

# Collective excitation in solids

In contrast to quasiparticles, **collective excitations are bosons**, and they bear no resemblance to constituent particles of real system. They involve collective (i.e., coherent) motion of many physical particles.

- **Phonon**: Corresponds to coherent motion of all the atoms in a solid — quantized lattice vibrations with typical energy scale of  $\hbar\omega = 0.1 \text{ eV}$
- **Exciton**: Bound state of an electron and a hole with binding energy  $e^2/\epsilon a = 0.1 \text{ eV}$
- **Plasmon**: Collective excitation of an entire electron gas relative to the lattice of ions; its existence is a manifestation of the long-range nature of the Coulomb interaction. The energy scale of plasmons is  $\hbar\sqrt{ne^2/m_e} : 5 - 20 \text{ eV}$
- **Magnon**: Collective excitation of the spin degrees of freedom on the crystalline lattice. It corresponds to a spin wave, with an energy scale of  
 $\hbar\omega : 0.001 - 0.1 \text{ eV}$

# Collective Excitations In Solids

**LP Steffe**



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