



The Center for
Light Matter Interaction
Tel Aviv University

LMI Seminar:

Probing Nonlinear Dynamics in Strongly Driven Quantum Materials

Dr. Alexander von Hoegen
Department of Physics at MIT



Wednesday October 22nd, 2022
13:00-14:00

Light refreshments and drinks will be served at 12:30

Auditorium 011, Engineering Classroom Building, Faculty of
Engineering, Tel-Aviv University

Abstract: The intricate phase diagrams and peculiar material properties of the so-called strongly correlated material are determined by the fine energy balance of competing degrees of freedom, such as structural, electronic or magnetic. The possibility of enhancing desirable functional properties in these materials using mode-selective electromagnetic drives has motivated a series of studies to investigate the interplay between the microscopic lattice and electronic degrees of freedom and to find ways for their ultra-fast optical manipulation. First experiments achieved this type of control through nonlinear coupling between a resonantly driven infrared active mode and a second mode which is interconnected with a macroscopic material property. We used this pathway to transiently reverse the polarization state of the ferroelectric LiNbO₃ and studied the ensuing dynamics using time-resolved second harmonic generation (tr-SHG). The amplitude and phase sensitive detection of the lattice dynamics revealed a transient reversal of the polarization state and allowed us to reconstruct the lattice potential energy.

In high-T_c cuprates, a similar large amplitude excitation of an infrared active lattice vibration has been shown to induce transient features in the reflectivity suggestive of non-equilibrium superconductivity. We measured time- and scattering angle-dependent second-harmonic generation in YBa₂Cu₃O_{6+x} after exciting the apical oxygen vibration that transiently induces a superconductor-like terahertz reflectivity. We observed a 2.5-THz electronic mode invisible in other measurements, which displays a unique symmetry, momentum, and temperature dependence. We identify this mode to be a Josephson plasmon polariton, a conclusion compatible with the previously observed transient superconductor-like terahertz reflectivity.