Title: Computing renormalization invariant properties of Levin-Wen phases

Speakers: Daniel Barter

Series: Mathematical Physics

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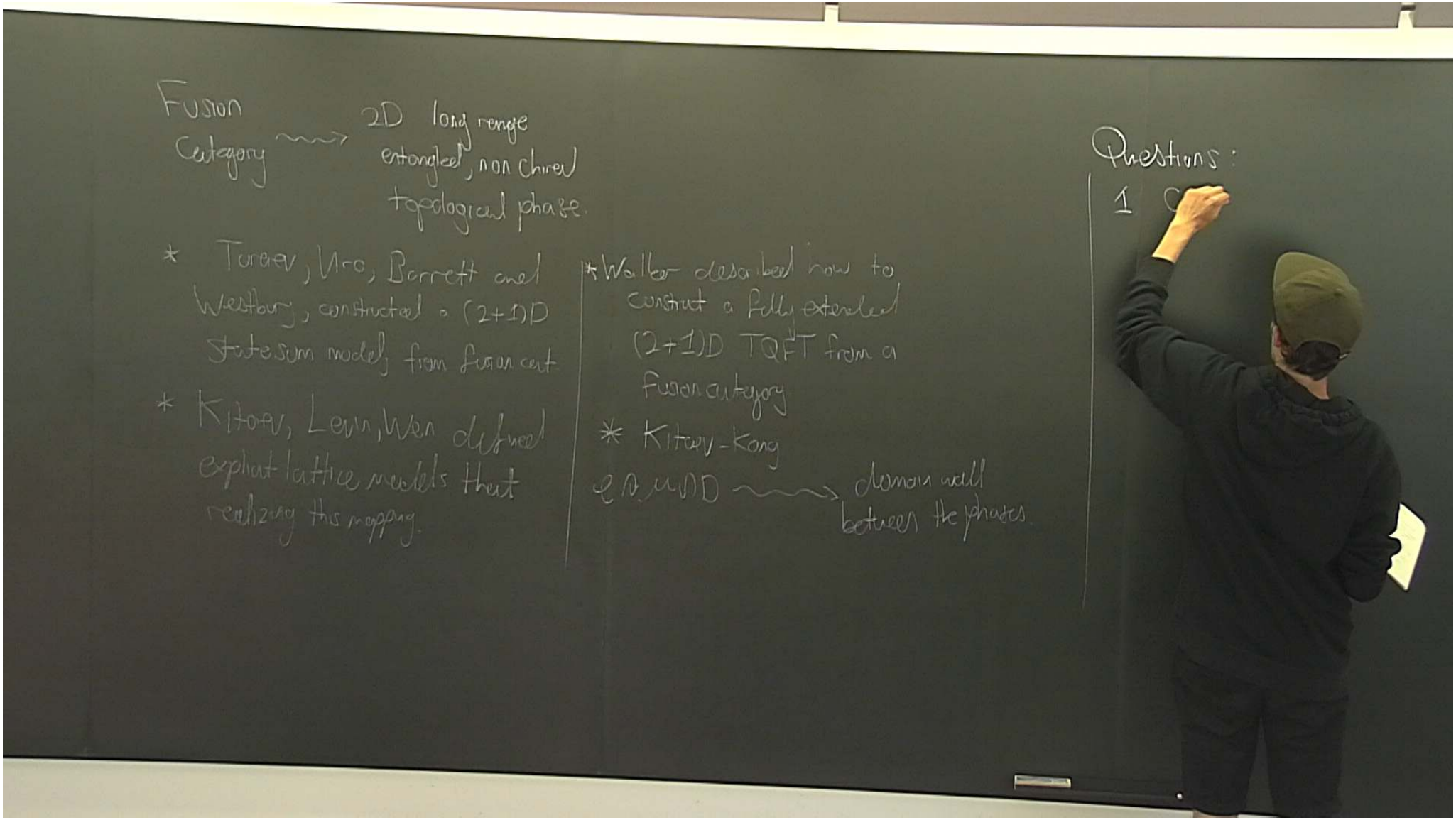
Abstract: In the 90s Turaev, Viro, Barrett and Westbury constructed a (2+1)D state sum TQFT associated to any fusion category. The associated phases of matter were popularized by Kiteav, Levin and Wen and are now central examples in condensed matter physics and quantum information theory.

