# *Introduction to disorder*

## Soft Matter In and Out of Equilibrium
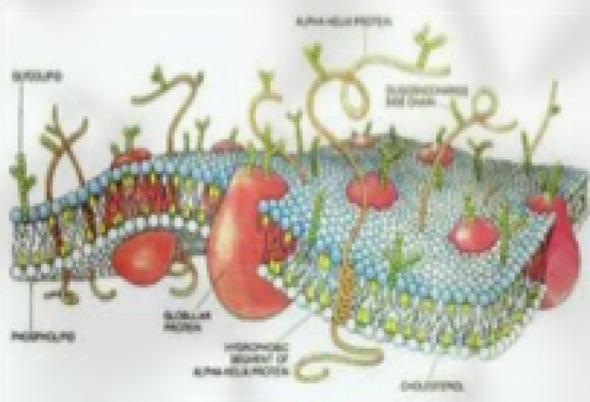


## Leo Radzihovsky

*Boulder Summer School, July 2015*
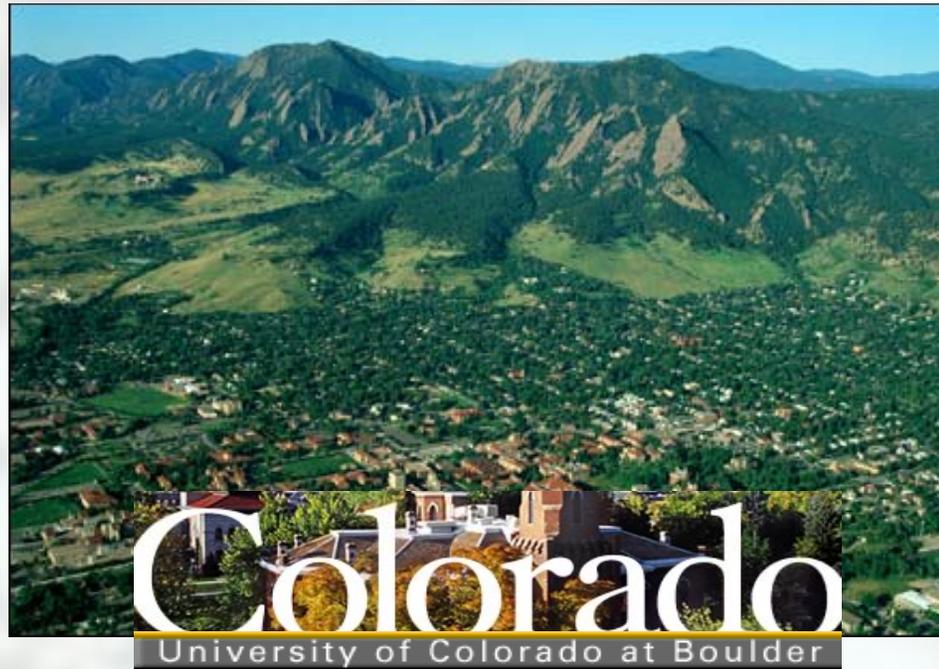
# *Outline*

