Photoinduced Magnetic Excitations in a Pumped Mott Insulator on a Square Lattice

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The recent development of time-resolved resonant inelastic x-ray scattering (trRIXS) and two-magnon Raman scattering (trTMR) opens a new avenue for probing magnetic excitations, from which one can investigate novel photoinduced nonequilibrium phenomena in the wide range of momentum and energy spaces. We theoretically investigate momentum dependent spin excitations that evolve after pumping within a femtosecond timescale in the antiferromagnetic Mott insulator on a square lattice [1,2]. Using a numerically exact-diagonalization technique based on the time-dependent Lanczos method and time-dependent density-matrix renormalization group for a half-filled Hubbard model, we find novel momentum-dependent transient spin dynamics.

We demonstrate characteristic temporal oscillations for the intensity of the dynamical spin structure factor, showing an antiphase behavior for two orthogonal directions that are parallel and perpendicular to the electric field of a pump pulse [1]. The same behavior is also seen in the static spin structure factor. Their oscillation period in time is determined by two-magnon excitation in the Mott insulator. This theoretical prediction will be confirmed for Mott insulating cuprates and iridates once trRIXS is ready for a femtosecond timescale.

In addition, we find a photoinduced low-energy magnetic excitation in the dynamical spin structure factor. The same excitation appears in calculated trTMR spectrum [2]. We propose that this low-energy excitation is a possible origin of photoinduced low-energy spectrum in recently reported trTMR experiment for $YBa_2Cu_3O_{6.1}$ [3].

References

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