Title: Quantum Foundations Lecture - 230118

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Collection: Quantum Foundations (2022/2023)

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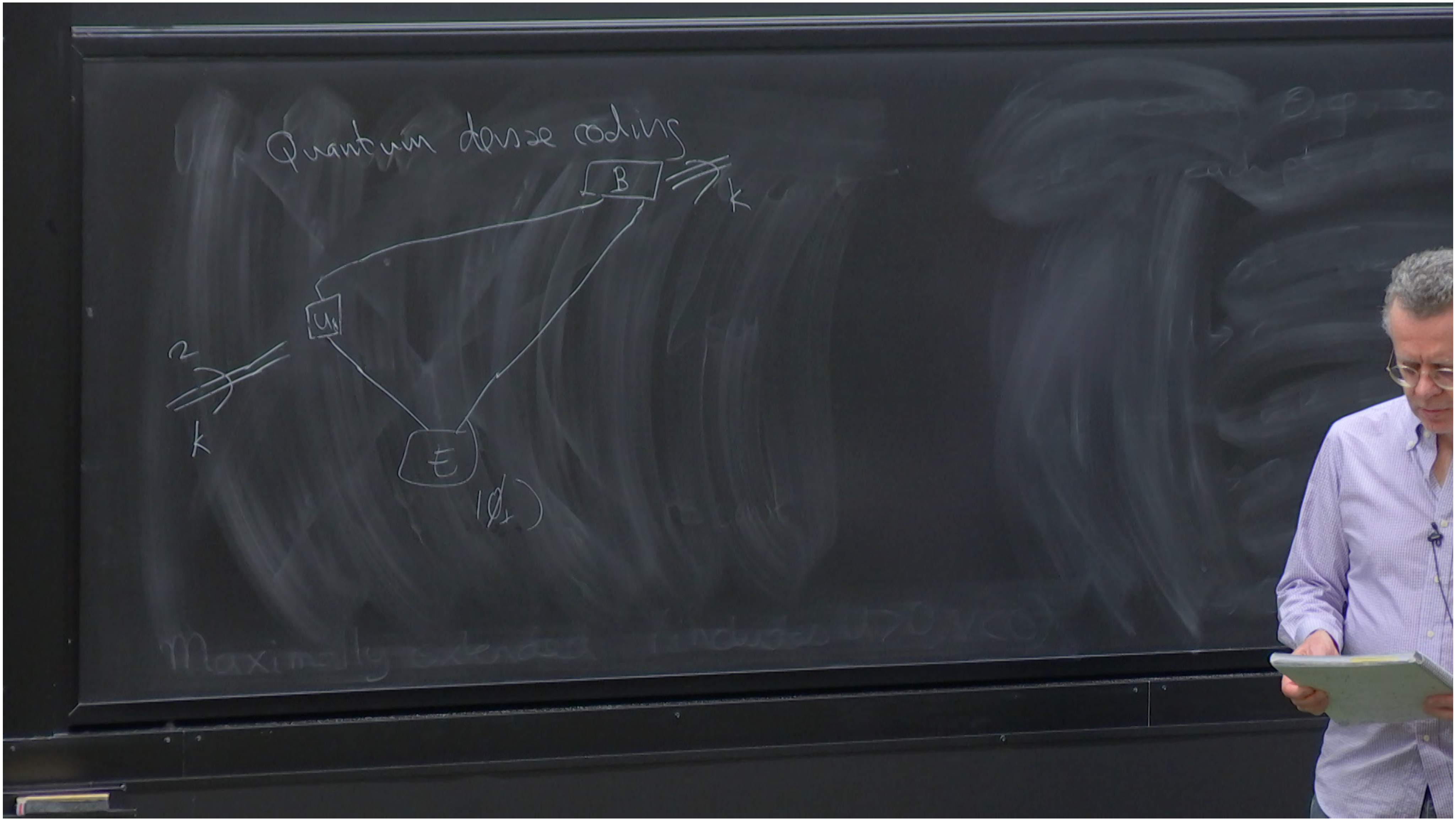
$$\left(\alpha|0\rangle_{a_1} + \beta|1\rangle_{a_1}\right)|\phi_+\rangle_{a_2 a_3} \qquad , \begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix}$$

