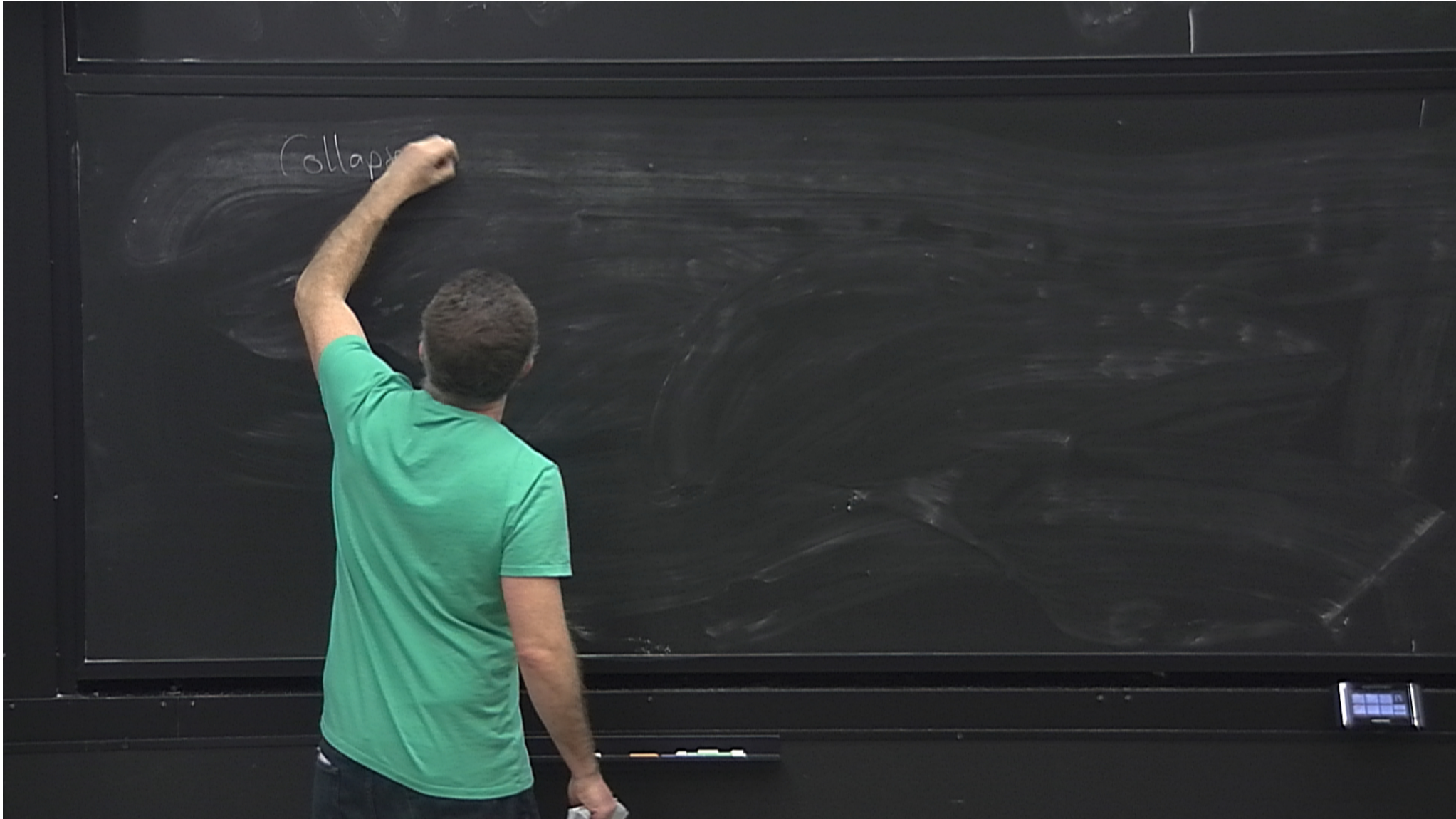


Title: 13/14 PSI - Foundations of Quantum Mechanics - Lecture 8

Date: Jan 16, 2014 11:30 AM

URL: <http://pirsa.org/14010055>

Abstract:



Collapse models P. Pearl / Ghisardi, Zimmer & Weber

Collapse models. P. Pearl / Ghirardi, Rimini, Weber

Motivation to solve the reality problem

Collapse models. P. Pearl / Ghirardi, Rimini, Weber

Motivation to solve the reality problem by
modifying evolution +

Collapse models. P. Pearle / Ghirardi, Rimini Weber.

Motivation to solve the reality problem by
modifying evolution from that of Schröd. eqn.

Idea. for small systems evolution hardly affected.

Collapse models. P. Pearle / Ghirardi, Rimini Weber

Motivation to solve the reality problem by
modifying evolution from that of Schrödinger eqn.

Idea. for small systems evolution is not protected.
(superposition)

Collapse models. P. Pearle / Ghirardi, Rimini Weber

Motivation to solve the reality problem by
modifying evolution from that of Schröd. eqn.

Idea. for small systems evolution hardly affected.
(superpositions persist)

for b

Collapse models. P. Pearle / Ghirardi, Rimini & Weber

Motivation to solve the reality problem by
modifying evolution from that of Schröd. eqn.

Idea. for systems evolution hardly affected.
(superpositions persist)

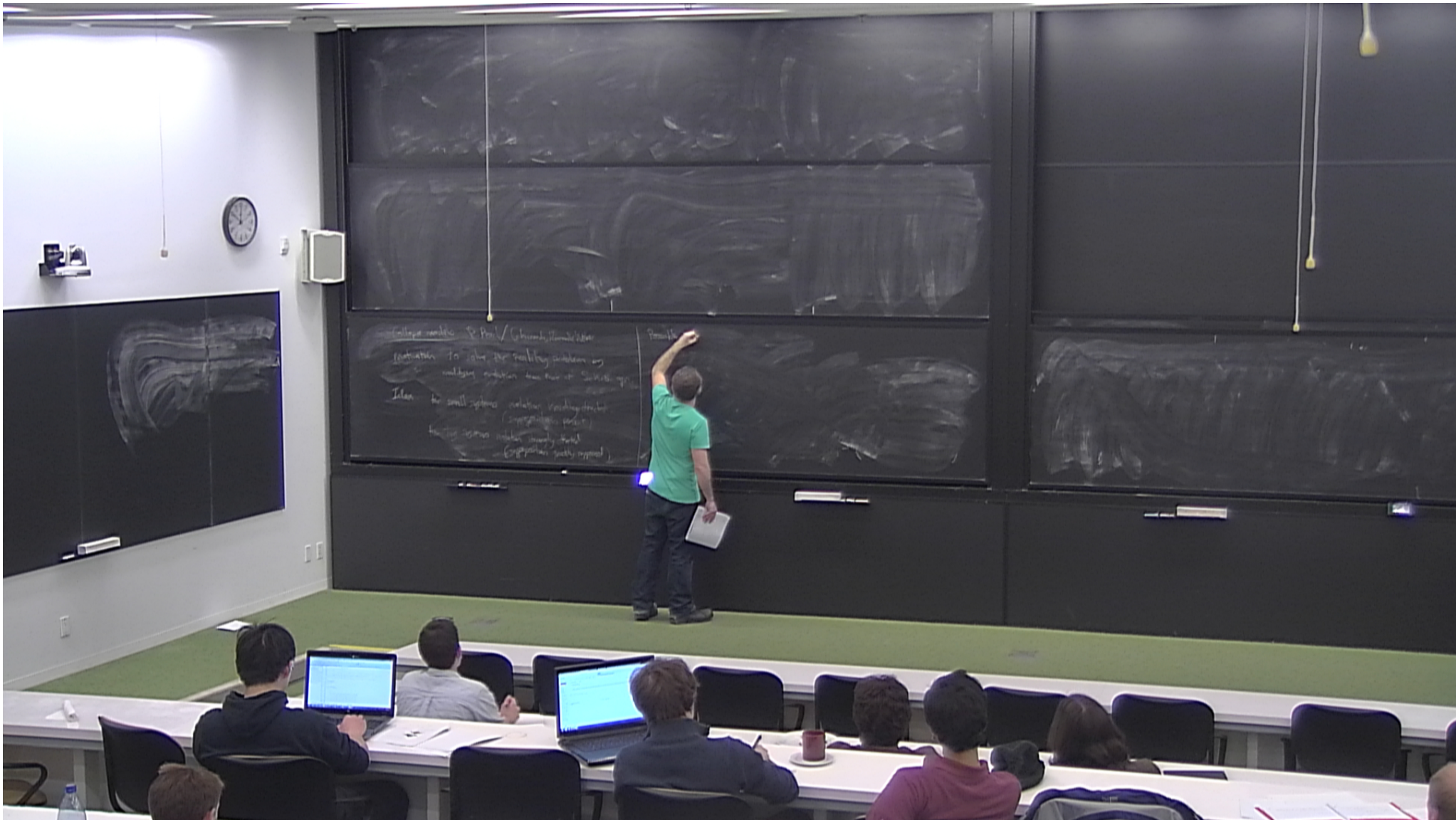
... evolution strongly affected

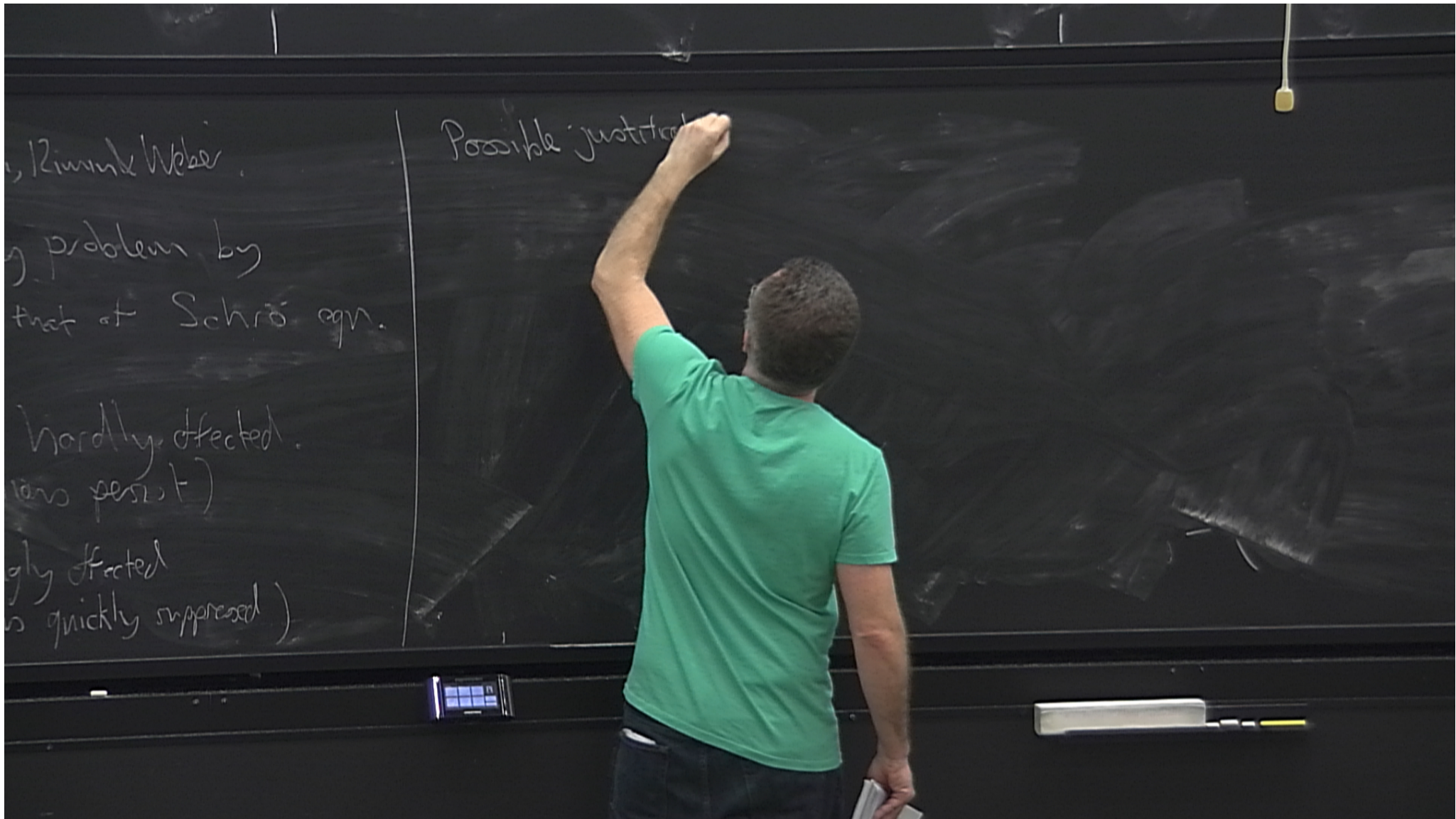
Collapse models. P. Pearle / Ghirardi, Rimini Weber.

