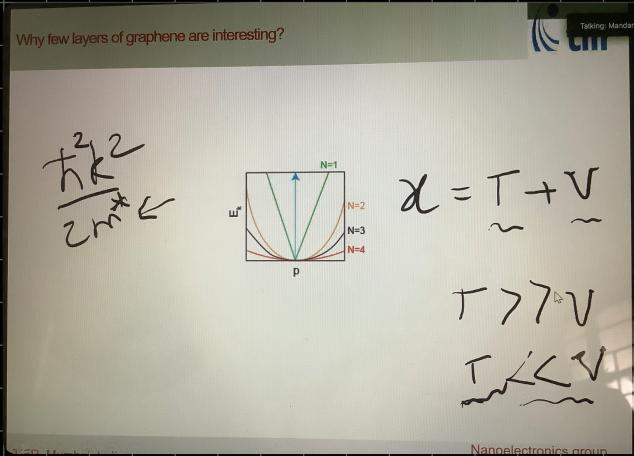


Chern insulator $\rightarrow \varphi$ flat without magnetic field
 ↳ con transport s, g without scattering

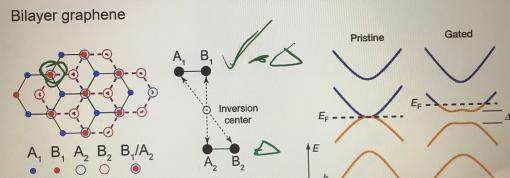
$\chi_{\text{monolayer}} = T + V$ $T \ggg V \rightarrow$ free "electronic"

$\chi_{>1 \text{ layer}} = T \lll V$

electric field
 ↳ Gaps the spectrum by, diff voltages

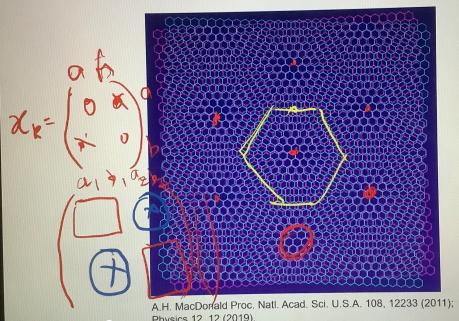


Bilayer graphene opens up a bandgap – electric field as a way to engineer band structure



Zhang et al. Nature 459, 820 (2009).

Twisted graphene – introducing a new periodicity in the system

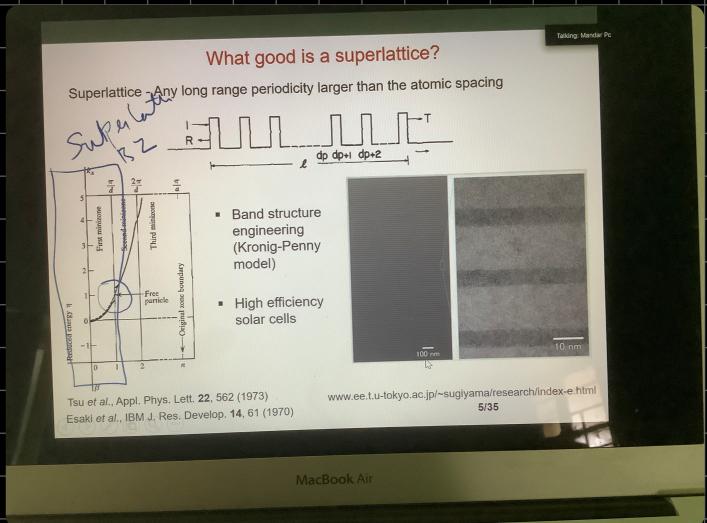


tiffr

↙ "super lattice structure"
 ↳ "periodicity is enlarged by the rotation angles"

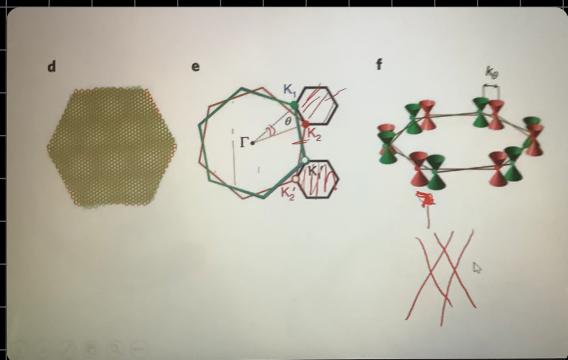
$\chi_{\text{bilayer}} = f(\text{angle} + \text{space})$

