

Title: Interpretation of Quantum Theory: Lecture 26 (Bonus)

Date: Apr 12, 2005 04:00 PM

URL: <http://pirsa.org/05040055>

Abstract:

(1) Quantum computation:



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$IP >$



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$$\langle a | U | p \rangle$$

$$|p\rangle = U_p |00\dots 0\rangle$$



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$$|p\rangle = U_p |00\dots 0\rangle$$

$$|a\rangle = U_a |00\dots 0\rangle$$

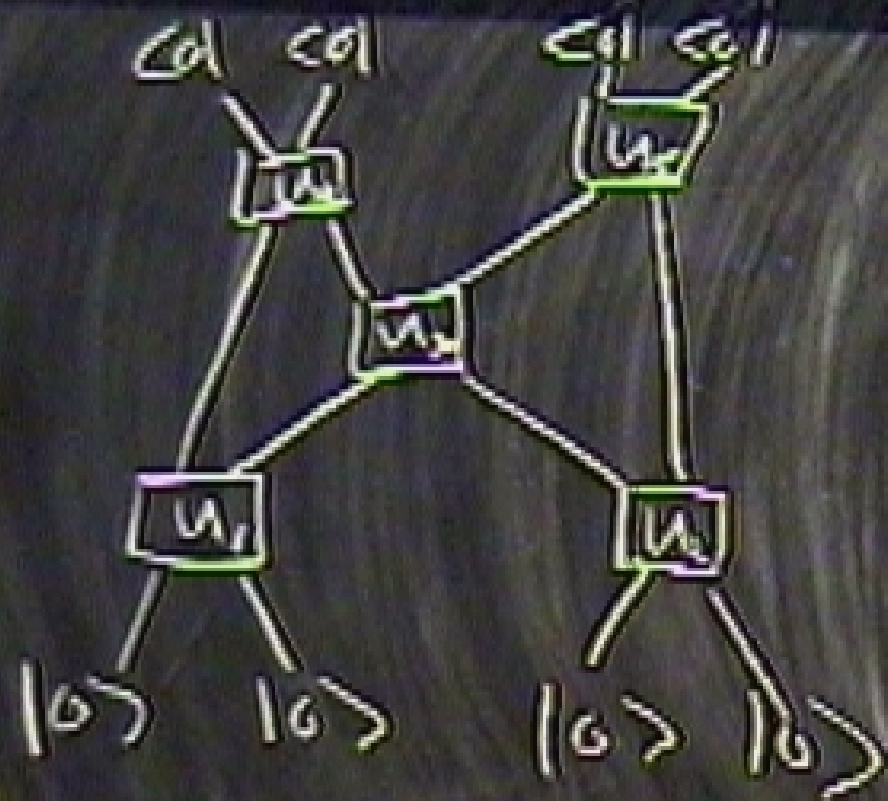
(1) Quantum computation:

