Title: Coarse-graining of Spin Foams - 1

Date: Jun 21, 2017 11:00 AM

URL: http://pirsa.org/17060077

Abstract:


fed from TX-6

Literature:

- Henneaux, Teitelboim "Quantization of gauge systems"
- Thiemann "Modern canonical QGR"
- Rovelli "Quantum Gravity"
- Perez arXiv: 1205.2019
- BTB, Steinhaus arXiv: 1605.07649, 1701.02311

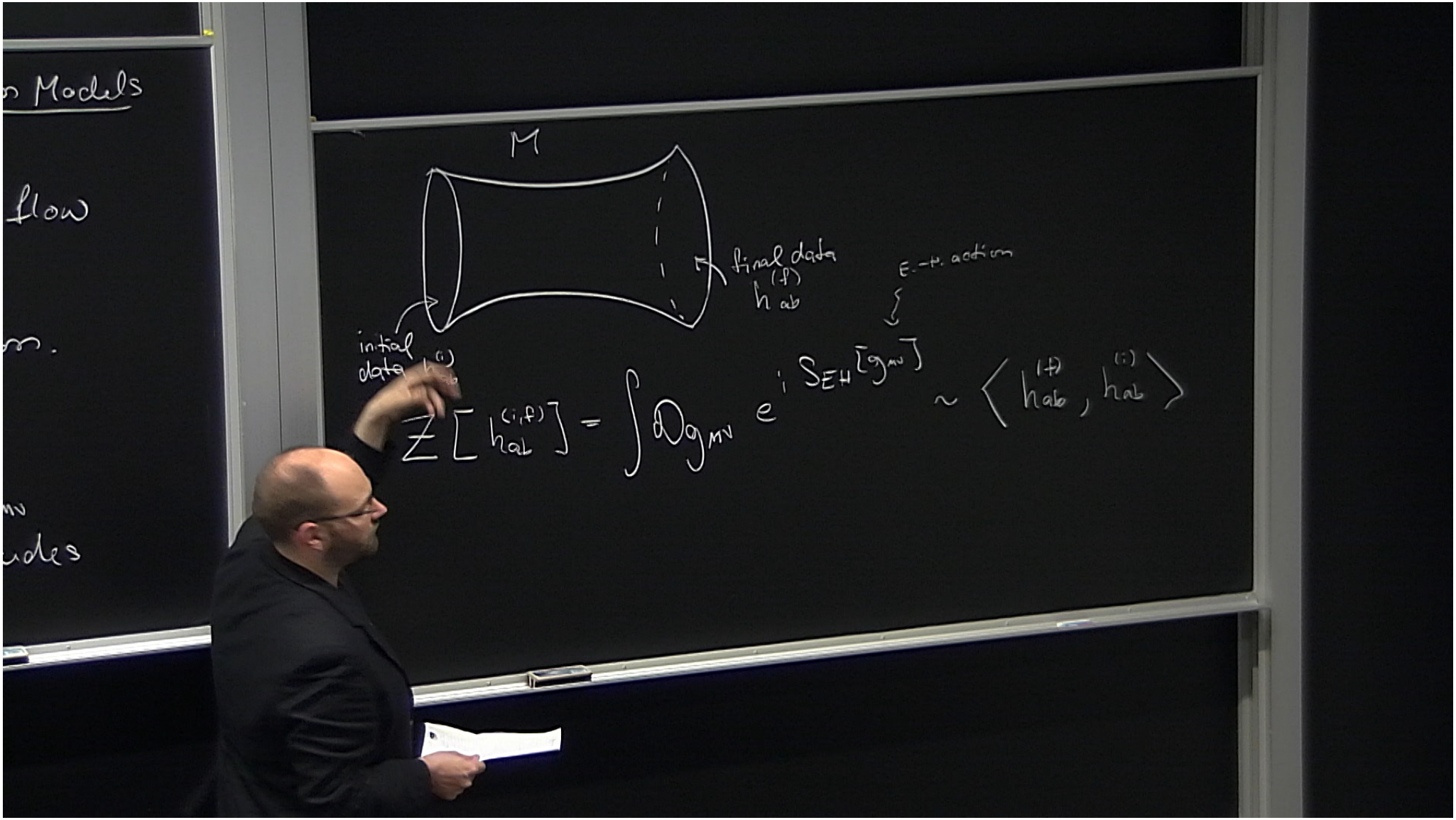
Renormalization in (truncated) SpinFoam Models

