Abstract Submitted
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Imaging the transition states in the thermal and nonthermal phase transitions of vanadium dioxide using coherent femtosecond electron beams[1] FARAN ZHOU, JOSEPH WILLIAMS, ZHENSHENG TAO, DAVID TORRES, NELSON SEPULVEDA, CHONG-YU RUAN, Michigan State Univ, RUAN GROUP TEAM, SEPULVEDA GROUP COLLABORATION — Phase transitions are often discussed within the context of thermal equilibrium where distinct phase change phenomena are described in the complex phase diagram in which temperature, chemical doping, or pressure are steady-state tuning parameters. Much less is understood in terms of excited states and dynamical phase transitions induced after sudden excitations using intense laser or electrical pulses. Here we present controlled studies to examine the transient emergence of new metastable phases and their nonequilibrium dynamics during photo- and electrically induced phase transitions of vanadium dioxide using femtosecond electron diffraction and diffusive scattering techniques, which allow us to directly monitor the momentum-dependent lattice dynamics. We discover a unique interaction-driven monoclinic emergent state that, interestingly, has a similar crystal symmetry as the thermodynamic M2 phase. Meanwhile, using an excitation pulse below the interaction-drive threshold we also isolate the thermal transitions, following a distinctly different pathway. We discuss these results in the context of charge doping, lattice instabilities, static and transient stresses that can invariably influence the phase transitions with potential applications in high-speed electronics.

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Faran Zhou
Michigan State Univ

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