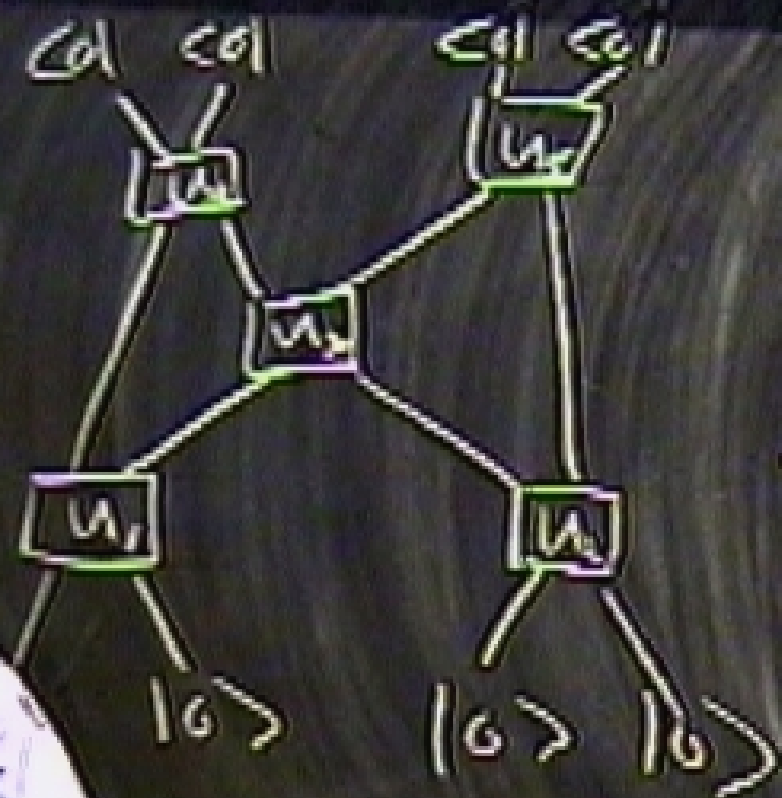
$$A = \langle a | U | p \rangle$$

$$A = \langle 00 \dots 0 | U_n \dots U_2 U_1 | 00 \dots 0 \rangle$$

$$|p\rangle = U_p |00 \dots 0\rangle$$

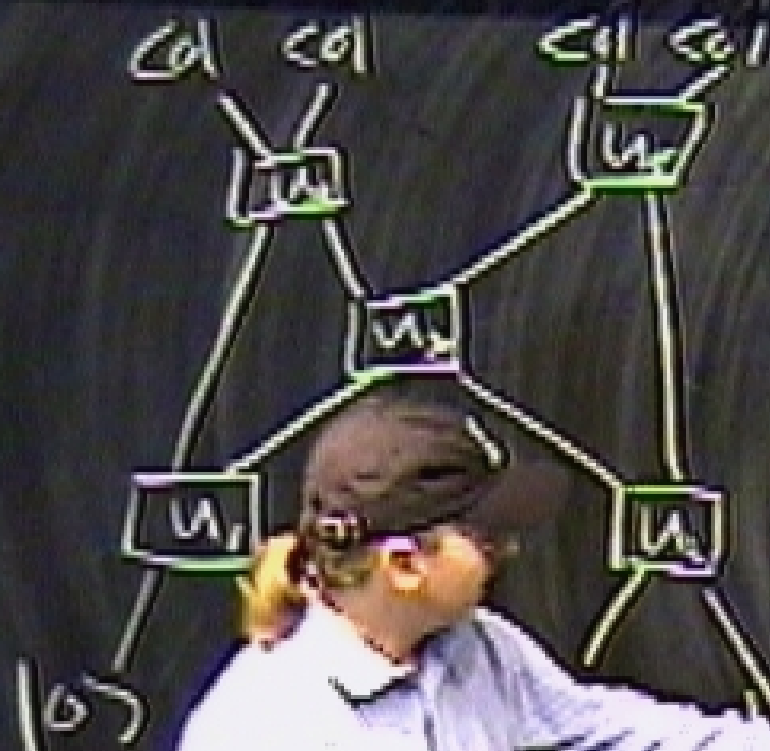
$$|a\rangle = U_a |00 \dots 0\rangle$$





$(N, B, \exists)$
'universal'
computations

t ↑



($N, B, \exists$
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Basic idea: each RC corresponds to
 α

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N.B. QC has a causal structure
(a set of 2^n related causal structures)



$\Rightarrow$

$$e^{-i\theta A}$$

$$A = A^\dagger$$





e.g.

$$\Leftrightarrow e^{-i\theta A}$$

$$A = A^\dagger$$

$$A = P$$

$$P^2 = P$$

$$\text{e.g. } P = P(\text{triplet})$$

$$e^{-i\theta P} = \text{continuous SWAP}$$



$$\Rightarrow e^{-i\theta A}$$

$$A = A^\dagger$$

e.g.

$$A = P$$

$$P^2 = P$$

e.g. $P = P(\text{triplet})$

$$e^{-i\theta P} \approx \text{contin.}$$

two eigenvalues

$$P(1) = P, \quad P(0) = 1 - P$$





$$\boxed{u} = P(0) + e^{-\theta} P(1)$$

↑
scattering



$$\begin{array}{c}
 \boxed{u} \\
 \nearrow \quad \searrow
 \end{array}
 = P(0) + e^{-\theta} P(1)$$

