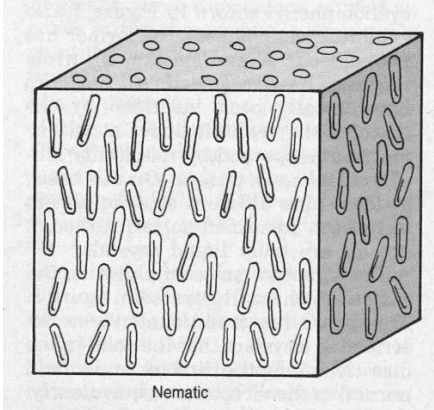
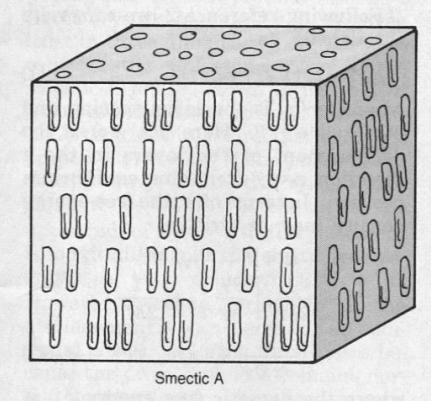
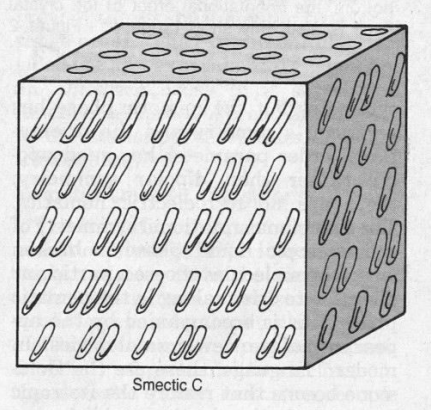
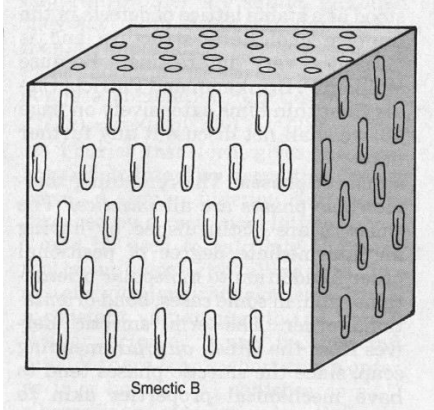
Common Liquid Crystal Phases [tsl51]

- **Nematic**: Molecular orientational ordering. Continuous rotational symmetry about *director*.
- **Smectic A**: Nematic ordering plus density wave along symmetry axis (director).
- **Smectic C**: Smectic A ordering with broken rotational symmetry. Density wave not perpendicular to director.
- **Smectic B**: Smectic A ordering plus density wave perpendicular to director.









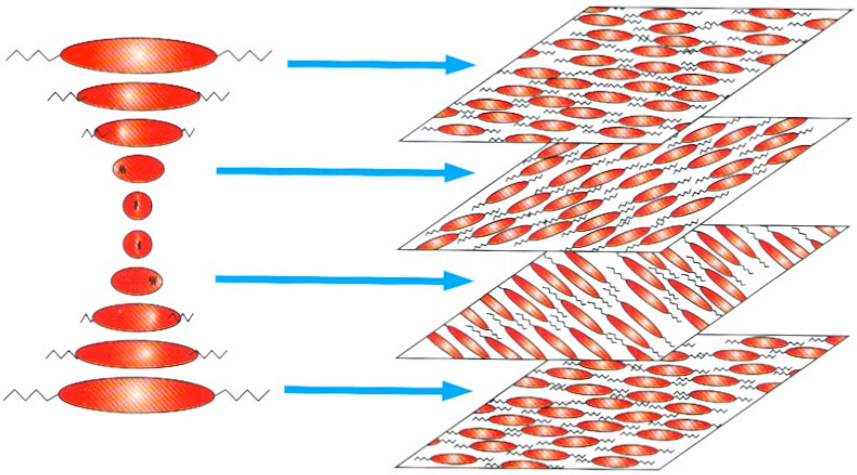
[images from Physics Today, May 1982]

Thermotropic transitions between smectic C and A are continuous. The tilt angle has a cusp singularity, $\theta(T) \sim (T_c - T)^\gamma$.

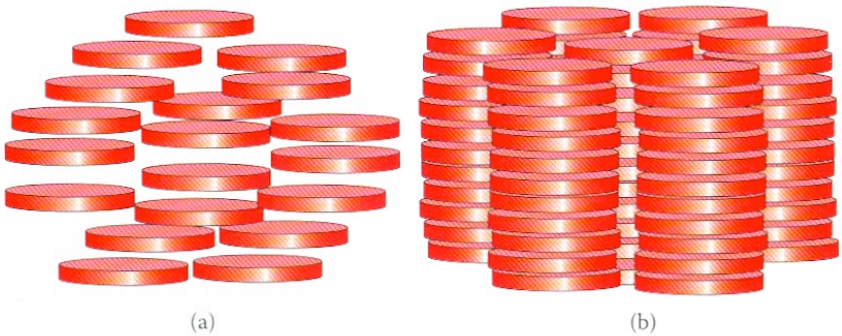
The layering in smectic phases is weak, characterized by a low-amplitude density modulation. True 1D LRO is suppressed by logarithmically diverging thermal fluctuations (Landau-Peierls instability).

- **Cholesteric**: Chiral nematic order with director rotating systematically about axis of fixed direction.

  The cholesteric phase (also named chiral nematic) has a T-dependent pitch P. The director $\mathbf{n}$ rotates 360° over this repeat distance. With T increasing, the pitch diverges at the cholesteric-nematic transition point. The T-dependent pitch is used for the design of thermochromatic devices (thermometers, sensors).



- **Discotic**: Liquid crystal order of disk-shaped molecules.
  (a) nematic (orientational),
  (b) hexagonal columnar (orientational and positional).



[images from Hirst 2013]