

Momentum-Resolved Photoemission Spectra of Photoexcited One-Dimensional Mott Insulators

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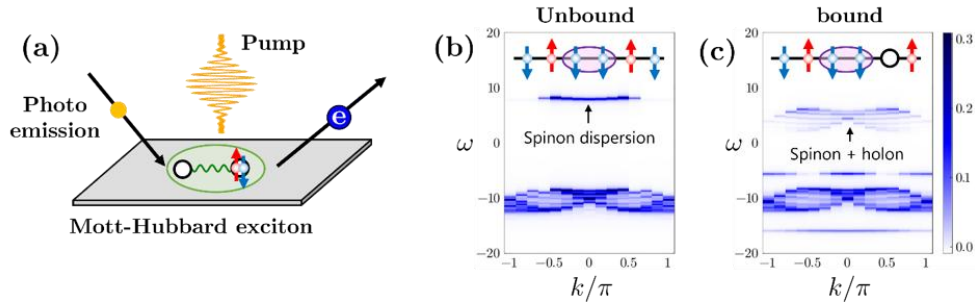
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Photoexcitation of Mott insulators creates nonequilibrium states governed by strong electronic correlations. In one dimension, photodoping generates doublons and holons, which may bind into Mott–Hubbard excitons embedded in a correlated spin background. Although such excitons have mainly been studied with optical probes, momentum-resolved photoemission can reveal how photoinduced charges couple to fractionalized spin and charge excitations. We theoretically investigate the photoemission spectra of photodoped one-dimensional Mott insulators within a quasi-steady-state description of the extended Hubbard model (Fig. 1(a)).

Using exact diagonalization and a slave-particle analysis, we identify qualitatively distinct signatures of bound and unbound photocarriers. When the doublon and holon remain unbound, photoemission from a doublon produces a dispersive in-gap signal that directly tracks the spinon dispersion, demonstrating that photocarriers can probe magnetic excitations (Fig. 1(b)). Once a Mott–Hubbard exciton forms, a replica of the lower Hubbard band emerges inside the Mott gap through the combined propagation of spinons and holons; its energy and spectral-weight distribution are sensitive to the binding strength and exciton wavefunction (Fig. 1(c)). These results establish time-resolved photoemission as a probe of carrier binding, spin–charge fractionalization, and magnetic correlations in strongly correlated materials.



(a) Schematic illustration of photoemission from a photoexcited Mott insulator. Momentum-resolved photoemission spectra for (b) an unbound doublon–holon pair and (c) a bound Mott–Hubbard exciton. The spectra reflect spinon (purple circle) and holon (white circle) excitations.