$\nearrow$ no scattering
 non-event

$\uparrow$ scattering $\rightarrow$ event



$$\boxed{u} = P(0) + e P(1)$$

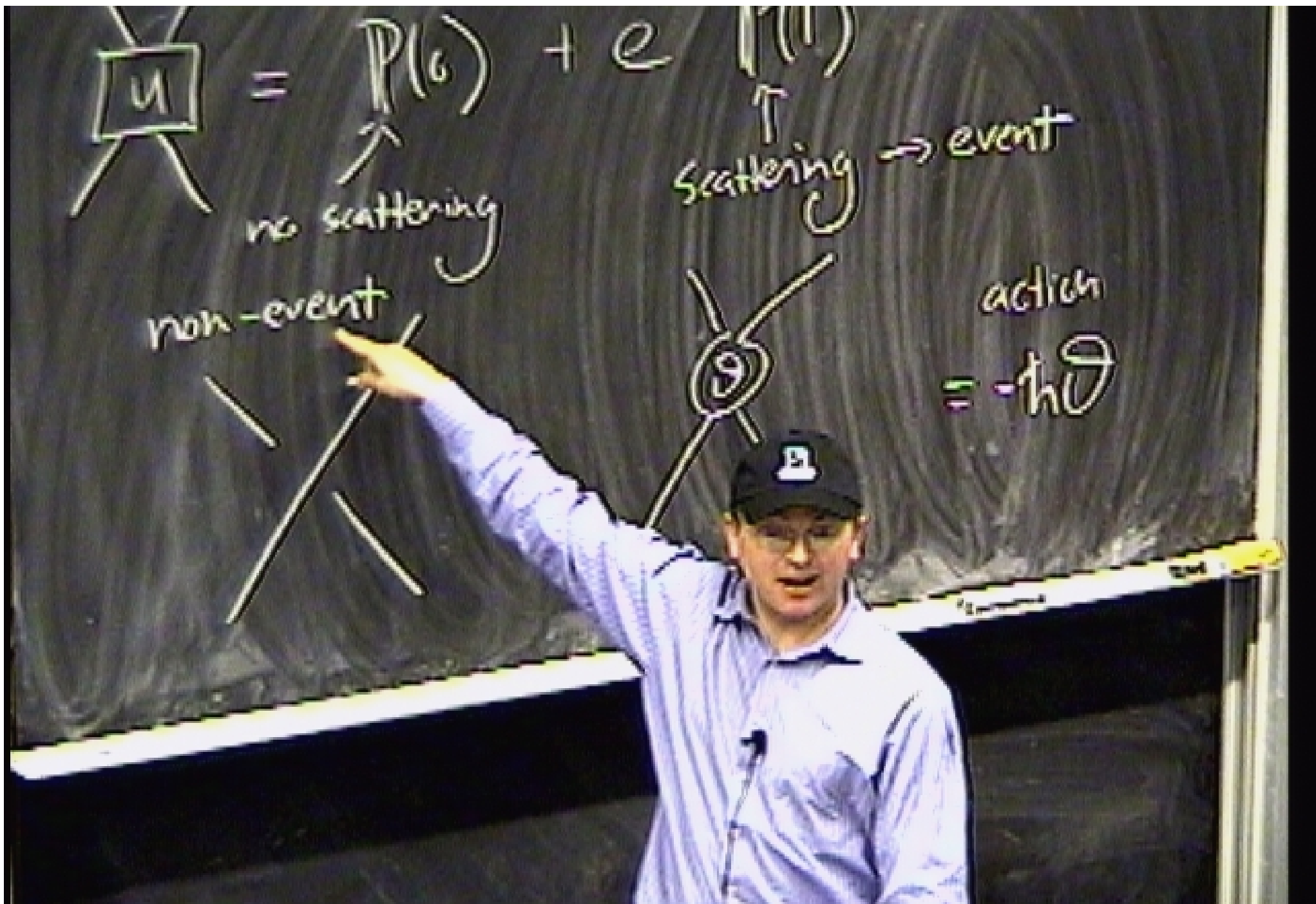
no scattering
non-event

