Domain Decomposition for Simulating Nematic Liquid Crystals

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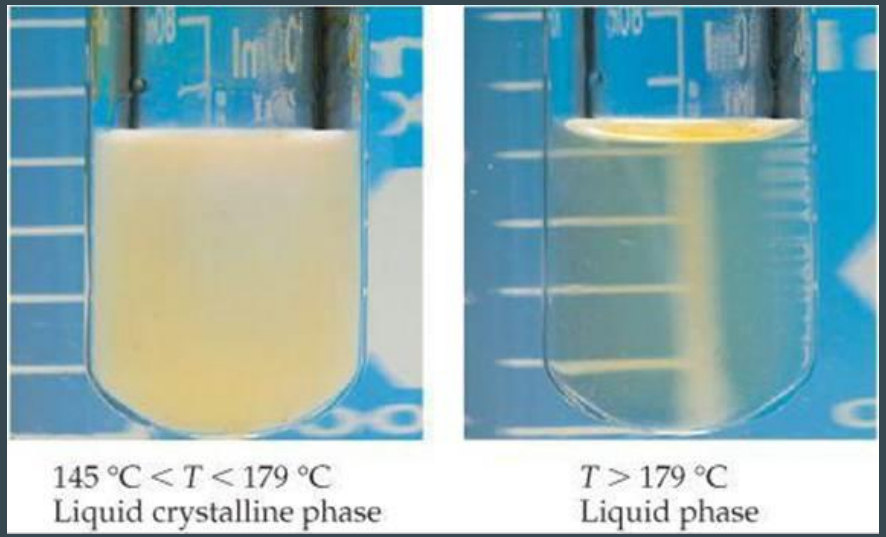
Sylver Carter
Mentor: Shawn Walker

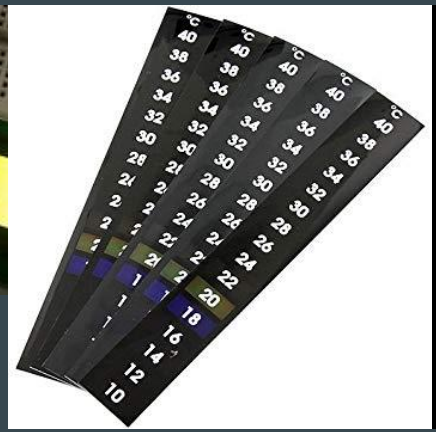
History

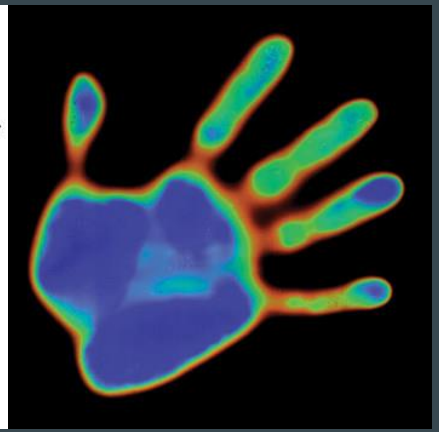
- Discovered in 1888 by Friedrich Reinitzer and Otto Lehmann.
- Performed experiments on cholesteryl benzoate
- At 145.5°C, the substance melted into a cloudy, translucent liquid.
- At 178.5°C, the clouding of the substance vanished.



Applications

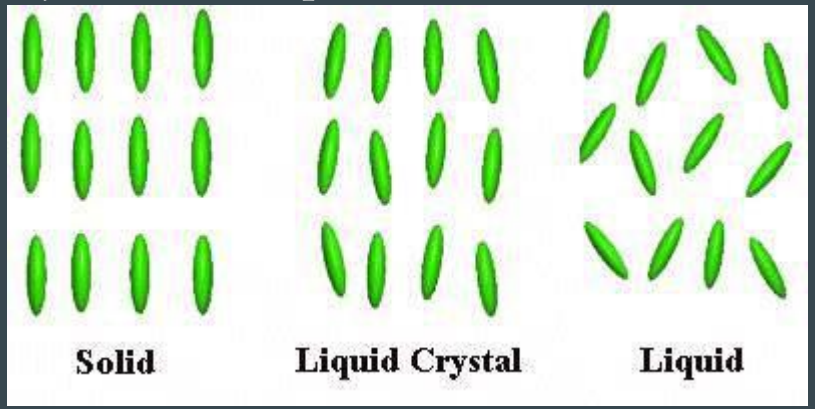
- LCD Screens
- Liquid Crystal Thermometers
- Liquid crystal sheets: hot spots, map heat flow, measure stress distribution patterns, etc.
- Polymer dispersed liquid crystal (PDLC) sheets and rolls as privacy shades





