

Colloquium

Department of Physics, Temple University

The new era of femtosecond materials physics: From making the molecular movie to engineering of topological states

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Over the past decade technologies for ultrafast, femtosecond resolution, characterization of fundamental processes in gases, molecules and in the solid state has been progressed rapidly. As well as non-linear optics methods; characterization of electronic structure through timeresolved angle-resolved photoemission spectroscopy (tr-ARPES) is particularly informative. This is complemented by ultrafast structural characterization experiments using either electrons or photons; and I will describe programs at MSU to develop and apply technologies for ultrafast characterization using electrons. In the solid state, strong (or intermediate) fields can be used to produce effects such as Floquet ladders, laser-induced topological states and photo-induced phase transitions (PIPT). Many PIPTs have been experimentally observed including: insulator to metal [1,2], metal to superconductor, and paramagnet to ferromagnet transitions. Three ongoing projects in my group will be described: Generating and controlling ultrafast electron bunches [3,4] for ultrafast electron sources; electronic structure, CDWs and the PIPTs of TaS₂ [5]; Using light to control topological states in a paradigmatic model of a topological insulator [6].

1. Z.S. Tao, T.R.T. Han, S.D. Mahanti, P.M. Duxbury, F. Yuan, C.Y. Ruan, K. Wang, J.Q. Wu, "Decoupling of structural and electronic phase transitions in VO₂" Phys. Rev. Lett. 109 (166406), pages 1-5 (2012)
2. T.T. Han, F. Zhou, C.D. Malliakas, P.M. Duxbury, S.D. Mahanti, M.G. Kanatzidis, C.-Y. Ruan. "Exploration of metastability and hidden phases in correlated electron crystals visualized by femtosecond optical doping and electron crystallography". Science Advances 1 (5), e1400173 (2015).
3. J. Portman, H. Zhang, K. Makino, C.Y. Ruan, M. Berz and P.M. Duxbury, "Untangling the contributions of image charge and laser profile for optimal photoemission of high-brightness electron beams", J. Appl. Phys. 116, 174302 (2014).
4. J. Williams, F. Zhou, T. Sun, Z. Tao, K. Chang, K. Makino, M. Berz, P.M. Duxbury, and C.-Y. Ruan, "Active control of bright electron beams for femtosecond diffraction and spectroscopy". Structural Dynamics 4, 44035 (2017).
5. D.C. Miller, S.D. Mahanti and P.M. Duxbury, "Charge density wave states in Tantalum dichalcogenides", Submitted to PRB
6. Bin Hwang and P.M. Duxbury, "Non-equilibrium Floquet band formation in pump-probe photoemission of a one-dimensional topological insulator", preprint

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Monday, October 16, 2017 at 3:00pm

SERC, Room 116

Refreshments served at 2:45pm