- Introduction and motivation

- Disorder near a continuous phase transition

- Disorder near ordered states
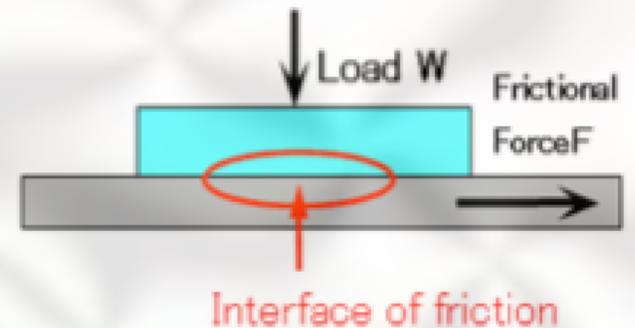
- Examples of physical systems
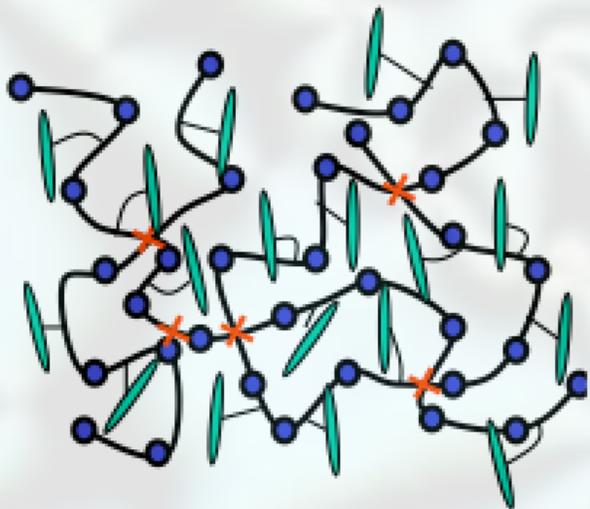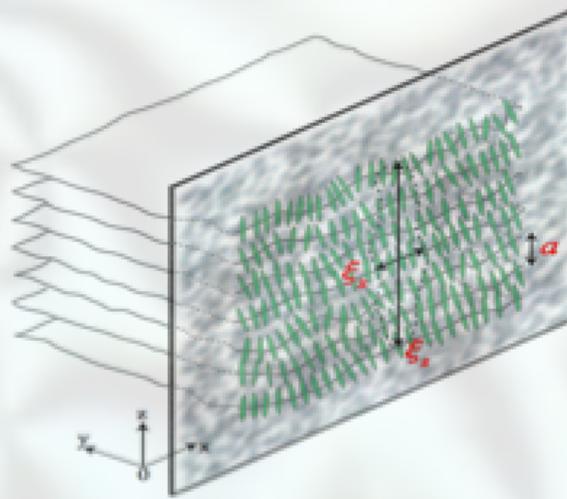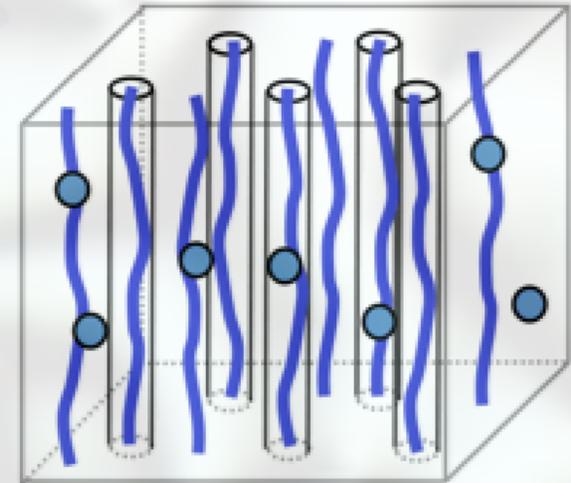
# *Physical examples*



