisotropic behavior in the crystal. These results are germane to the field of strongly correlated electron systems (SCES) as CrSBr exhibits delicate couplings between different quantum sectors. The results will also be of relevance to the important problem of *ultrafast demagnetization*. And the findings exemplify an emerging field termed *strongly correlated electron-photon systems* (SCPS). The talk will place the results within the context of these 3 areas while emphasizing the novel behavior suggested by our experiments.

BIO: B. Freelon is an assistant professor in the physics department at the University of Houston. Prior to UH, he was briefly at the University of Louisville. He received the PhD, in condensed matter physics, from the University of Minnesota. Next, he did postdoctoral work at Lawrence Berkeley National Laboratory. He has held scientific staff positions at UC Berkeley, Argonne National Laboratory and the Massachusetts Institute of Technology.