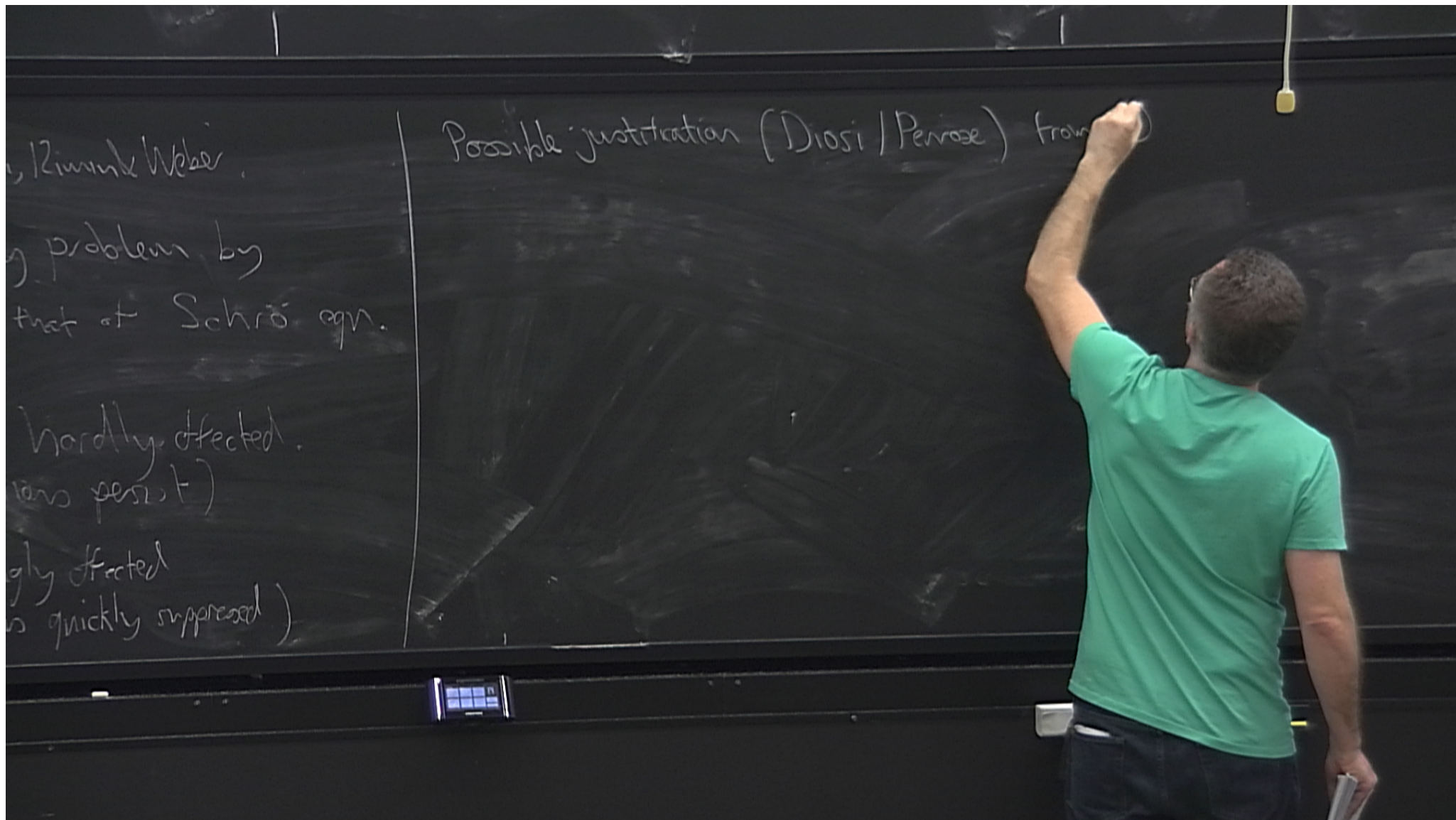
Motivation to solve the reality problem by
modifying evolution from that of Schröd. eqn.

Idea. for small systems evolution has collapsed.
(suppression of ψ)

for big systems evolution
(suppression of ψ)







, Zimm & Weber.

problem by
that of Schröd. eqn.

hardly affected.
(no persist)

gly affected
(is quickly suppressed)

Possible justification (Diosi / Penrose) from

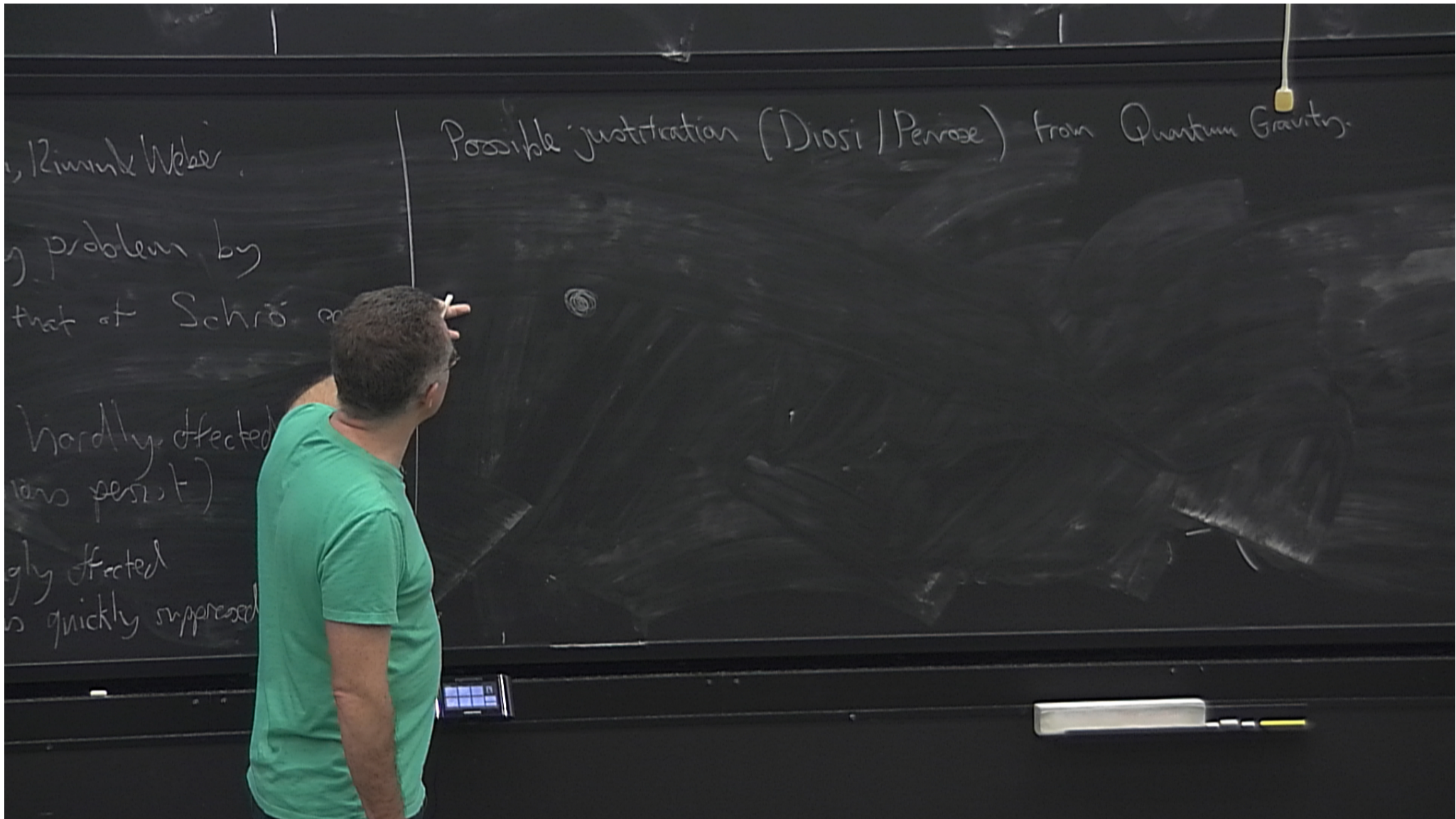
, Zimm & Weber.

problem by
that of Schröd. eqn.

hardly affected.
(persists)

ly affected
(quickly suppressed)

Possible justification (Diosi / Penrose) from Quantum Gravity.



, Zimm & Weber

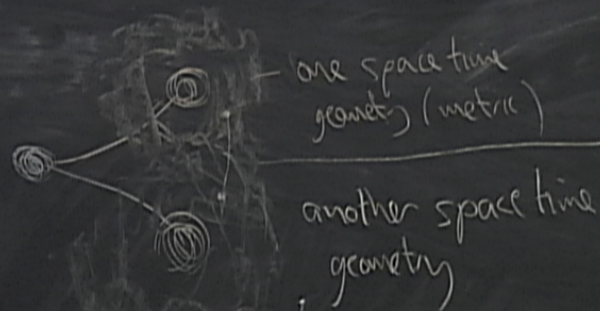
problem by
that of Schröd. eqn.

hardly affected.
(persists)

gly affected
(is quickly suppressed)

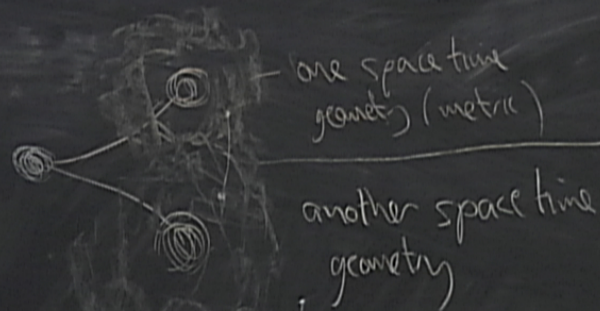
Possible justification (Diosi / Penrose) from Quantum Gravity.

Possible justification (Diosi / Penrose) from Quantum Gravity.



no sensible way
of identifying x between
the two

Possible justification (Diosi / Penrose) from Quantum Gravity.



no sensible way
of identifying points x between
the two solns.

Possible justification (Diosi / Penrose) from Quantum Gravity.

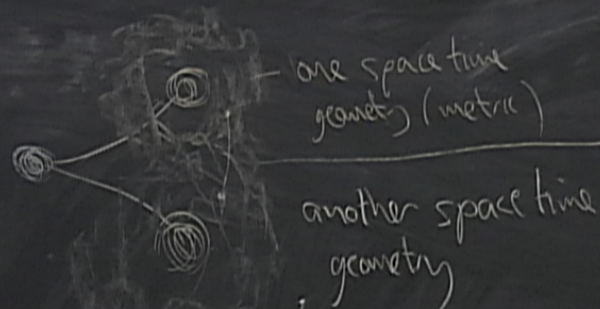


one spacetime
geometry (metric)