(a) biological membrane

(b) wrinkled sheet

(c) friction via crystal pinning

Load W
Frictional ForceF
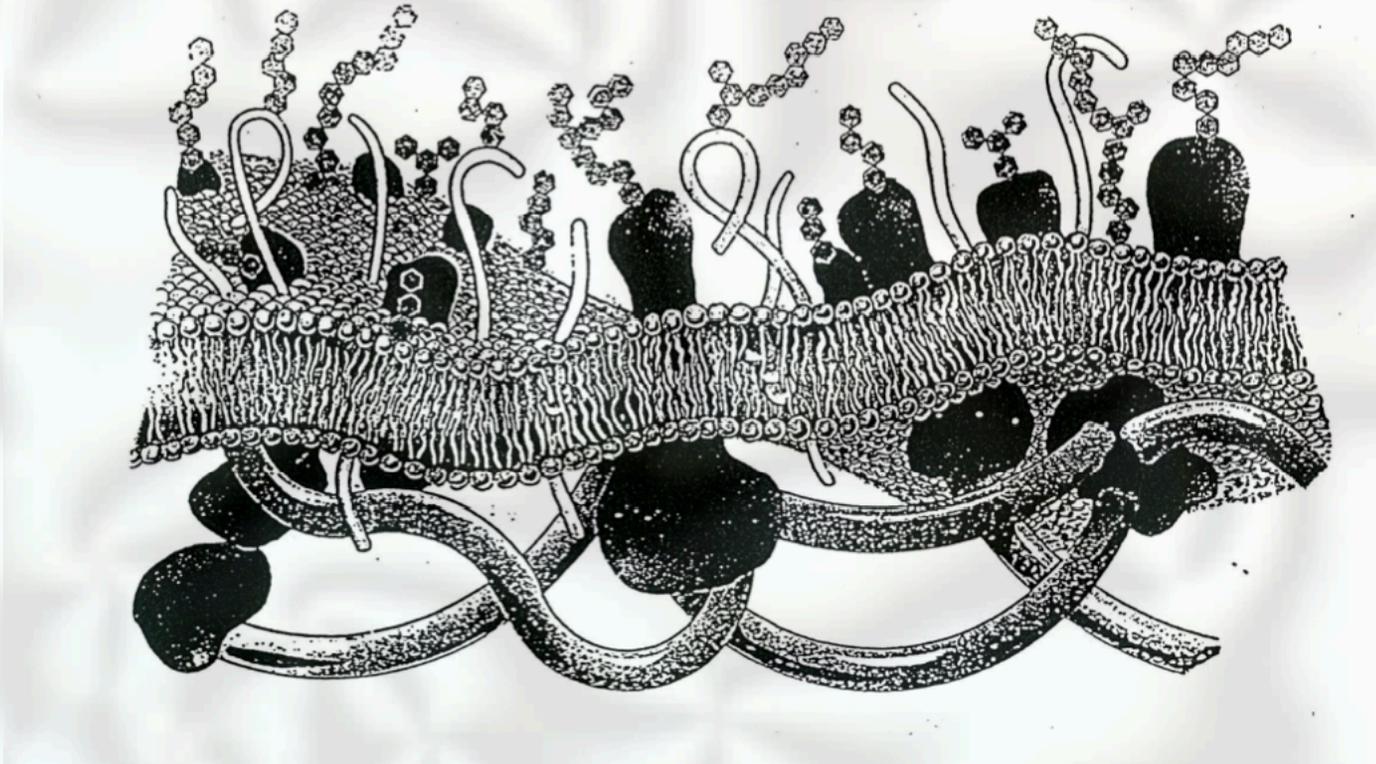Interface of friction

(d) nematic elastomer

(e) smectic on dirty substrate

(f) vortex lattice with pinning

# *Physical examples*



charge density wave

liquid crystals in aerogel
*(Bellini, RT, Toner, Clark Science 2001)*
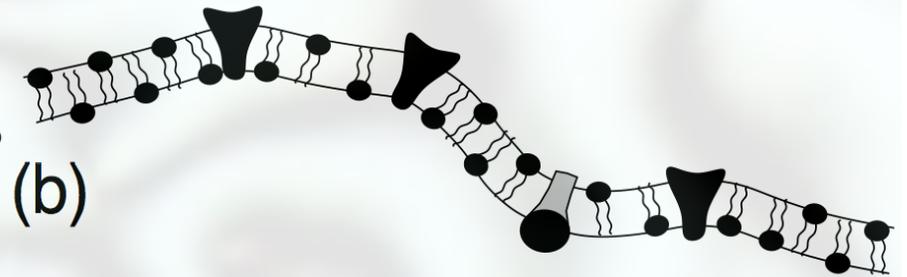
# Disordered bilayer membrane
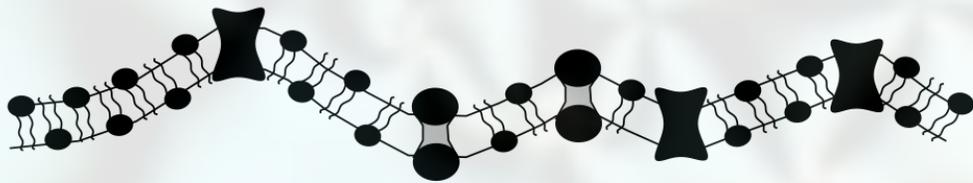