$$= \frac{1}{2}|\phi_+\rangle_{a_1 a_2}\left(\alpha|0\rangle_{a_3} + \beta|1\rangle_{a_3}\right) + \frac{1}{2}|\phi_-\rangle_{a_1 a_2}\left(\alpha|0\rangle_{a_3} - \beta|1\rangle_{a_3}\right)$$

$$+ \frac{1}{2}|\psi_+\rangle_{a_1 a_2}\left(\beta|0\rangle_{a_3} + \alpha|1\rangle_{a_3}\right) + \frac{1}{2}|\psi_-\rangle_{a_1 a_2}\left(\beta|0\rangle_{a_3} - \alpha|1\rangle_{a_3}\right)$$

Measure in Bell basis. Get on of the four terms.

$U_0 = \mathbb{1}$ (for $\phi_+$ term) $U_1 = \begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix}$ for $\phi_-$ term | $U_2 = \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}$ for $\psi_+$ case. | $U_3 = \begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix}$ for $\psi_-$ case.


Quantum dense coding
B
k
2
k
E

# The Quantum Zeno Effect.

Sudarshan & Misra (1977)

System in initial state $|0\rangle_a$ $t=0$.

$$|\psi(\delta t)\rangle = e^{i\hat{H}\delta t/\hbar}|0\rangle_a$$

$$\simeq \left(\mathbb{1} + \frac{i\hat{H}}{\hbar}\delta t\right)|0\rangle_a = |0\rangle + \frac{i\hat{H}\delta t}{\hbar}|0\rangle$$

Perform a

77 )

Perform a projective meas onto $\hat{P}_0 = |0\rangle\langle 0|$  $\hat{P}_{\bar{0}} = \sum_{n=1}^{N-1} |n\rangle\langle n|$