Superlattice :- Kronig Penny model



→ "Quantum cascade laser"
uses such idea

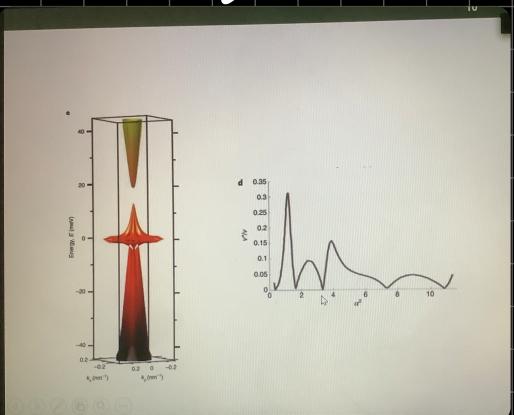
way to think about the rotation



② large angles → layers behave
like they're independent
↳ low overlap b/w cones

under right choice of angles, we get
a "flat bond"

bondwidth $\sim 0(eV)$ ←
in others
here bondwidth $\sim \underline{10meV}$



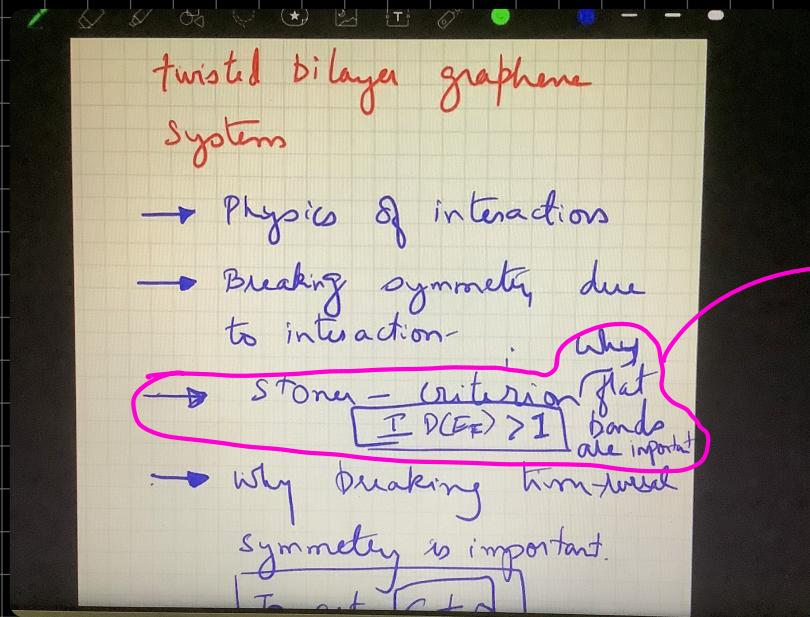
→ "new crystal structure"
can emerge from relaxation

$$v_{eff} \sim \frac{\partial E}{\partial k} \quad m_{eff} \sim \frac{1}{\frac{\partial^2 E}{\partial k^2}}$$

↳ for a linear disp.,
 $m \sim \frac{1}{2} \propto v_{eff}^2$

Superconductivity & insulating behaviour exist simultaneously.

↳ some connection to High T_c . → topological aspects of SC



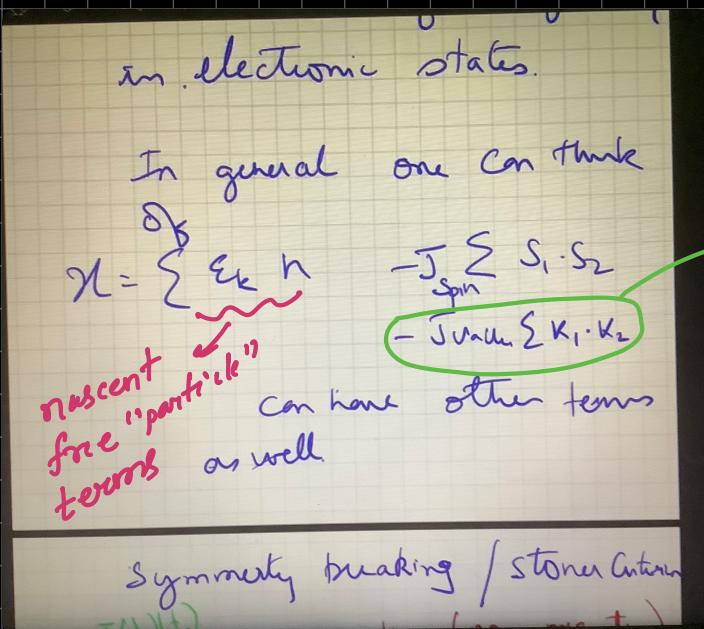
Very very important

→ system spontaneously breaks TRS

→ $C \neq 0 \rightarrow$ PASHF /
PHE
Type physics

Two flavours in "graphene"

