Max-Planck-Institut für Struktur und Dynamik der Materie
Max Planck Institute for the Structure and Dynamics of Matter

Wednesday, August 19th 2015 – 15:00
CFEL Seminar room III, EG.080 (Bldg. 99)

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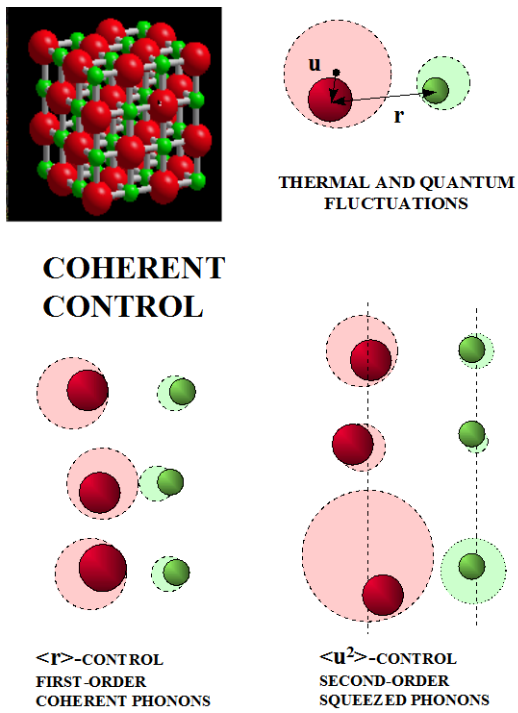
An Introduction to Phonon Squeezing

The propagation of light pulses in solids is accompanied by intense, monochromatic THz lattice vibrations showing a high degree of spatial and temporal coherence. Ultrafast laser pulses have also been used to generate squeezed phonon fields in a wide variety of materials. The availability of coherent and squeezed phonon fields holds promise for fundamental studies and applications involving, in particular, photon control of the ionic motion. Coherent states are, in some sense, the vibrational analogs to lasers. Their generation is central to the control of the average distance between ions. Phonon squeezing allows one to manipulate thermal and quantum fluctuations providing an avenue for experimental measurements to overcome the standard quantum limit for noise imposed by vacuum fluctuations. A pictorial representation of coherent and squeezed states is given in the accompanying figure. In the coherent case, the average relative position for the two ions in the unit cell, $\langle r \rangle$, oscillates in time while the size of the uncertainty regions, i.e., $\langle u^2 \rangle^{1/2}$, remains constant; u denotes the displacement of an ion from equilibrium. Pure squeezing consists of a time-varying variance, but time-independent $\langle r \rangle$.

This talk presents an elementary introduction to the mechanism of light induced generation of coherent and squeezed phonons together with an overview of the field which emphasizes physical concepts and applications. Magnon squeezing will be briefly discussed.



Coherent and squeezed phonons: Diagrams illustrate the time behavior of a unit cell. The relative position between ions, represented by the darker circles, and the deviation from equi-librium are denoted by r and u. The centers of the lighter circles denote the average position while their radius depicts the uncertainty in u. At $T = 0$, the latter becomes equal to the zero-point motion of the ions.

Host: Andrea Cavalleri

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