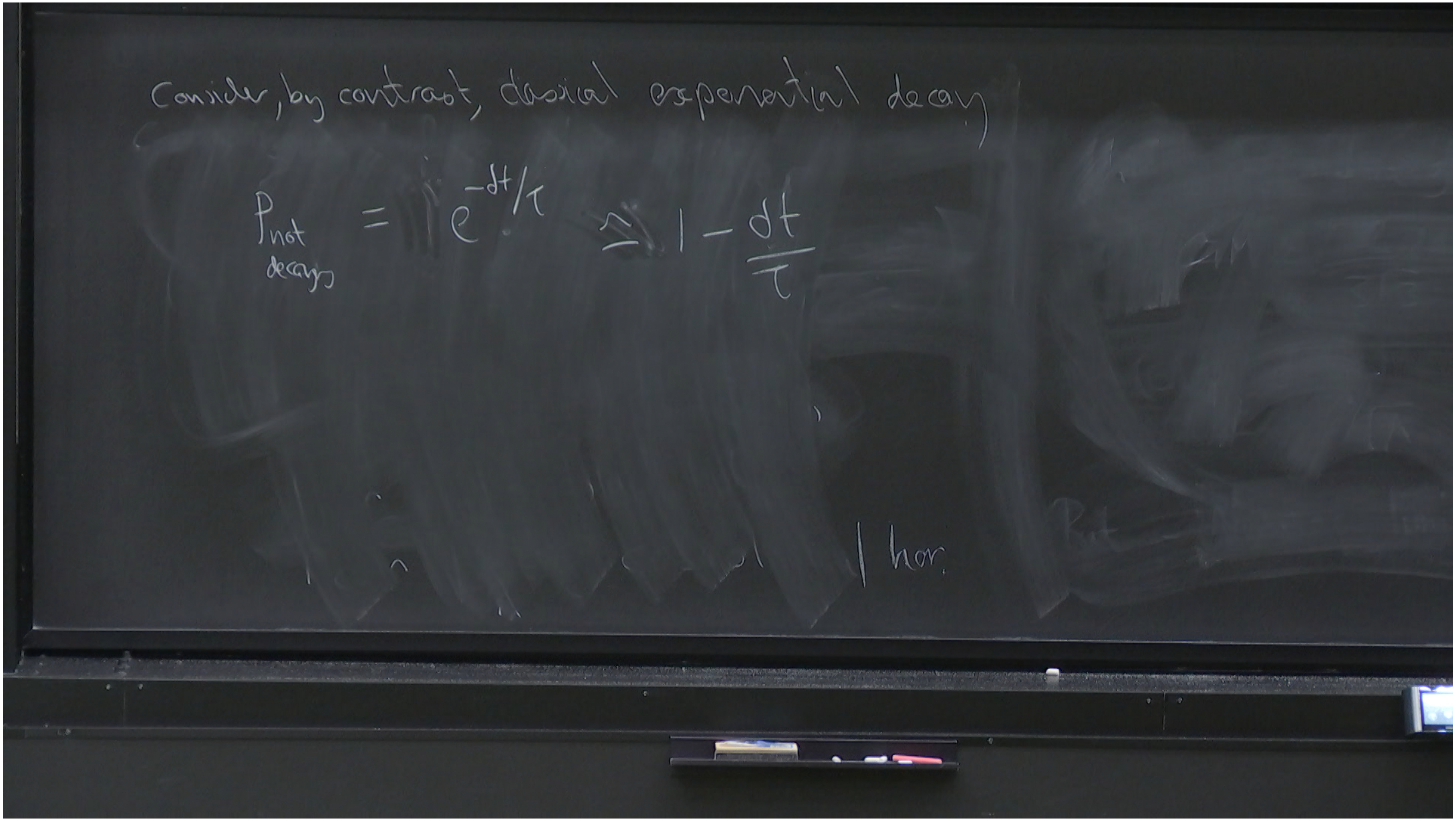
$$\hat{P}_0 + \hat{P}_{\bar{0}} = \mathbb{1}$$

$$\text{prob}\left(P_{\bar{0}}\right) = k^2 (\delta t)^2$$

$$= \langle \psi(\delta t) | \sum_{n=1}^{N-1} |n\rangle\langle n| \, | \psi(\delta t)\rangle$$

$$= \left(\langle 0| - \frac{iH}{\hbar}\delta t \langle 0|\right) \sum_{n=1}^{N-1} |n\rangle\langle n| \left( |0\rangle + \frac{iH}{\hbar}\delta t |0\rangle \right)$$

$$= \sum_{n=1}^{N-1} \frac{(\delta t)^2}{\hbar^2} \langle 0|\hat{H}|n\rangle\langle n|\hat{H}|0\rangle = \sum_{n=1}^{N-1} \frac{|\langle 0|\hat{H}|n\rangle|^2}{\hbar^2} (\delta t)^2$$


Consider, by contrast, classical exponential decay
$P_{\text{not decays}} = e^{-dt/\tau} \approx 1 - \frac{dt}{\tau}$
hor.