→ spin - 2 } lead to 4 fold deg. in electronic states.
→ valley - 2 }

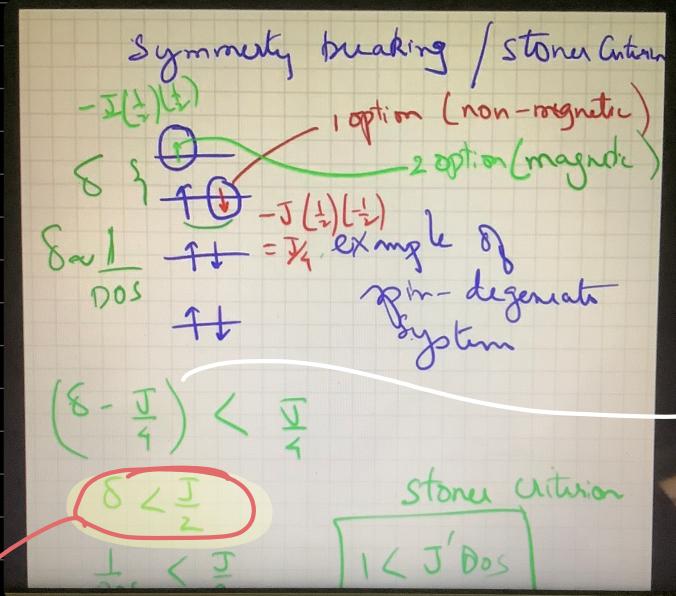


why ???

valleys → have some

angular momentum
 $\Leftrightarrow \overrightarrow{L_1} \cdot \overrightarrow{L_2}$

Some discussion here
that I missed]



Stoner criterion

$\hookrightarrow P \propto B$

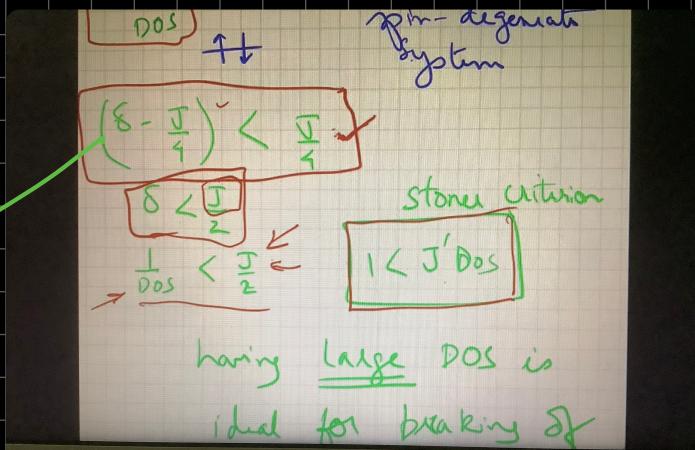
here I get ferromagnetism.

\hookrightarrow spin polarized filling of orbitals.

as soon happens,
as this is
then we get spin DOS (PDS)
but when we get
a flat band, $DOS \rightarrow \infty$,
then ferromagnetism
occurs

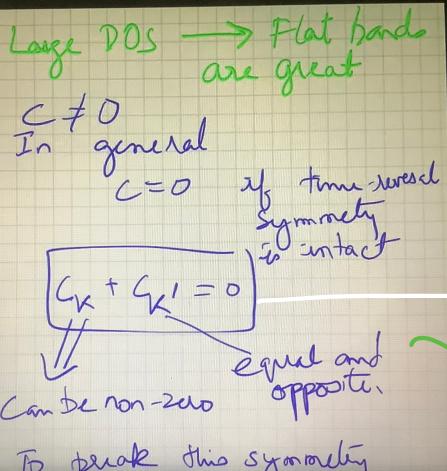
$\delta = \text{spacing}$
more

$\hookrightarrow DOS \sim 0$
for graphene.



Revolut'n \rightarrow flatband system = another magnetization
 \equiv orbital magnetization

\hookrightarrow \equiv "valley magnet"
 $\hookrightarrow \sim 10$ Bohr magneton.



valley differentiated Chern numbers
 \hookrightarrow we automatically populate one valley more than the other

→ & now we have non-zero Chern # materials.

in a nutshell → $S < \frac{J}{2}$ can give rise to ferromagnetism.

Chern insulating behaviour of tBG has been observed.

Remind → modality of final exam