

Title: Manybody Physics meets Quantum Information

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URL: <http://pirsa.org/07060072>

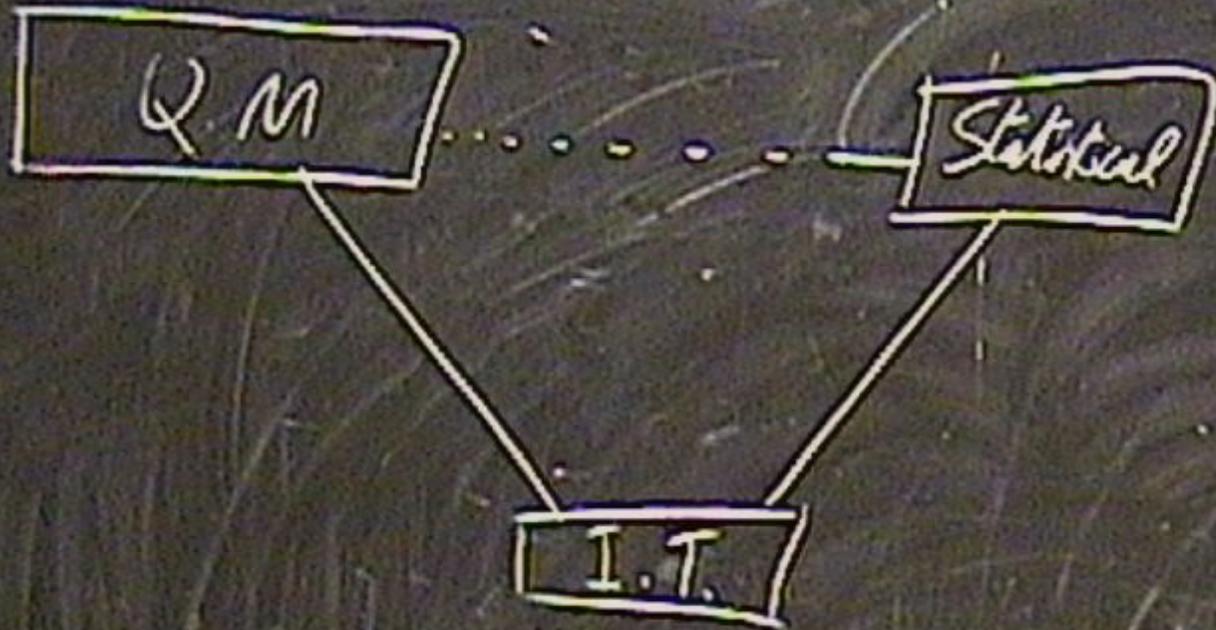
Abstract:

① topologically protected states
(Zohar Nussinov)

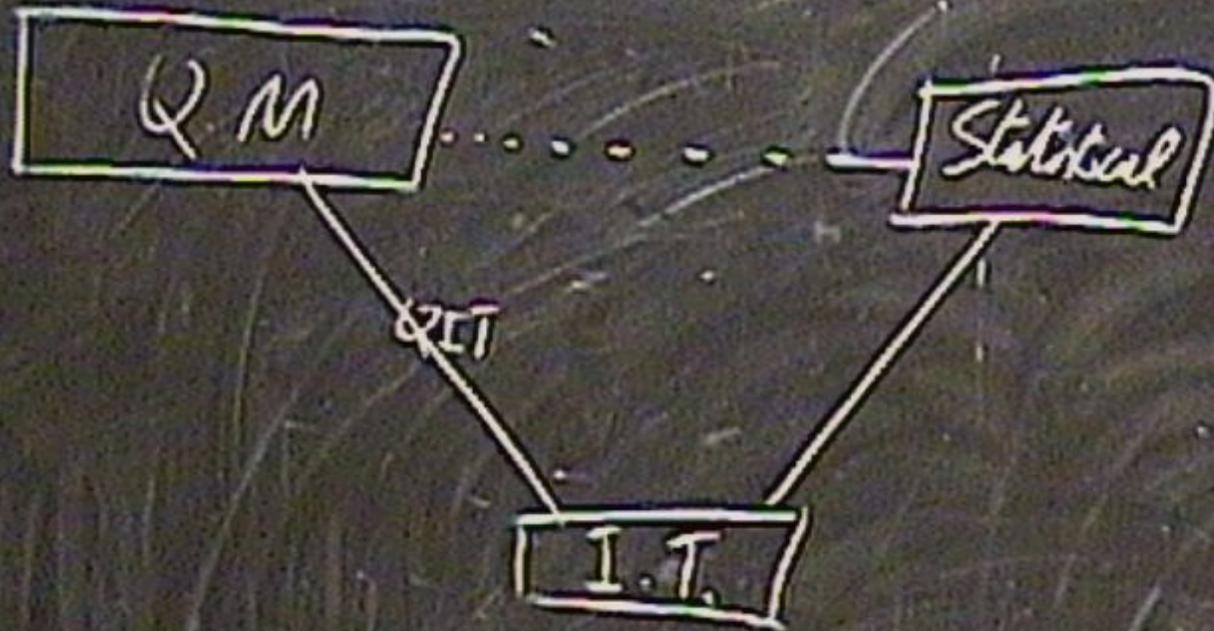


I.T.