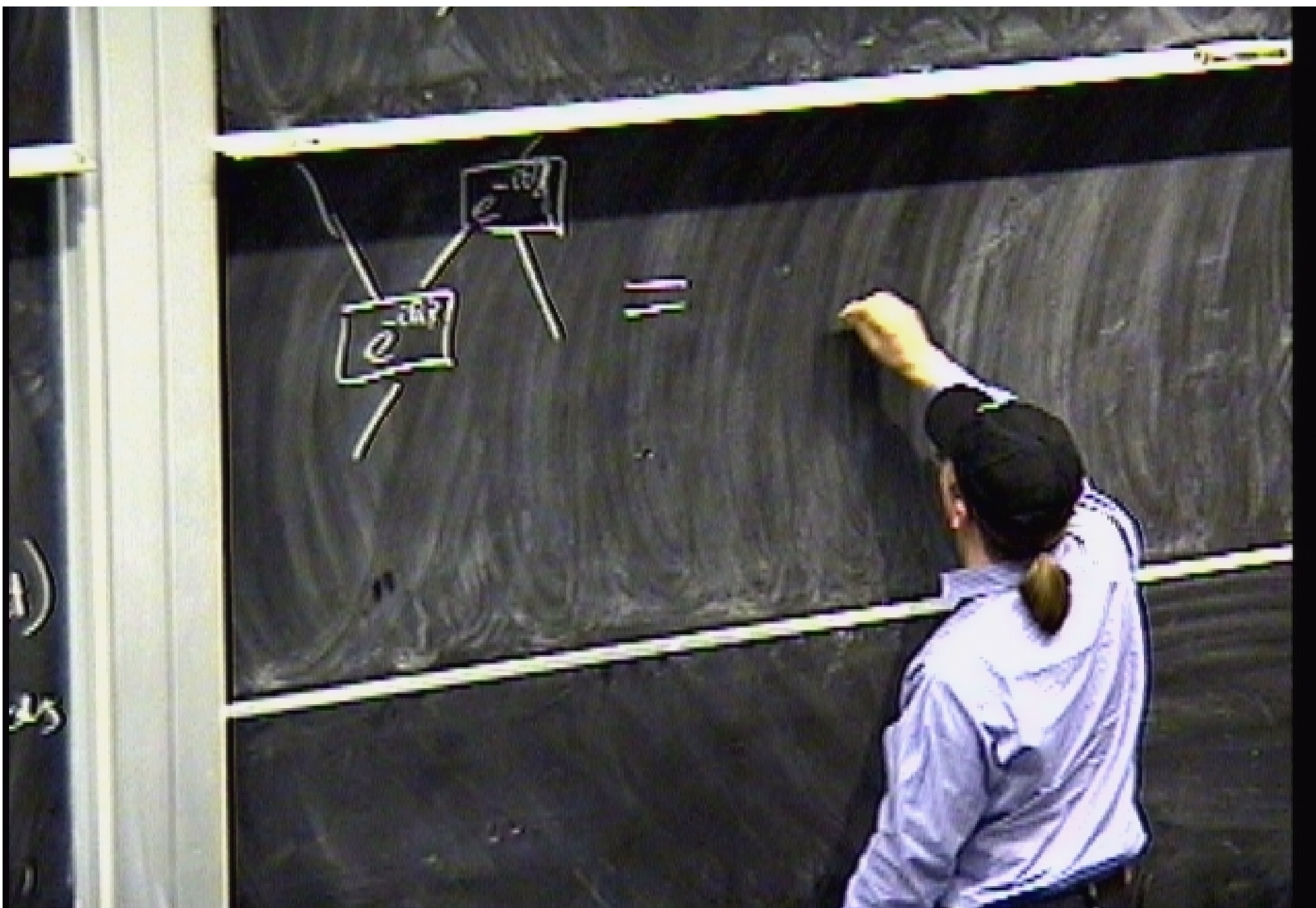
scattering $\rightarrow$ event

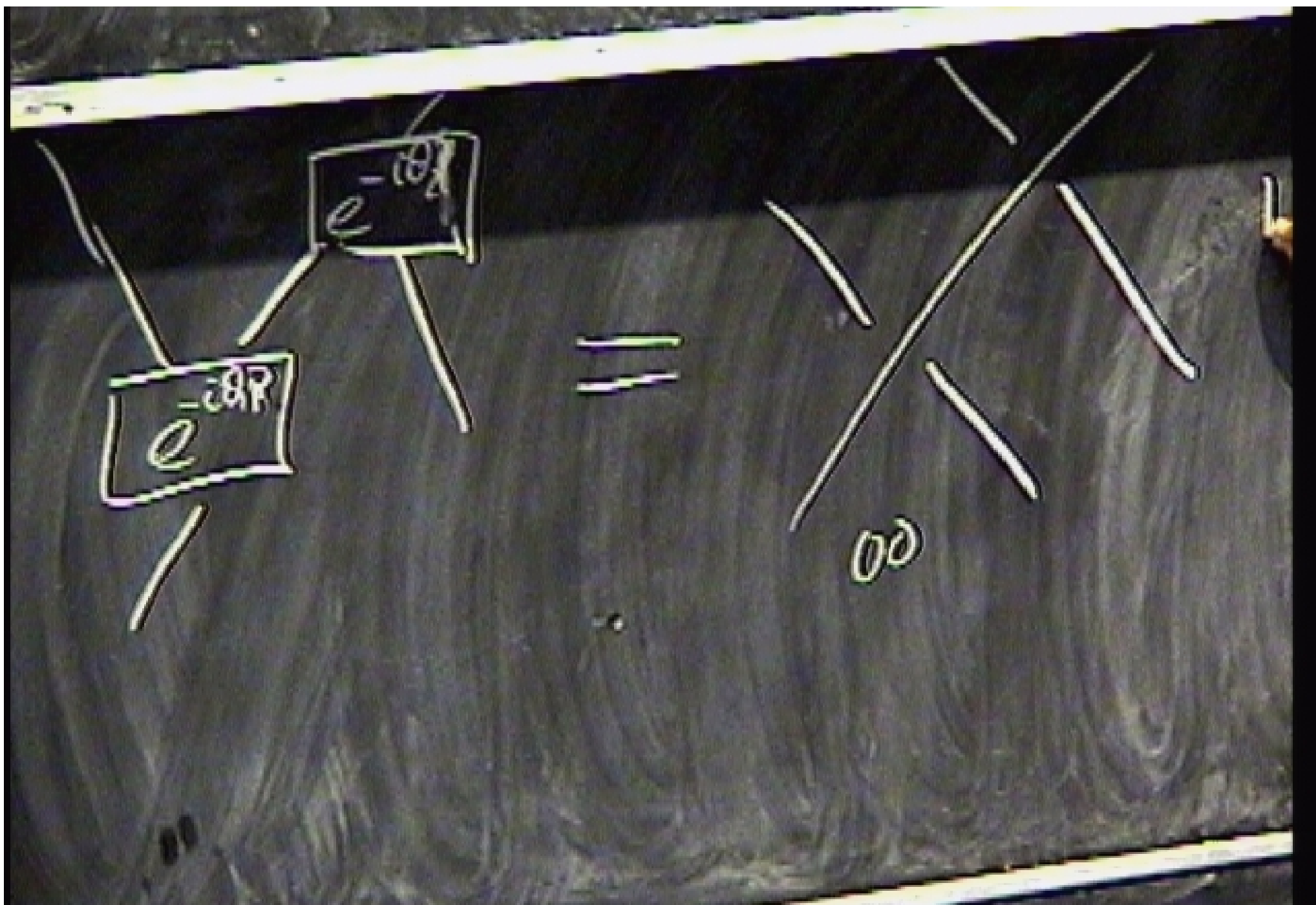


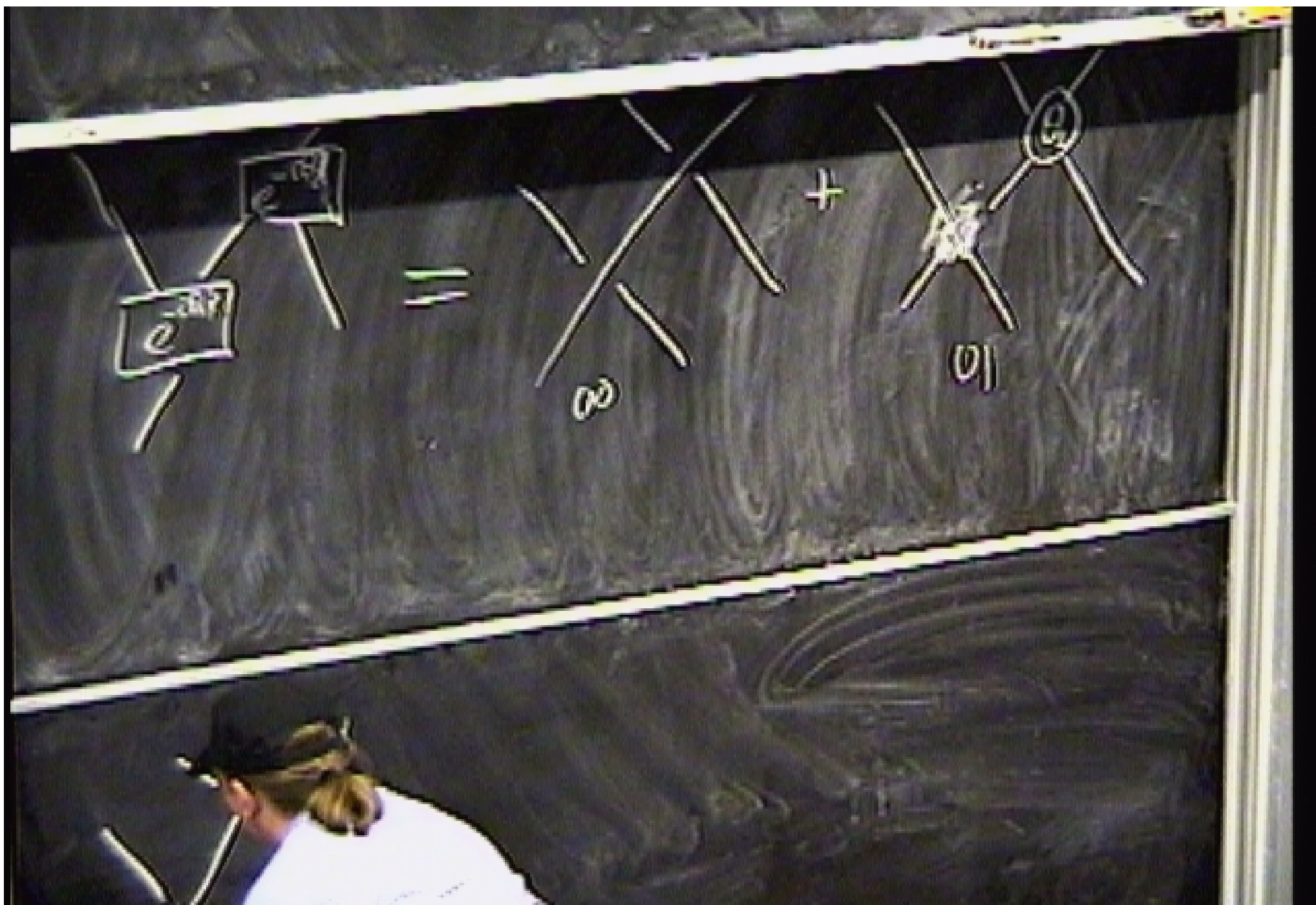
$$\begin{array}{c}
 \boxed{u} = P(0) + e \uparrow P(1) \\
 \text{no scattering} \quad \uparrow \text{scattering} \rightarrow \text{event} \\
 \text{non-event} \\
 \text{action} \\
 = -\hbar \theta
 \end{array}$$

