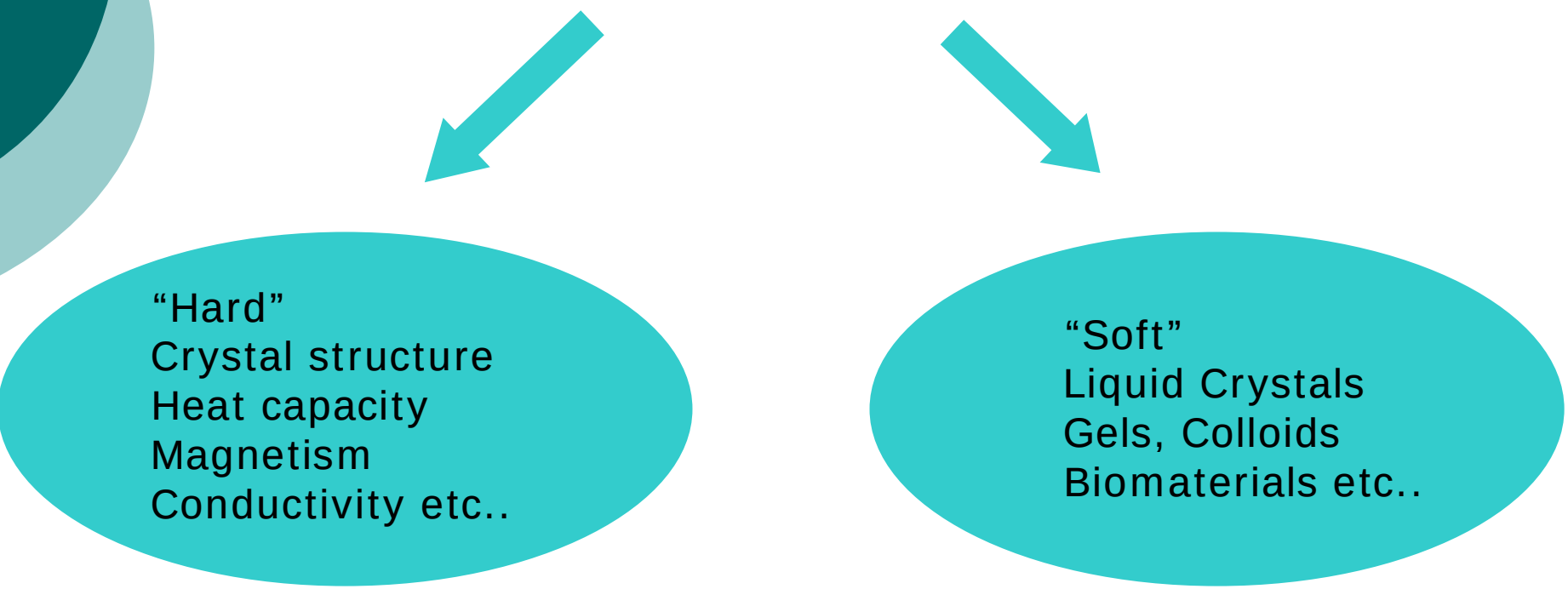
