Title: Quantum Foundations Lecture

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Collection: Quantum Foundations

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URL: https://pirsa.org/24020026

Collapse models. Pearl, GRW

↑ Bell

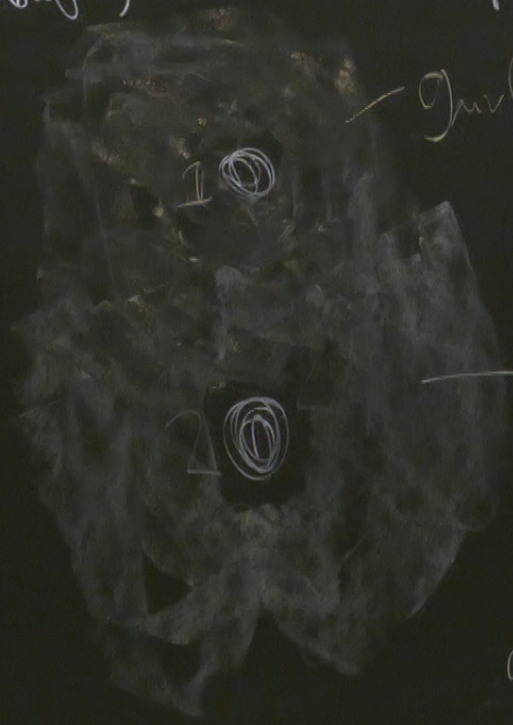
Motivation is to solve meas. prob by explicitly modifying Schrö eqn.
so that:

small object hardly influenced by modification
⇒ still see quantum interference, etc...

large object: evolution should be strongly influenced by modification so very quickly get collapse.

Possible physical justification from Quantum

large(enough) mass in superposition



$g_{\mu\nu}(x)[1]$

$g_{\mu\nu}(x)[2]$

something has

$\Rightarrow$ collapse

diffeomorphism invariance

$\Rightarrow$ no way of identifying points

l justification from Quantum Gravity

perposition

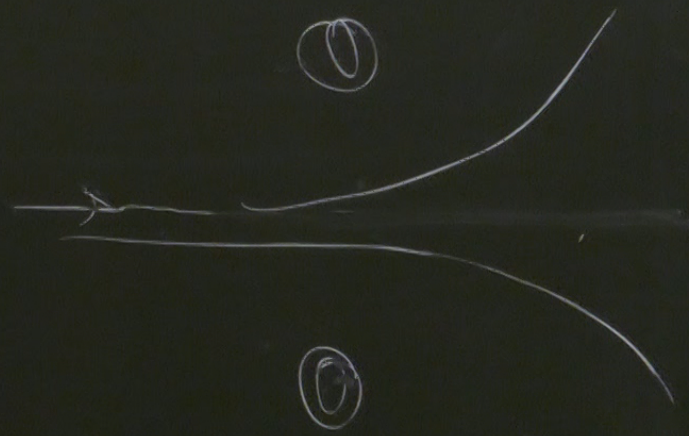
$g_{\mu\nu}(x)[1]$

$g_{\mu\nu}(x)[2]$

something has gotta give

$\Rightarrow$ collapse.

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



E_Δ

diffeomorphism invariance
$\Rightarrow$ no way of identifying points

Bell presentation)

ntology:

a) a wavefn $\psi(\vec{r}_1, \vec{r}_2, \ldots \vec{r}_N, t)$

b) a way to get local beables → Bell flash ontology
→ Ghirardi mass density approach

GRW (Bell presentation)

(1) The ontology:

(a) a wavefn $\psi(\vec{r}_1, \vec{r}_2, \ldots \vec{r}_N, t)$

(b) a way to get local beables → Bell f
→ Ghirardi

(2) Time dynamics.

Schrö evolution except when jump events occur.

approach

More details.

(i) Probability per unit time per particle for a jump is

$\frac{1}{\tau}$ τ as a new fundamental constant of nature

$$\text{prob}(m \text{ events in time } T) = \frac{e^{-(NT/\tau)}\left(\frac{N}{\tau}\right)^m}{m!}$$

Usual choice for $j(\vec{x})$ is

$$j(x) = k \exp\left(-|\vec{x}|^2/2a^2\right)$$

a is also a fundamental constant of nature.

$$|R_n(\vec{x})|^2 = \int d^3\vec{r}_1 d^3\vec{r}_2 \cdots d^3\vec{r}_N \left| j(\vec{x}-\vec{r}_n)\, \psi(\vec{r}_1, \cdots \vec{r}_N, t) \right|^2$$

mass density approach

(ii) The jump has an effect on ψ.

