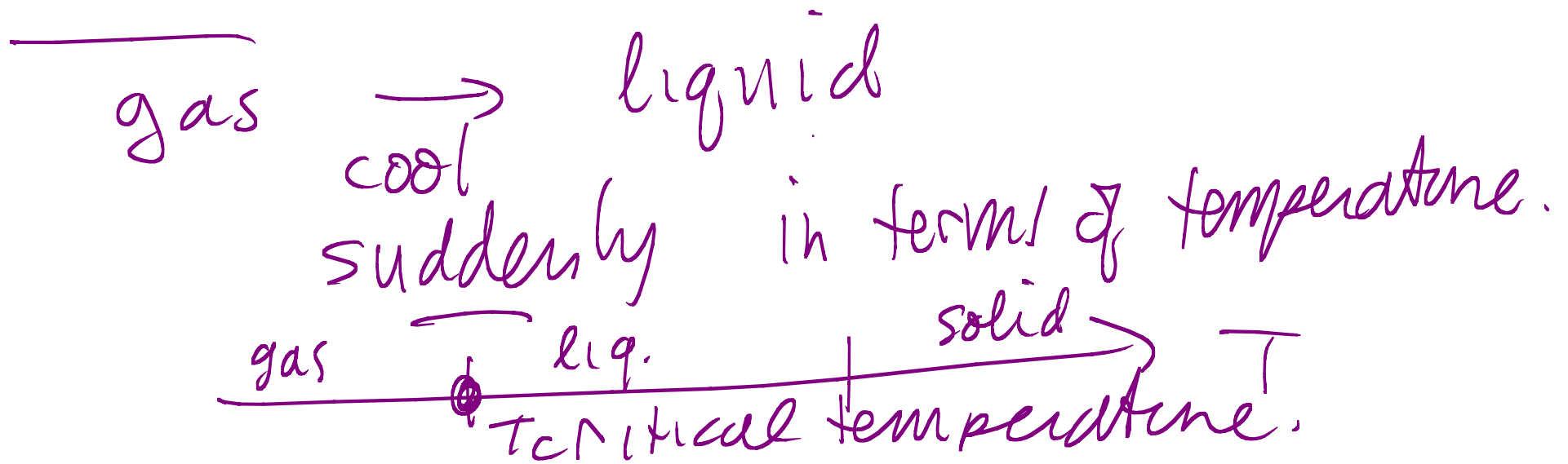


Emergence lec 20 2011

phases + phase transitions

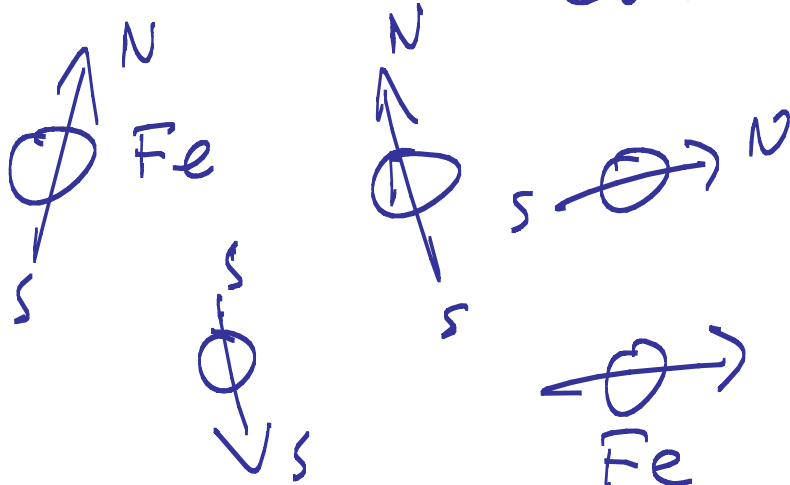
⇒ bifurcations  
⇒ pattern formation.

"collective" behavior.