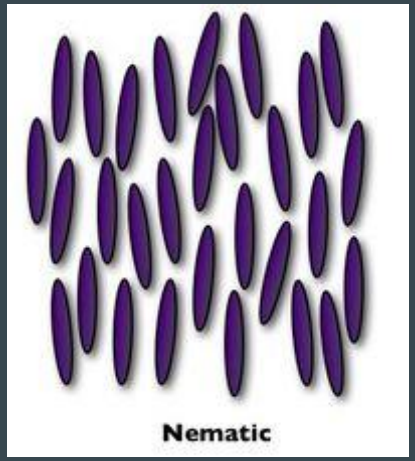
Physical Properties of Liquid Crystals

- Intermediate states of matter
- Flow like nearly incompressible viscous fluids, and yet retain some characteristics of crystals
- Liquid crystals are induced into a mesogenic phase by changing its temperature or its concentration in a solvent
- Nematic liquid crystals have a partial (orientational) order but are free to flow



Nematic Liquid Crystals

- Nematic liquid crystals closely resemble rods.
- Head-tail and mirror symmetry
- Nematic Liquid Crystals orient themselves such that the orientation minimizes the total energy in the system.

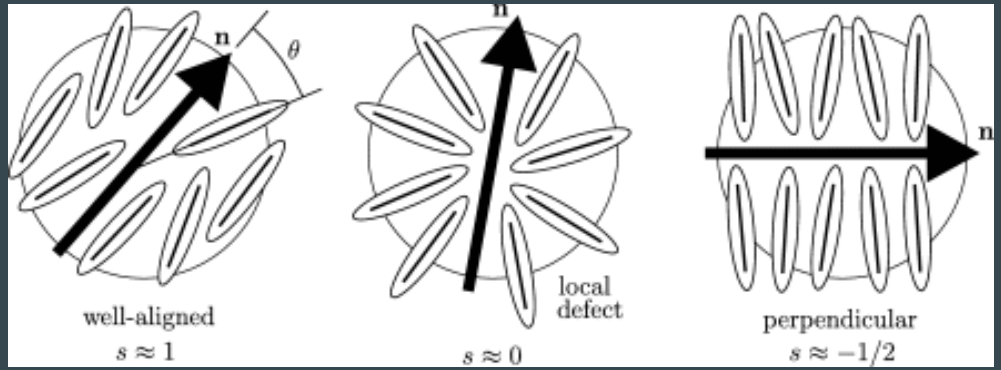


Ericksen Model

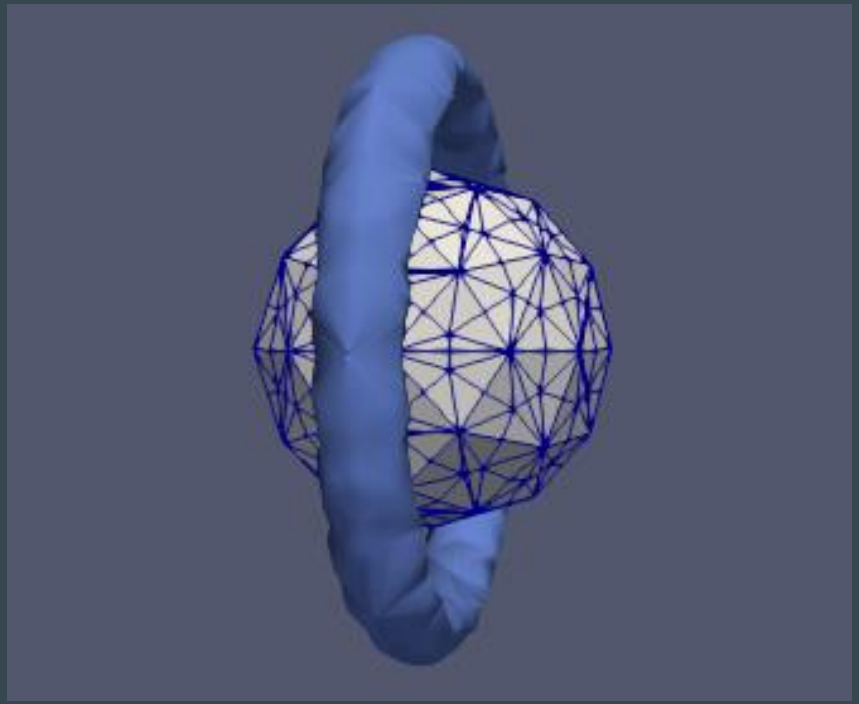
- Ericksen's model seeks a minimizer of a free energy functional, whose simplest form is the following (dimensional) energy:

$$E_{erk}[s,\mathbf{n}] = E_s[s,\mathbf{n}] + \int_\Omega \psi(s)dx, \quad E_s[s,\mathbf{n}] := \frac{1}{2}\int_\Omega (b_0|\nabla s|^2 + k_0 s^2|\nabla \mathbf{n}|^2)dx,$$

- Defects are regions where **n** is discontinuous.



Example: Saturn Ring



Questions?