Photo-induced Phase Transitions in Charge Density Waves

Speaker: **Nuh Gedik** 

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Place: <https://epfl.zoom.us/j/89778378177>

Abstract: Upon excitation with an intense laser pulse, materials can undergo a non-equilibrium phase transition through pathways different from those in thermal equilibrium. The mechanism underlying these photoinduced phase transitions has long been researched, but many details in this ultrafast, non-adiabatic regime still remain to be clarified. To this end, we studied light induced phase transitions in two different charge density wave (CDW) systems. First, we investigated the photo-induced melting of a unidirectional CDW in LaTe3. Using a suite of time-resolved probes, we independently track the amplitude and phase dynamics of the CDW. We find that a fast (approximately 1 picosecond) recovery of the CDW amplitude is followed by a slower re-establishment of phase coherence dictated by the presence of topological defects in CDW. Furthermore, after the suppression of the original CDW by photoexcitation, a different, competing CDW along the perpendicular direction emerges. The timescales characterizing the relaxation of this new transient CDW and the reestablishment of the original CDW are nearly identical, which points towards a strong competition between the two orders. Secondly, I will also report the realization of optical chiral induction and the observation of a gyrotropically ordered CDW phase in 1T -TiSe2. Our results provide a framework for understanding other photoinduced phase transitions and for unleashing novel states of matter that are “trapped” under equilibrium conditions.

[1] Anshul Kogar, Alfred Zong, Pavel E. Dolgirev, Xiaozhe Shen, Joshua Straquadine, Ya-Qing Bie, Xirui Wang, Timm Rohwer, I-Cheng Tung, Yafang Yang, Renkai Li, Jie Yang, Stephen Weathersby, Suji Park, Michael E. Kozina, Edbert J. Sie, Haidan Wen, Pablo Jarillo-Herrero, Ian R. Fisher, Xijie Wang, Nuh Gedik, ***Nature Physics 16***, 159–163 (2020)

Professor Gedik joined MIT Physics Department as an assistant professor in January 2008. He received his B.S. in Physics in 1998 from Bogazici University, Istanbul, Turkey and his Ph.D in Physics in 2004 from University of California, Berkeley. After his Ph.D, he moved to Caltech where he worked as a postdoctoral scholar till January 2008. His awards include National Science Foundation CAREER Award, Department of Energy Early Career Award, Sloan fellowship, DARPA Young Faculty Award and Moore Experimental Investigator award. He was promoted to Full Professor of Physics in 2018.  
Professor Gedik's research centers on investigating quantum materials by using advanced optical and electron based spectroscopies. Quantum materials are systems in which strong correlations lead to fascinating emergent phenomena such as high temperature superconductivity or colossal magnetoresistance. Despite intense research for                     decades, uncovering the physics of these materials with conventional techniques has been very difficult. This is mainly because of the fact that different degrees of freedoms (i.e. charge, spin and lattice) are strongly coupled in these systems and interplay between them is responsible for many of their exciting properties. Gedik group develops novel time-resolved techniques to selectively probe dynamics of charge, spin and lattice excitations with unprecedented time, momentum and energy resolutions. Material systems of interest include topological insulators, high temperature superconductors and atomically layered materials.