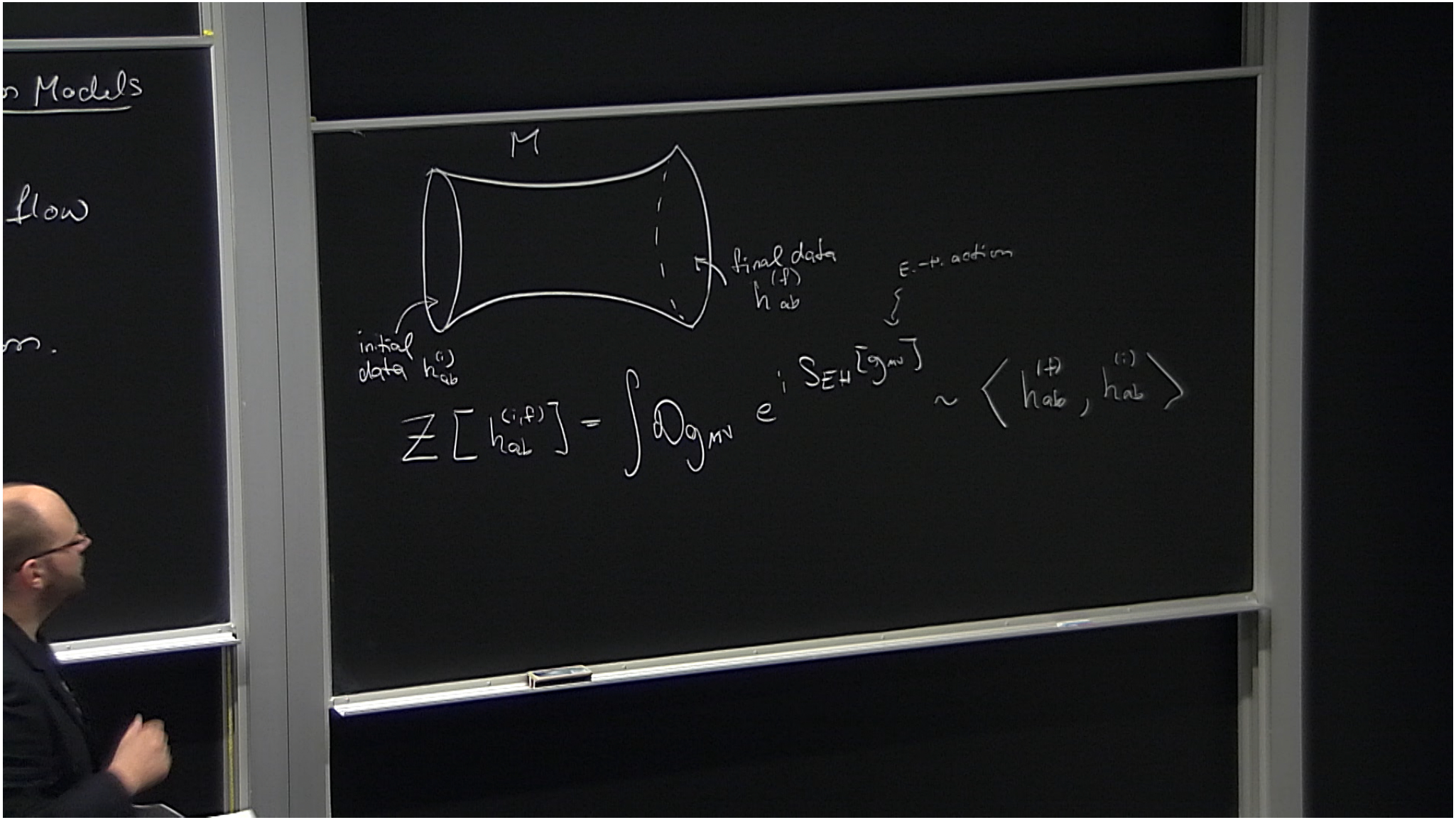
- Intro to SFM as proposal for QGR
- Renormalization: coarse graining & RG flow
- Setup of truncated model
- Afternoon: You do the RG computation.