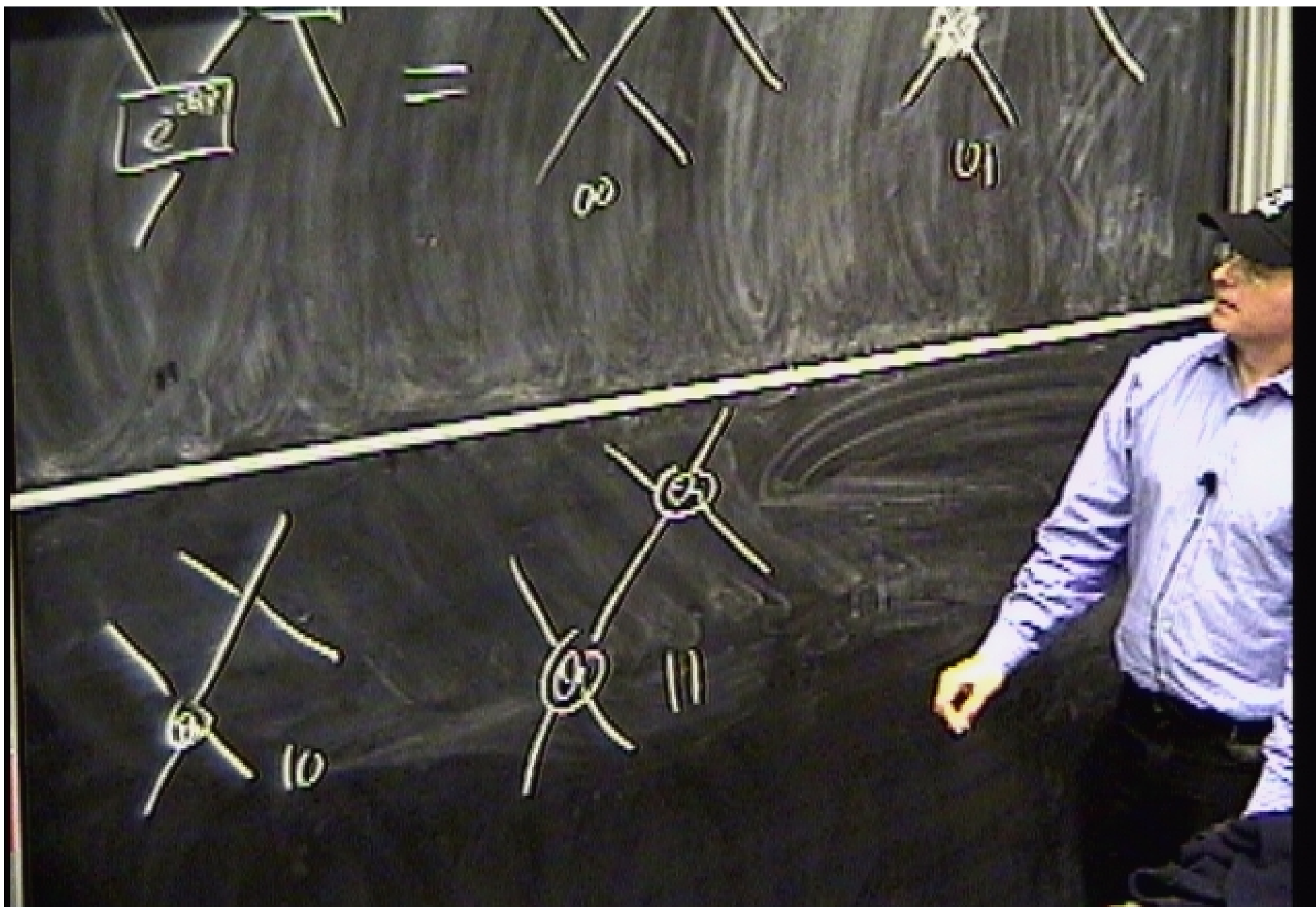

The diagram shows a vertex where two lines cross. A circle is drawn around the intersection point, containing the letter 'S'. This diagram is associated with the 'action' term in the equation, which is given as $-\hbar \theta$.

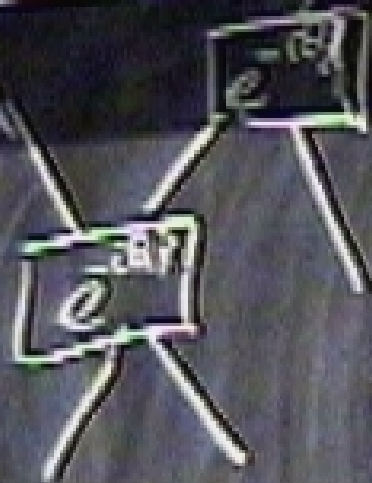












$=$



$+$

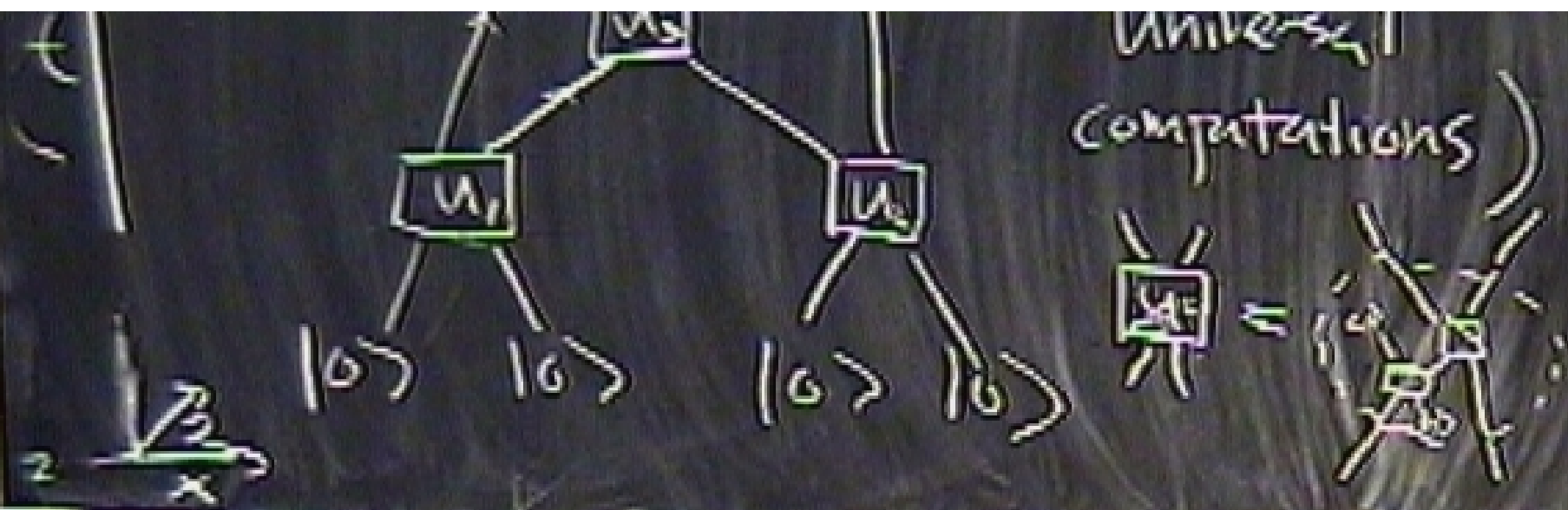


01

is a 'computational history'

each C_b , $b=00,01,10,11$





Embed

Embed: So that



4 wires at each
point are
linearly independent



Embed: So that



4 wires at each
point are
linearly independent



Embeck: So that



4 wires at each
point are
linearly independent

Fact: d null lines determine g_{ab} up to
 $g_{ab} \rightarrow \Omega^2 g_{ab}$ in d dimensions.