Q Zeno effect

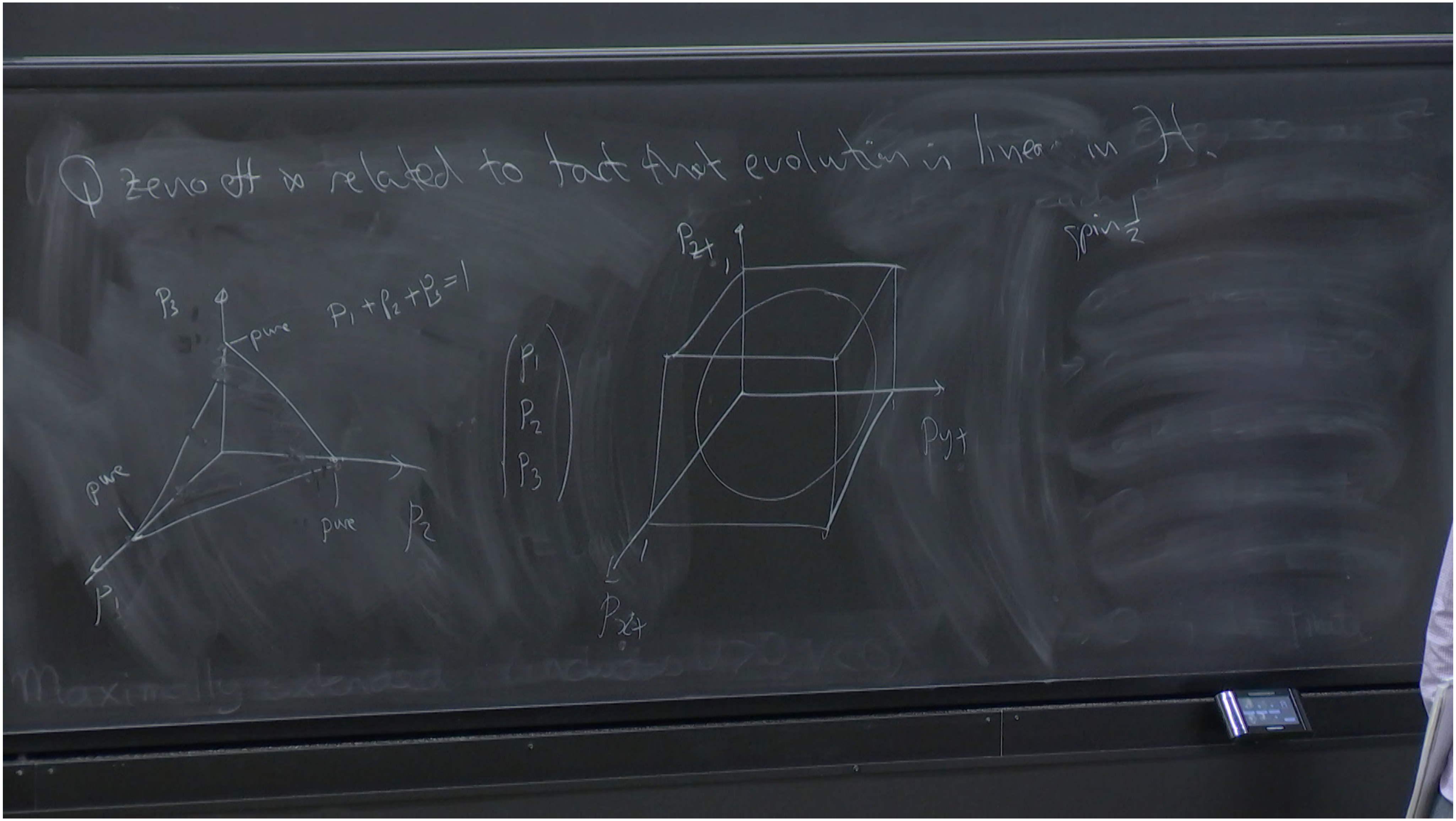
Keep measuring system every $\delta t$. do this $\frac{T}{\delta t}$ times

