

What are quasiparticles?

Elementary excitations of a system of interacting particles.

Give some examples!

phonons: lattice vibrations

plasmons: coupled electromagnetic charge wave

polarons: electron plus ionic polarization field

bipolarons: are a bound pair of polarons which has an integer spin and becomes a boson

excitons: bound pair of an electron and a hole found in insulators and semiconductors

magnons: excitations of ordered magnetic states; bosons

polaritons: transverse optical phonons couple with photons $\hat{=}$ soundwave couples to light;

Why do quasiparticles have a finite lifetime?

Quasiparticles correspond to eigenstates of the Hamiltonian. The lifetime of such quasiparticles can be calculated using Fermi's Golden Rule:

$$\Gamma_{i \rightarrow f} = \frac{2\pi}{\hbar} |\langle f | H | i \rangle|^2 \delta(E_f - E_i)$$

For low quasiparticle energies the lifetime is rather long and becomes quickly shorter for higher energies.

How could you observe these quasiparticles experimentally?

An experimental technique to measure quasiparticles is Raman Spectroscopy: The specimen is exposed to laserlight from which a small part scatters inelastically. The laserlight photons can give off energy to produce a quasiparticle or take the energy from an already existing. In the Raman spectra these processes can be related to the Stokes (creation of quasiparticle) and the Anti-Stoke peaks.

additionally especially for:

plasmons: Electron Energy Loss Spectroscopy (EELS/ HREELS) (equidistant peaks in spectrum \rightarrow peak distance = plasmonenergy)

magnons: Neutron scattering- inelastic scattered neutrons create or annihilate magnons