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Hyperspectral Imaging of Ultrafast and Nanoscale Phase Transitions in Quantum Materials

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Using light to drive phase transitions in quantum materials is an emerging tool for inducing material properties "on demand"[1]. However, while we have many methods to measure the average change in material properties on the femtosecond timescale, observing the spatial dynamics of the phase transition with femtosecond time resolution has remained challenging.

In this work, I will summarize our recent work to use coherent diffractive imaging to image light-induced phase transitions in the quantum material vanadium dioxide (VO2) on the femtosecond timescale. In particular, I will show how spectrally-dependent imaging at the oxygen K and Vanadium L edges can be used to obtain contrast and identify phase transitions [2,3] and how the use of X-ray lasers enables direct measurement of the phase transition pathway [4]. In addition, I will present some unpublished work on the stability of light-induced domains and the recovery pathway for the light induced phase transition.

1. D. N. Basov, R. D. Averitt, and D. Hsieh, Nature Materials 16, 1077 (2017).
2. L. Vidas, et al, Nano. Letters 18, 3449 (2018).
3. A. S. Johnson, et al, Science Advances 7, eabf1386 (2021)
4. A. S. Johnson, et al, Nature Physics 19, 215 (2023)

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