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Fourier-transform inelastic x-ray scattering from time- and momentum- dependent phonon-phonon correlations MARIANO TRIGO, SLAC, DAVID REIS, SLAC/Stanford — In a solid, the elementary excitations of the crystalline lattice (phonons) determine the macroscopic properties such as thermal transport and structural stability. The spectrum of these elementary excitations is normally obtained from inelastic neutron and x-ray scattering near equilibrium conditions, which is a Fourier transform of the spatial and temporal correlations of the system. Recent advances in Free Electron Laser sources provide sufficient flux and time-resolution to explore the dynamics of solids at the fundamental time- and length-scales of the atomic motions. In this talk I will show that by probing phonon correlations by femtosecond diffuse scattering in photoexcited germanium, we were able to obtain the phonon dispersion with extreme frequency and momentum resolution without analyzing the energy of the outgoing photon. I will show that time-dependent coherences are generated when an ultrafast laser pulse slightly quenches the phonon frequencies, generating pairs of correlated phonons at equal and opposite momenta. Using this approach we obtain an extremely high-resolution probe of the excited-state phonon dispersion over large sections of momentum space by a simple Fourier transform.

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