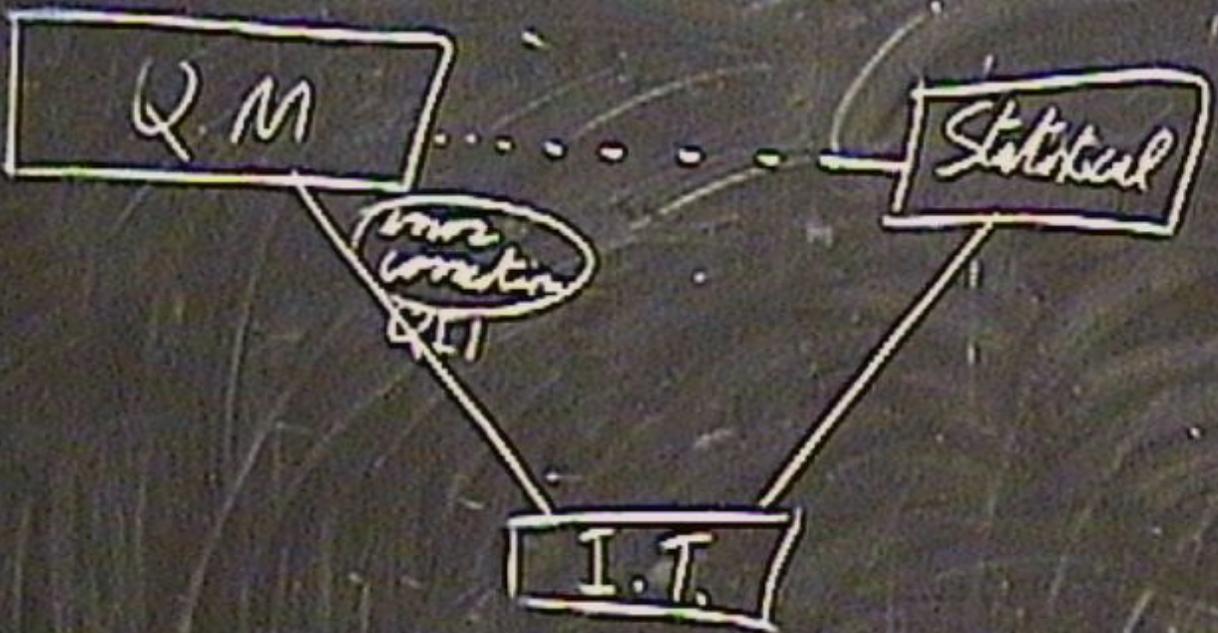
(Zohar Nussinov)



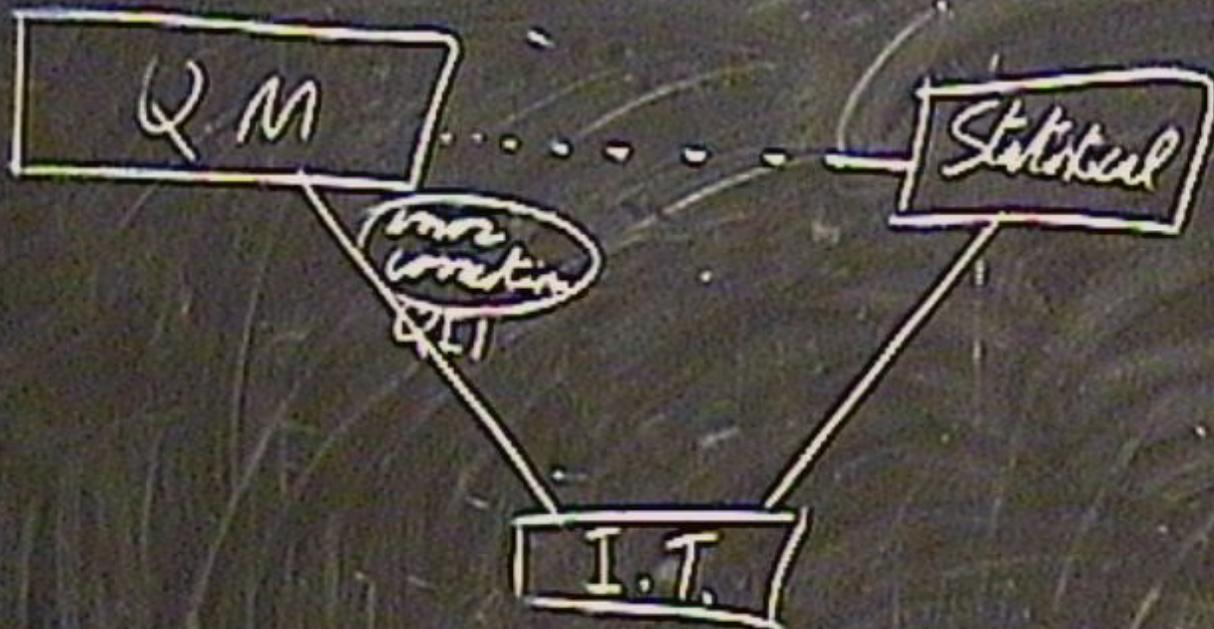
(Zohar Nussinov)

