Old Dominion University
Department of Physics

Virtual Colloquium

Thursday, March 11, 2021
3:00 pm

"Ultrafast Dynamics in Quantum Materials"

Dr. Shambhu Ghimire
Stanford PULSE Institute

Abstract: The fundamental response of isolated atoms and molecules to strong laser fields is known to exhibit a nonlinear optical phenomenon called high-order harmonic generation (HHG). During this process, the laser field pulls an electron from the outer shell of an atom, provides some kinetic energy to it, and brings it back to recollide to the parent ion -- much like a particle collider. Because the re-collision process is coherent, it can probe the detailed structure and ultrafast dynamics of the target molecule. Recently, we have also observed HHG in solid materials subjected to intense mid-infrared laser fields [1], which has sparked interest in the ultrafast science community, particularly at the intersection of ultrafast AMO and condensed matter physics [2-5]. The exciting possibilities include the use of underlying microscopic electron dynamics of HHG to probe valence charge density in the real space, electronic band-structure in the momentum space, and non-equilibrium states of matter in all-optical settings. This strength lies in the fact that driven dynamics occur in ultrafast time scales and are yet governed by the material's band structure. In this talk, I will give a brief overview of the field and present our latest results in ultrafast spectroscopy of quantum materials such as atomically thin two-dimensional crystals and topological insulators. These results have implications in quantum information science, particularly in identifying suitable materials for quantum computing infrastructures, and more generally in pushing the speed limits of electronics.

Short Bio: Dr. Shambhu Ghimire is a Lead Scientist and a Principal Investigator at Stanford PULSE Institute, SLAC National Accelerator Laboratory. He is a recipient of the prestigious Young Investigator award from the U.S. Department of Energy (2014-2019). His research interests are on Strong-field Quantum Physics and Nonlinear X-ray Science. He received his Ph.D. in physics from Kansas State University in 2007 and went to University of Michigan for a post-doc job before he joined Stanford in 2009.

Selected Publications:

1. **S. Ghimire** et al., Observation of high-order harmonics in a bulk crystal, Nature Physics 7, 2, 138 (2011)
2. N. Dabashimiye, **S. Ghimire**, M. Wu, D Browne, K. Schafer, M. Gaarde and D. Reis, Solid-state harmonics beyond atomic limit, Nature 534, 520-523 (2016).
3. Y. You, D. Reis and **S. Ghimire**, Anisotropic high-harmonic generation in bulk crystals, Nature Physics, 13, 345-349 (2017).
4. **S. Ghimire** and D. Reis, Review: High-order harmonic generation from solids, Nature Physics Online November (2018).
5. J. Lu, E. Cunningham, Y. S. You, D. A. Reis and **S. Ghimire**, Interferometry of dipole phase in high harmonics from solids, Nature Photonics 13, 96100 (2019)

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