another
geometry

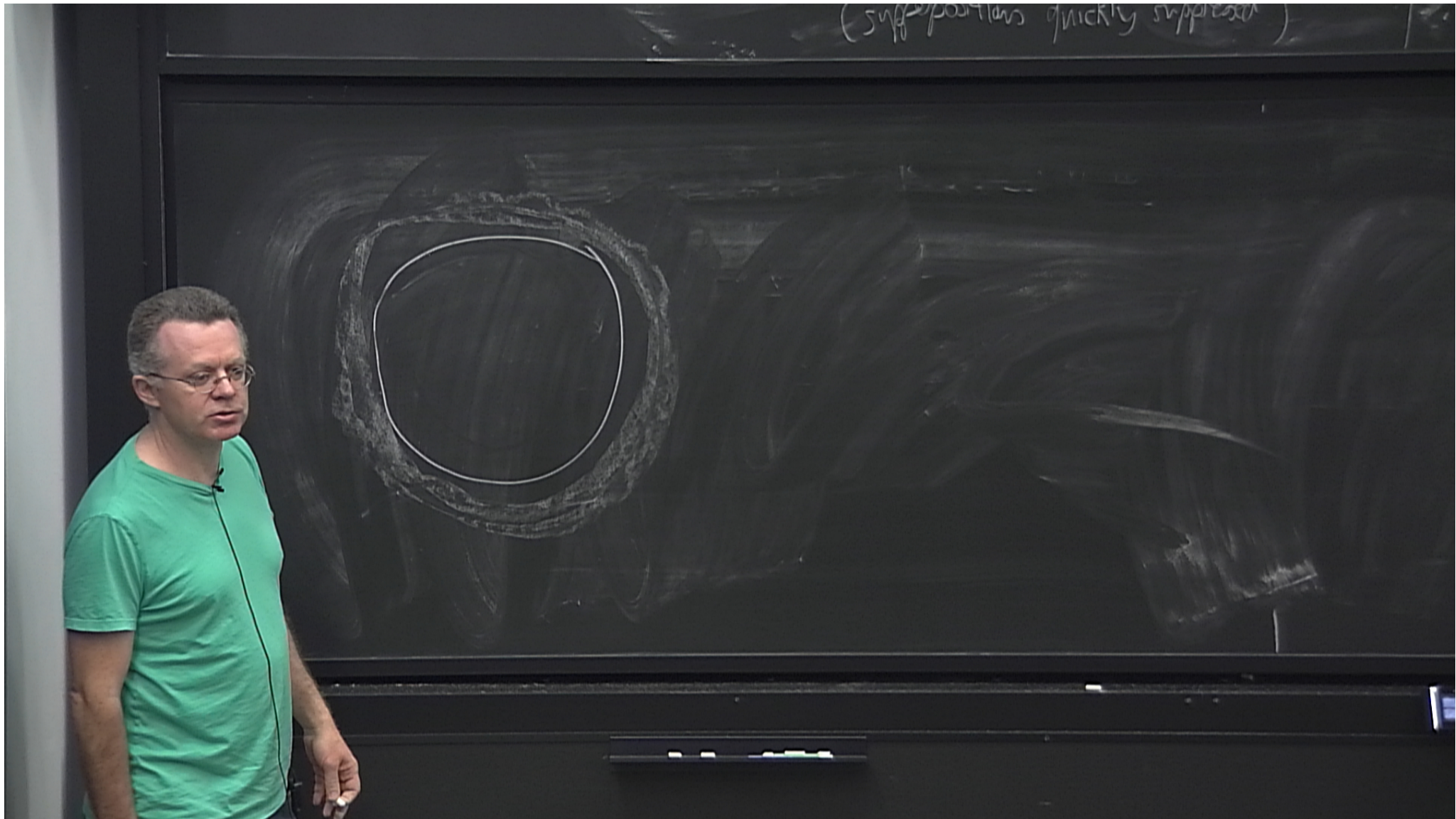
no sensible way
of identifying points x between
the two solns.

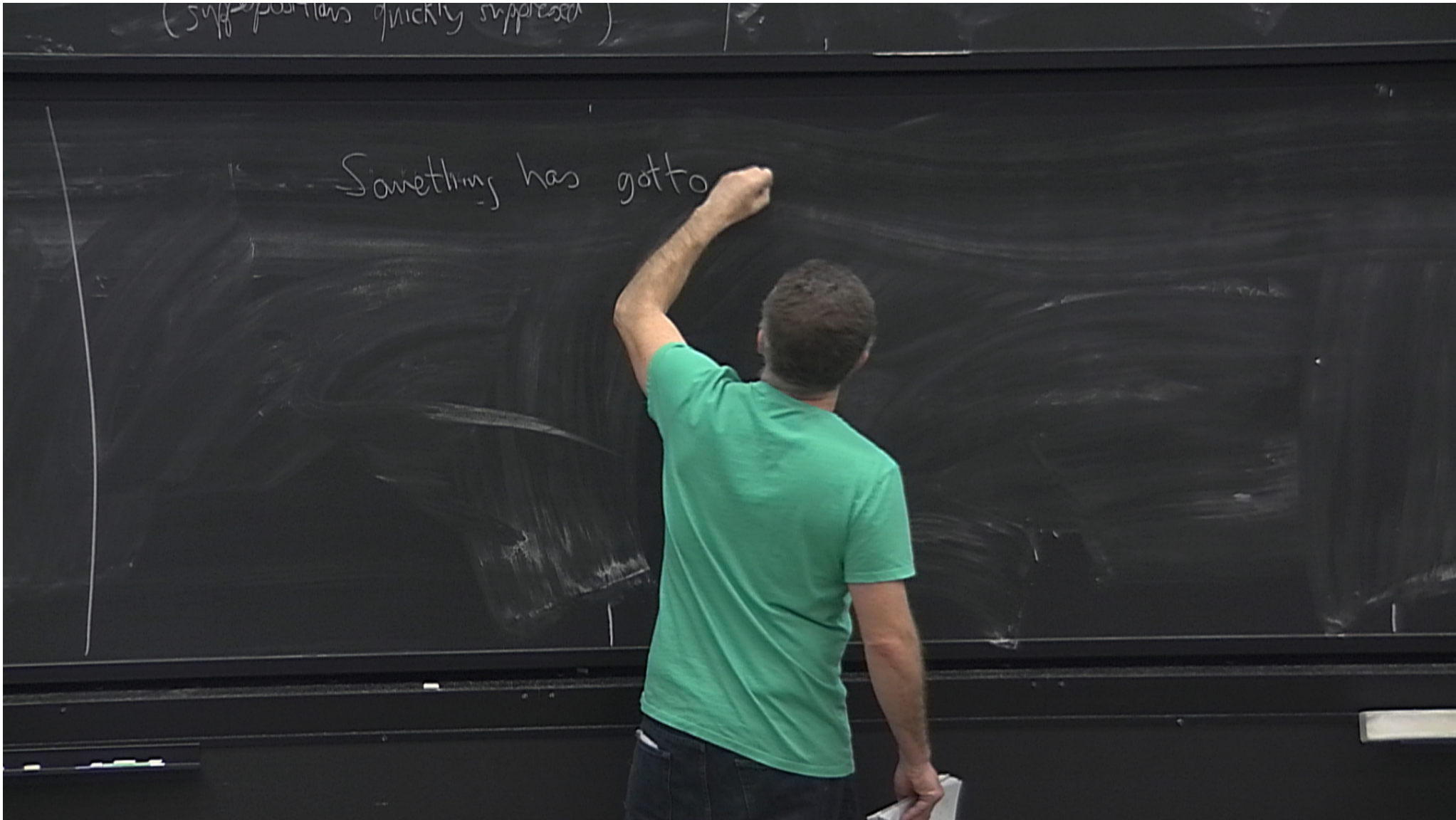
Possible justification (Diosi / Penrose) from Quantum Gravity.



no sensible way
of identifying points x between
the two solns.

Hence, no consistent way to choose
a common foliation and evolve the state.





(superpositions quickly suppressed)

Something has gotta give.

So the wave function has gotta collapse.

(superpositions quickly suppressed)

Something has gotta give.

So the wave function has gotta collapse.

T

(superpositions quickly suppressed)

Something has gotta give.

So the wave function has gotta collapse.

$$T = \frac{\hbar}{E_0}$$

E_0

(superpositions quickly suppressed)

Something has gotta give.

So the wave function has gotta collapse.

$$T = \frac{\hbar}{E_0}$$

E_0 = gravitational
self energy difference
between two mass distributions

positions quickly suppressed)

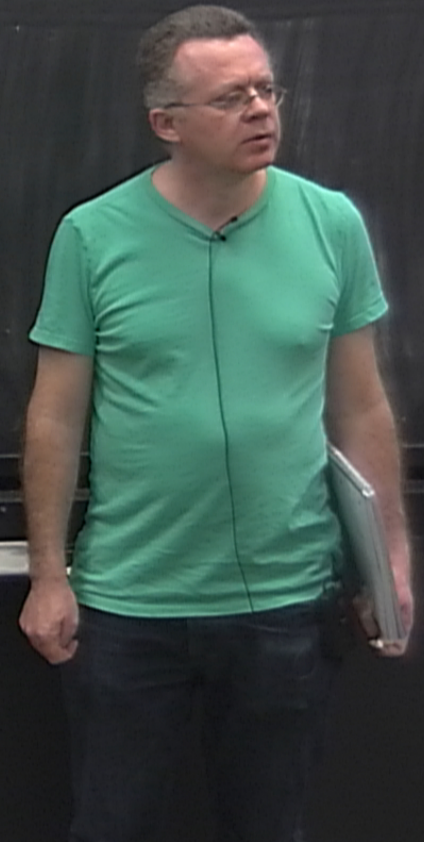
Something has gotta give.

So the wave function has gotta collapse.

$$T = \frac{\hbar}{E_0}$$

E_0 = gravitational
self energy difference
between two mass distributions

$$= G \int \rho(x) \rho(y) / |x-y| d^3x d^3y$$



(superpositions quickly suppressed)

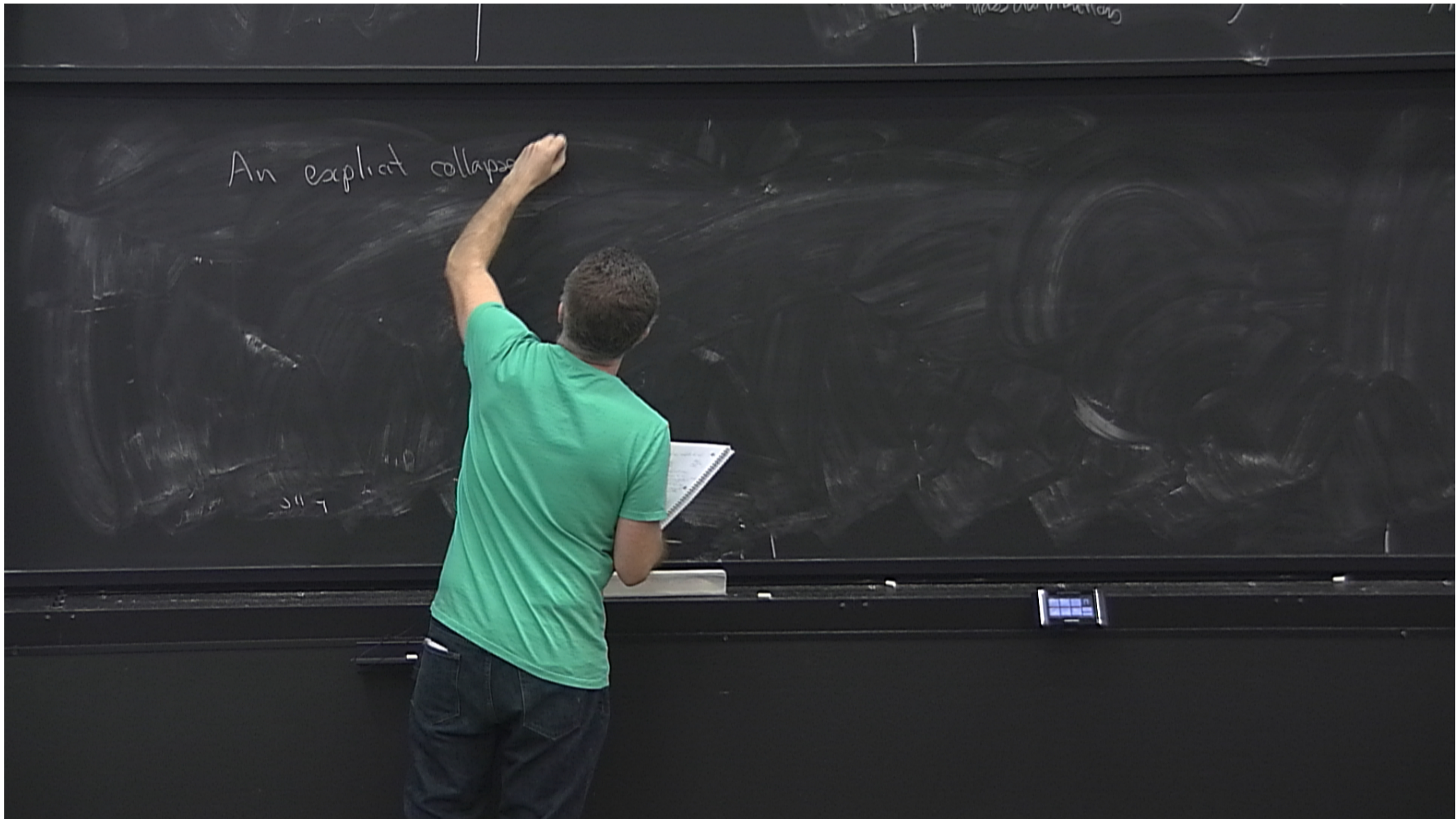
Something has gotta give.