(a) random-bond curvature disorder

(b) random-field stress disorder

# *Disorder-free critical point*

FM     WF     PM
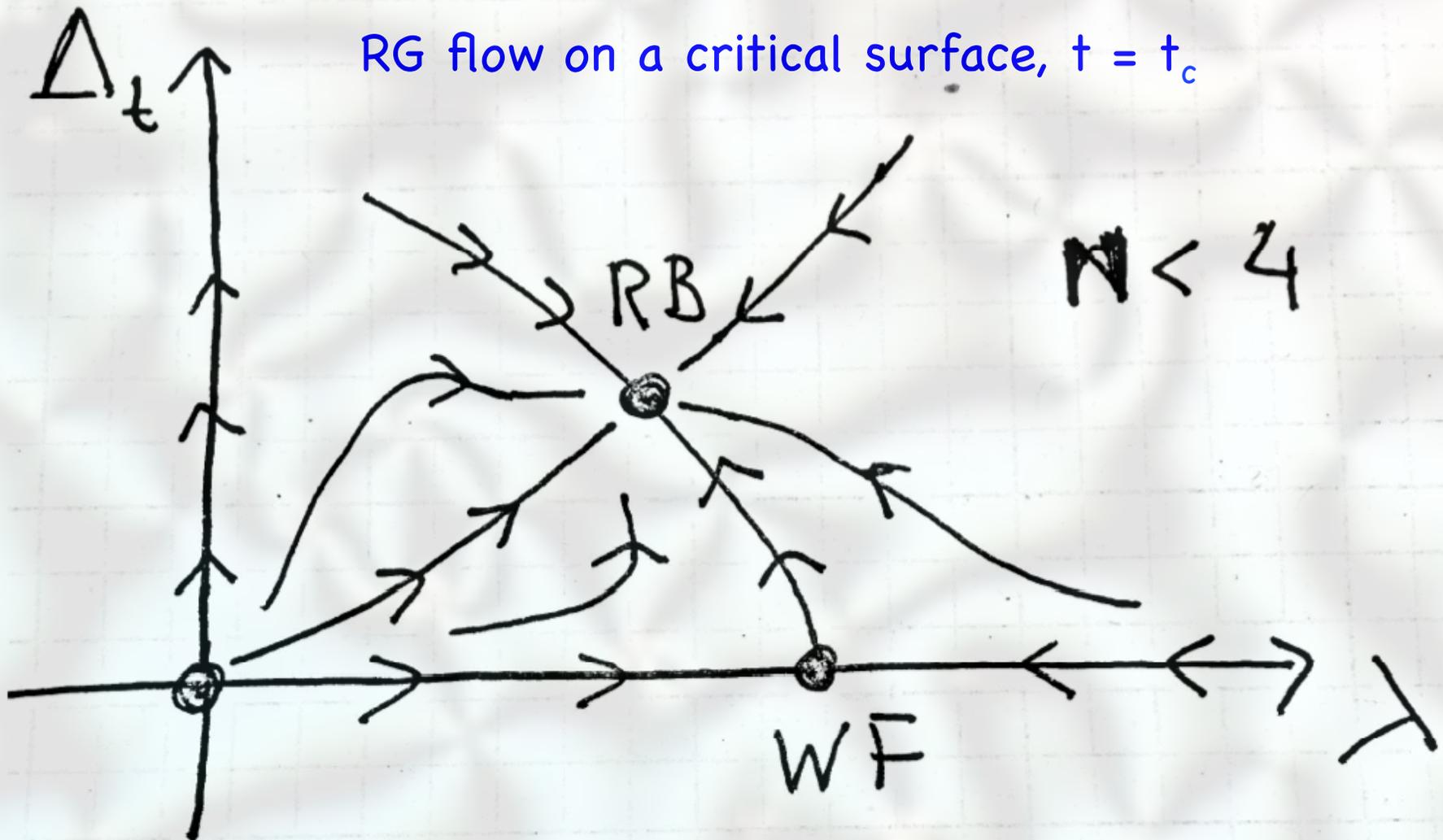
G