Choose n (from 1 to N) randomly

$$\psi \longrightarrow j(\vec{x} - \vec{r}_n)\, \psi(\vec{r}_1, \ldots \vec{r}_N, t) \Big/ R_n(\vec{x})$$

$\vec{x}$ is the jump centre chosen randomly according to a prob distribution in (iii).

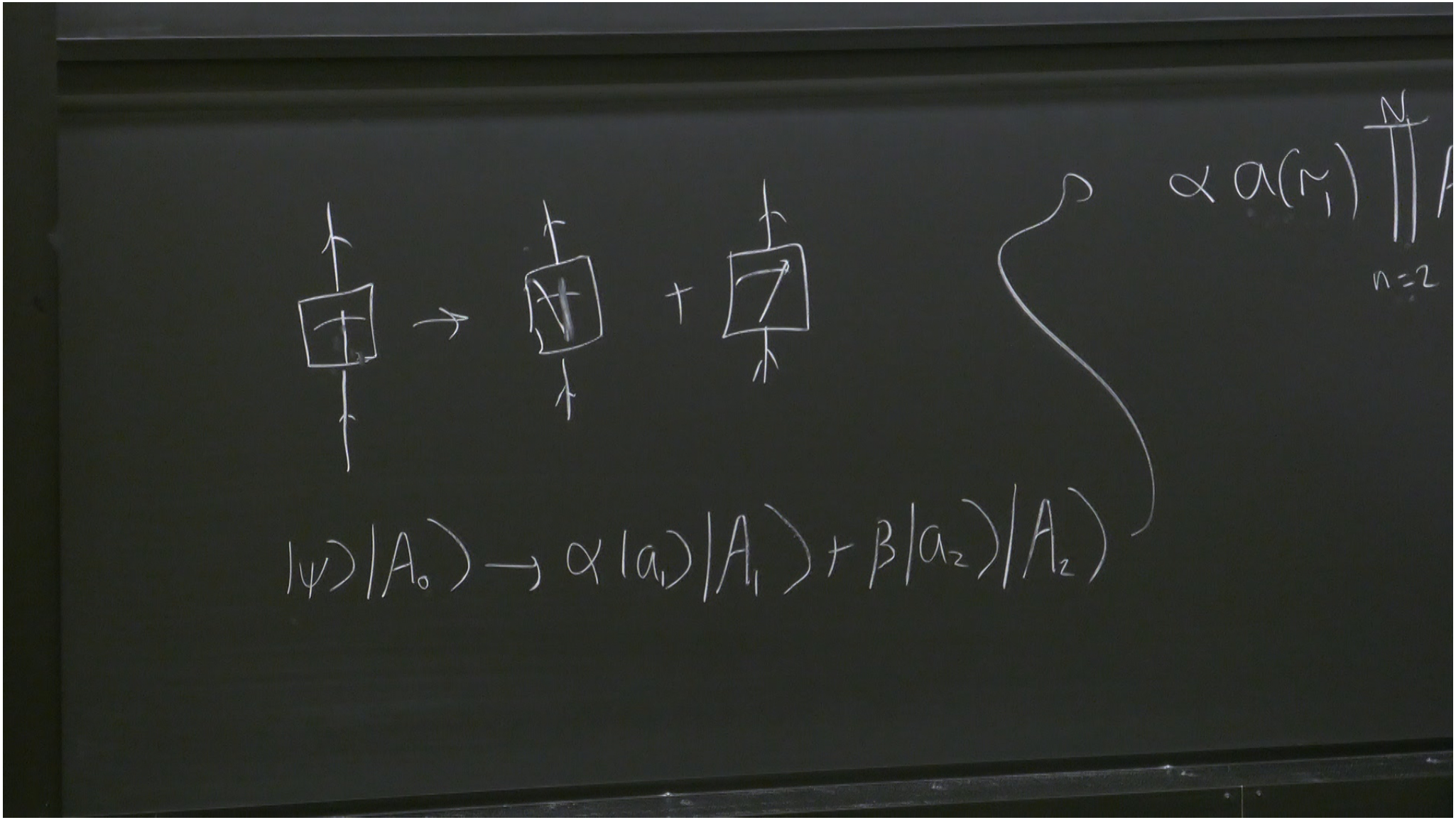
(normalise $j(x)$ $\int d^3\vec{x}\, |j(x)|^2 = 1$

