Ultrafast quantum phenomena in correlated oxides and heterostructures

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The possibility of investigating the dynamics of solids on timescales faster than the thermalization of the internal degrees of freedom has disclosed novel non-equilibrium phenomena
that have no counterpart at equilibrium. Transition metal oxides (TMOs) provide an interesting playground in which the correlations among the charges in the metal d-orbitals give rise to a wealth of intriguing electronic and thermodynamic properties involving the spin, charge, lattice and orbital orders. Furthermore, the physical properties of TMOs can be engineered at the atomic level, thus providing the platform to investigate the transport phenomena on timescales of the order of the intrinsic decoherence time of the charge excitations. Here, we will address the timescales and techniques necessary to observe the ultrafast decoherence process in correlated materials and we will discuss the possible exploitation of quantum paths for the transport and collection of charge excitations in TMO-based few-monolayers devices.