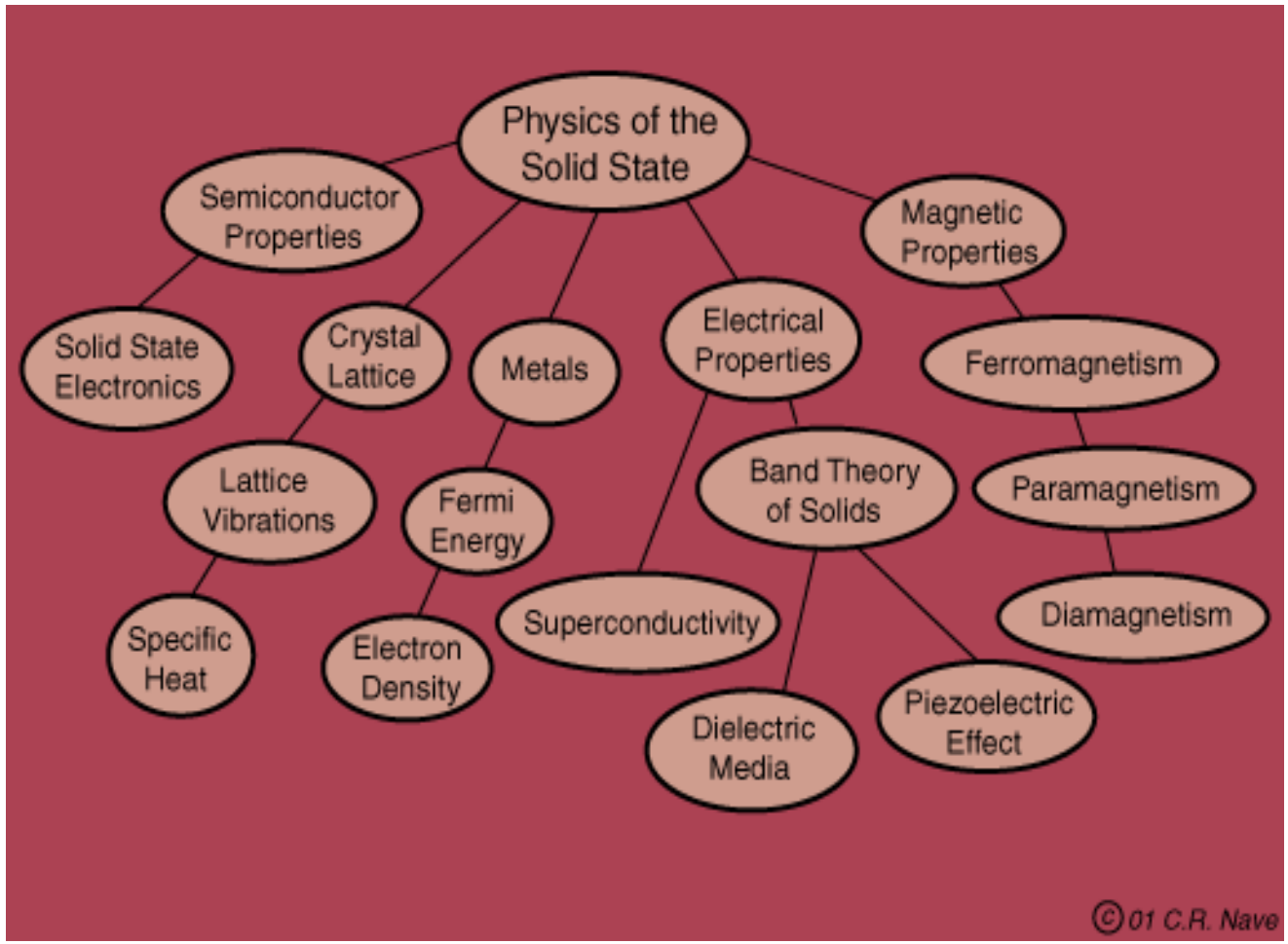
Hard and Soft Condensed Matter



