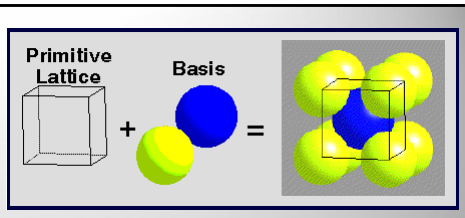
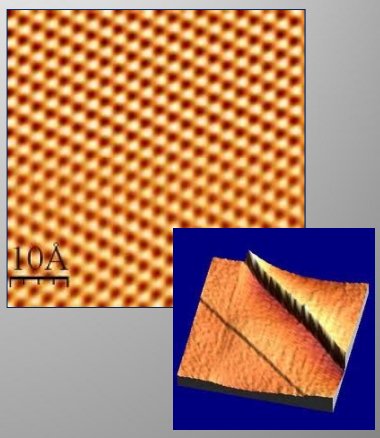


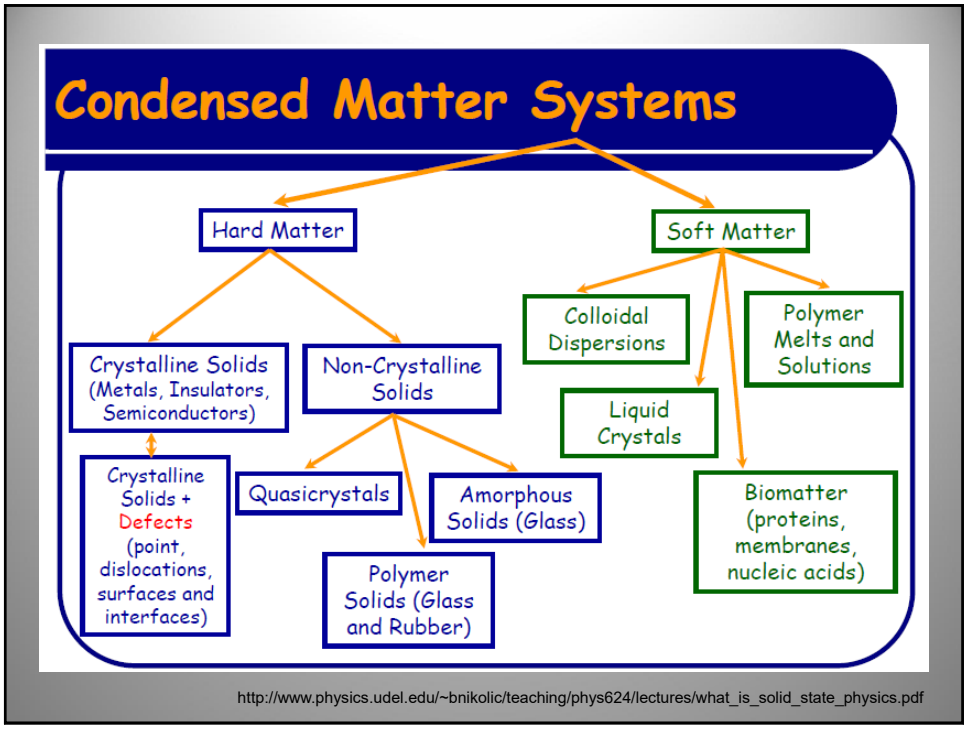
PHYS485
Materials Physics

Dr. Gregory W. Clark
Manchester University

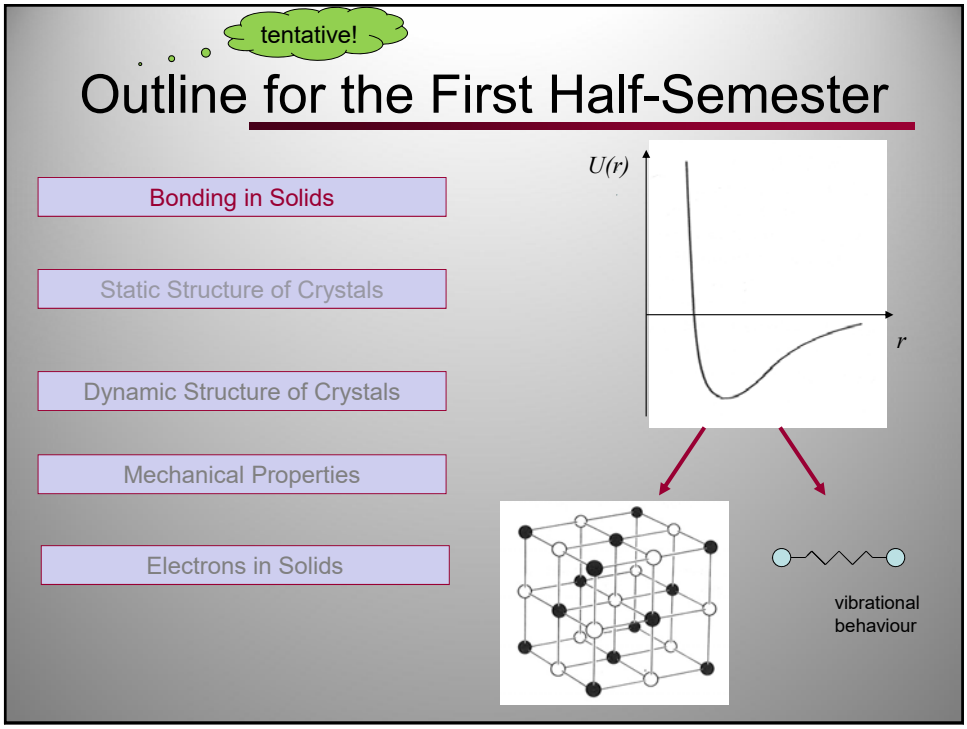


Materials Physics

- Condensed matter physics
  - Solid state – crystalline vs. amorphous; strong interatomic/molecular interactions
  - Liquid state - no long range order; weak interatomic/molecular interactions
  - Exotic phases: *e.g.*, superfluids, superconductors
- Macroscopic & micro/nanoscopic properties
  - Bulk vs. surface\interface
  - Electrical, mechanical, thermal, magnetic

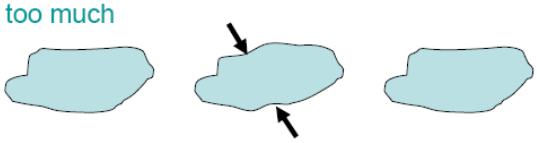


http://www.physics.udel.edu/~bnikolic/teaching/phys624/lectures/what_is_solid_state_physics.pdf

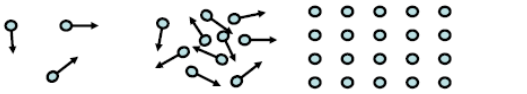