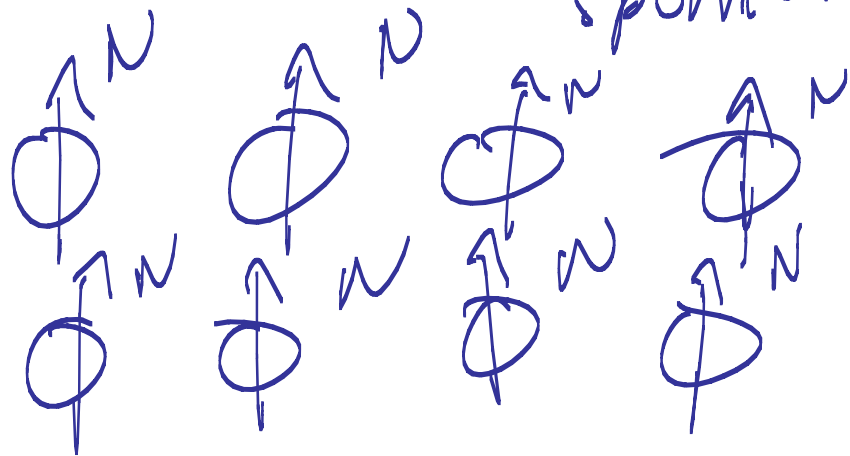
equilibrium phases -  
→ a big objective of theory,  
stat mech.

Magnetic phase transitions -  
Curie point



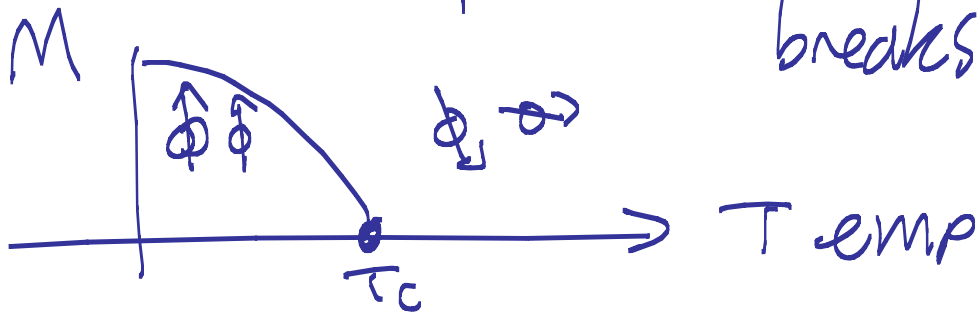
hightemp  
→ no  
magnetism  
- "spins".

cool slowly, suddenly magnetizes spontaneously.



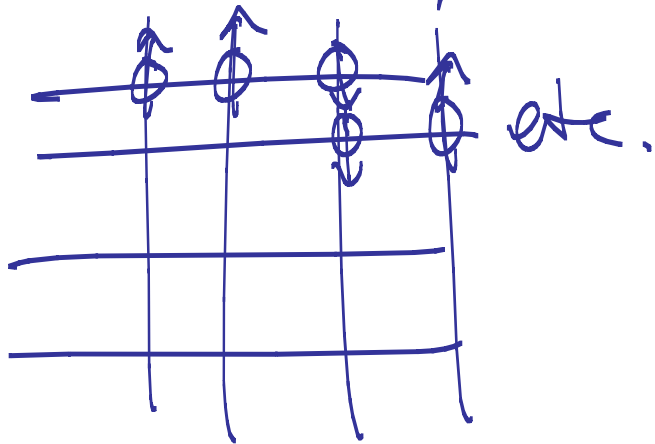
Net magnetism ferromagnet.

— picks a direction to be North, breaks symmetry.



# Model Ising Model.

— simplify to  $\uparrow$  up or  $\downarrow$  down.



$\rightarrow \sum \text{spins} = M.$   
"temperature"

$\rightarrow$  random jostling of spins.

$\uparrow \uparrow$   
 $\downarrow \downarrow$   
 $T = 0$

= likes this orientation

$\rightarrow$  all spins will cooperate  $\Rightarrow$  align.

$T \neq 0 \rightarrow$  jostled.

— sharp phase transition.

2D Ising Model — can be  
"solved" exactly in Stat Mech

3D Ising Model (lattice is 3D)  
— not solved except numerically.

