Physics of Liquid Crystals [pln79]

Points of interests:

- Thermal equilibrium state with liquid flow attributes and some attributes of (orientational and partial translational) long-range order.
- The liquid crystalline states are not to be confused with the semicrystalline state, a common nonequilibrium state in soft matter (e.g. polymers).
- Liquid crystal phases may reflect ordering of molecules or ordering of molecular aggregates (e.g. colloids). The particles undergoing ordering are named mesogens. some but not all mesogens are in solution.
- Typical sequence of phases of increasing order: (i) isotropic liquid, (ii) nematic liquid crystal, (iii) smectic liquid crystal, (iv) solid crystal.
- Liquid crystal phases may form out of isotropic liquids in two main modes:
 - thermotropically (driven by change in temperature),
 - lyotropically (driven by change in concentration).
- Liquid crystal ordering is stabilized by entropic effects (gaining wiggle room through alignment) and enthalpic effects (repulsive and attractive interactions between adjacent molecules).
- Each liquid crystal phase has its distinct order parameter that grows from zero continuously or discontinuously and breaks some spatial symmetry.
- Liquid crystalline ordering is susceptible to defects of three main types: (i) point defects are localized, (ii) wall defects exist along surfaces and interfaces, (iii) line defects are topological in nature.
- Disclinations are topological defects associated with orientational order and dislocations are topological defects associated with translational order.
- Polymers that are sufficiently stiff may show a propensity, in solution, to realize liquid crystal phases. One source of stiffness are helix conformations.
- The typical size of mesogens, ~ 20nm 50nm is well below the resolution limit of optical microscopes, ~ 200nm. However, defect structures (e.g. disclinations) can be resolved optically.
- X-ray diffraction is useful for probing molecular packing structures in liquid crystals. Soft materials tend to yeld low scattering intensity. Diffraction peaks are broadened by spatial deformations of LRO.