What is a solid?

- A material that keeps its shape
  - Can be deformed by stress
  - Returns to original shape if it is not strained too much



  - Solid structure is defined by the atoms



http://www.phys.psu.edu/~ralbert/phys412/chapter1.pdf

Phenomena and Principles in Materials Physics

- Mechanical
  - Structures
  - Strength
- Thermal
  - Heat capacity
  - Heat conduction
  - Phase transitions
- Electrical
  - Insulators
  - Metals
  - Semiconductors
  - Superconductors
- Magnetic
  - Ferromagnetism
- Optical
  - Reflection, refraction
  - Colors

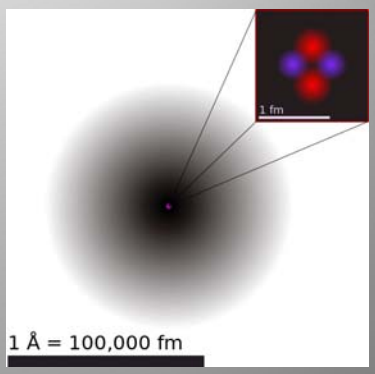
- Newton's Laws
- Maxwell's Equations
- Thermodynamics and Statistical Mechanics
- Quantum Mechanics
  - Schrodinger's Equation
  - Pauli exclusion principle
- Order and Symmetry