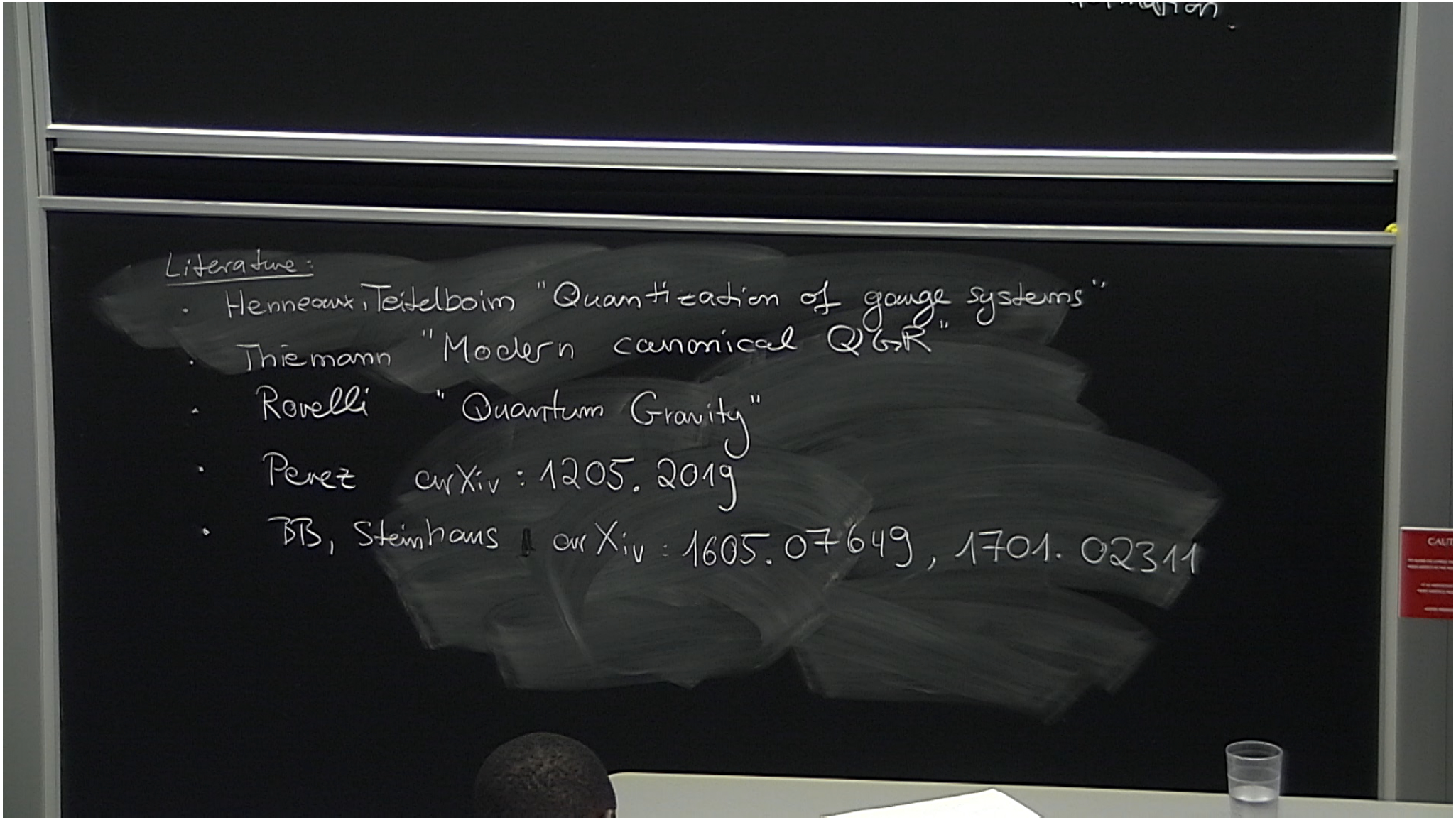
I Intro

GR: gravity $\hat{=}$ geometry of space-time $\hat{=} g_{\mu\nu}$

QGR: attempt to define transition amplitudes (à la SFM) for GR.


Models
flow
M
final data
(f)
h_{ab}
E.-H. action
initial
data
$h^{(i)}_{ab}$
$Z[h^{(i,f)}_{ab}] = \int \mathcal{D}g_{\mu\nu}\, e^{i S_{EH}[g_{\mu\nu}]} \sim \langle h^{(f)}_{ab}, h^{(i)}_{ab} \rangle$


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$h^{(f)}_{ab}$
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Discretization.