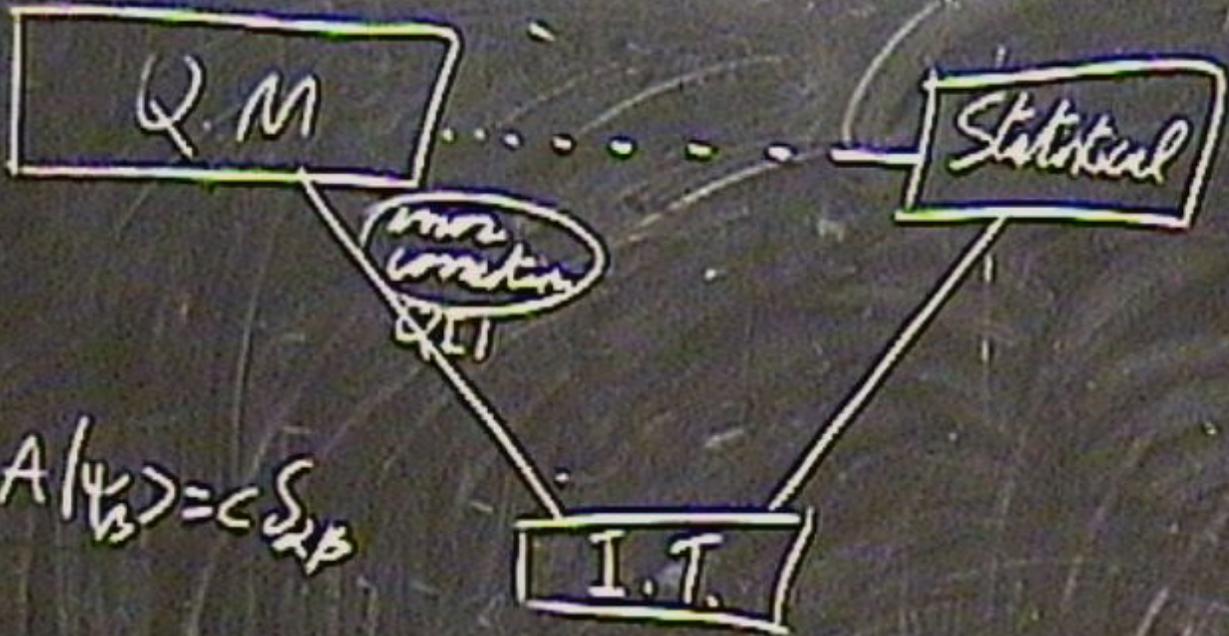


(Zohar Nussinov)



(Zohar Nussinov)

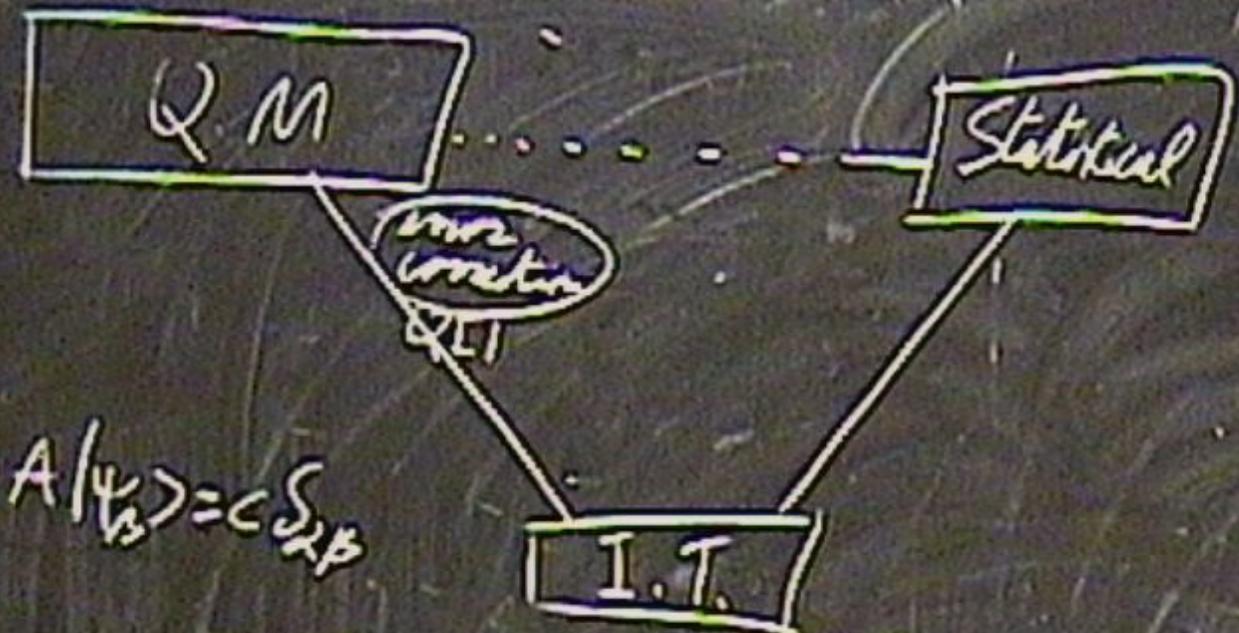




$$\langle \psi_2 | A | \psi_3 \rangle = c_{23}$$

weakly predicted

MANY BODY

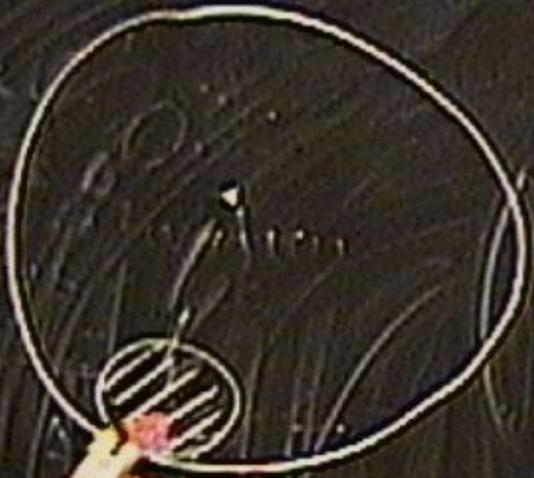


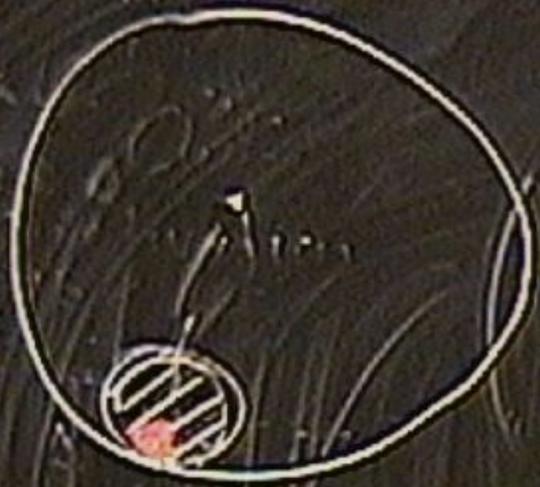
$$\langle \psi_2 | A | \psi_3 \rangle = c S_{23}$$

weakly perturbed











$$H = \sum_{\langle i,j \rangle} \vec{S}_i \cdot \vec{S}_j = E = \sum_{\langle i,j \rangle} T_{ij}(\vec{S}_i, \vec{S}_j)$$



