Lattice dynamics of two-dimensional colloidal model crystals

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Using positional data from video-microscopy and applying the equipartition theorem for harmonic Hamiltonians, we determine the wave-vector-dependent normal mode spring constants of two-dimensional colloidal crystals and compare the measured band-structure to predictions of the harmonic lattice theory. We find good agreement for the transversal and satisfactory agreement for the longitudinal mode. For $q \to 0$, the measured spring constants approach correctly the elastic moduli of the crystal. The autocorrelation function of the normal modes contains information on the phonon dynamics; a few of the long-wavelength phonons in our system behave as damped oscillators, but most phonons are overdamped. The relaxation rates of these phonons provide access to the wave-vector-dependent friction factors.