

# Introductory Solid State Physics I

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### I. Classification of Solids:

- compressibility, shear forces, Hook's law
- X'tals, polycrystalline, nanocrystalline materials, glasses, important types of defects, texture
- along optical  
  electrical  
  magnetic } properties
- bonds
  - Molecular
  - Ionic
  - Covalent

### II. Types of bonds, structure & symmetry in Solids

- interaction potentials; general idea,
- Lennard-Jones potential & Cohesive energy, isothermal compressibility,
- Ionic Solids, Coulomb-potential, Madelung constant,
- Covalent solids: Basic ideas, Heitler-London, bonding-antibonding states,  $\sigma$  &  $\pi$ -bonds, hybrids,
- translational symmetry, Bravais lattice, unit cells, Wigner-Seitz-cell,
- point symmetries, crystal systems, screw rotations & glide planes,
- Bravais lattice + basis
- Miller indices
- important crystal structures: sc, bcc, fcc, hcp,  $\text{CaF}_2$ , diamond,

### III. How to experimentally determine symmetry

- various wavelengths of: Light, electrons, neutrons
- idea of scattering: Elastic scattering, Fraunhofer-approach,
- reciprocal lattice
- intensity if scattering vector equal to some reciprocal lattice vector, Ewald construction, Bragg's law, structure factor & selection rules for bcc & fcc

### IV. Lattice vibrations & thermal properties of insulators

- General ideas: Classical equ. motion, harmonic approx., 2-atomic linear chain, density of states,
- Phonons: Basic idea, Debye-model, Bose-Einstein-fct.,
- phonon energy, specific heat,
- Grüneisen relation,
- thermal conductivity by phonons, thermal expansion coefficient

### V. Metals

- basic properties:  $\rho(T)$ ,  $S(T)$ ,  $C_p(T)$ , .....
- free electron models: Drude
- Sommerfeld:  $k_F$ ,  $E_F$ , Pauli principle,
- density of states  $D(E)dE \sim E^{1/2}$   
Fermi-Dirac fct., Fermi-integral,  $n_{eff}(T)$ ,
- heat capacity  $\sim T$
- thermal conductivity
- Nearly free electron model: Bands & gaps, Bloch-fct., k-space density of states, partly-versus-completely filled bands, Fermi-surface