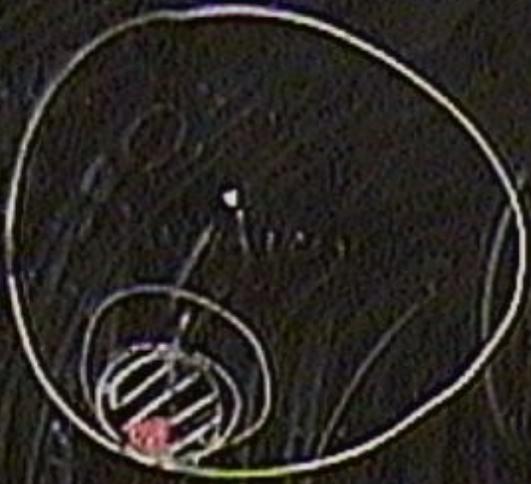
$$H = \sum_{\langle i,j \rangle} \zeta_i \zeta_j = E = \sum_{\langle i,j \rangle} T_{ij}(\zeta_i, \zeta_j)$$



$$H = \sum_{\langle i,j \rangle} \vec{S}_i \cdot \vec{S}_j = E = \sum_{\langle i,j \rangle} T_0 \{ \vec{S}_i \cdot \vec{S}_j, \rho_{ij} \}$$

• monogamy of entanglement

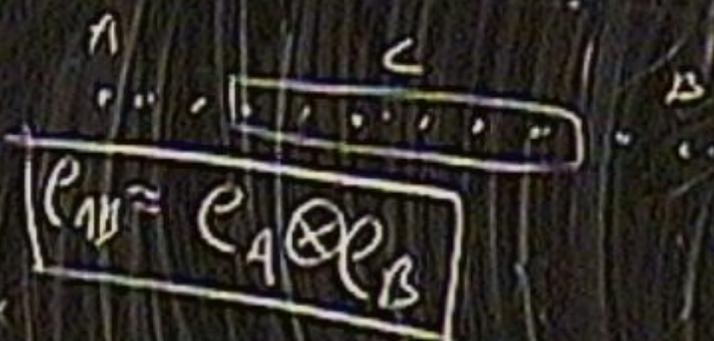
$$\langle A, A_j \rangle \approx \frac{1}{|i-j|^\alpha}$$

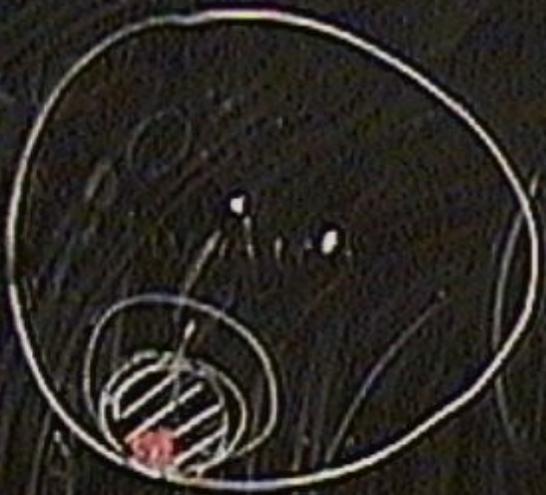


$$H = \sum_{\langle i,j \rangle} \zeta_i \zeta_j = E = \sum_{\langle i,j \rangle} T_0(\zeta_i, \zeta_j, \epsilon_{ij})$$

