

Supplementary information to “Phonons in two-dimensional soft colloidal crystals”

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S1. Characterization of colloidal crystals.

Colloidal crystals are characterized by sample lattice structure. Figure S1a is the Fourier transformation of a snapshot of the microscopy image of the PNIPAM crystal sample. A six-fold symmetry indicates that colloidal particles are packed in a triangular lattice. Figure S1b plots the spatial correlation of the bond orientational order parameter Ψ_6 . Long range correlation of the orientational order indicates uniform crystalline structure in the sample.

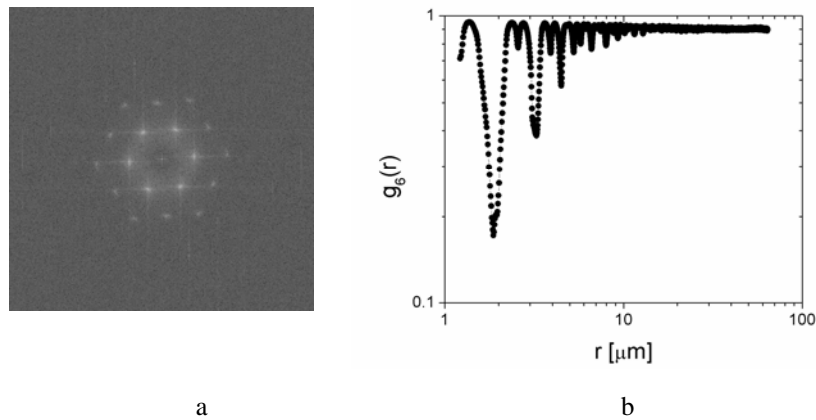


Figure S1. Crystal characterization. **a.** Fourier transformation of a microscopy image of PNIPAM crystal sample. **b.** Spatial correlation of bond orientational order parameter Ψ_6 .

S2. Low frequency modes in real space

The real space structure of low frequency modes obtained from pristine colloidal crystals exhibit features of plane waves or mixture of plane waves. Fig. S2 shows some of the lowest modes in real space. The swirling features from interfering plane-waves at different directions can be clearly seen.

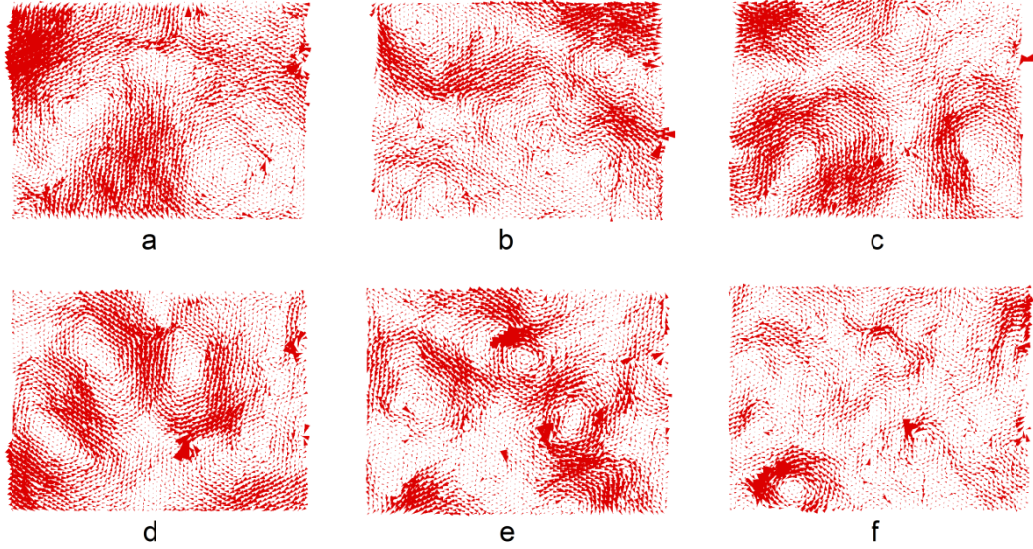


Figure S2. Crystal phonon modes in real space. The direction and size of the red arrows on individual particles correspond to the direction and relative magnitude of the polarization vector components of the eigenvector, from **a** to **f** are mode number 4, 9, 11,14, 16, and 28.

S3. Colloidal crystal with defects and soft modes

The correlation between soft modes and defects in imperfect crystal is robust against variation of participation ratio cut-offs. Fig. S3a shows a snapshot of a imperfect colloidal crystal with a grain boundary, among other defects. Fig. S3b-d show the spatial distribution of the soft modes from the crystal with defects when the participation ratio cutoff is varied from 0.1 to 0.3. The pattern of regions with high concentration of soft modes does not change qualitatively with different PR cut-offs.

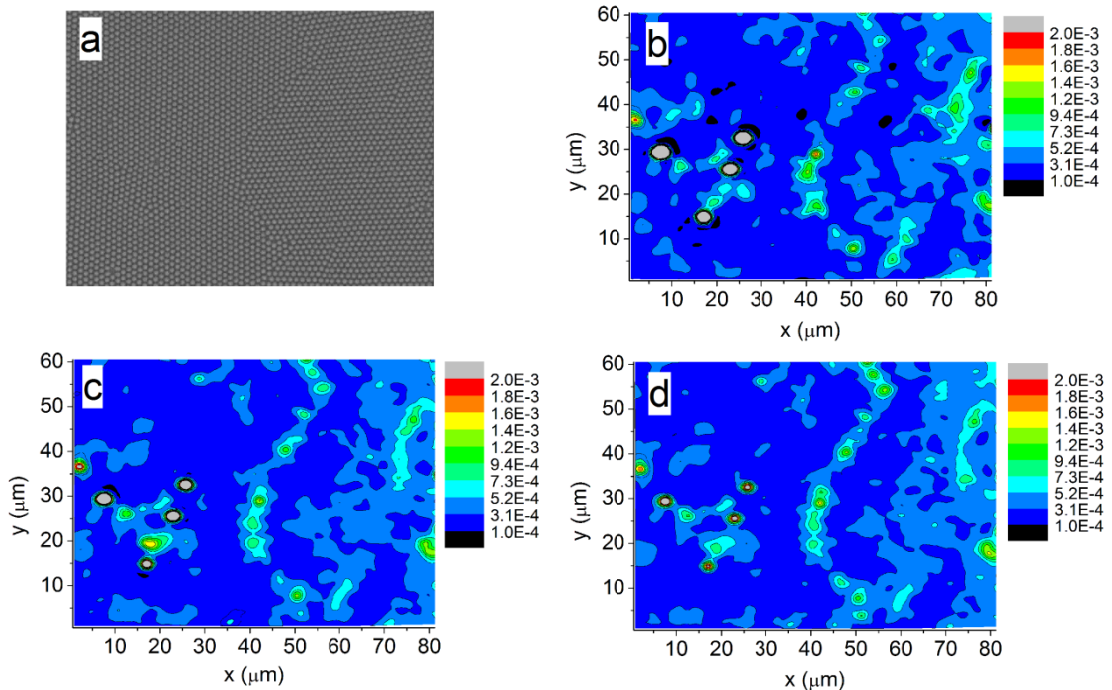


Figure S3. Soft modes and crystal with defects. **a.** A snapshot of a crystal sample with a grain boundary and other defects. **b-d.** Spatial distribution of the soft modes with participation ratio cut-off of 0.1 (b), 0.2 (c), and 0.3 (d). Lighter areas have higher concentration of soft modes.