So the wave function has gotta collapse.

$$T = \frac{\hbar}{E_\Delta}$$

$E_\Delta =$ gravitational self energy difference between two mass distributions

$$= G \int \rho(x) \rho(y) / |x-y| d^3x d^3y$$



An explicit collapse model (GRW (1986), Bell (1987))

An explicit collapse model (GRW (1986), Bell (1987))

① The ontology

An explicit collapse model (GRW (1986), Bell (1987))

① The ontology

② the ontic state is given by a wavefunction $\psi(\vec{r}_1, \vec{r}_2, \dots, \vec{r}_n, t)$ at time t

③

An explicit collapse model (GRW (1986), Bell (1987))

① The ontology

② the ontic state is given by a wavefn $\psi(\vec{r}_1, \vec{r}_2, \dots)$ at time t

③ A way to get local beables $\rightarrow$ Bell

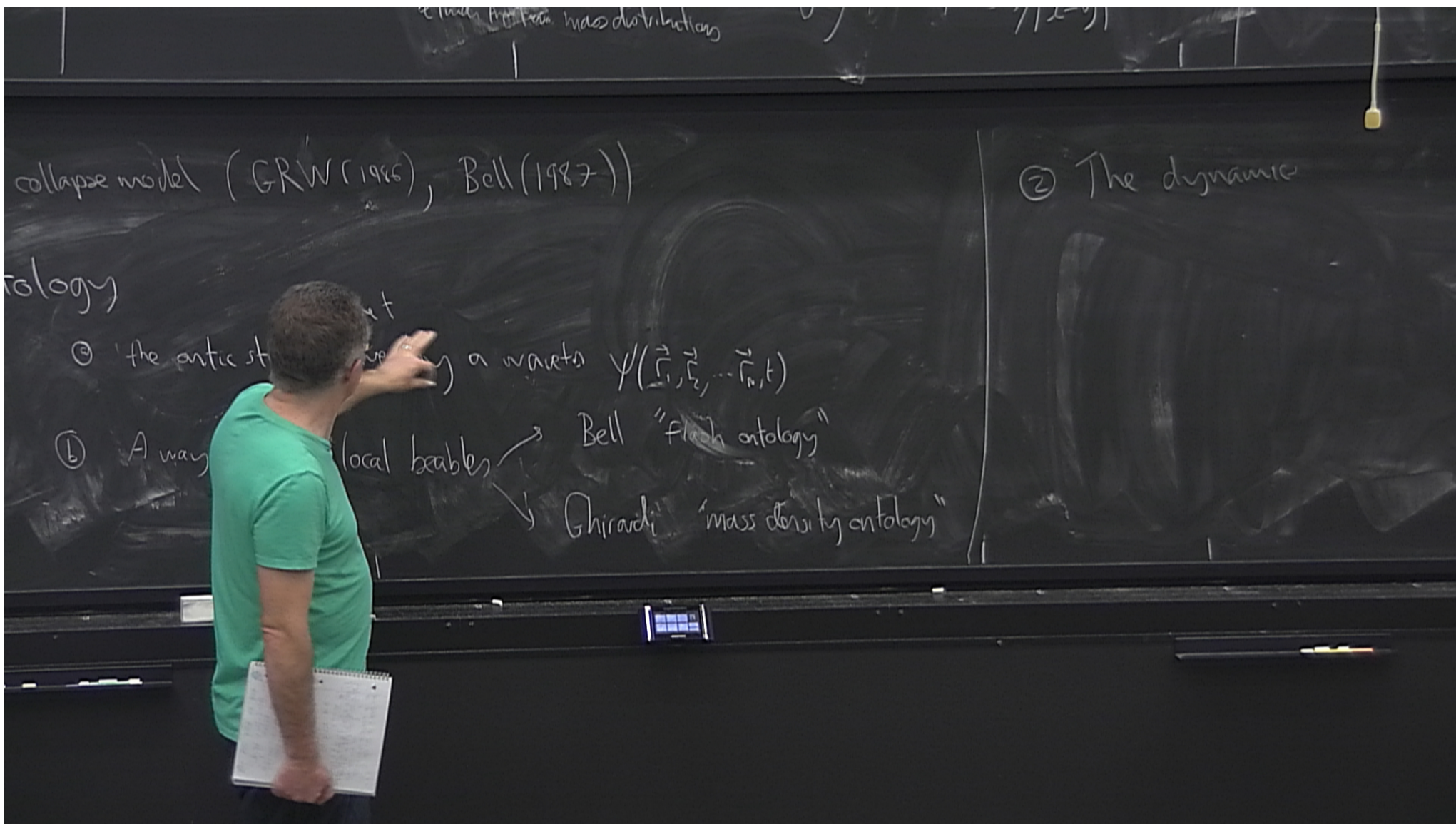
An explicit collapse model (GRW (1986), Bell (1987))

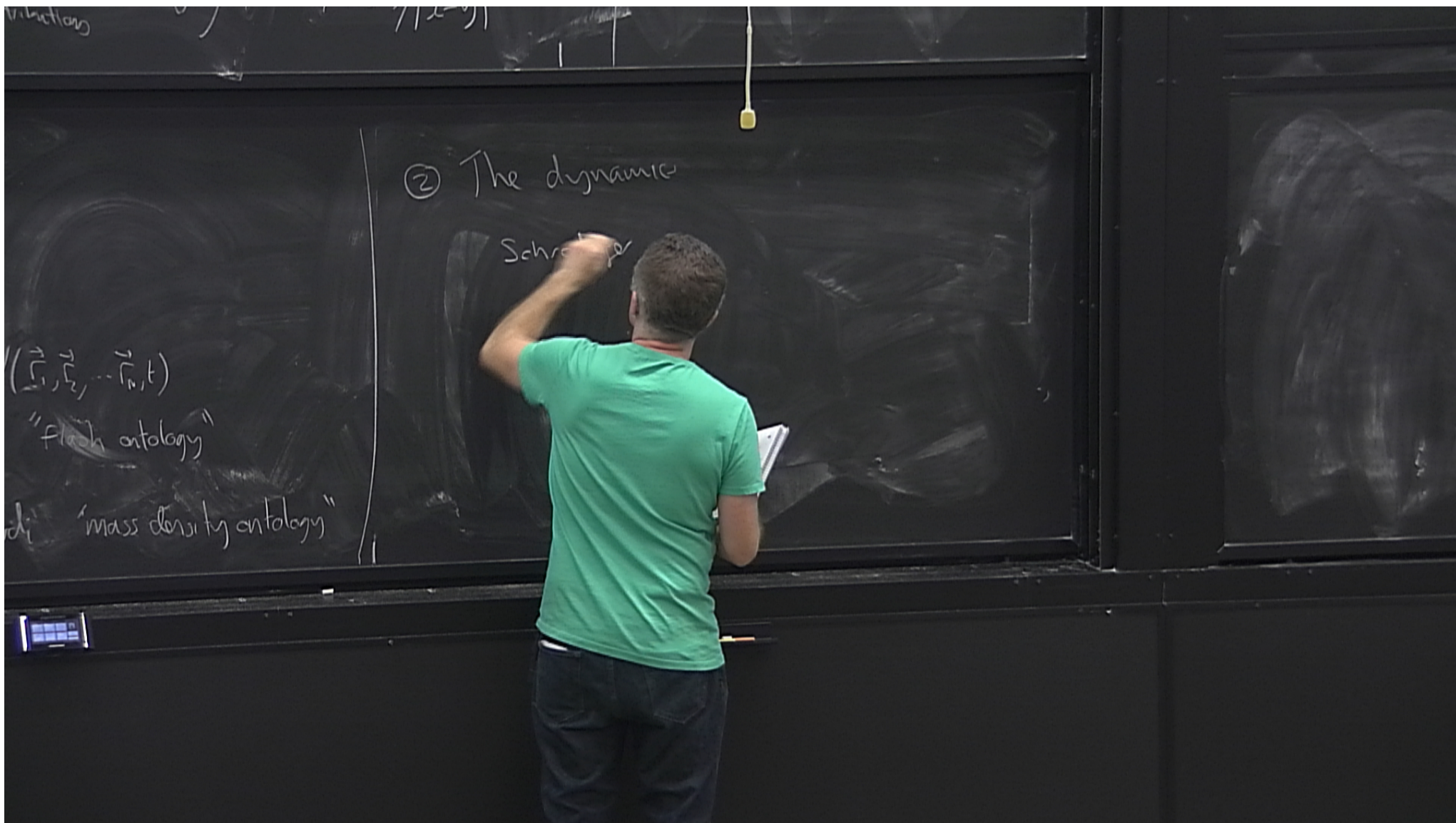
① The ontology

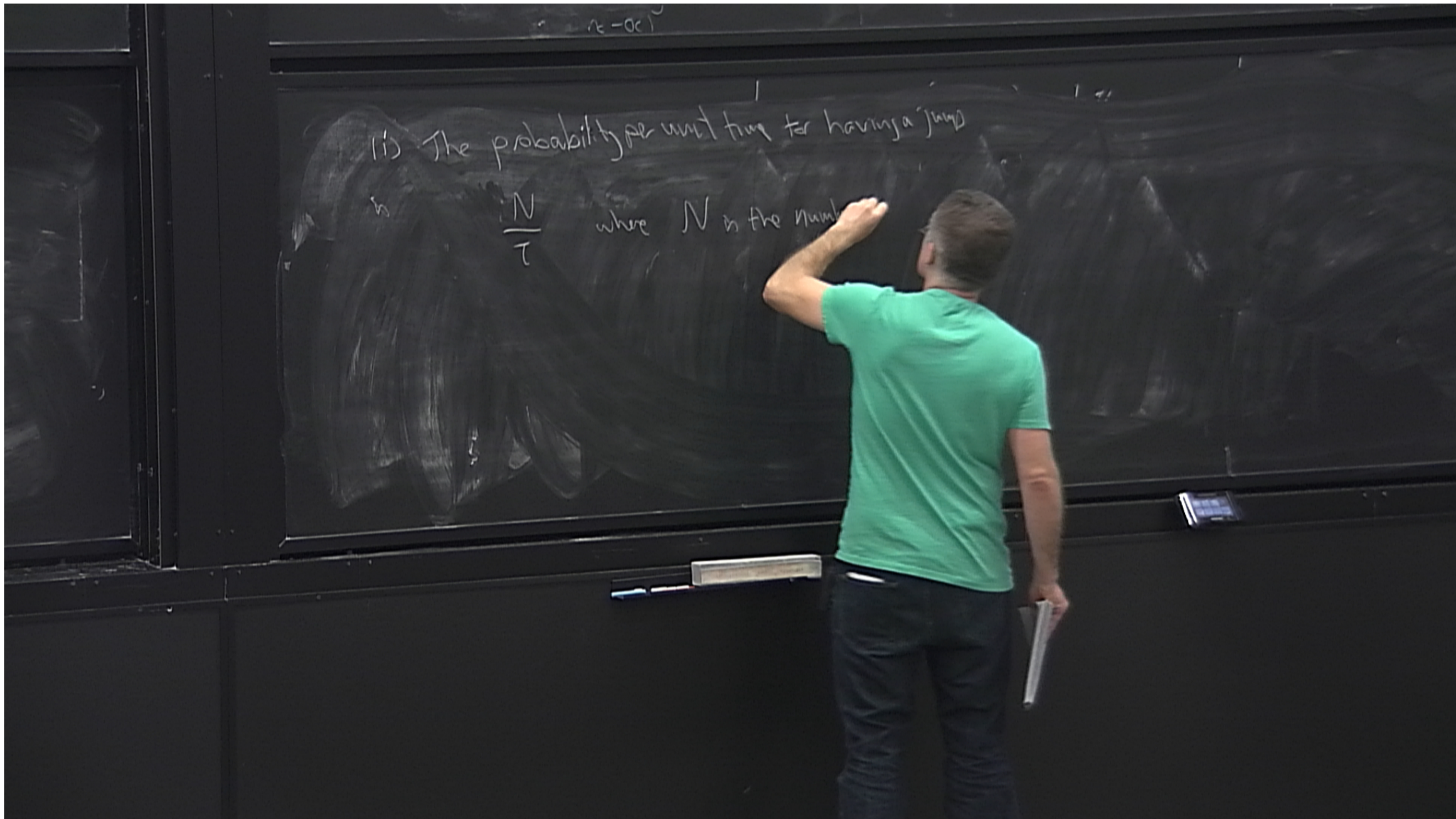
② the ontic state ^{at time t} is given by a wave $\psi(\vec{r}_1, \vec{r}_2, \dots, \vec{r}_N, t)$