Embed: So that



4 wires at each
point are
linearly independent

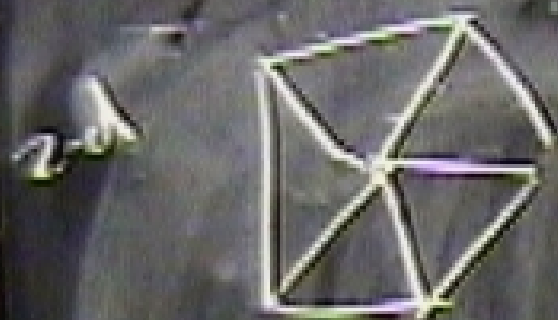
Fact: d null lines determine g_{ab} up to
 $g_{ab} \rightarrow \Omega^2 g_{ab}$ in d dimensions.

Henceforth take $d=4$

Regge calculus:

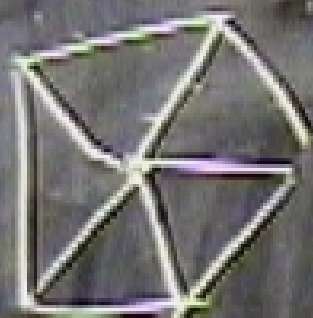


Regge calculus requires simplicial lattice.



Regge calculus: requires simplicial lattice.

2-d



3 points

4 edges

3-d



4

6

4



5

10

10

5

Construct 4-d simplicial lattice
by adding edges to

Construct 4-d simplicial lattice
by adding edges to form
a Delunay lattice + associated
simplicial Voronoi



Regge calculus: requires simplicial lattice.



4
6
4

5
10
10
5

3 points, 4S

4 edges >

6

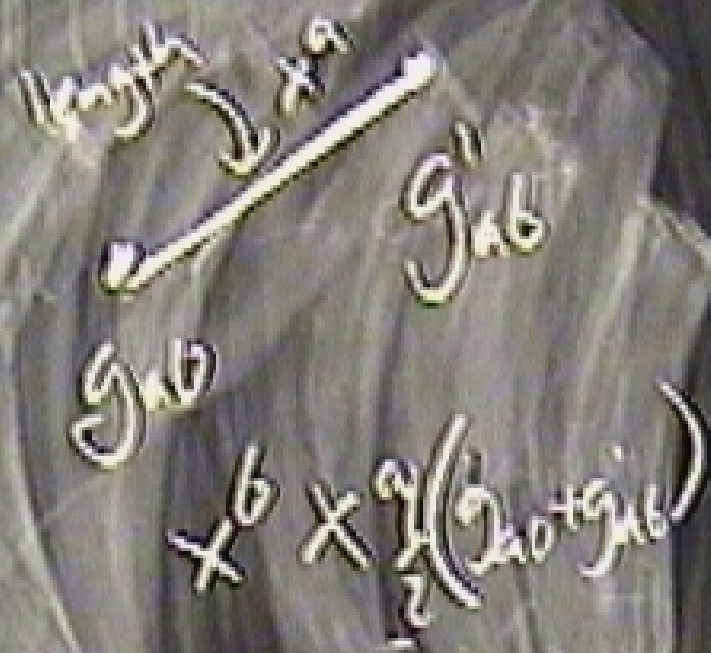
4

10

5



Fixing Ω_l at each vertex l now fixes
 whole R-calculus.



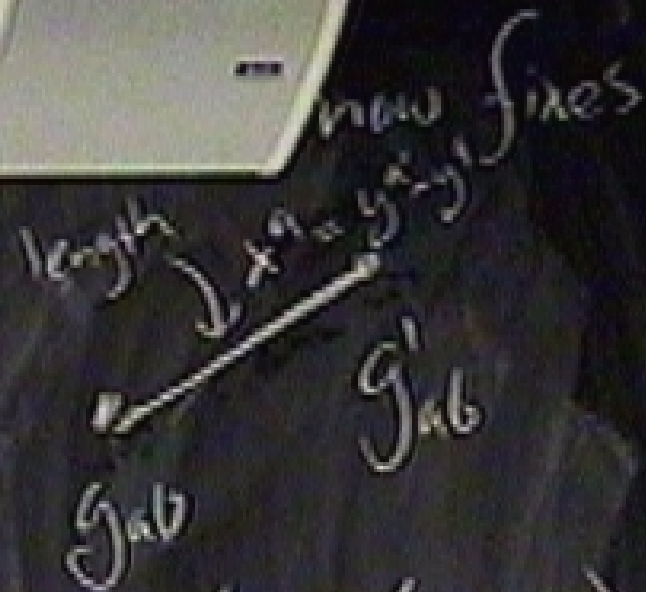
A diagram showing a line segment. An arrow labeled "length" points to the segment. A point on the segment is labeled x^a . Below the segment, the metric tensor g_{ab} is written. To the right of the segment, the metric tensor g'_{ab} is written. Below g'_{ab} , the expression $x^b x^a \frac{1}{2} (g_{ab} + g'_{ab})$ is written.

