Watching ultrafast excitation dynamics in momentum space

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The dynamics of quasi-particles in non-equilibrium states of matter reveal the underlying microscopic coupling between electronic, spin and vibrational degrees of freedom. We aim for a quantum-state-resolved picture of coupling on the level of quasi-particle self-energies, which goes beyond established ensemble-average descriptions, and which requires ultrafast momentum-resolving techniques. The dynamics of electronic and excitonic excitations are measured with time- and angle-resolved photoemission spectroscopy (trARPES) in layered magnets, molecular crystals [1] and van der Waals heterostructures [2,3]. Topological properties of the electronic structure can be retrieved from the polarization dependence of ARPES signals [4]. The complementary view of ultrafast phonon dynamics is obtained through femtosecond electron diffraction. The elastic and inelastic scattering signal reveals the temporal evolution of vibrational excitation of the lattice and momentum- as well as element-resolved information of transient phonon populations generated by electron- and exciton-phonon coupling [5].

References

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