Replace M by discrete structure △
("polyhedral decomposition")

Rules:
- 4d pieces "vertices" •
- 3d pieces "edges" —
- 2d pieces "faces"



"hinges" will carry curvature information.

In CDT: Simplices

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QGR: aff
(à la SFM) for

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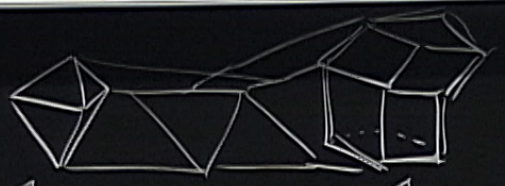
In CDT: Simplices, here allow for more general shapes

4d pieces internally flat space-time, curvature sits at hinges.

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QGR: aff
(à la SFM) for

(a la SFM) for GR.



3d boundary "in"

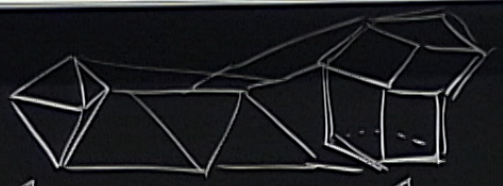
"out"

Important: Δ by itself does not carry geometrical information yet (only combinatorial info).

Geometry is provided by "state"

$f \longmapsto j_f = 0, \frac{1}{2}, 1, \frac{3}{2}, \ldots$ ~ area of 2d piece

(a la SFM) for GR.



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"out"

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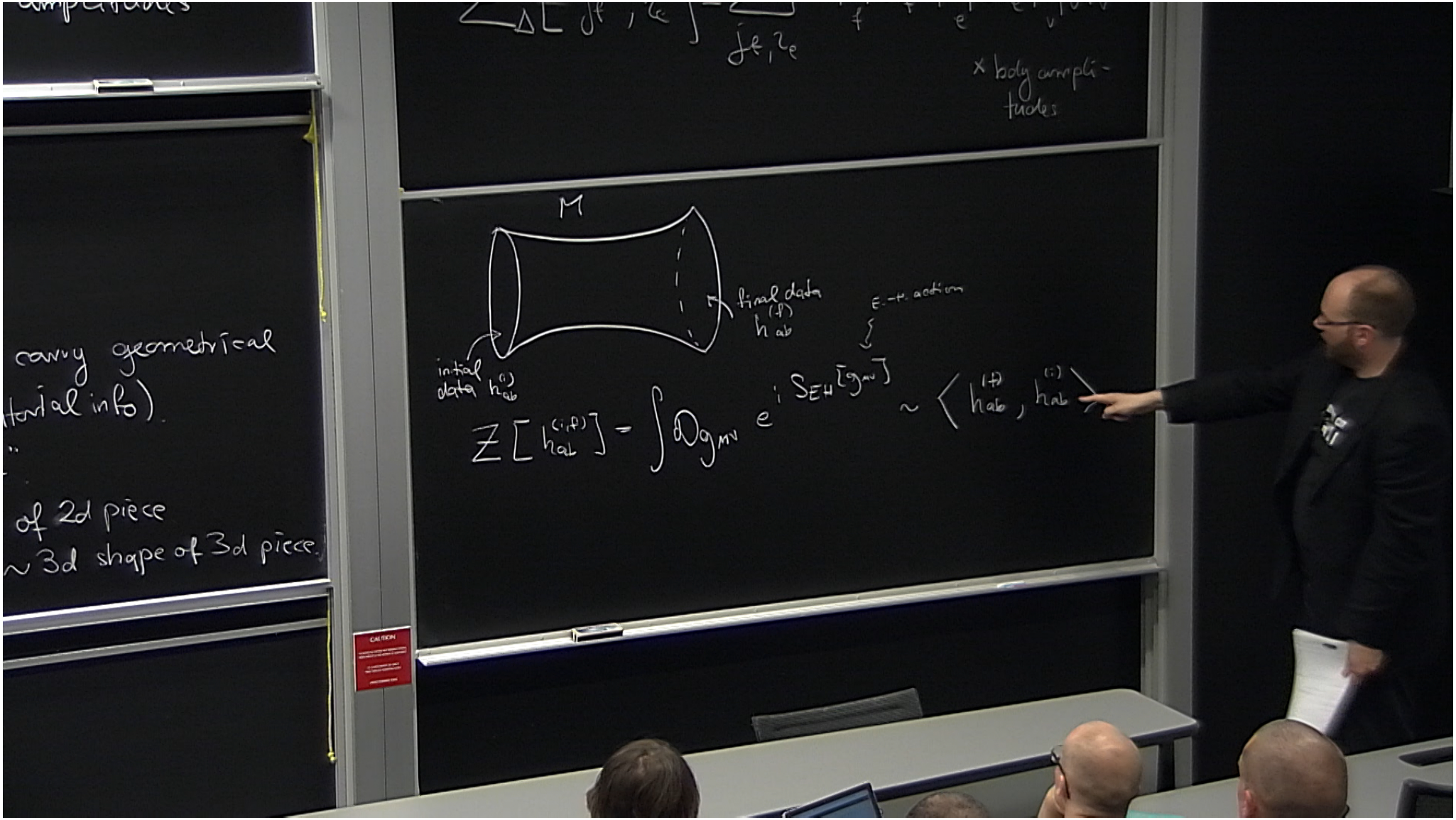
3d boundary ("in") ("out")