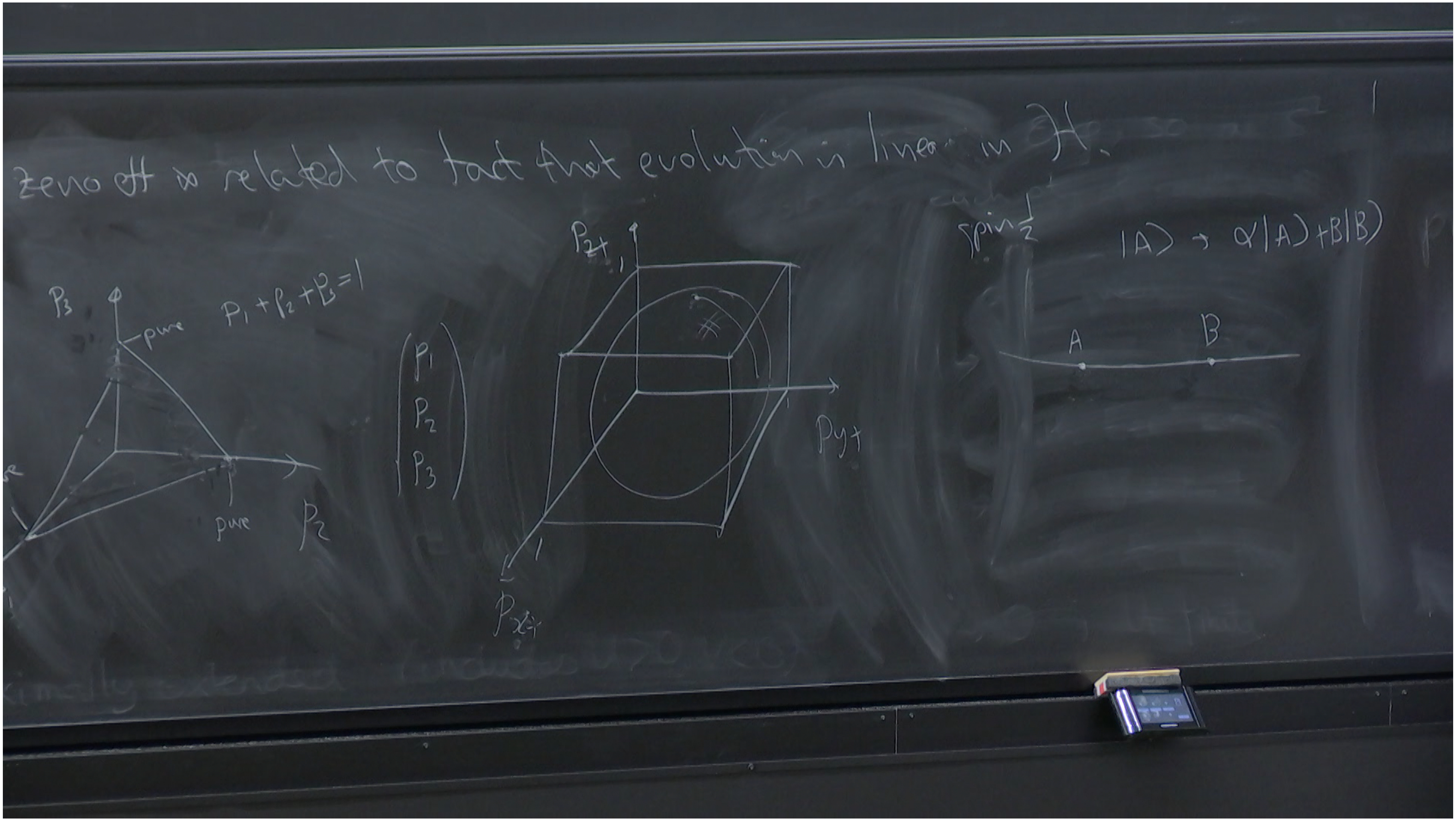
$$\text{prob}\begin{pmatrix}\text{in } 0 \\ \text{after } T\end{pmatrix} = \left(1 - k^2(\delta t)^2\right)^{\left(\frac{T}{\delta t}\right)}$$

$$= 1 - \frac{T}{\delta t} k^2 (\delta t)^2 + \dots$$

$$\simeq 1 - T k^2 \delta t$$

as $\delta t \to 0$ this prob $\to 1$


zeno eff is related to fact that evolution is linear in H
spin 1/2
p1 + p2 + p3 = 1
pure
pure
pure
p1
p2
p3
pz+
py+
px+


Zeno eff is related to fact that evolution is linear in H.
p₃
pure
p₁ + p₂ + p₃ = 1
pure
p₂
p₁
p₂
p₃
p₂+
pₓ+
pᵧ+
spin ½
|A⟩ → α|A⟩ + β|B⟩
A
B