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Nanoscale heterogeneous dynamics in the light-induced insulator metal phase transition in VO2

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The properties of quantum materials are increasingly being manipulated by light to induce new functionalities such as light-induced superconductivity. Understanding how such materials change is vital for determining how such properties arise. While we have many sophisticated probes that can track material changes on the ultrafast timescale, most lack spatial resolution and thus only provide the average dynamics of the sampled area. However, many quantum materials are either heterogeneous in their initial state or are believed to be heterogenous in their transient state, which makes it challenging to interpret exactly how the material is changing.

In this talk, I will show how coherent soft X-ray imaging can be used to image heterogenous dynamics of the light-induced insulator-metal phase transition with 150 fs time resolution and ~25 nm spatial resolution. I will show how soft X-ray absorption spectroscopy, combined with time-resolved imaging can be used as a nanoscale spectroscopic tool to directly measure the properties of the heterogenous state. By using spatially, temporally and spectrally resolved imaging, we show that the light-induced metallic phase in VO2 is different from the thermal phase transition, due to the presence of strain [1]. This work opens up the opportunity to directly measure dynamics heterogenous systems, or the formation of heterogenous dynamics in the time-domain.

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