③ A way to get local beables $\rightarrow$ Bell "flash ontology"

$\searrow$ Ghirardi "mass density ontology"

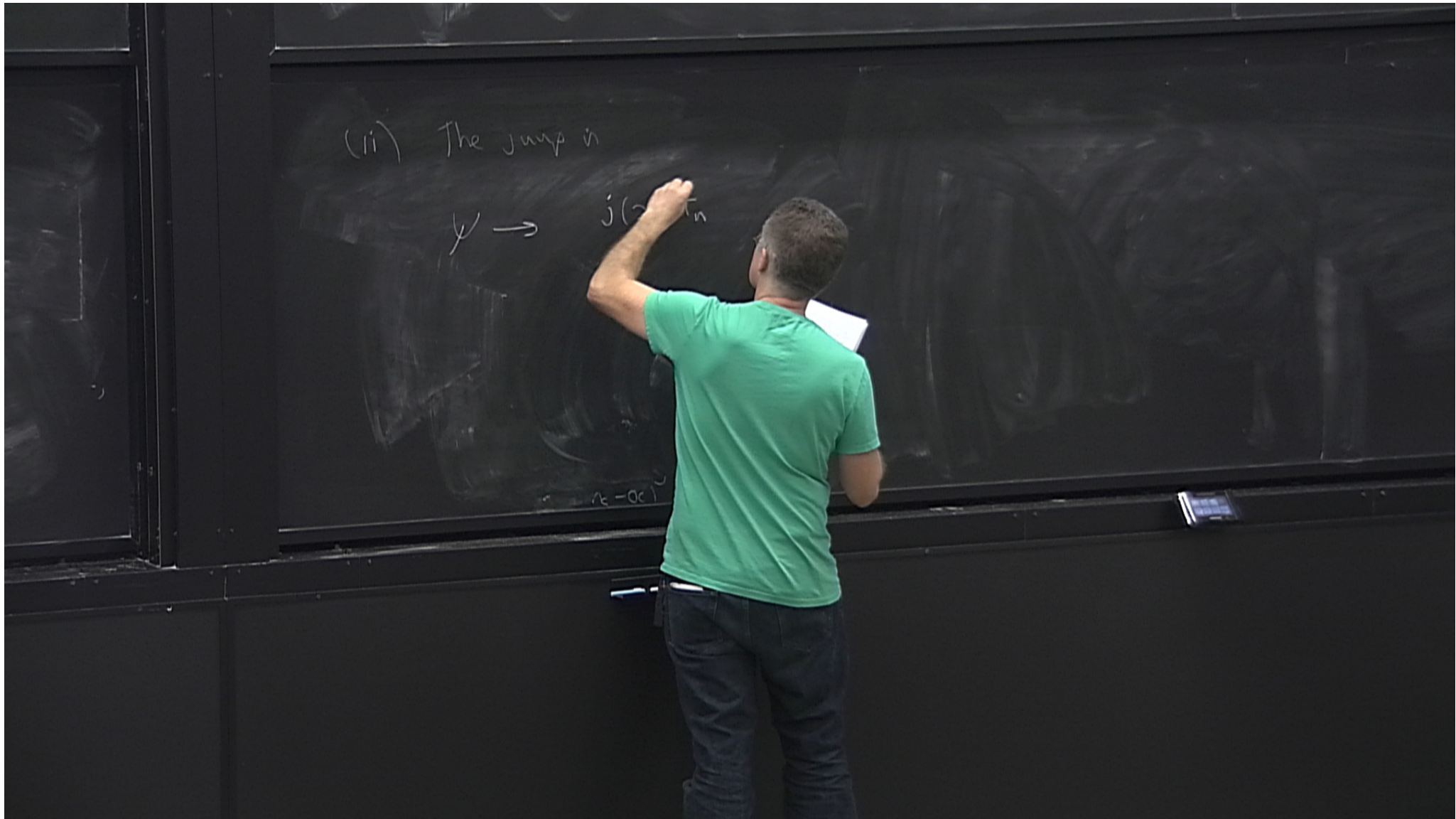






(i) The probability per unit time for having a jump
is $\frac{N}{\tau}$ where N is the number

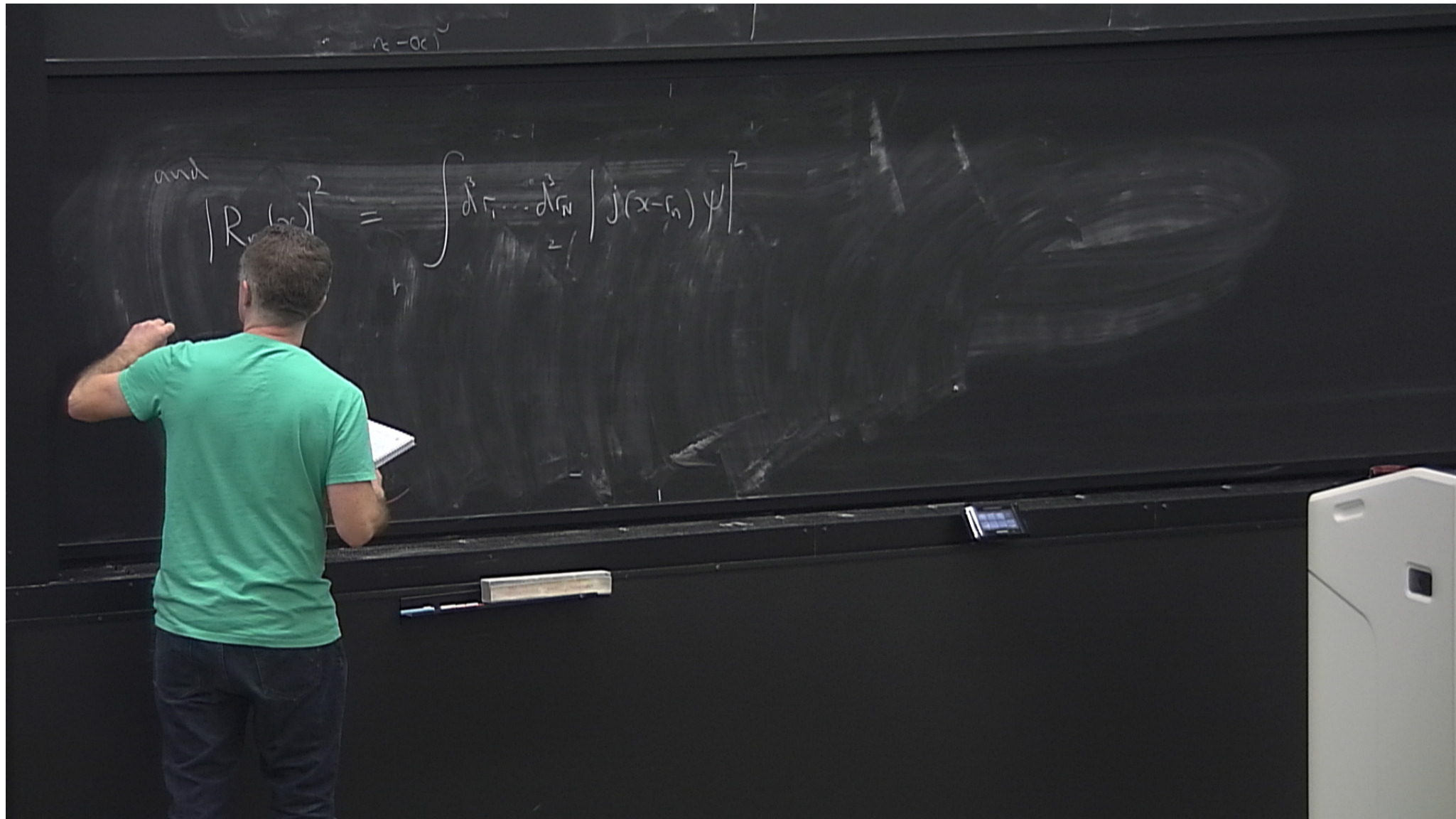
(i) The probability per unit time for having a jump
is $\frac{N}{\tau}$ where N is the number of particles
and τ is a new fundamental constant of nature.



(ii) The jump is

$$\psi \rightarrow \frac{j(\vec{x} - \vec{r}_n) \psi(\vec{r}_n, -\vec{r}_n, t)}{R_n(\vec{x})}$$

where n is chosen at random (from 1 to N)



and

$$|R_n(x)|^2 = \int d\mathbf{r}_1 \dots d\mathbf{r}_N \frac{1}{Z} |j(x-r_n)\psi|^2$$

(iii) The "jump centre" x is chosen randomly

and

$$|R_n(x)|^2 = \int d^3r_1 \dots d^3r_n |j(x-r_n)\psi|^2$$

(iii) The "jump centre" x is chosen randomly.
with prob

$$d^3x |R_n(x)|^2$$

and

$$|R_n(x)|^2 = \int d^3r_1 \dots d^3r_n \frac{1}{2!} |j(x-r_n)\psi|^2$$

(iii) The "jump centre" x is chosen stochastically,
with prob

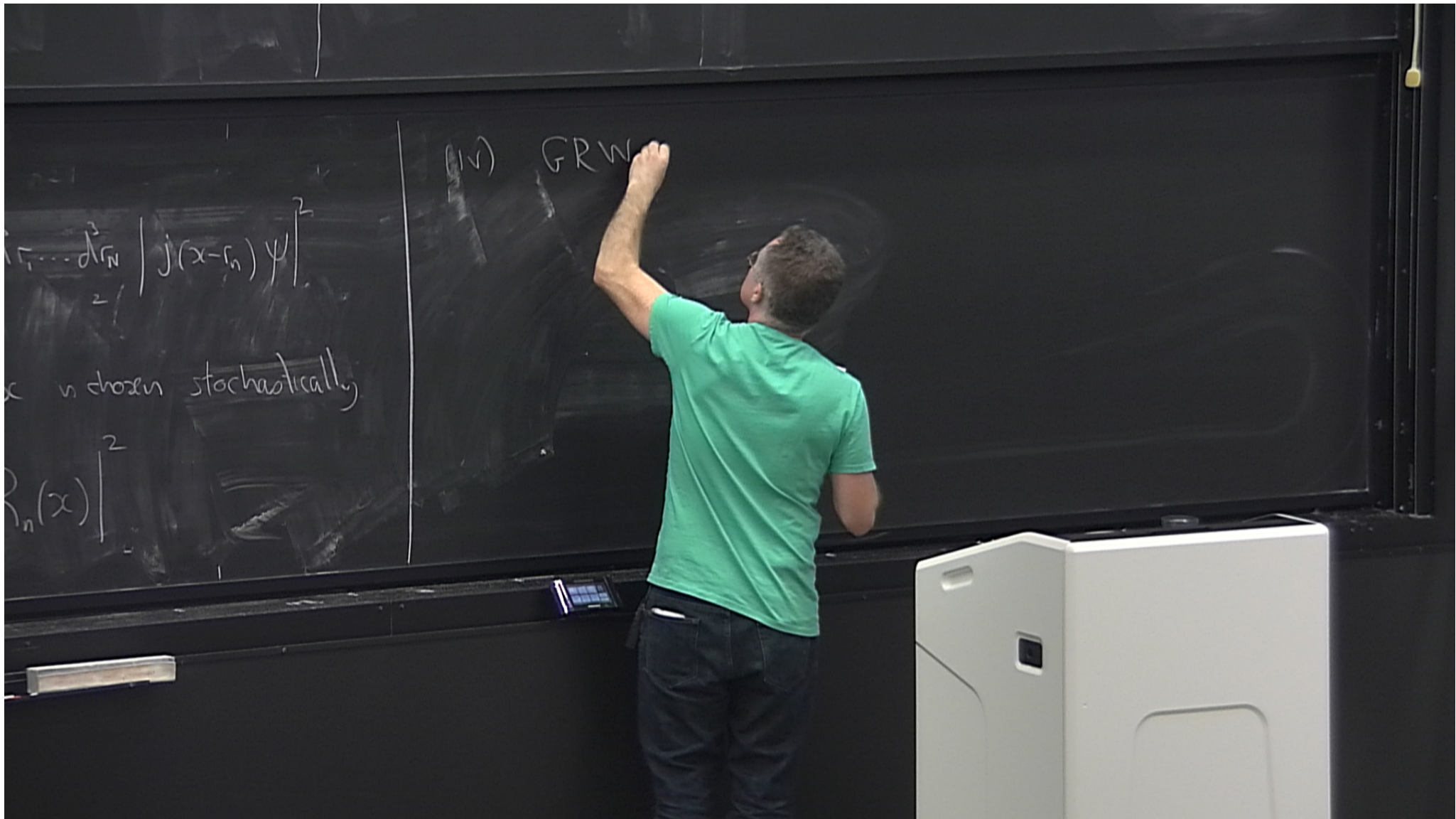
$$d^3\vec{x} |R_n(x)|^2$$

and

$$|R_n(x)|^2 = \int d^3r_1 \dots d^3r_N \left| \sum_{i=1}^N \delta(\vec{r}_i - \vec{r}_n) \psi \right|^2$$