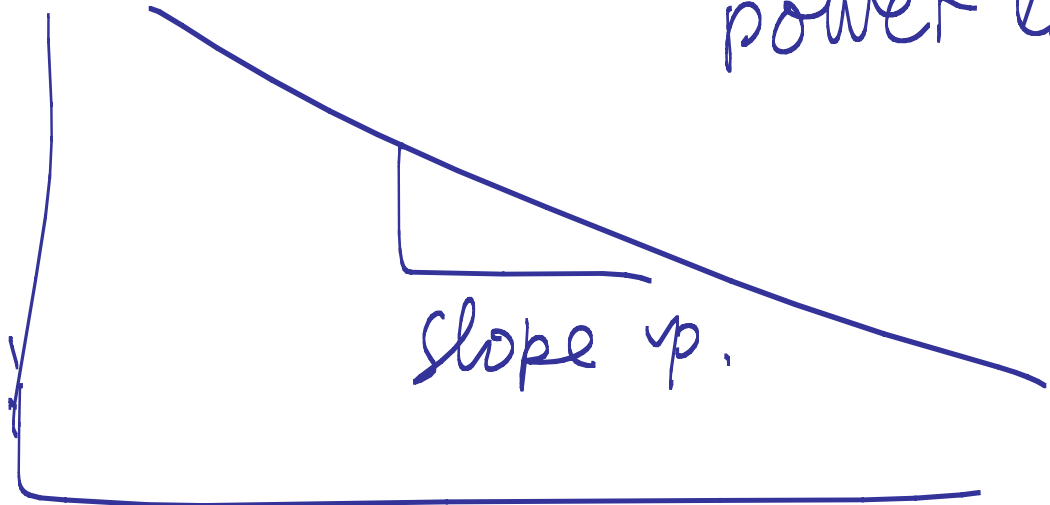
@  $T = T_c$  — islands  
of spins

have NO scale

power law.

log

Number  
of islands



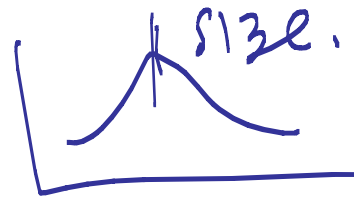
slope  $p$ .

log. size of islands

— average scale does not exist  
 $N \sim (\text{size})^p$  distribution  
ln

had no average!

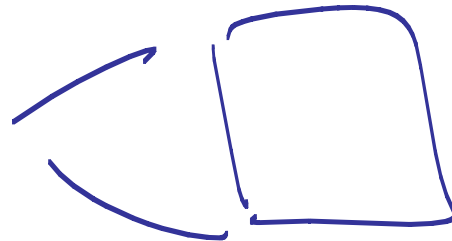
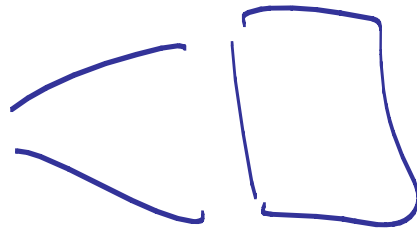
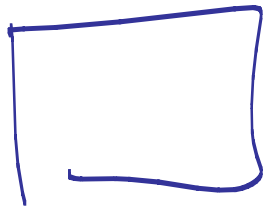
— no characteristic size,



— no bumps.

only big islands and small ones  
and all sizes in between

— Fractal distribution of islands.



etc

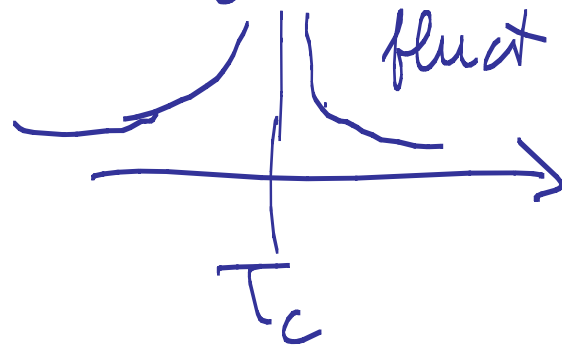
looks same

on average.  
random Fractal.

Near the critical point  
→ fluctuations dominate

"Scale free"

fluct. - blow up.



one big  
island.

- ordered  
state

hot end  
- small islands  
lot of fluct.

susceptibility diverges.