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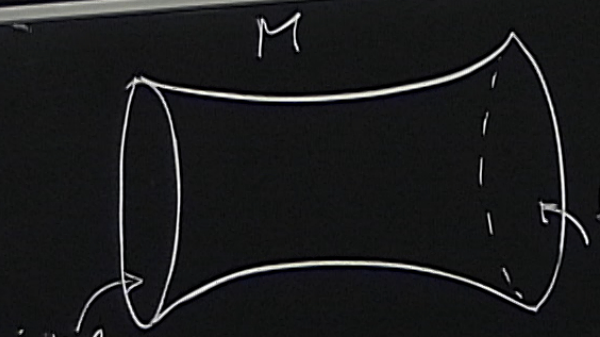
$e \longmapsto 2e$ SU(2)-invariant tensors ~ 3d shape of 3d piece ("intertwiners")


M
final data
initial data
E.-H. action
x body amplitudes
carry geometrical
of 2d piece
~ 3d shape of 3d piece

$Z_\Delta[j^{(i,f)}, z_e] = \sum_{j_f, z_e} \prod_f |A_f| \prod_e |A_e| \prod_v |A_v|$

j_f, z_e: sum over all states

× body amplitudes



E.-H. action

$Z[h^{(i,f)}_{ab}] = \int \mathcal{D}g_{\mu\nu}\, e^{i S_{EH}[g_{\mu\nu}]} \sim \langle h^{(f)}_{ab}, h^{(i)}_{ab} \rangle$

allow for more general shapes

4d pieces internally flat space-time, curvature sits at hinges.

$A_{f,e,v}$: weights = amplitude functions.
= local functions of the j_f, z_e

Choices for $A_{e,f,v} \hat{=}$ choice of SpinFoam Model.

Z_Δ describes an <u>effective theory</u> on Δ.

(a la SFM) for GR.

(Conditional) expectation values of observables

observable O : function of j_f, i_e

$$\langle O \rangle_{\Delta, j_f^{(i,f)}, j_e^{(i,f)}} = \frac{1}{Z_\Delta[\dots]} \sum_{j_f, i_e} O(j_f, i_e) \prod_f \mathcal{A}_f \prod \dots$$

(a la SFM) for GR.

(Conditional) expectation values of observables

observable O : function of j_f, i_e

$$\langle O \rangle_{\Delta, j_f^{(int)}, j_e^{(bdy)}} = \frac{1}{Z_\Delta[\,\dots\,]} \sum_{j_f, i_e} O(j_f, i_e) \prod_f dA_f \prod \dots$$

These sums can not be carried out analytically for large lattices (= fine $\Delta \hat{=}$ many vertices)