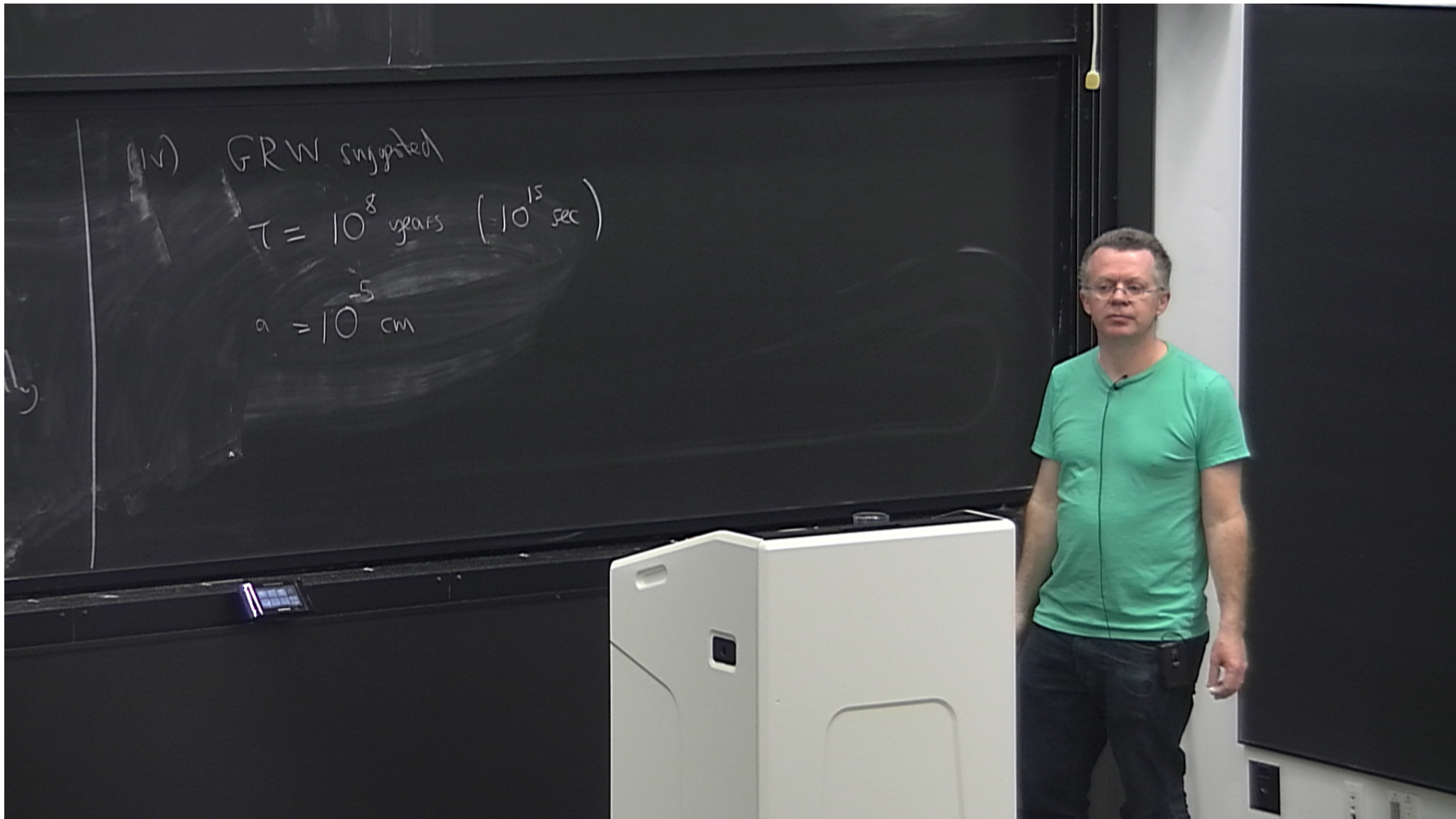
(iii) The "jump centre" x is chosen stochastically,
with prob

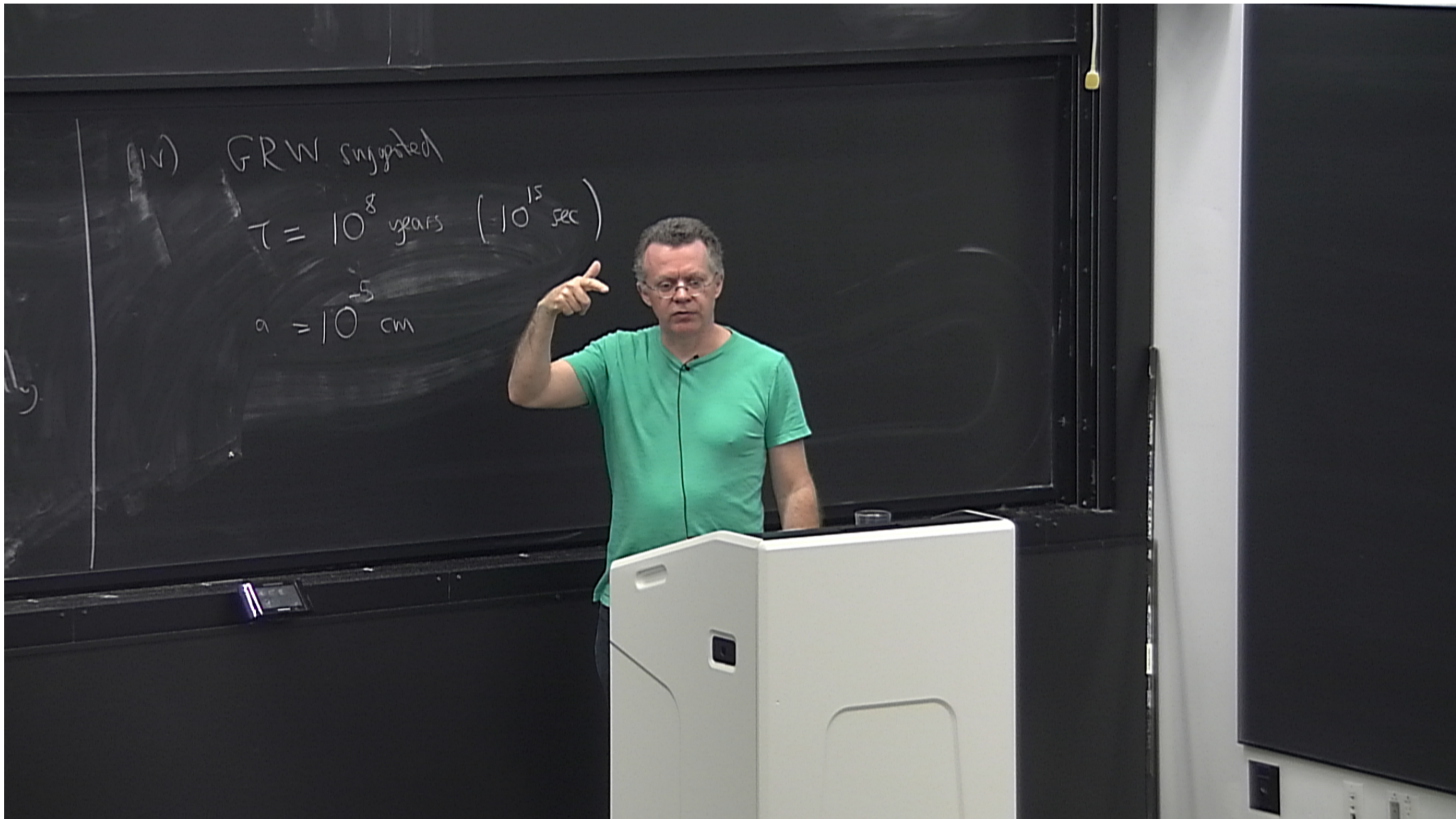
$$d^3\vec{x} |R_n(x)|^2$$



$\int_{\Gamma} \dots d\Gamma_n \left| j(x - \Gamma_n) \psi \right|^2$
 x is chosen stochastically,
 $\left| R_n(x) \right|^2$

