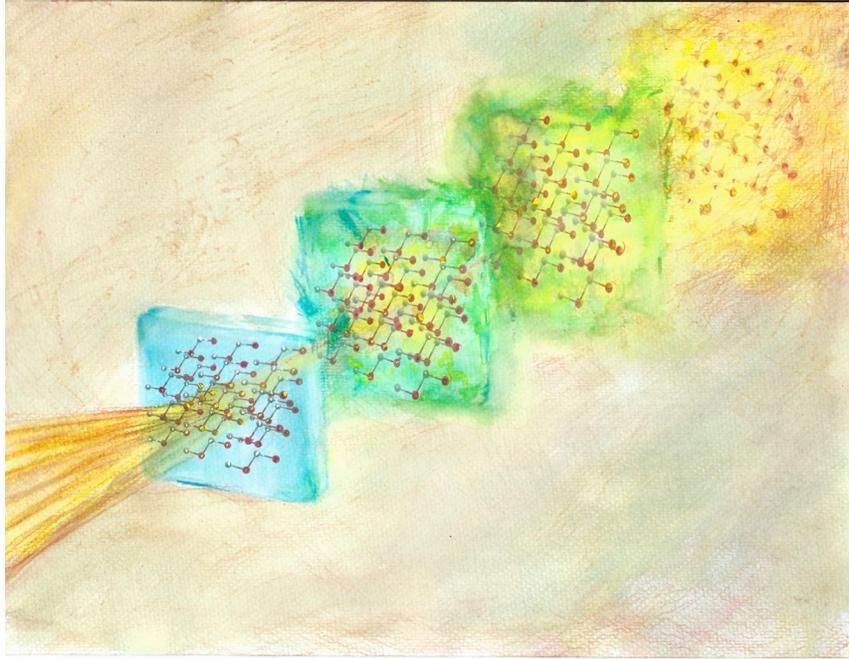


# How Light Reshapes Matter: Structure–Function Relations in Laser-Dressed Materials

Ignacio Franco, University of Rochester



Strong light–matter interactions offer a powerful route to creating and probing nonequilibrium materials with on-demand functionality. Yet, the effective structure–function relations that govern these laser-dressed materials remain poorly understood. In this talk, I will discuss recent theoretical and computational advances that enable the first-principle modeling and interpretation of the response properties of solids dressed by light of arbitrary strength and photon energy [1-3]. In this strongly driven regime, the Floquet states emerge as the natural states for characterizing the physicochemical properties of matter. I will present purely optical signatures of Floquet state formation in one-, two-, and three-dimensional materials, and show how these signatures evolve from the nanoscale to the bulk [4,5]. This evolution reveals finite-size effects that are unique to nonequilibrium quantum materials. Together, these developments provide new tools to model, control, and experimentally characterize the emergent properties of laser-dressed materials.

[1] V. Tiwari and I. Franco, “Robust purely optical signatures of Floquet states in crystals” *Phys. Rev. Lett.*, **135**, 186901 (2025)

[2] V. Tiwari and I. Franco, “First-principle based Floquet engineering of solids in the velocity gauge”, *Phys. Rev. B*, **112**, 085139 (2025)

[3] V. Tiwari, B. Gu and I. Franco, “Floquet theory and computational method for the optical absorption of laser-dressed solids”, *Phys. Rev. B*, **108**, 064308 (2023)

[4] V. Tiwari, L. Sierra-Ossa, P. Wojcik and I. Franco, “Transition from the Nanoscale to Bulk in the Nonequilibrium Optical Response of Laser-Dressed Materials” *J. Phys. Chem. Lett.*, **17**, 214 (2026)

[5] B. Gu and I. Franco, “Optical absorption properties of laser-dressed matter”, *Phys. Rev. A*, **98**, 063412 (2018)