• monogamy of entanglement

$$\langle A, A_j \rangle \approx \exp\left(-\frac{1}{\zeta_j}\right)$$





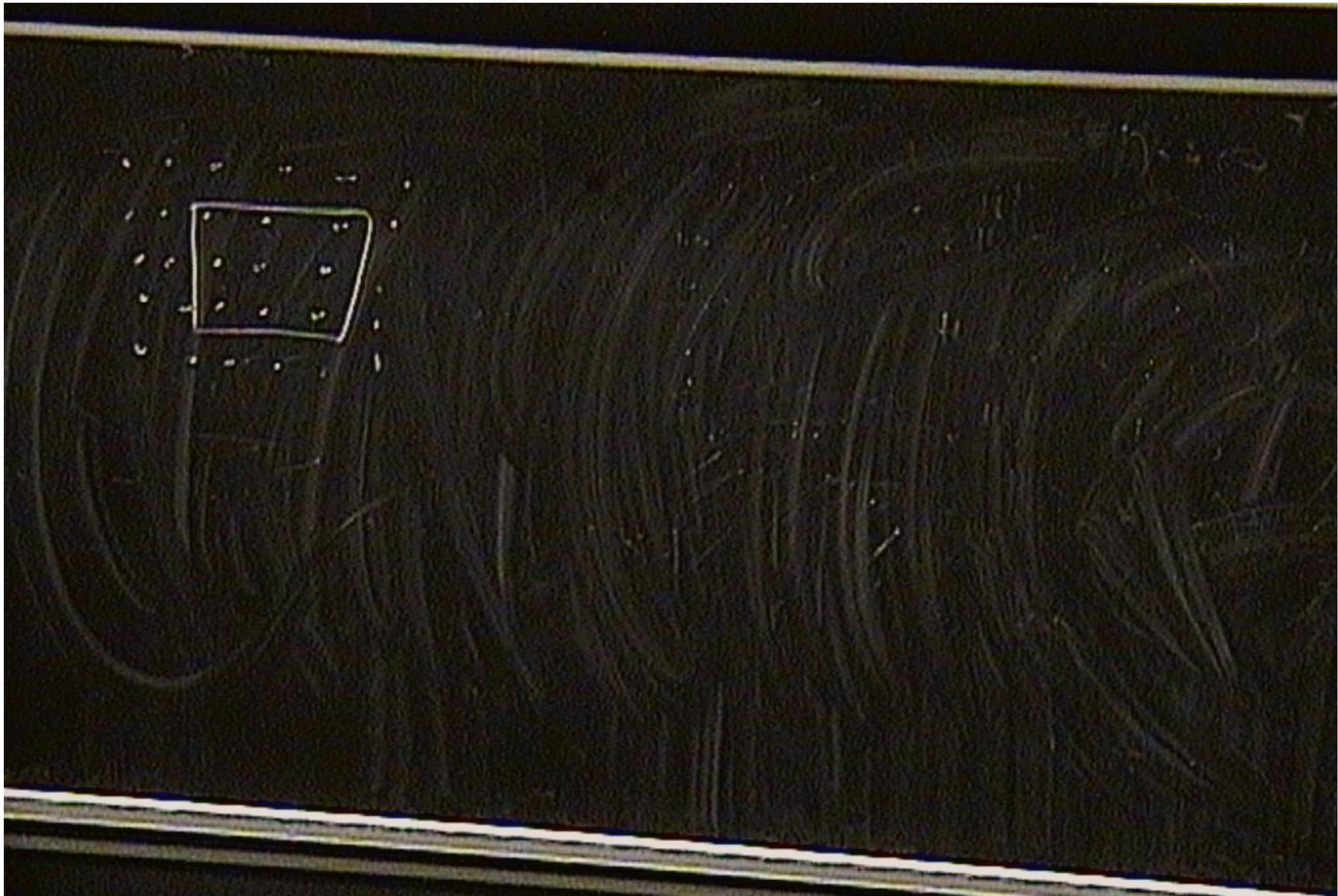
$$H = \sum_{\langle ij \rangle} \vec{S}_i \cdot \vec{S}_j = E = \sum_{\langle ij \rangle} T_{ij} \{ \vec{S}_i \cdot \vec{S}_j, \rho_{ij} \}$$

• monogamy of entanglement

$$\langle A, A_1 \rangle_{\langle A, A_1 \rangle} \propto \exp\left(-\frac{1}{S_1}\right)$$

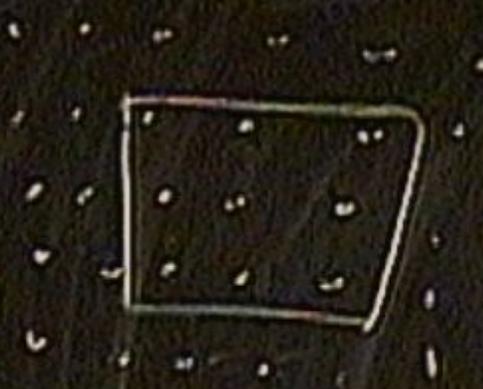
$$\rho_{AB} = \rho_A \otimes \rho_B$$

$$S_A + S_B - S_{AB} \leq S$$





$$S_A = -T \left\{ \log e_A \right\}$$



$$S_A = -T \left\{ \sum_n \log e_n \right\}$$



$$S_A = -T \{ \text{entropy} \}$$
$$= L$$


$$S_A = -T \{ e_{log} e_A \}$$
$$= L$$



$$S_A = -T \left\{ \ln \frac{\Omega}{\Omega_A} \right\}$$

$$= L$$



$$\left. \begin{aligned} \Psi_{AK}^{II} &\rightarrow \mathcal{L}_{AB} \simeq \mathcal{L}_A \otimes \mathcal{L}_B \\ \Psi_{AK}^{III} &\rightarrow \mathcal{L}_{AB} \simeq \mathcal{L}_A \otimes \mathcal{L}_B \end{aligned} \right\} \Rightarrow$$



$$S_A = -T \{ \log e_A \}$$

$$= L$$



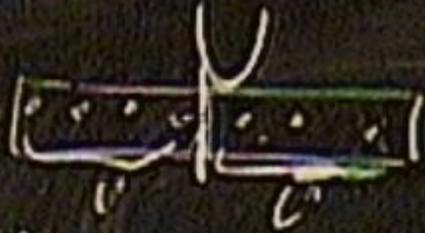
$$\left. \begin{array}{l} \psi_{AK}^{(1)} \rightarrow e_{AB} \simeq e_A \otimes e_B \\ \psi_{AK}^{(11)} \rightarrow e_{AB} = \frac{e_A \otimes e_B}{\sqrt{2}} \end{array} \right\} \Rightarrow \psi^{(11)} = U$$

$$\psi_{AK}^{(1)} \otimes \psi_{AK}^{(1)}$$



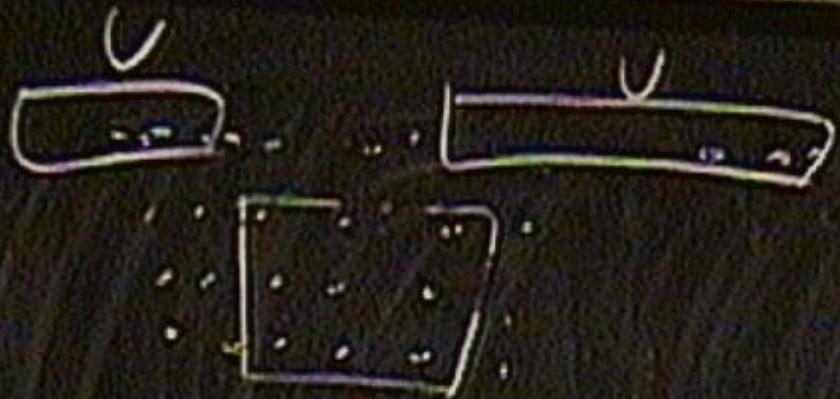
$$S_A = -T \{ \log e_A \}$$

$$= L$$



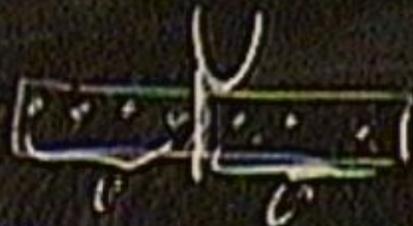
$$\left. \begin{array}{l} \psi_{AK}^{(1)} \rightarrow e_{AB} \approx e_{A \otimes B} \\ \psi_{AK}^{(1)} \rightarrow e_{AB} \approx \frac{e_{A \otimes B}}{12} \end{array} \right\} \Rightarrow \psi^{(1)} = U_C \psi^{(1)}$$