Despite the importance of these phases, many of the computational techniques for working with fusion categories have not percolated into condensed matter physics. Many of these techniques are "folk theorems"
and have not appeared in the literature in a digestible form.

Jacob Bridgeman and myself have spent the last two years extracting these computational techniques from Corey Jones, and have been using them to understand defects in Levin-Wen phases. Our papers 1806.01279,
1810.09469, 1901.08069, 1907.06692 document the development of our understanding, and demonstrate how to do physically relevant fusion category computations.


Fusion Category ~~> 2D long range entangled, non chiral topological phase.
* Turaev, Viro, Barrett and Westbury, constructed a (2+1)D state sum model from fusion cat
* Kitaev, Levin, Wen defined explicit lattice models that realizing this mapping.
* Walker described how to construct a fully extended (2+1)D TQFT from a fusion category
* Kitaev-Kong
2D 1D ~~> domain wall between the phases.
Questions:
1

Questions:

1 Can bulk/local description of of the TQFT be extended to include defects? **Defect TQFTs**

Yes: "Algebraic completions of higher categories"

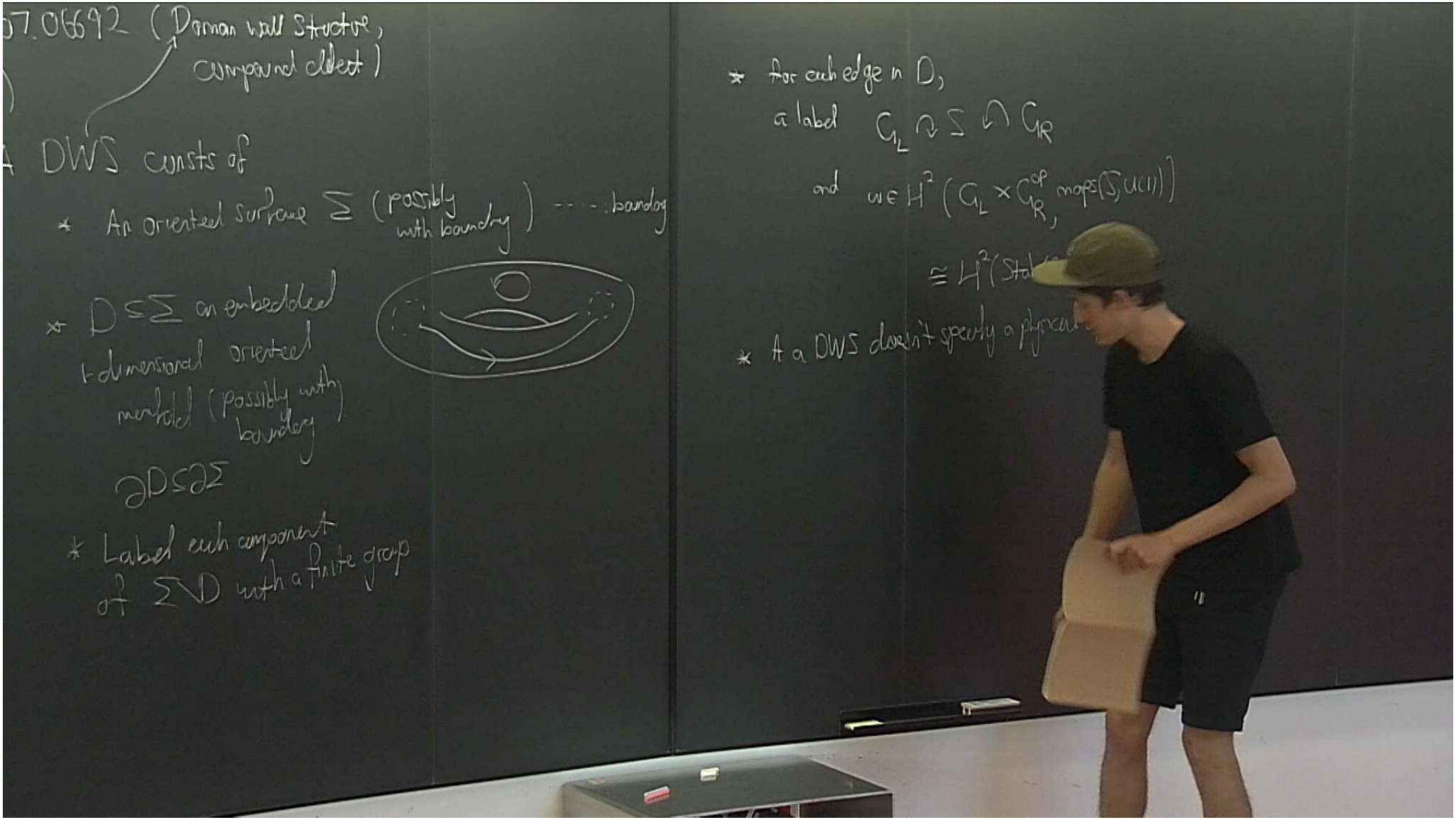
+ecstatically, also yes computationally

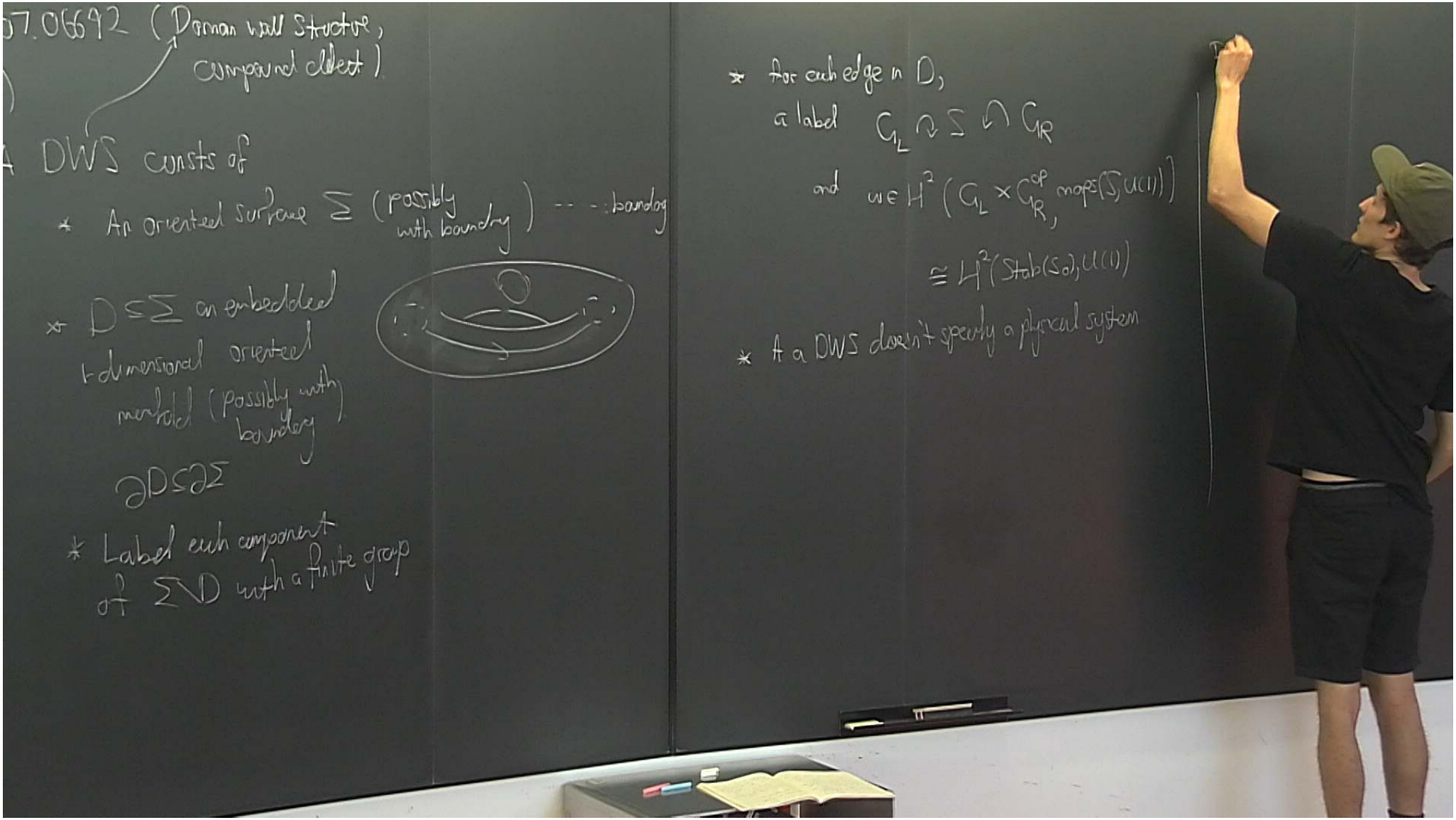
2 Given numerical data for a fusion category and bimodules, how do you do physically relevant computations?