Traditional Topics in Condensed Matter physics



Experimental techniques

- **Scattering**: x-rays, neutrons, electrons
- **Resonance methods**: nuclear magnetic resonance, muon spin resonance
- **Thermodynamic properties**: specific heat, thermal conductivity
- **Electronic properties**: resistivity, Hall effect, photoemission
- **Optical measurements** : microwave, infrared, etc.

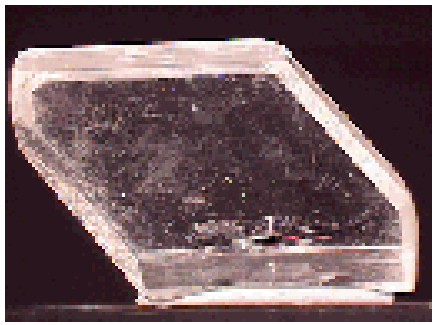
Heat capacity (low temperatures)

Neutron scattering
(at NIST, USA)

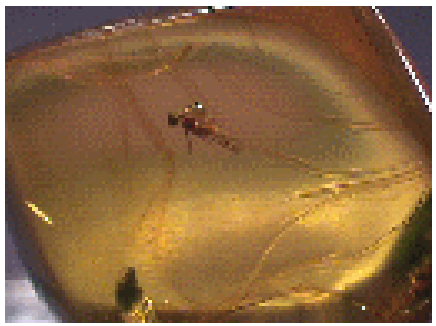
Crystals

Hexagonal beryl

Monoclinic gypsum



Triagonal quartz



Amorphous amber (no underlying crystal symmetry)

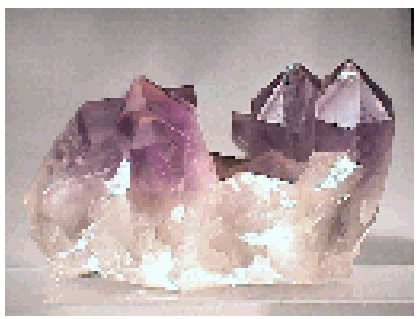
Liquid Crystals

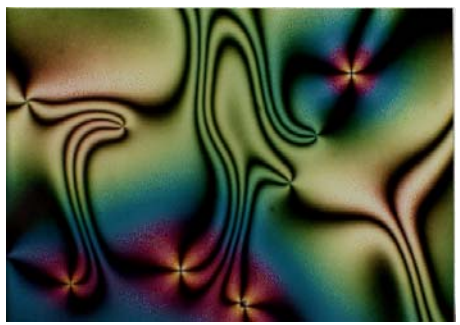
The Liquid Crystalline state of matter is somewhere in-between solid crystals and isotropic liquids.

Molecules have orientational order but do not sit on a lattice
- they can flow like a fluid
- they are **anisotropic** liquids

Crystal Liquid Crystal Liquid

Temp



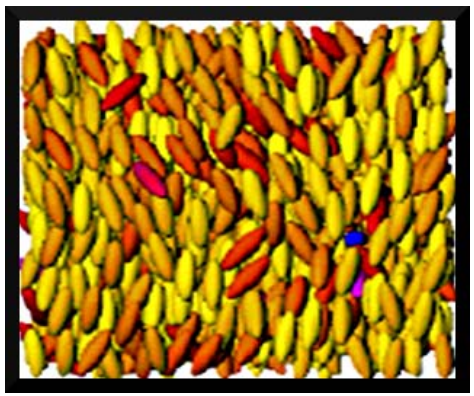


Liquid crystal phases

There are many different liquid crystalline phases, all defined by

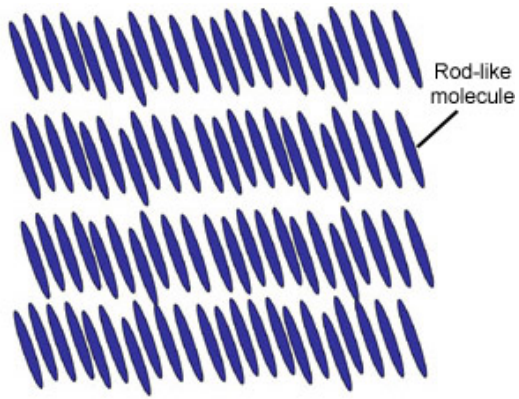
a) Fluid-like properties
b) Molecular anisotropy
c) They are birefringent

The Nematic Phase



A liquid in which all the molecules point in roughly the same direction

The smectic C phase



Liquid-like sheets of molecules arranged in layers