$$\psi_{AK}^{(1)} \otimes \psi_{AK}^{(1)}$$



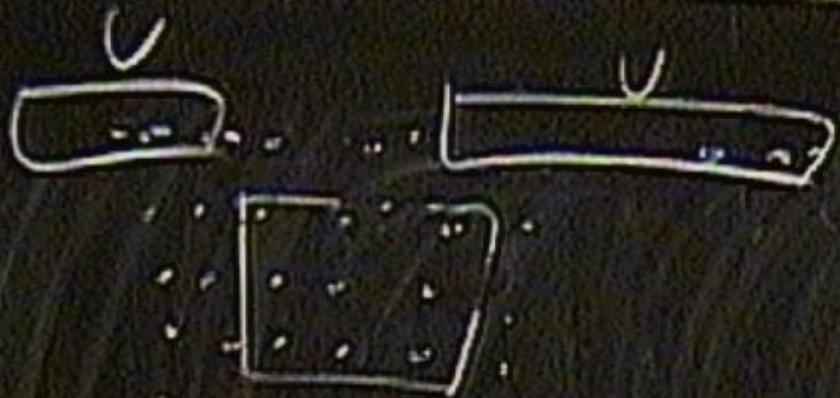
$$S_A = -T \ln \{ \prod_n e^{-\beta \epsilon_n} \}$$

$$= L$$



$$\left. \begin{aligned} \psi_{NS}^{(1)} &\rightarrow \mathcal{L}_{AB} \cong \mathcal{L}_A \otimes \mathcal{L}_B \\ \psi_{NS}^{(11)} &\rightarrow \mathcal{L}_{AB} \cong \mathcal{L}_A \otimes \mathcal{L}_B \end{aligned} \right\} \Rightarrow \psi^{(11)} = U_C \psi^{(1)}$$

$$\psi_{AC}^{(2)} \otimes \psi_{BC}^{(2)}$$



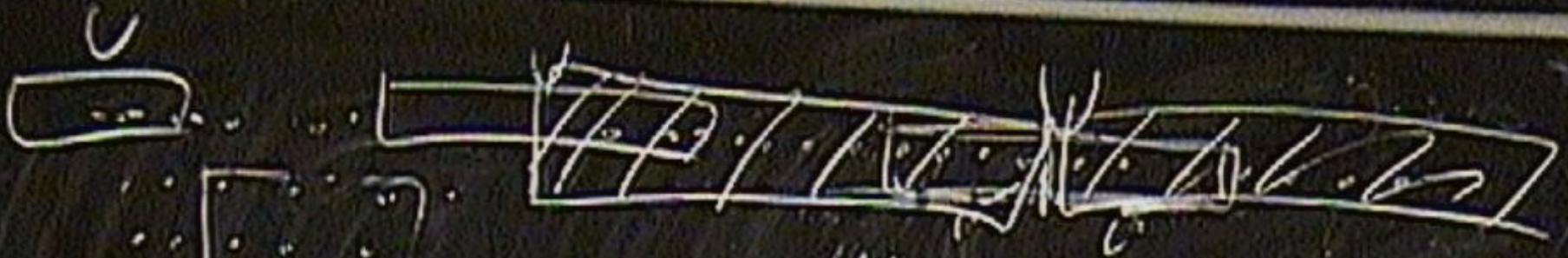
$$S_A = -T_1 \left\{ \sum_n \log e_n \right\}$$

$$= L$$

Hand-drawn diagram of a cylinder with a vertical line through its center, similar to the first diagram.

$$\left. \begin{array}{l} \psi_{\text{fix}}^{(1)} \rightarrow \mathcal{L}_{AB} \simeq \mathcal{L}_A \otimes \mathcal{L}_B \\ \psi_{\text{fix}}^{(11)} \rightarrow \mathcal{L}_{AB} \simeq \mathcal{L}_A \otimes \mathcal{L}_B \end{array} \right\} \Rightarrow \psi^{(12)} = U_C \psi^{(12)}$$

$\mathcal{L}_A \otimes \mathcal{L}_B$
 \downarrow
 $\psi_{\text{fix}}^{(1)} \otimes \psi_{\text{fix}}^{(1)}$

