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a phonon is a collective excitation in a periodic elastic arrangement of atoms or molecules in condensed matter specifically in solids and some liquids a type of quasiparticle in physics 1 a phonon is an excited state in the quantum mechanical quantization of the modes of vibrations for elastic structures of interacting particles when trying to control the way heat moves through solids it is often useful to think of it as a flow of particles a computer simulation shows phonons depicted as color variations traveling through a crystal lattice a phonon is a definite discrete unit or quantum of vibrational mechanical energy just as a photon is a quantum of electromagnetic or light energy phonons and electrons are the two main types of elementary particles or excitations in solids heat transfer physics describes the kinetics of energy storage transport and energy transformation by principal energy carriers phonons lattice vibration waves electrons fluid particles and photons chen broadens the readership by incorporating results from related disciplines from the point of view of thermal energy storage and transport and presents related topics on the transport of electrons phonons photons and molecules phonons are collective excitations of the lattice displacement field there are two key distinctions between phonons and fundamental particles like electrons firstly phonons are an effective description that only makes sense above a certain length scale the lattice spacing if you look so closely that you can resolve the microscopic motion parallel treatments of photons electrons phonons and molecules as energy carriers aiming at fundamental understanding and descriptive tools for energy and heat transport processes from nanoscale continuously to macroscale in this chapter we turn to phonons photons and their interactions with electrons these interactions play an important role in condensed matter physics at room temperature the resistivity of metals results mainly from electron phonon interaction in this paper we report a systematic study on how vibrational spectra mismatch affects the degree of phonon nonequilibrium near an interface how fast it is relaxed as the phonons diffuse into but unlike photons the particles that carry light or other electromagnetic radiation which generally don't interact at all if they have different wavelengths phonons of different wavelengths it has been pointed out by kohn that the interaction of phonons with the conduction electrons in a metal should cause anomalies in the phonon spectra the phonon dispersion should exhibit kinks at wave vectors  $q = k + g$  where  $k$  is the fermi wave vector and  $g$  is the reciprocal lattice vector this chapter provides a brief summary of existing microscale heat transfer models including the microscopic two step model phonon electron interaction for metals model phonon scattering for semiconductors dielectric crystals and insulators model phonon radiative transfer model and the thermal wave model nanoscale energy transport and conversion a parallel treatment of electrons molecules phonons and photons oxford university press 2005 isbn 9780195159424 in bcs theory pairs of electrons called cooper pairs have their motion coupled to nearby matter via lattice vibrations called phonons thereby avoiding the collisions with atoms that normally create electrical resistance gang chen createspace independent publishing platform aug 8 2017 science 274 pages nanoscale energy transport and conversion a parallel treatment of electrons molecules phonons chen broadens the readership by incorporating results from related disciplines from the point of view of thermal energy storage and transport and presents related topics on the transport of both electrons and phonons are present in a metal and they can act as carriers for heat transport nonetheless conduction through the free electrons within the metal lattice is typically considered to be the dominant mechanism of heat transfer in metals nanoscale energy transport and conversion a parallel treatment of electrons molecules phonons and photons the current state of the art for determining thermoelectric properties is limited to the investigation of electrons or phonons without including the inherent electron phonon coupling that is in all where  $\omega_{\nu q}$  is the frequency of the  $\nu$ th optical mode at the  $\Gamma$  point  $n$  is the excitation density number of conduction electrons per unit cell and  $n_{\nu}$  are effective

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when trying to control the way heat moves through solids it is often useful to think of it as a flow of particles a computer simulation shows phonons depicted as color variations traveling through a crystal lattice

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phonons are collective excitations of the lattice displacement field there are two key distinctions between phonons and fundamental particles like electrons firstly phonons are an effective description that only makes sense above a certain length scale the lattice spacing if you look so closely that you can resolve the microscopic motion

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parallel treatments of photons electrons phonons and molecules as energy carriers aiming at fundamental understanding and descriptive tools for energy and heat transport processes from nanoscale continuously to macroscale

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in this paper we report a systematic study on how vibrational spectra mismatch affects the degree of phonon nonequilibrium near an interface how fast it is relaxed as the phonons diffuse into

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but unlike photons the particles that carry light or other electromagnetic radiation which generally don't interact at all if they have different wavelengths phonons of different wavelengths

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it has been pointed out by kohn that the interaction of phonons with the conduction electrons in a metal should cause anomalies in the phonon spectra the phonon dispersion should exhibit kinks at wave vectors  $q = 2k_f$  where  $k_f$  is the fermi wave vector and  $g$  is the reciprocal lattice vector

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in bcs theory pairs of electrons called cooper pairs have their motion coupled to nearby matter via lattice vibrations called phonons thereby avoiding the collisions with atoms that normally create electrical resistance

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both electrons and phonons are present in a metal and they can act as carriers for heat transport nonetheless conduction through the free electrons within the metal lattice is typically considered to be the dominant mechanism of heat transfer in metals

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the current state of the art for determining thermoelectric properties is limited to the investigation of electrons or phonons without including the inherent electron phonon coupling that is in all

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