(iv) GRW

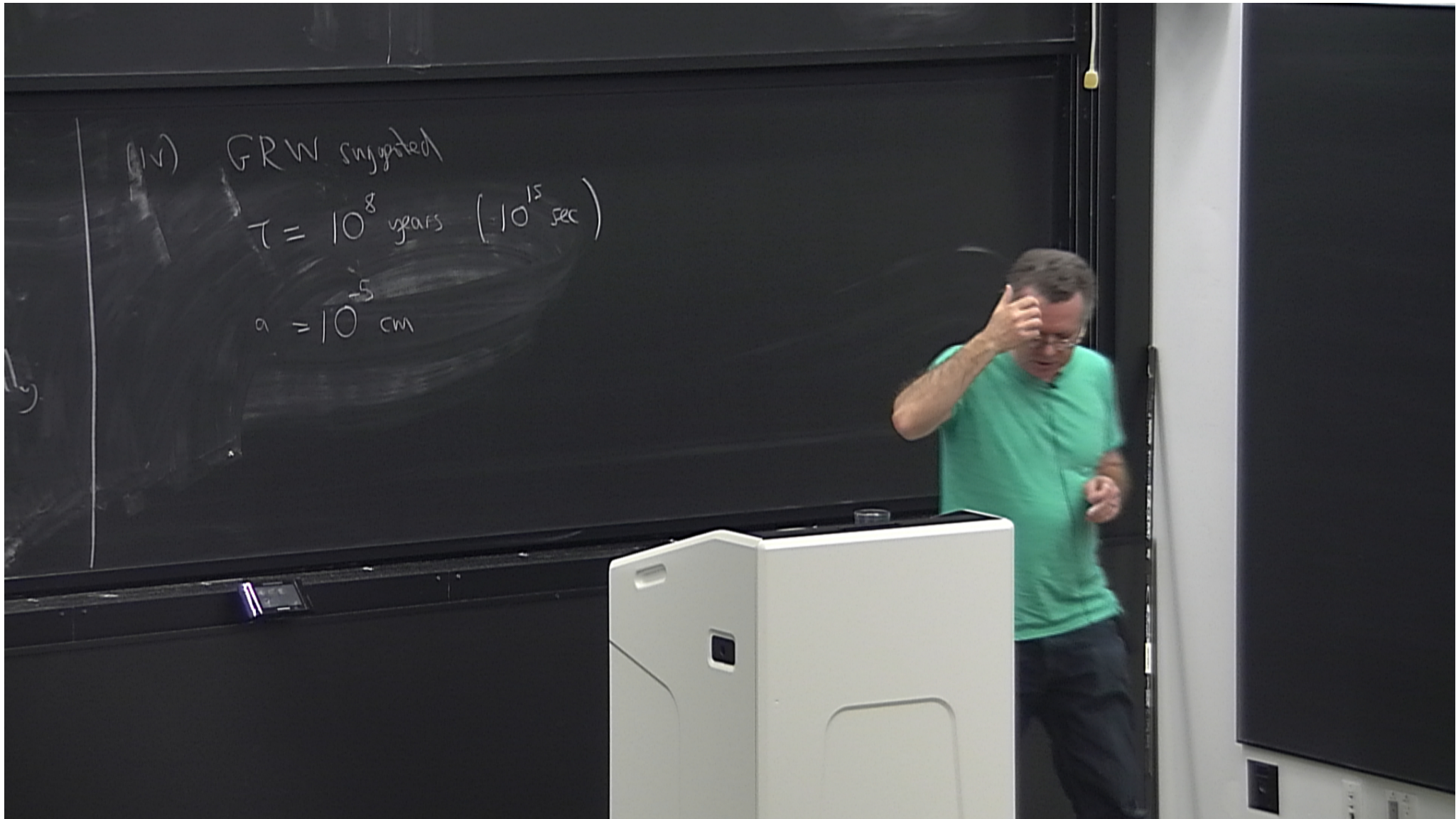




(iv) GRW suggested

$$\tau = 10^8 \text{ years} \ (10^{15} \text{ sec})$$

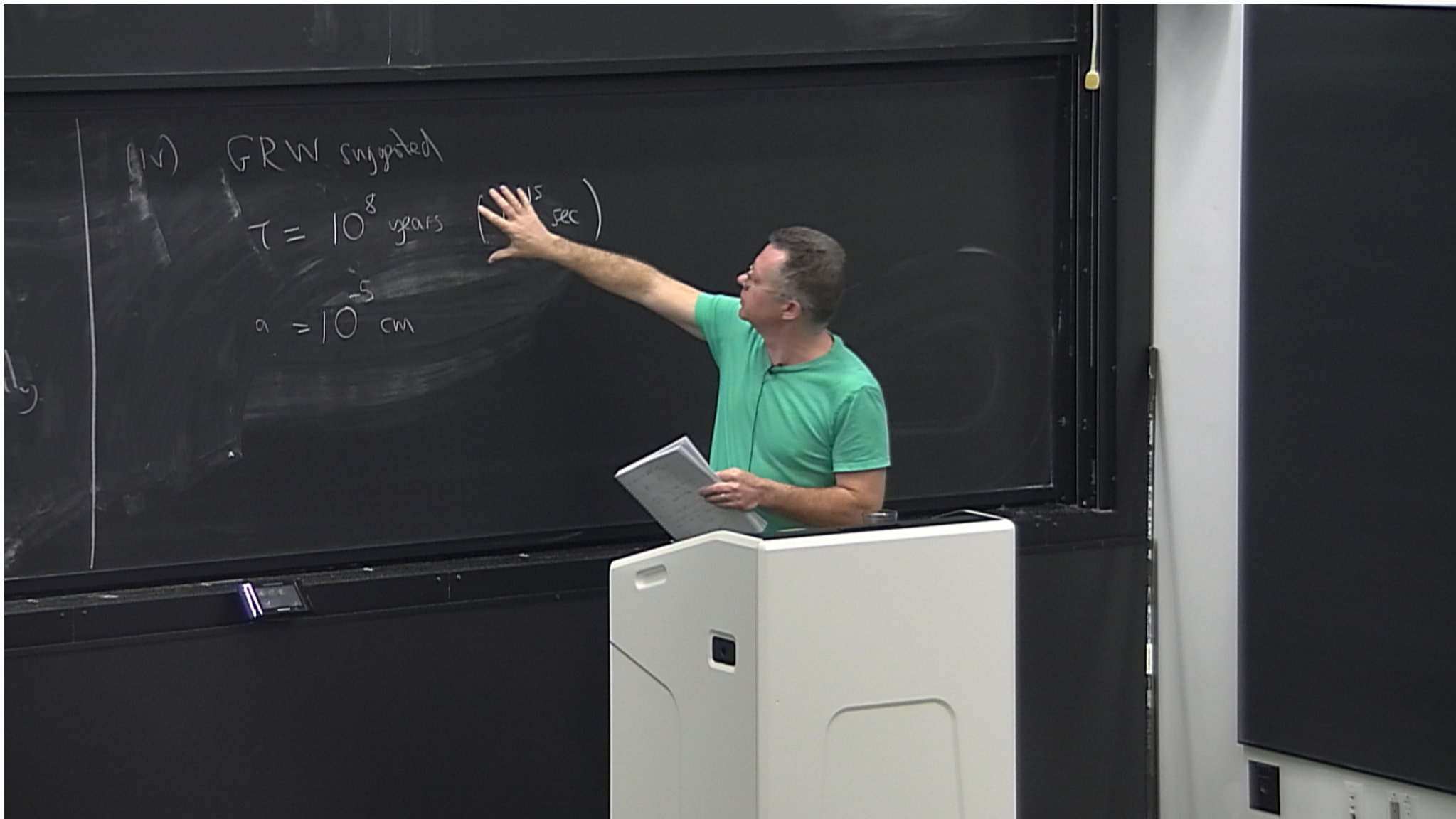
$$a = 10^{-5} \text{ cm}$$



(iv) GRW suggested

$$\tau = 10^8 \text{ years } (10^{15} \text{ sec})$$

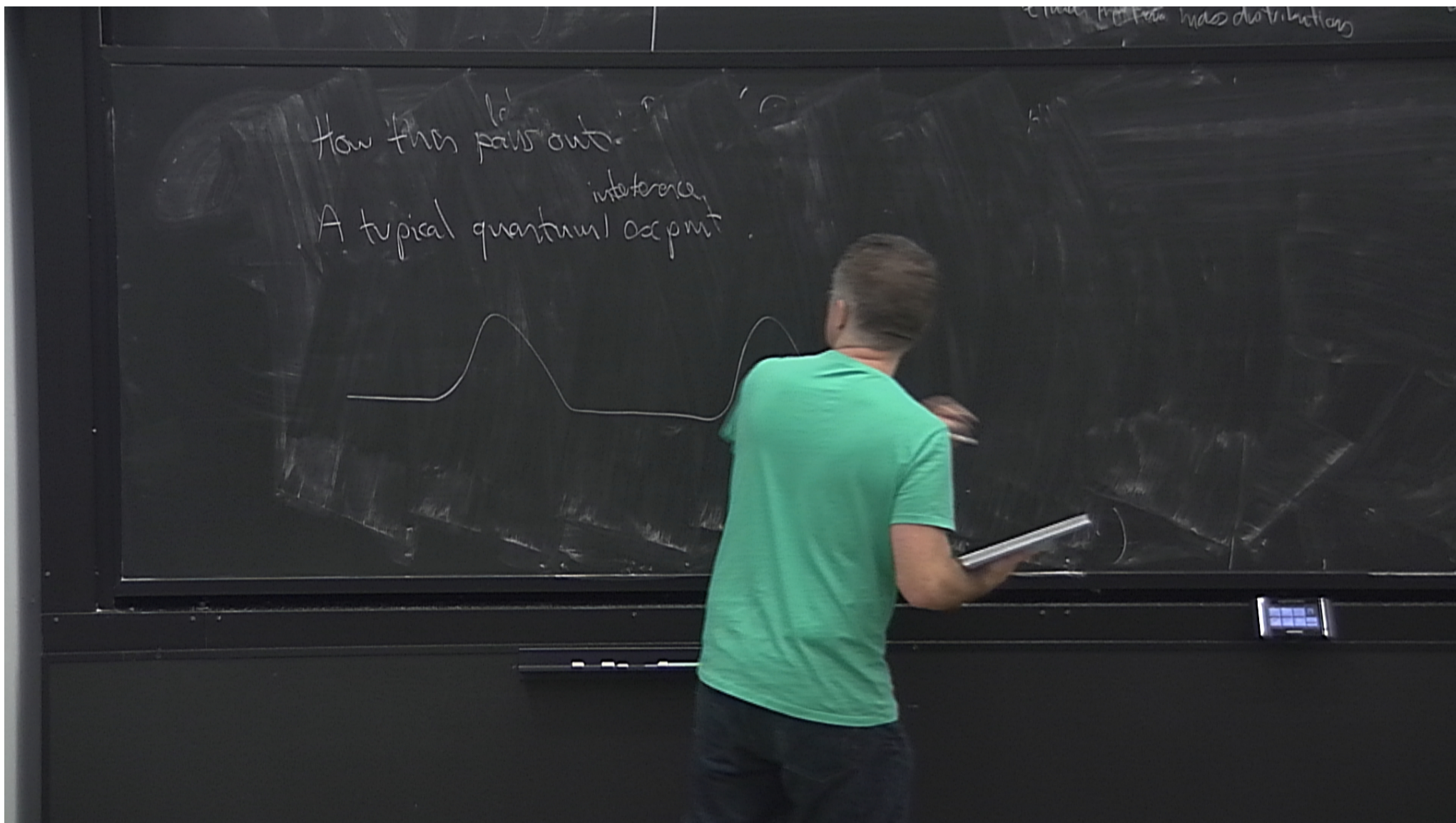
$$a = 10^{-5} \text{ cm}$$



(iv) GRW suggested

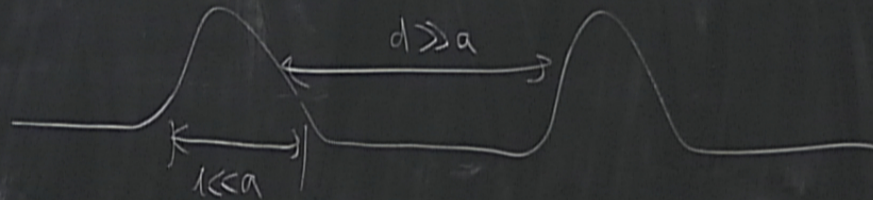
$$\tau = 10^8 \text{ years} \left(10^{15} \text{ sec} \right)$$

$$a = 10^{-5} \text{ cm}$$



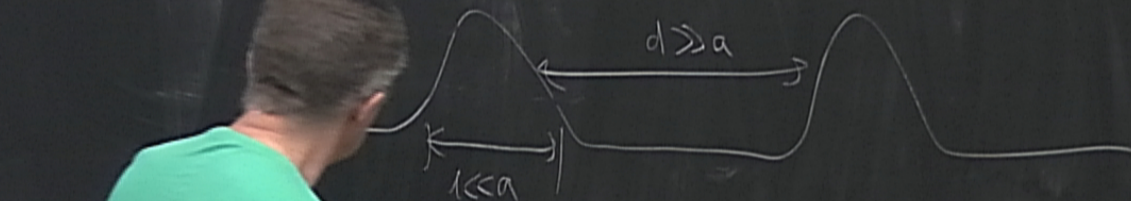
How then pass out?

A typical quantum ^{interference} experiment



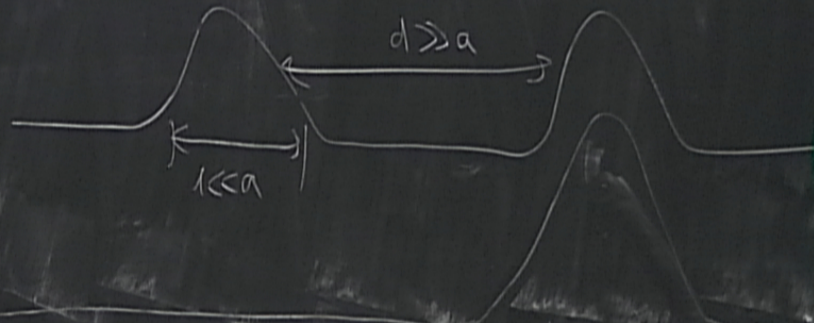
How then pass out?

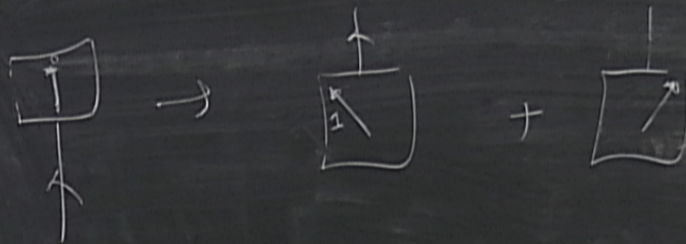
A typical quantum ^{interference} experiment



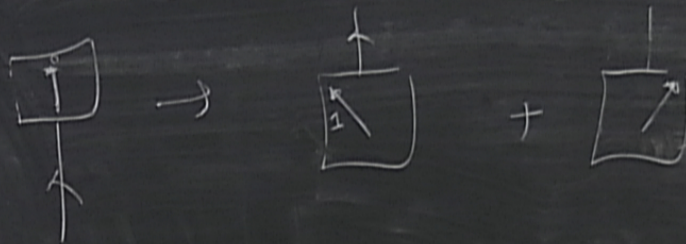
How then pass out?