$\mathbb{Q}(\sqrt{13}, e^{2\pi i/26}, e^{2\pi i/3})$ Haagerup

We can reproduce Izumi's computations upto machine error in < 1 second

Yes


07.06692 (Domain wall Structure, compound defect)
A DWS consists of
* An oriented surface Σ (possibly with boundary) ---: boundary
* D ⊆ Σ an embedded 1-dimensional oriented manifold (possibly with boundary)
∂D ⊆ ∂Σ
* Label each component of Σ \ D with a finite group
* for each edge in D,
a label $G_L \curvearrowright S \curvearrowleft G_R$
and $\omega \in H^2(G_L \times G_R^{op}, \mathrm{maps}(S, U(1)))$
$\cong H^2(Stab$
* A a DWS doesn't specify a physical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* Label each component of Σ\D with a finite group
* for each edge in D,
a label $G_L \curvearrowright S \curvearrowleft G_R$
and $\omega \in H^2(G_L \times G_R^{op}, \mathrm{maps}(S, U(1)))$
$\cong H^2(\mathrm{Stab}(s_0), U(1))$
* If a DWS doesn't specify a physical system

Def) Skein vectors on a DWS

$D \subseteq \Sigma$

* $\Gamma \subseteq \Sigma$ oriented trivalent graph

* edge labels: each edge of Γ is labeled with a group element

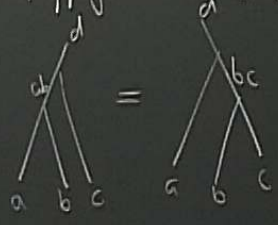
each "edge" of D is labelled with an element of S