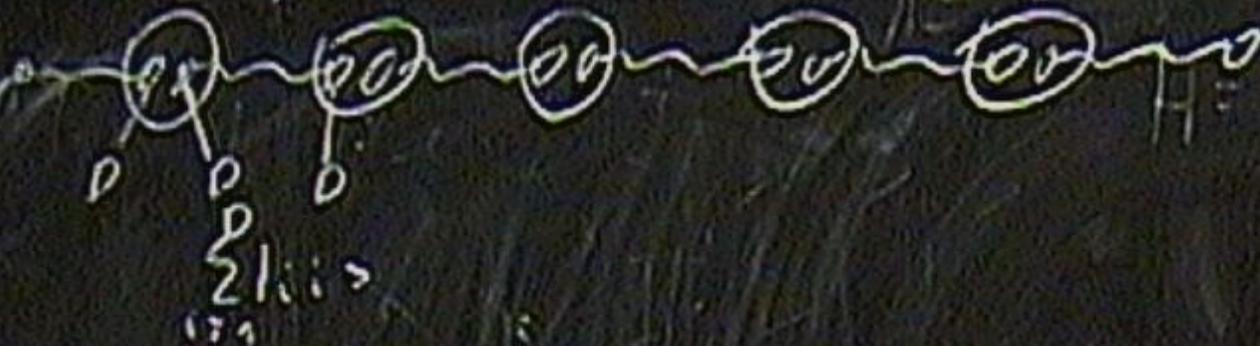


$$S_A = -T \left\{ \sum_n \log e_n \right\}$$

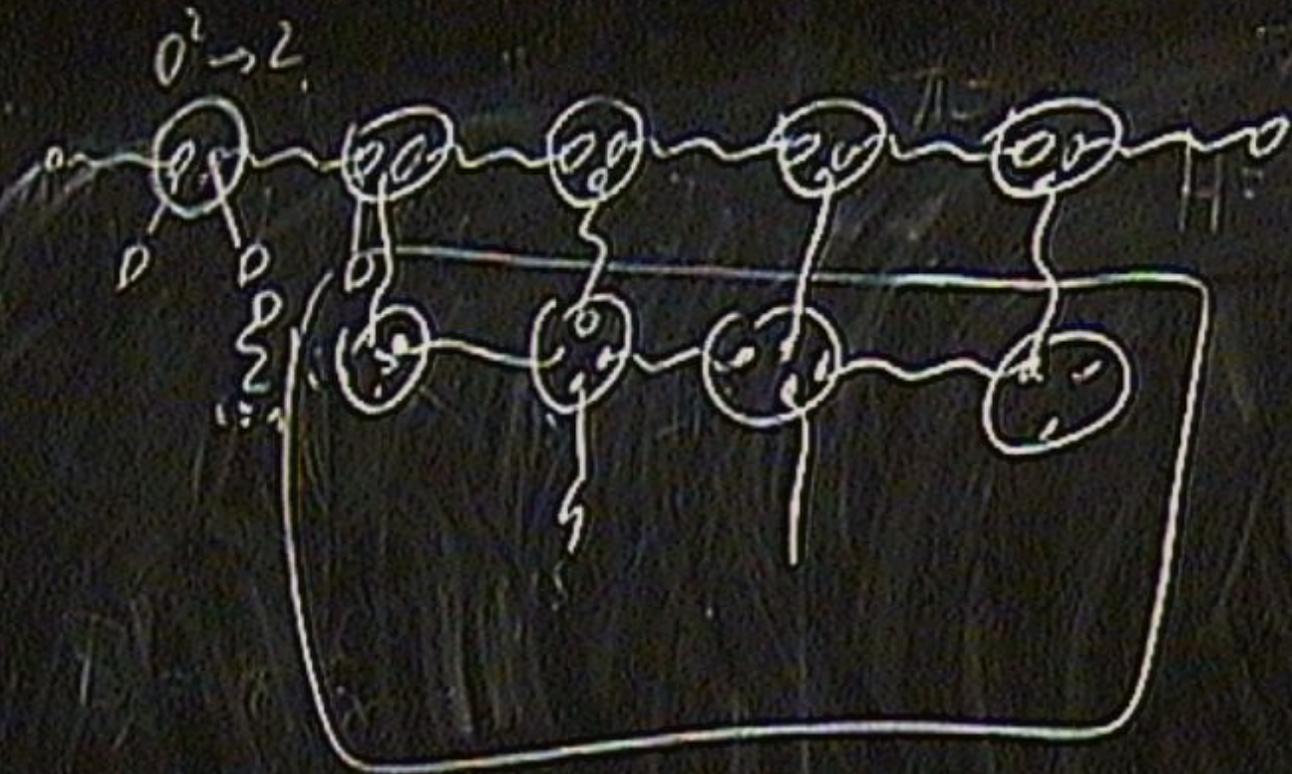
$$= L$$

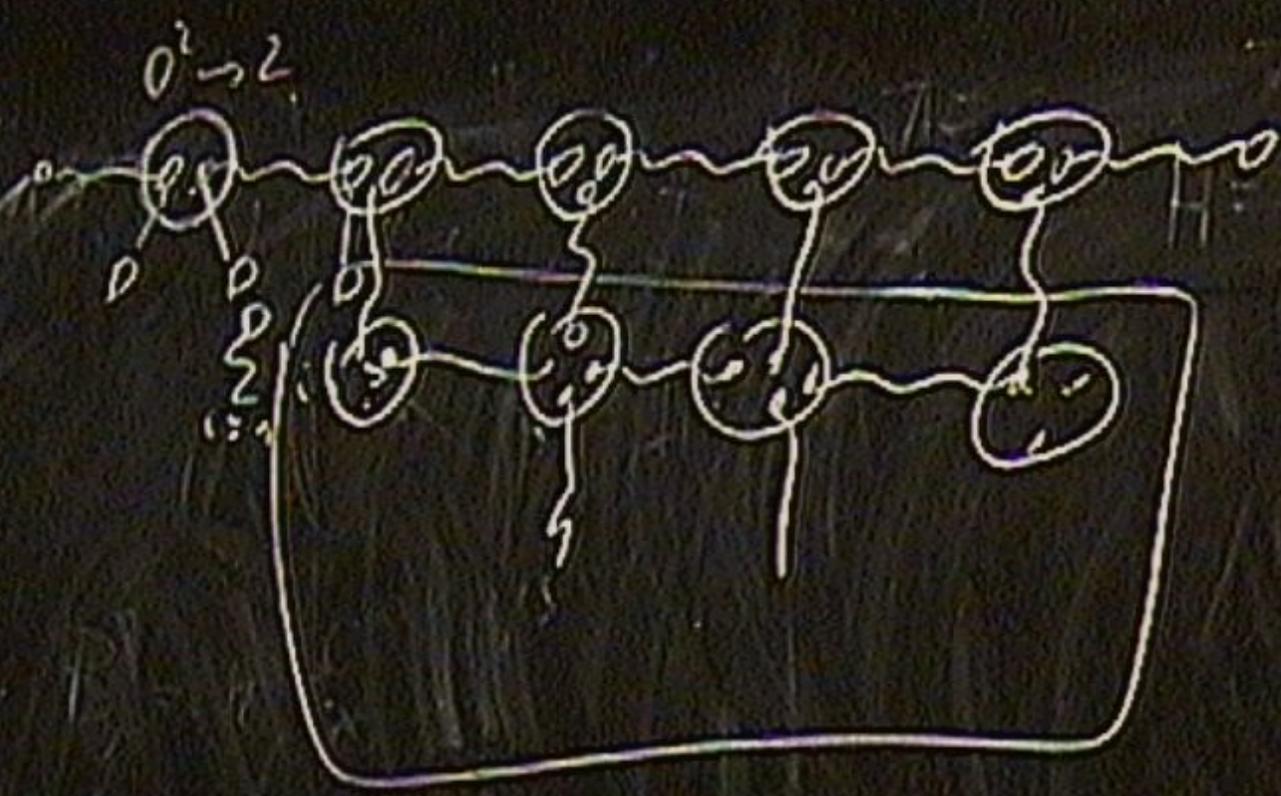
$$\left. \begin{array}{l} \psi_{AK}^{(1)} \rightarrow e_{AB} = e_{A0} e_{B0} \\ \psi_{AK}^{(11)} \rightarrow e_{AB} = \frac{e_{A0} e_{B0}}{1} \end{array} \right\} \Rightarrow \psi^{(11)} = U_C \psi^{(1)}$$