II Coarse graining & renormalization

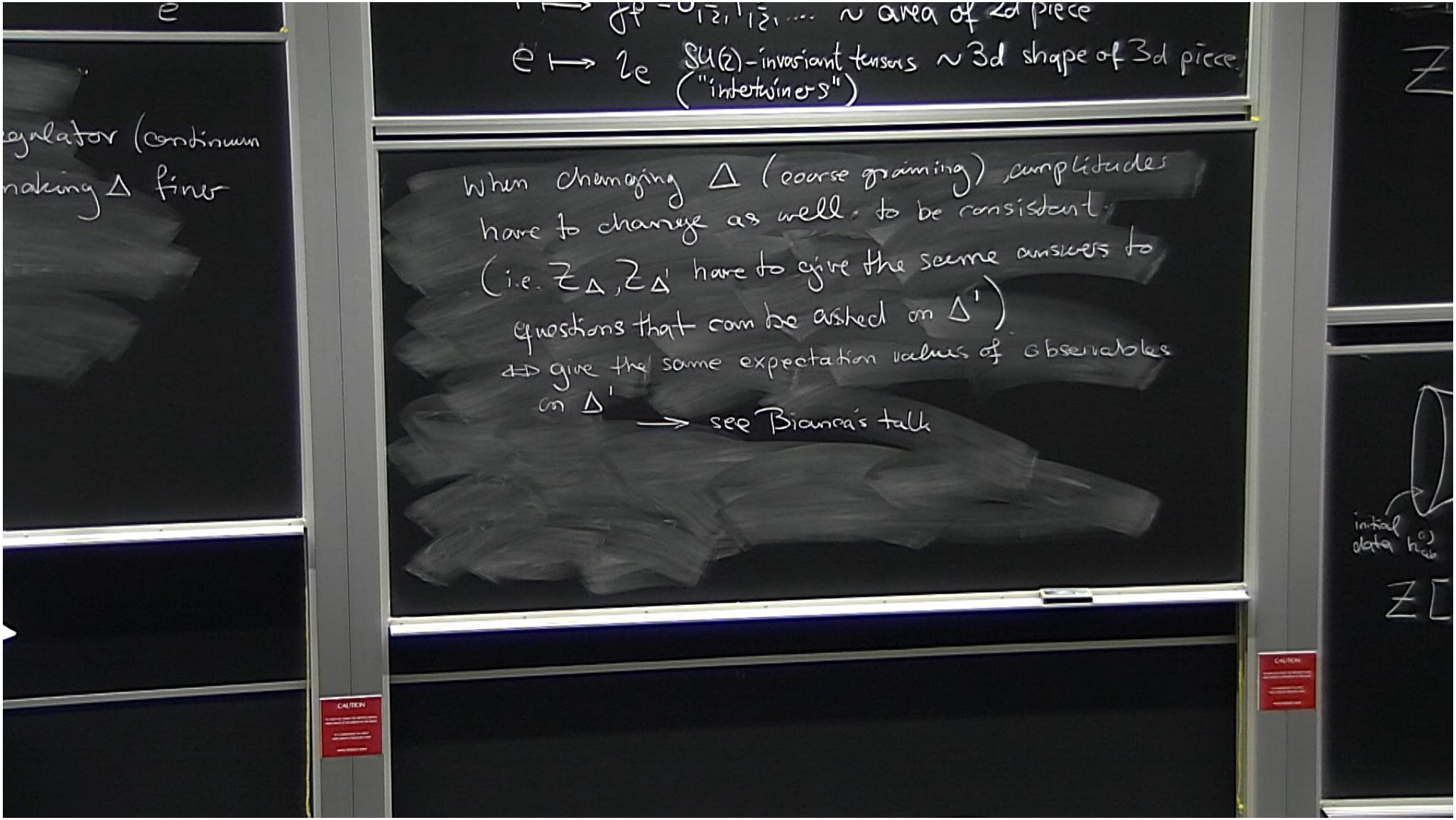
In the Wilsonian sense, Δ is a regulator (continuum → discrete) Removing regulator → making Δ finer

Composing $Z_\Delta, Z_{\Delta'}$



Δ Δ'

$\mathcal{A}_f, \mathcal{A}_e, \mathcal{A}_v \to \mathcal{A}'_f, \mathcal{A}'_e, \mathcal{A}'_v$


e
egulator (continuum
naking Δ finer
$e' \longmapsto 2e$
SU(2)-invariant tensors ~ 3d shape of 3d piece
("intertwiners")
When changing Δ (coarse graining) amplitudes
have to change as well, to be consistent
(i.e. $Z_\Delta, Z_{\Delta'}$ have to give the same answers to
questions that can be asked on Δ')
⇔ give the same expectation values of observables
on Δ'
→ see Bianca's talk
initial
data
CAUTION

i.e. $SU(2)$-invariant tensors ("intertwiners")

When changing Δ (coarse graining) amplitudes have to change as well, to be consistent.

(i.e. $Z_\Delta, Z_{\Delta'}$ have to give the same answers to questions that can be asked on Δ')

$\Leftrightarrow$ give the same expectation values of observables on Δ'

$\longrightarrow$ see Bianca's talk

see Guifre's talk