Fixing Ω_l at each vertex l now fixes
 whole R-calculus.



A diagram showing a vector x^a starting from a point labeled g_{ab} and ending at a point labeled g'_{ab} . A curved arrow labeled "length" indicates the distance between these two points. Below the diagram, the equation
$$l^2 = x^b x^a \left(g_{ab} + g'_{ab} \right)$$
 is written.

Fixing Ω_L at each
whole R-calculus.



$\Rightarrow$ curvature
is fixed

$$l^2 = x^b x^a \left(\partial_{[a} g_{b]c} \right)$$

Curvature: lives on triangular hinges



Curvature: lives on triangular hinges



$$\frac{1}{8\pi G} \sum_h \epsilon_h A_h = I_G$$

(cf. $\frac{1}{8\pi G} \int R dv$)



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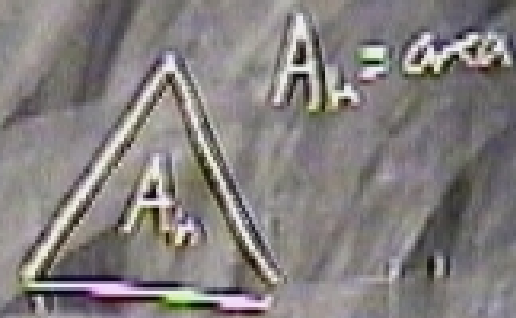


$A_h = \text{area}$

Curvature: lives on triangular hinges

$$\frac{1}{8\pi G} \sum_h \epsilon_h A_h = I_G$$

(cf. $\frac{1}{8\pi G} \int R dv$)



Recall $I_c = \frac{1}{4\pi} \sum_l \theta_l$

Curvature: lives on triangular hinges

$$\frac{1}{8\pi G} \sum_h \epsilon_h A_h = I_G$$

(cf. $\frac{1}{8\pi G} \int R dv$)



Recall $I_c = \frac{1}{2} \sum_l \theta_l$ ($= 'E_l t_l'$)

$E-R$ eqs.

$$\sum_{\vec{g} \in \Gamma} (I_G + I_C) = 0$$

$$E = IR \text{ eq.}$$

$$\sum (I_G + I_c) = 0$$

$$\sum \epsilon_h \frac{\delta A_h}{\delta g_h(\theta)}$$



$$I_c = \int \mathcal{L} dv$$

$$-h \Phi_l = \Delta V_l \left(g^{ab} \uparrow T_{ab} - U_l \right)$$

$$I_{cr} = \int \mathcal{L} dV$$

$$\hbar \Phi_{cl} = \Delta V_{cl} \left(\underbrace{g^{ab}}_{0} \hat{T}_{ab} - U_{cl} \right)$$

KE
↓

PE
↓

$\hat{T}_{ab}$ (KE) is some traceless tensor

(1) fix Ω_R so that trace of $E-R$ held

$$\sum_{h \in N(R)} \epsilon_h \frac{\delta A_h}{\delta \tilde{g}_{ab}}$$



(1) fix Ω, R so that trace of E, R hold

$$\sum_{h \in N(R)} \epsilon_h \frac{\delta A_h}{\delta \tilde{g}_{AB}(R)} = 16\pi h G \partial_R$$



(1) fix Ω_R so that trace $\in \mathbb{R}$ hold

$$\sum_{h \in N(R)} \epsilon_h \frac{\delta A_h}{\delta \tilde{\phi}_h(R)} = 16\pi h G \partial_R$$

matter tells space
how to curve.

(2)

(1) fix Ω_R so that trace of $E-R$ held

$$\sum_{h \in N(R)} \epsilon_h \frac{\delta A_h}{\delta \tilde{\gamma}_{ab}(R)} = 16\pi h G \partial_R$$

matter tells space
how to curve.

(2) assign $\tilde{T}_{ab}$ so that
the rest of $E-R$ eqs. hold $\left(\tilde{T}_{ab}{}^{;b} = 0 \right)$

Now
each C_6



corresponds to a Renge
calculus that obeys "E-R"

Now each C_6



corresponds to a Range
calculus

Now each C_6



corresponds to a Regge

calculus

This a quantum th. of gravity

(1) fix $\Sigma, \mathcal{Q}$ so that trace of $E, \mathcal{R}$ hold

$$\sum_{h \in N(\mathcal{Q})} \epsilon_h \frac{\delta A_h}{\delta \tilde{g}_{\text{ind}}(\mathcal{Q})} = \text{width}(\mathcal{Q}) \approx \text{width}(\mathcal{E} \text{ of } \mathcal{Q})$$

matter tells space
how to curve.

(2) assign $\vec{T}_{ab}$ so that
the rest of $E, \mathcal{R}$ eqs. hold $\left(\vec{T}_{ab} \neq 0 \right)$

Now each C_6



corresponds to a Renge

calculus

This a quantum th. of gravity
provides a theory of back reaction

Now each C_6



corresponds to a Regge

calculus

This a quantum th. of gravity
provides a theory of back reaction
• black hole evaporation

Now each C_6  corresponds to a Regge calculus

This a quantum th. of gravity
provides a theory of + back reaction
• black hole evaporation
• primordial curvature fluctuations

... in hinges

- holography

$$I_c = \hbar \sum_l \theta_l \quad (= 'E_l t_l')$$