1. J System with fixed electron density n Recall: Number of states per LL:  $N = \frac{AB}{\phi_{e}}$ -> Lowest VEN LLS exactly filled for: By = 0.4 - Only for the discrete By the Hall response Oxy is topological and this quantized: -) This does not explain the observed plateaus P  $\int_{XY} \int_{XX} \int_{X}$  $\frac{124}{2}$ Solution: Disorder  $\frac{\underline{R}_{4}}{\underline{2}}$  $\sigma_{xx} = \frac{\rho_{xx}}{\rho_{xx}^2 + \rho_{xy}^2}$ Ru + 2  $O_{xy} = \frac{-P_{xy}}{P_{xx}^2 + P_{xy}^2}$ 

2. First effect of divorder: LL are broadened: Li= ? MILLIUM > · · · //////// Tecconic S(E) -> This does still not explain the observed planta aus of 3. Seroud effect of disorder: \* (Most) single-election states are localized and prinned at local potential peaks / dips -> Do not contribute to conductivity \* At least one mode along the edge cannot be localized - Contributes to conductivity

-) Mosility gap delocationed youndary mode localized de lo culided Locahzation localized mosility gap localized  $P_{XY}, P_{XX}$ -) S(E) (9 =Goundary. רג גר \_ Explains extended (1 = 2)-> Tilling / Lepiehion of Lioudened Hall plateaus oround LLI for B> B, loss not By with quantiped allect conductivity as long as LuisGF Rulo ET is in the mobility yap.

lu a unishell:					
* Topology fixes the height of the plateaus but					
* disorder gives them their finite ceid+4					
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· · · · · · · · · · · · · · · · · · ·	· ·	· ·	· ·	•	•••
<u>A.A.G. /Votes on edge states</u>					
1. Classical picture:					
1 [ ] ouder					
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$					
Edge -> Chinal conents along	ed g	۶ J			
2 hrd 10 phrase 1 phr					

2. Quantum picture: 6) Namillouian in Landa zauge: a) & Steip geometry: Edges in X-direction Potential  $/ = \frac{1}{2\omega} P_{x}^{2} + \frac{\omega \omega_{B}^{2}}{2} (x + 4l_{0}^{2})^{2} + V(x)$ V(x): Pokuhial Alat varies ou length Scales 33 1B u=2u=nu=0c) LL convertinuctions  $U_{N, K}$  Still eigenfunctions  $\xi LLL: U_{0, K} [X, Y] = N e^{-\frac{(X+4/h^2)^2}{2l_B^2}}$ y-momentum le -> localized at XK=-K/B d) Group velocity;  $\rightarrow$  Tigenenergy  $E_u = \frac{1}{2} t_U U_B + V(X_y)$  $-\frac{13^2}{43}\frac{\partial V(X)}{\partial X} = -\frac{1}{63}\frac{\partial V(K)}{\partial X}$  $V_{g}^{\gamma}(X) = \frac{1}{4} \frac{\Im E_{4}}{\Im u} = \frac{1}{4} \frac{\Im E_{4}}{\Im X_{u}} \frac{\Im X_{4}}{\Im U}$ 

-> (urrent denuity Iy (x1 = -e vg (x) p(x)  $\uparrow v_{\mathfrak{s}}^{\gamma}(\mathfrak{k}) \cdot \mathcal{P}(\mathfrak{k}) \ll \overline{\mathfrak{s}} \mathfrak{k}$  $\mathcal{O}$ Edge currents  $\overline{J}y = Jy(x)dx$  $\frac{\partial 4}{2\pi} \frac{1}{4} \frac{\partial \mathcal{E}_{4}}{\partial 4} \rho(4)$ MR -<u>C</u> 2774 dĒ  $-\frac{\rho}{2\tau_1 t_1} \left( \mathcal{M}_{\mathcal{T}_1} - \mathcal{M}_{\mathcal{L}_2} \right)$ 

e) Hall conductivity:  $V_{H}$ Apply electoric field in X-direction: M2-M2 = eVX -> Hall current:  $\overline{I}_{\gamma} = -\frac{e}{2\pi f} \left( \mathcal{M}_{12} - \mathcal{M}_{c} \right) = -\frac{e^{2}}{2\pi f} \mathcal{V}_{x}$ Hall conductivity:  $\mu_{l}$ O<sub>XY</sub> = 3. Disorder -> The Hall conductivity is roluit 10 childred er D

4. Chiral odge modes are special: A Non-interacting fermions on a lattice in 1D: 8E4/24 20 -) Boillouin zove = Circle 5-1 YR" ushi waver" 1000 - every physics GF=0 . G. G -) Equal 4umber of left (4)  $\frac{\partial E_{\zeta}}{\partial c} < o$ and right movens (4n) in low-every, theory vover " of lattice models 2D (014 -) (him edge modes can only appear on the boundary of a material D

The majnetic field spatially separates left- and right movers: NNT: X Boundary 2D Bula "Zoo w out" 1D Systen 

1.1.7. Notes ou classification. 1 add interactions 2 USE as Slueprint to combined nece models · · · · /· · · Top. Kulular,  $(\mp Q H E)$ & Superconductor, eramples for crowpled for Topological order of interacting formions SPT places Of uou-interacting femison, () leep the QHE setting but consider fourtionally filled LLS: 2 Leave WHE selfing but stay wills noci- interacting formious - Fractional quantum (dall offect (FOHE) -) Construct lattice modest with logs. Chenn bands - Different topologically ordered states \* \_ Lolo magnetic field \* .... W/o breaking time-reverse sym. Vop live la fors & \* ... lo/o particlo-humber concervation Super conductors