t
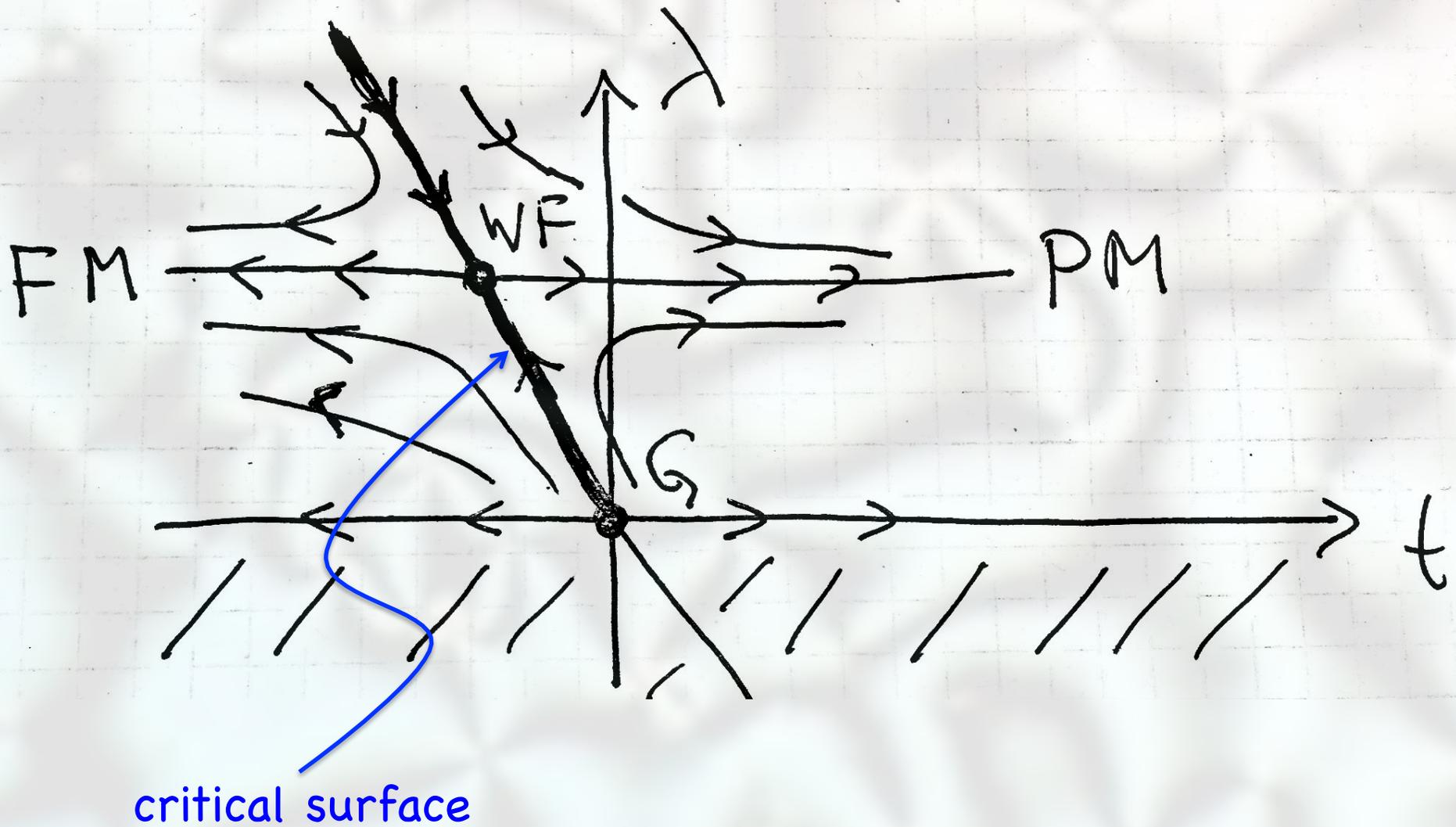
critical surface

# *Random-bond critical point*



RG flow on a critical surface, $t = t_c$

*Random-field critical point*