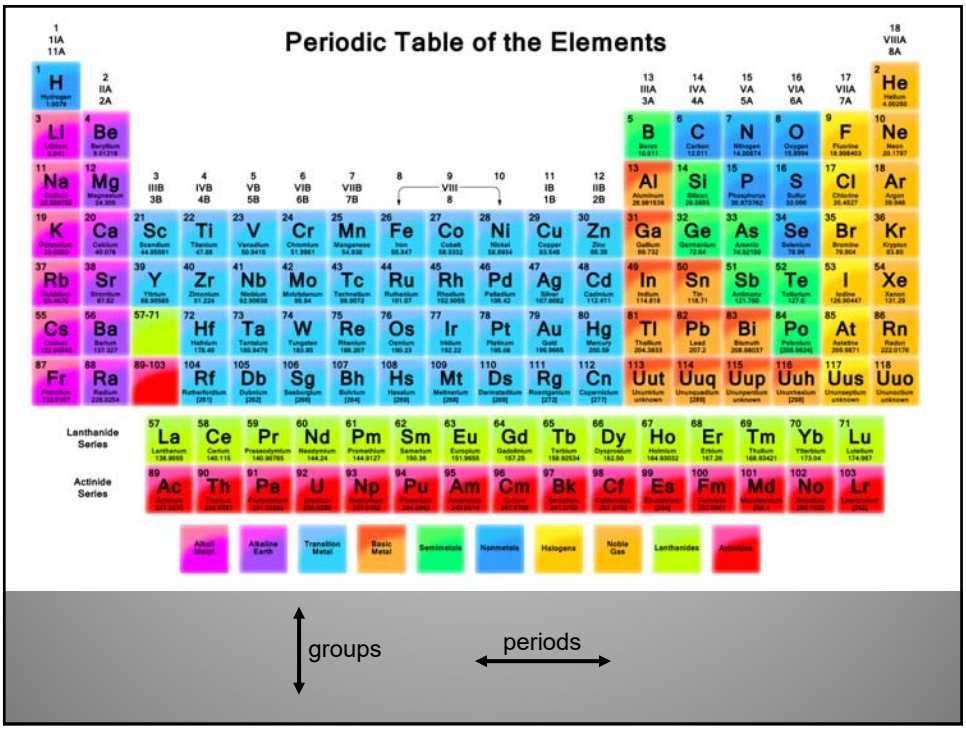
http://www.phys.psu.edu/~ralbert/phys412/chapter1.pdf

Atoms

- An **atom** is a stable, electrically neutral unit of matter consisting of neutrons, protons, and electrons held together by electromagnetic and strong nuclear interactions.
- The central part of the an atom is its nucleus, containing n's and p's.
- Z = atomic number, specifies the number of p's and indicates the corresponding element
- $A = N + Z$, atomic mass number, specifies the isotope and the total number of nucleons in the nucleus (N = # neutrons)
- A_r = atomic weight (relative A), weighted average of naturally occurring isotopes

Recall that $q_p = -q_e = 1.602 \times 10^{-19}$ C





Atomic Structure: Emission Spectra

- For example: Hydrogen!
- As excited electrons relax to lower energy levels, photons are emitted of energy $E = h\nu = hc/\lambda$.

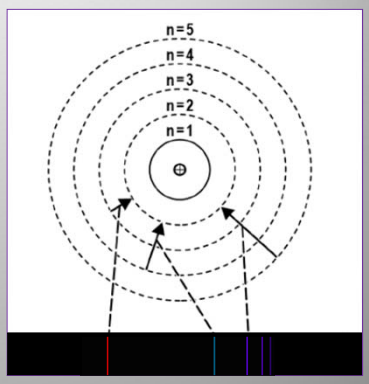
  ($h = 6.63 \times 10^{-34}$ Js)
- 1885, Balmer: $\lambda = 364.56nm\left(\frac{m^2}{m^2 - 2^2}\right)$

  (for visible lines, empirically)

  (m = integer > 2)
- 1888, Rydberg: $\lambda^{-1} = R_H\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$

  ($n_1 < n_2$ = integers)

  ($R_H = 1.097 \times 10^7\ m^{-1}$)
- 1911, Bohr: causal explanation for these observations!



Atomic Structure

- Atomic orbitals/electron shells: energy levels or energy states that electrons can occupy
- These energy levels are quantized.
- Each denoted by principle quantum number, n