Topic: Introduction to Solid State Physics

Subject: SOLID STATE PHYSICS (PH-523)

Course: M.Sc-Physics (3rd Sem)

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Solid State Physics: PH-515

UNIT I - CRYSTALLOGRAPHY

Review of crystal structure, Crystallographic Directions, Crystallographic Planes,

Close-Packed Crystal Structures, crystal symmetry, space groups; reciprocal lattice; **Bonding in Solids:** Bonding Forces and Energies, Primary Interatomic Bonds, Secondary Bonding or Van der Waals Bonding; **Imperfections:** Point defects; Dislocations—Linear Defects, Interfacial Defects, Bulk or Volume Defects, Atomic Vibrations.

UNIT II - X-RAY DIFFRACTION

Electromagnetic radiation, The continuous spectrum, The characteristic spectrum, Production of x-rays, Detection of x-rays,

Diffraction, The Bragg law, X-ray spectroscopy, Diffraction directions, Diffraction methods, Scattering by an electrons, Scattering by an atom, Scattering by a unit cell, Structure-factor calculations, Application to powder method, Debye-Scherrer method.

Solid State Physics : PH-515

UNIT III - LATTICE VIBRATIONS & THERMAL PROPERTIES

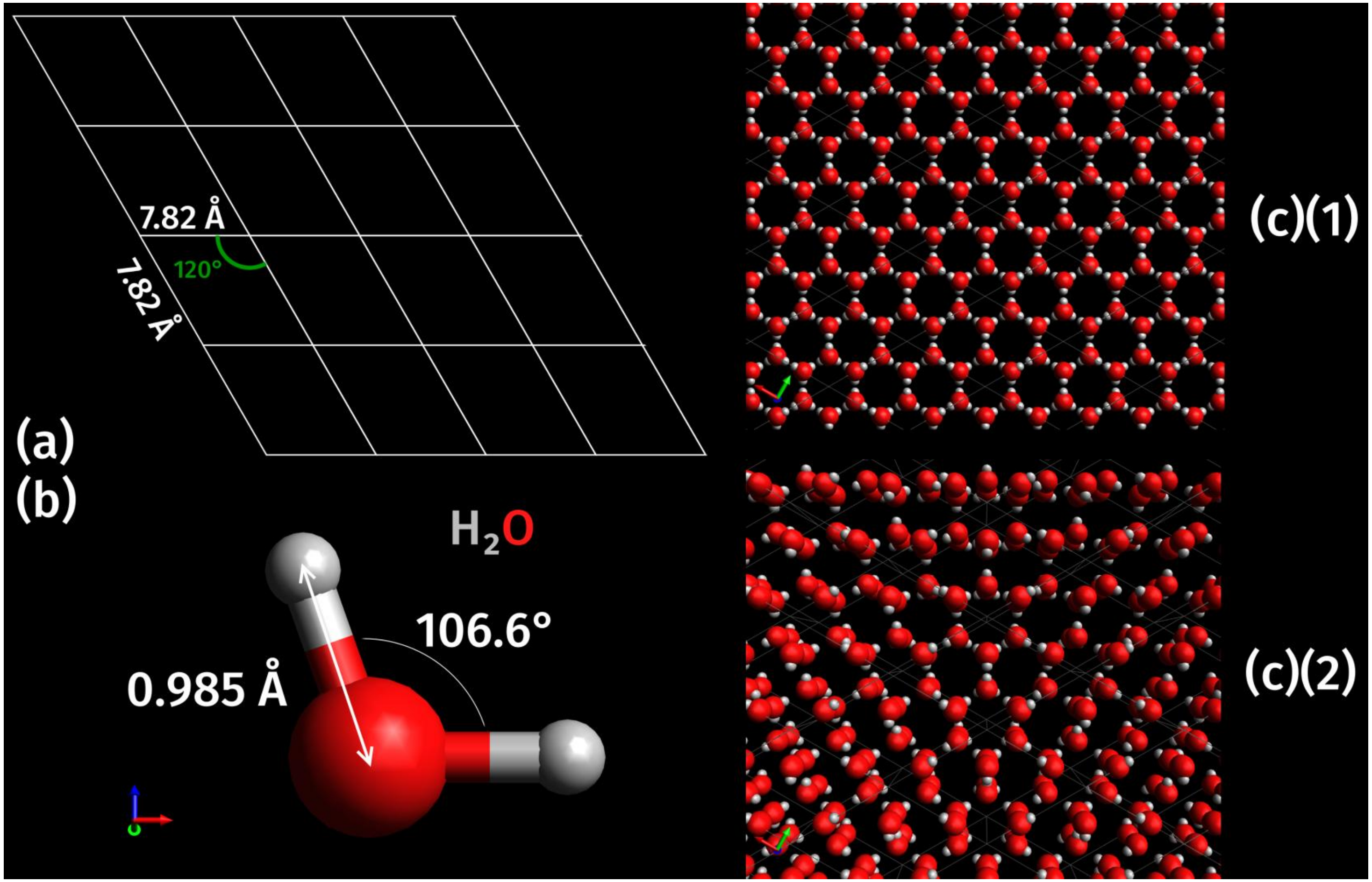
Vibrations of monoatomic lattices- first Brillouin zone, group velocity, long wavelength limit, **Vibrations of a diatomic lattice**, phonons, phonon momentum, inelastic scattering by phonons; Lattice heat capacity, Specific heat, **Classical Theory** (Dulong-Petit Law), **Einstein's Theory** of Specific Heat, **Debye's Theory**

UNIT IV – SUPERCONDUCTIVITY

Introduction, Experimental survey, Mechanism of Superconductors, Effects of Magnetic field, A.C. resitivity, Critical Currents, Flux exclusion-The **Meissner Effect**, Thermal Properties, The energy gap, Isotope effect, Mechanical effects Meissner effect, type I and type II superconductors, isotope effect, thermodynamics of the superconducting transitions, **London equation**, coherence length, **BCS theory**, Ginzburg-Landau theory, Flux quantization in a superconducting rings, Josephson superconductor tunneling, DC Josephson effect, **AC Josephoson effect**, applications of superconductors, high temperature superconductors.

