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# Webinar

## Statistics of non-affine displacements: Defect precursors and stability of lattices

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Atomic position fluctuations are generally represented in terms of long and short wavelength phonon modes. This representation has led to a deeper understanding of the many observed properties of crystalline solids. However, identifying the subset of normal modes which correspond to the lattice defects is often a nontrivial task. Recently shown, any set of displacement of particles away from a specified reference configuration can be projected onto two mutually orthogonal spaces viz. affine and non-affine. These affine modes involve smoothly varying, elastic displacements and can be written as a linear transformation of the reference configuration. Whereas, the latter consists of discontinuous displacements and is related to defects in certain two-dimensional crystalline solids. In this thesis, we generalize this projection formalism to investigate statistics of non-affine fluctuations in several two- and three-dimensional crystals. For various lattices, we show that the non-affine modes are indeed associated with the commonly observed lattice defects. Furthermore, the susceptibility of a crystalline solid to any particular defect can also be estimated from the excitation spectra of the non-affine modes. Using this knowledge we devise an experimental protocol to (a) stabilize any lattice of colloidal particles. (b) stabilizing the patterns of active swarms of drones. This is accomplished in an energy efficient way by imposing “non-affine forces”. These forces alter the particle’s arrangement in order to minimize non-affine fluctuations and allow only affine transformations such as translations and rotations. In the former case, the colloidal lattice thus generated is translationally invariant and retains all the low energy modes. The patterned swarm of the drones is free to move in space and can be used for surveying territories and do scientific measurements. As a novel outcome of our study, we present a convenient way of obtaining the statistics of the underlying fluctuation solely from the applied non-affine forces.

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***11:30 AM***