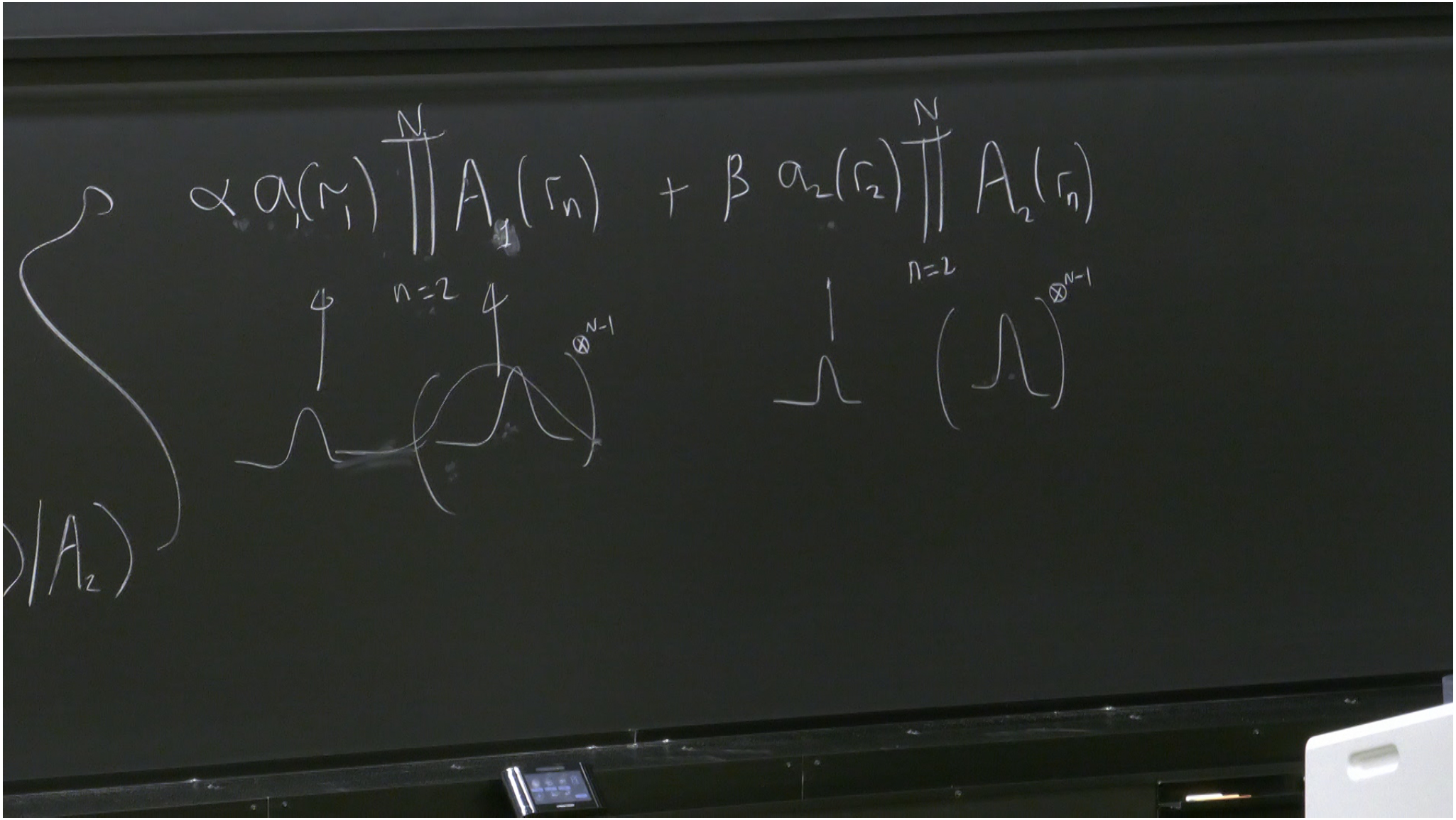
(iii) The 'jump centre' $\vec{x}$ is chosen randomly with prob distribution

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

(iv) GRW $\tau = 10^{15}$ sec $\simeq 10^8$ years $\frac{N}{\tau}$.

$a = 10^{-5}$ cm


$\alpha\, a(r_1) \prod_{n=2}^{N}$
$|\psi\rangle|A_0\rangle \rightarrow \alpha|a_1\rangle|A_1\rangle + \beta|a_2\rangle|A_2\rangle$


$\alpha\, a_1(r_1) \prod_{n=2}^{N} A_1(r_n) + \beta\, a_2(r_2) \prod_{n=2}^{N} A_2(r_n)$
$n=2$
$\otimes^{N-1}$
$\otimes^{N-1}$
$A_2)$

Criticisms

(1) Hard to make covariant.

(2) Model is ad hoc.

(3)