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Nonequilibrium Dynamical Mean Field Theory for Inhomogeneous and Photo-Excited Systems[1]

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Photodoping of a Mott insulator triggers a nonequilibrium phase transition from a correlation induced insulating state to a nonthermal conducting state with electron- and hole-like carriers. Using the nonequilibrium extension of (inhomogeneous) dynamical mean field theory[2,3] in combination with a strong-coupling impurity solver[4] we study the relaxation and diffusion of photo-doped carriers in Mott insulating bulk systems and hetero-structures. In large-gap insulators, the life-time of the carriers depends exponentially on the gap size,[5] while in small-gap insulators, strongly pulse-energy dependent impact ionization processes lead to a double-exponential relaxation.[6] In the paramagnetic phase, the photo-doped carriers spread through the insulator in a diffusive manner, while the scattering with an antiferromagnetic background leads to a rapid loss of kinetic energy.[7] In the presence of strong fields, as realized e. g. in polar heterostructures, the ability to dissipate energy locally in an antiferromagnetic system enables fast carrier transport.[8] These insights should be relevant for designing Mott insulating solar cells[9] and light-controlled devices which operate on an ultra-fast timescale.

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