Tata Institute of Fundamental Research
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Seminar

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

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Atomic fluctuations are generally represented in terms of long and short wavelength phonon modes. This representation has led to a deeper understanding of many observed properties of crystalline solids. However, determining the precise set of phonons which tantamount to the dominant lattice defect is often a non-trivial task. As shown recently that any set of displacement of particles away from some specified reference configuration can be projected onto two mutually orthogonal space viz. affine and non-affine. In this new way of classifying fluctuations, the affine modes involves smoothly varying, elastic displacements and can be written as a linear transformation of this reference configuration. Whereas the latter consists of discontinuous displacements and has been proved to be related to defects in certain two dimensional crystalline solids. Proceeding along the similar lines, we generalise the projection formalism to investigate statistics of non-affine fluctuations in several two and three dimensional crystals. In each case we show that the non-affine modes are indeed associated with the commonly observed lattice defects. Furthermore, susceptibility of a crystalline solid to any particular defect can also be estimated from the excitation spectra of non-affine modes. Using this knowledge we devise an experimental protocol to (a) Stabilise any lattice of colloidal particles, (b) Stabilise 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 minimise non-affine fluctuations and allow only affine transformations such as translation and rotation. In the former case, the colloidal lattice thus produced 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, the statistics of the underlying source of fluctuation can be obtained solely from that of the applied non-affine forces.

Wednesday, Nov 13th 2019

4:00 PM (Tea/Coffee at 3:30 PM)

Auditorium, TIFR-H