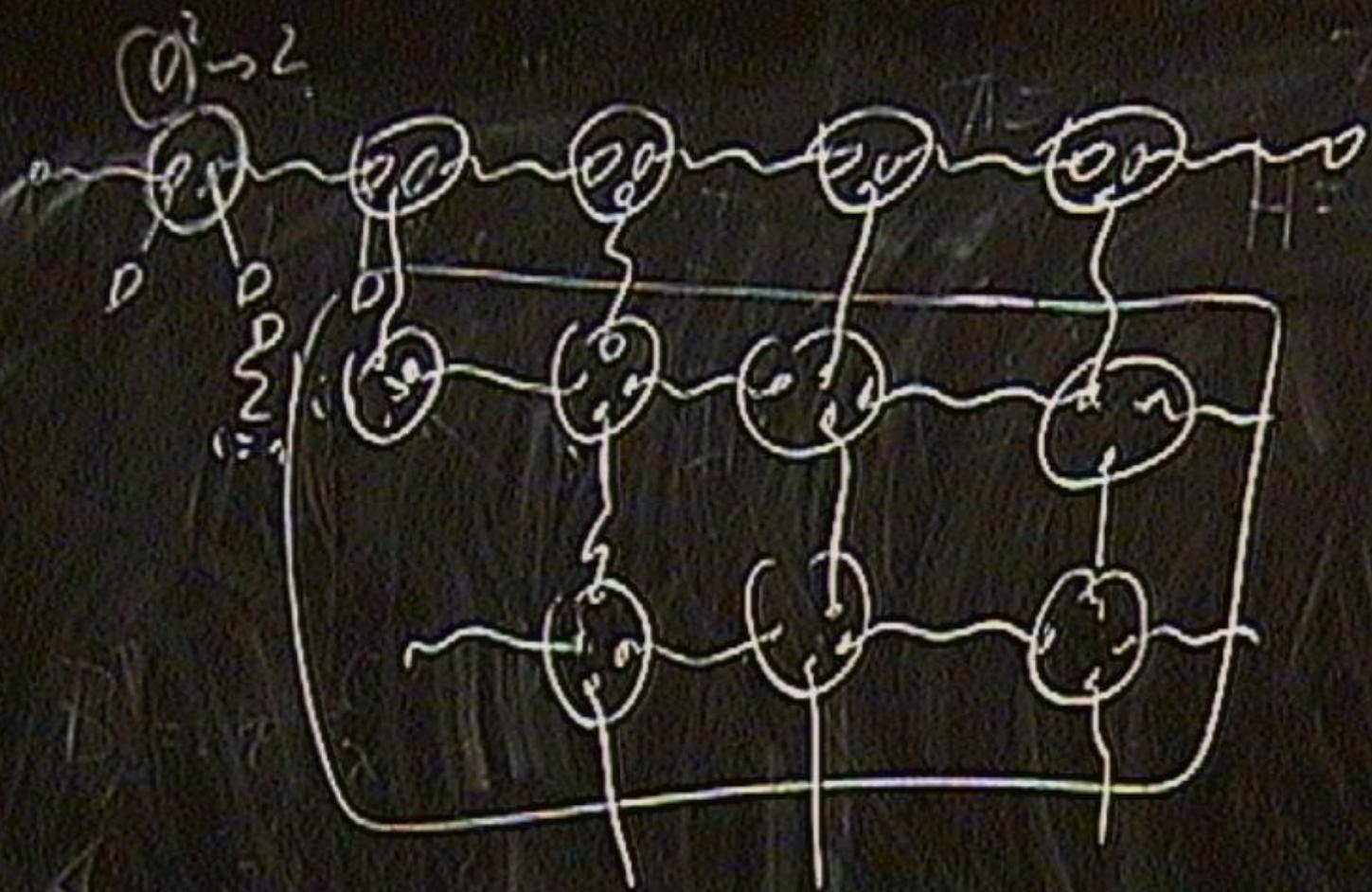
$\psi_{AK}^{(11)}$











$$D \approx 2^N$$