Text books:

- Introduction to solid state physics : Charles Kittel (Tata McGraw Hill)
- Solid State Physics: C M Kachchhava (New Age International)
- Solid state physics: S O Pillai (New Age International)
- Principles of Condensed Matter Physics: Chaikin Lubensky (Cambridge Uni. Press) free ebook available
- Solid State Physics: Ashcroft & Mermin (Cengage Learning)
- Solid State Physics: Structure and Properties of Materials: M.A. Wahab



The (3-D) crystal structure of H_2O ice Ih (c) consists of bases of H_2O ice molecules (b) located on lattice points within the (2-D) hexagonal space lattice (a). The values for the H–O–H angle and O–H distance have come from *Physics of Ice*[1] with uncertainties of ±1.5° and ±0.005 Å, respectively. The white box in (c) is the unit cell defined by Bernal and Fowler

What is Solid State Physics ?

Condensed matter physics is a branch of physics that deals with the physical properties of condensed phases of matter. The most familiar condensed phases are solids and liquids, while more exotic condensed phases include the superconducting phase, the ferromagnetic and antiferromagnetic phases.

The diversity of systems and phenomena available for study makes condensed matter physics the most active field of contemporary physics: one third of all American physicists identify themselves as condensed matter physicists, and The Division of Condensed Matter Physics is the largest division of the American Physical Society.

The field overlaps with chemistry, materials science, and nanotechnology, and relates closely to atomic physics and biophysics. Theoretical condensed matter physics shares important concepts and techniques with theoretical particle and nuclear physics.

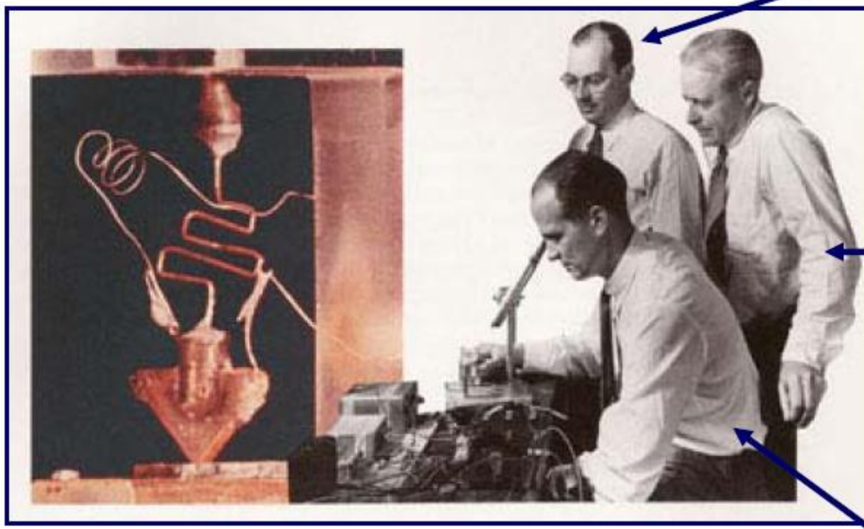
Why it is important ?

- Understanding the electrical and magnetic properties of solids and liquids is right at the heart of modern society and technology.

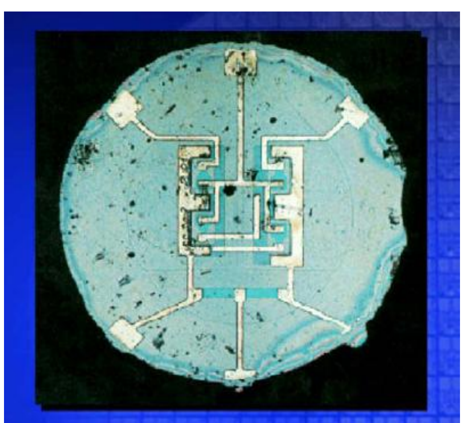
- For example: The entire computer and electronics industry relies on tuning of a special class of material, the semiconductor.

- New technology for the future will inevitably involve developing and understanding new classes of materials.

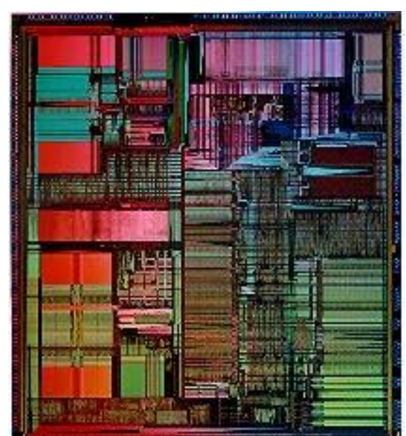
Discovery of Transistor



Bell Laboratories, 1947



First chip in 1961
1000 Transistors



Pentium 4 processor
in 2002
100 000 000 Transistors

Pauli about semiconductors

In 1931 Wolfgang Pauli famously wrote to the Physicist, Rudolf Peierls "*Ueber Halbleiter sollte man nicht arbeiten, das ist eine Schweinerei, wer weiss, ob es überhaupt Halbleiter gibt.*"

"One shouldn't work on semiconductors, that is a filthy mess; who knows if they really exist!"