



The Center for
Light Matter Interaction
Tel Aviv University

LMI Seminar:

Structural states of optically driven SrTiO₃

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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: Shaping crystal structures and altering their properties utilizing optical pulses has become a unique approach in ultrafast science. But how versatile is this approach, and how many of these states possibly exist in a single material? Here I will examine this question for SrTiO₃, a prototypical perovskite material.

Illuminating SrTiO₃ with optical pulses covering wavelengths ranging from 4 meV to 4 eV produces distinctive non-equilibrium states [1–4]. For example, optical pulses in the low-frequency range (4meV-100 meV) create a short-lived polar ordering, metastable ferroelectricity, or antiferrodistortive ordering. In contrast, pulses tuned to the frequency of the eV range results in a suppression of these orders.

I will show how this diverse and rich behavior originates from the initial optical excitations processes involving lattice or electronic degrees of freedom and their interplay. Utilizing the results of first-principle calculations, I will show that although the interaction of lattice, electronic degrees, and fluctuations is the same, the non-linear processes launched by the optical pulses result in different final states. To support this discussion, I will compare these theory results with the experimental findings of ultrafast X-ray and spectroscopic investigations. Finally, I will discuss how these findings for SrTiO₃ apply to other materials.

References:

1. Kozina, M. et al. Terahertz-driven phonon upconversion in SrTiO₃. Nat Phys 15, 387–392 (2019).
2. Li, X. et al. Terahertz field-induced ferroelectricity in quantum paraelectric SrTiO₃. Science 364, 1079–1082 (2019).
3. Nova, T. F., Disa, A. S., Fechner, M. & Cavalleri, A. Metastable ferroelectricity in optically strained SrTiO₃. Science 364, 1075–1079 (2019).
4. Porer, M. et al. Ultrafast Relaxation Dynamics of the Antiferrodistortive Phase in Ca Doped SrTiO₃. Phys Rev Lett 121, 055701 (2018).