A typical quantum ^{interference} experiment

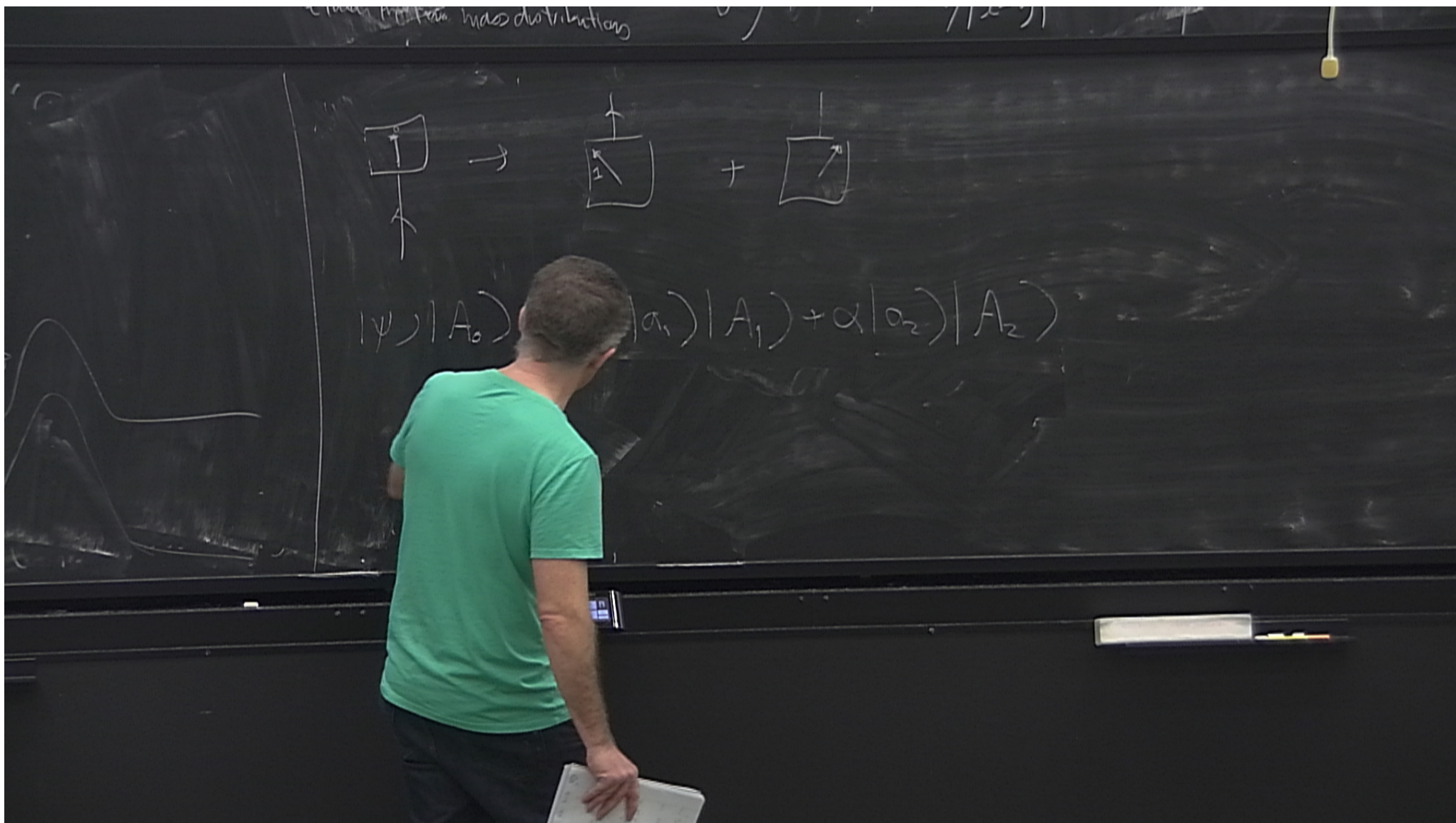


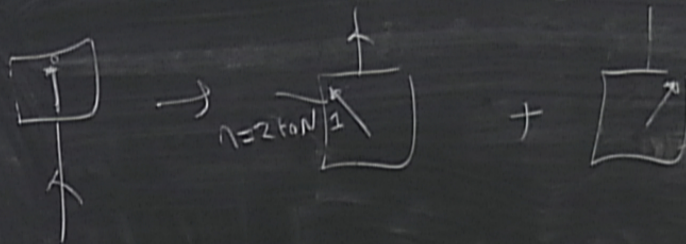


$$|\psi\rangle|A_0\rangle \rightarrow \alpha|a_1\rangle|A_1\rangle + \alpha|a_2\rangle|A_2\rangle$$



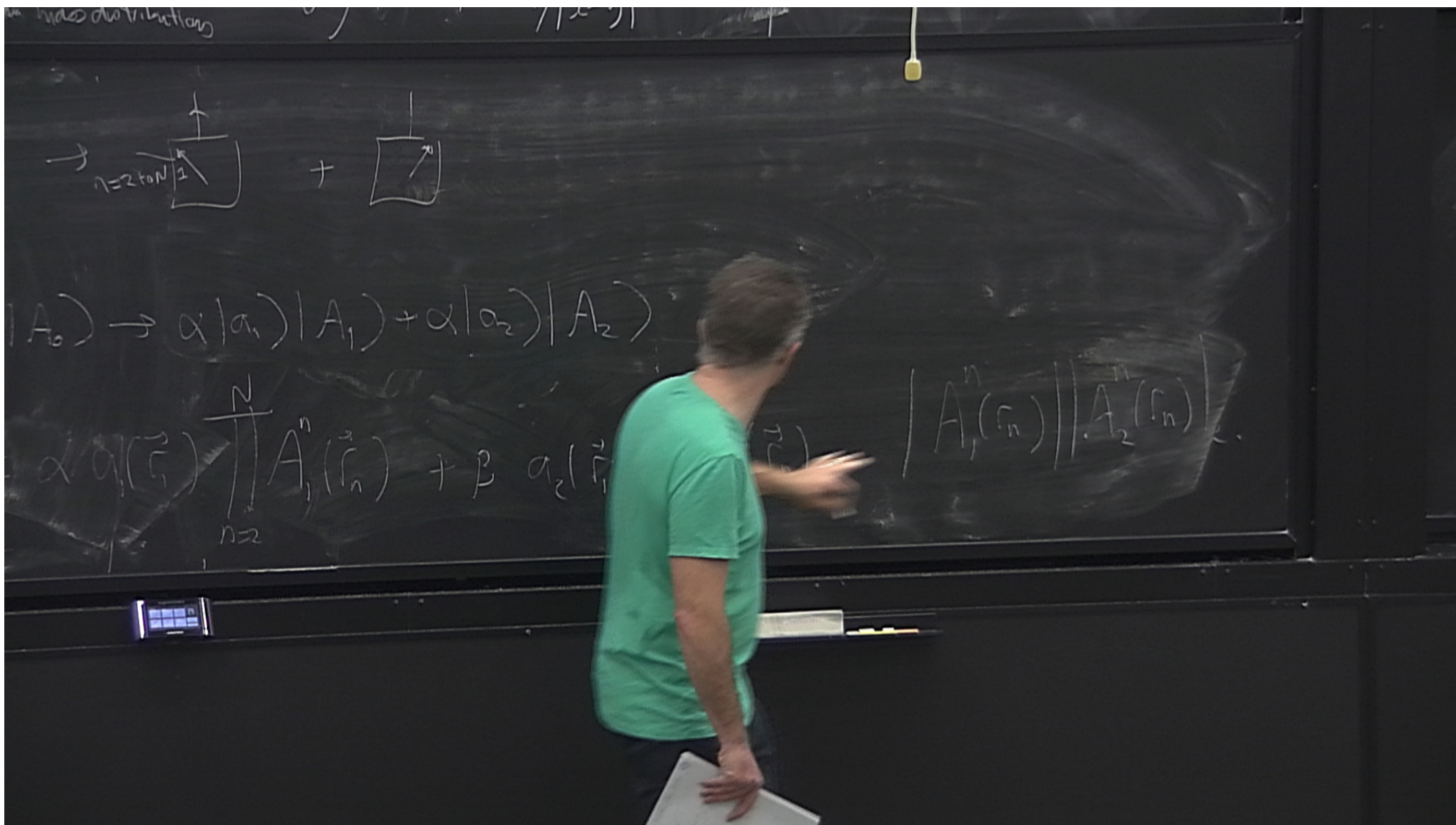
$$|\psi\rangle|A_0\rangle \rightarrow \alpha|a_1\rangle|A_1\rangle + \alpha|a_2\rangle|A_2\rangle$$

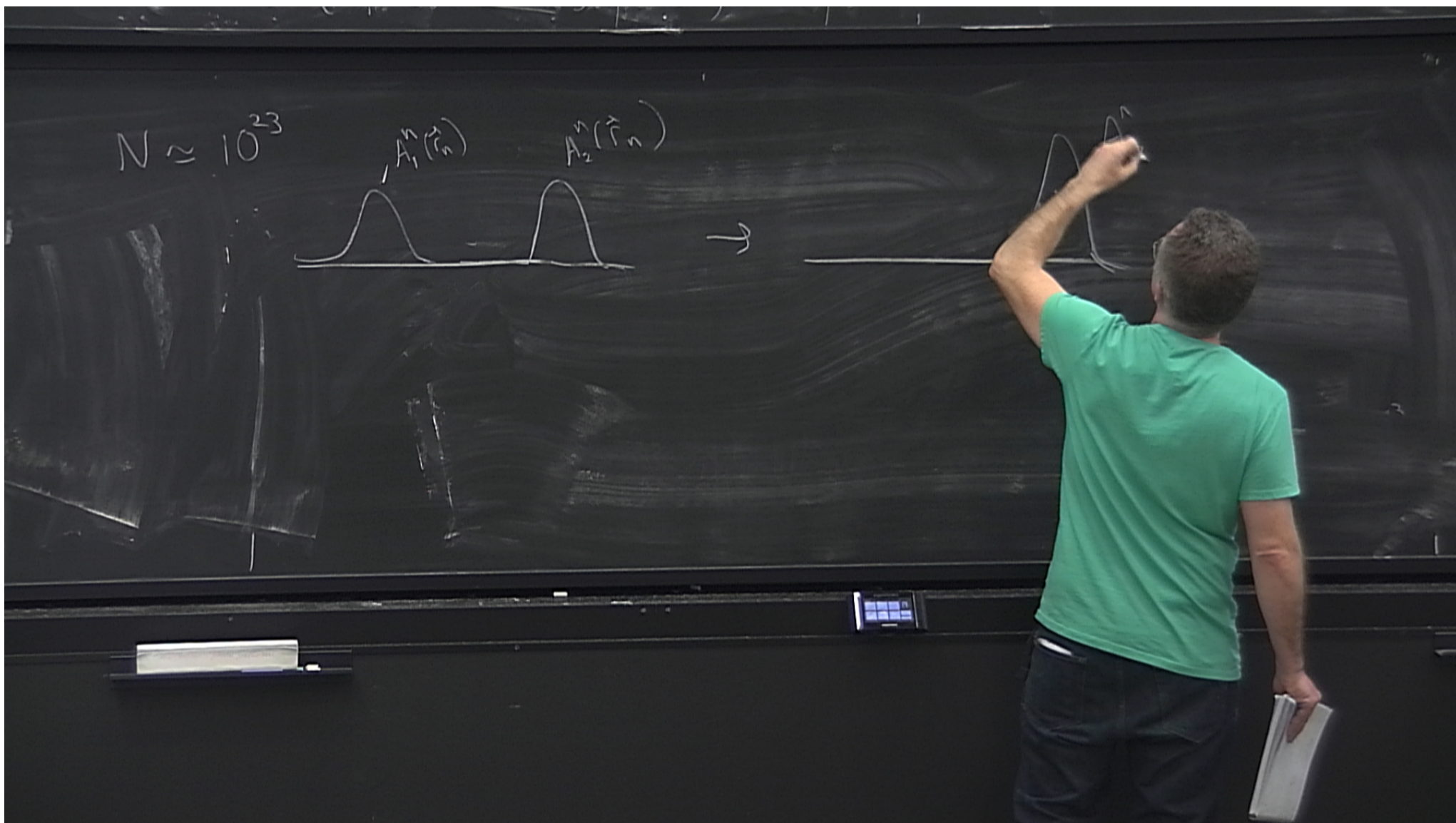




$$|\psi\rangle|A_0\rangle \rightarrow \alpha|\alpha_1\rangle|A_1\rangle + \alpha|\alpha_2\rangle|A_2\rangle$$

$$\approx \alpha a(\vec{r}) \prod_{n=2}^N A_1(r_n) + \beta a_2(r_1) \prod_{n=2}^N A_2(r_n)$$





$$N \approx 10^{23}$$



a single jump collapses the entire wavefunction.