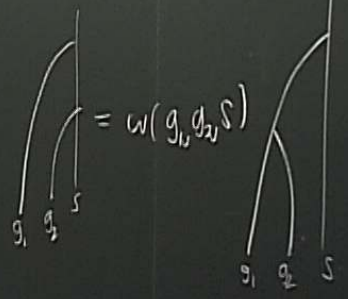
* vertex conditions

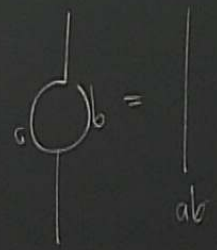
$g_1 g_2 g_3^{-1} g_4 = 1$

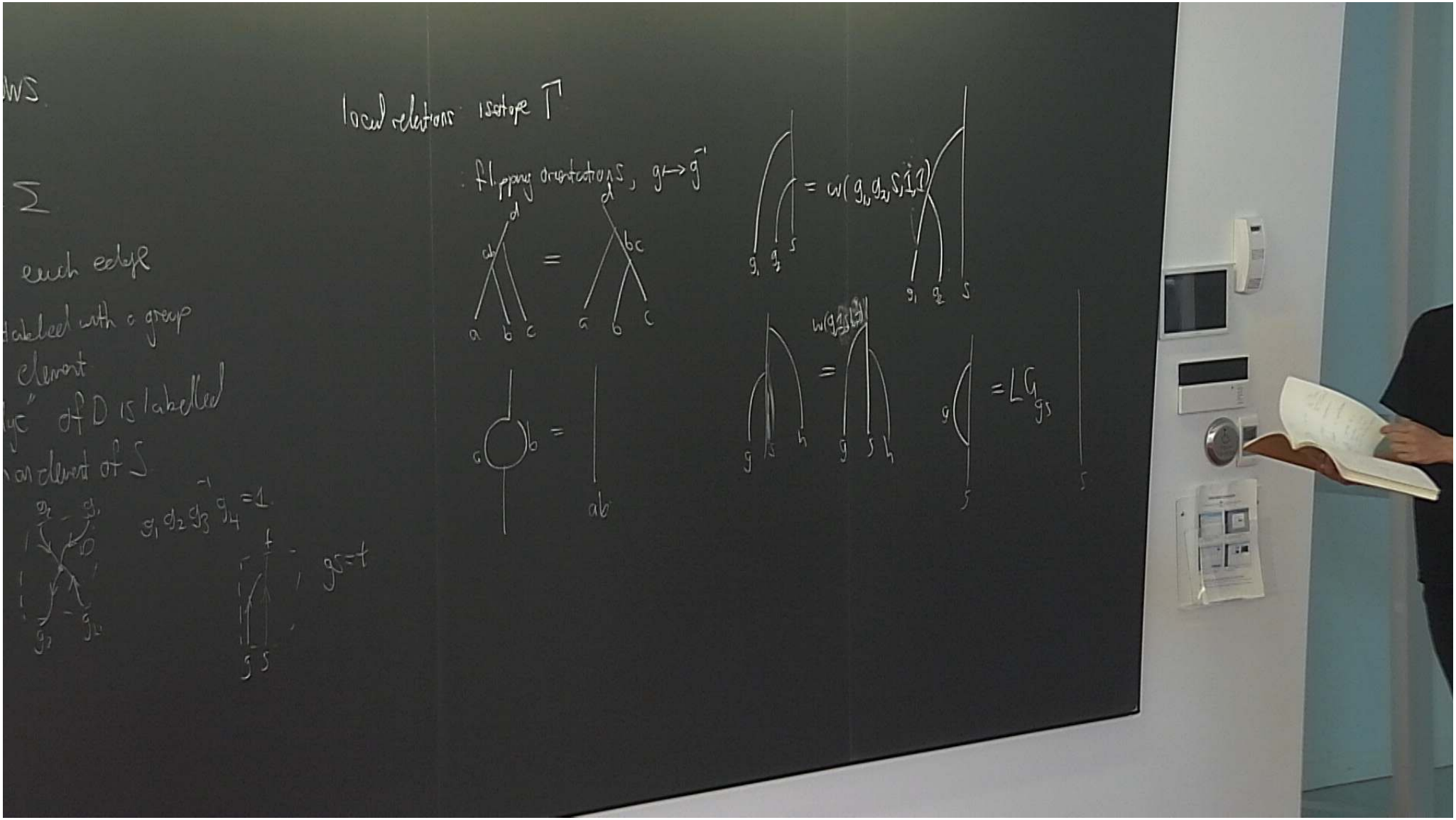
local relations: isotope Γ

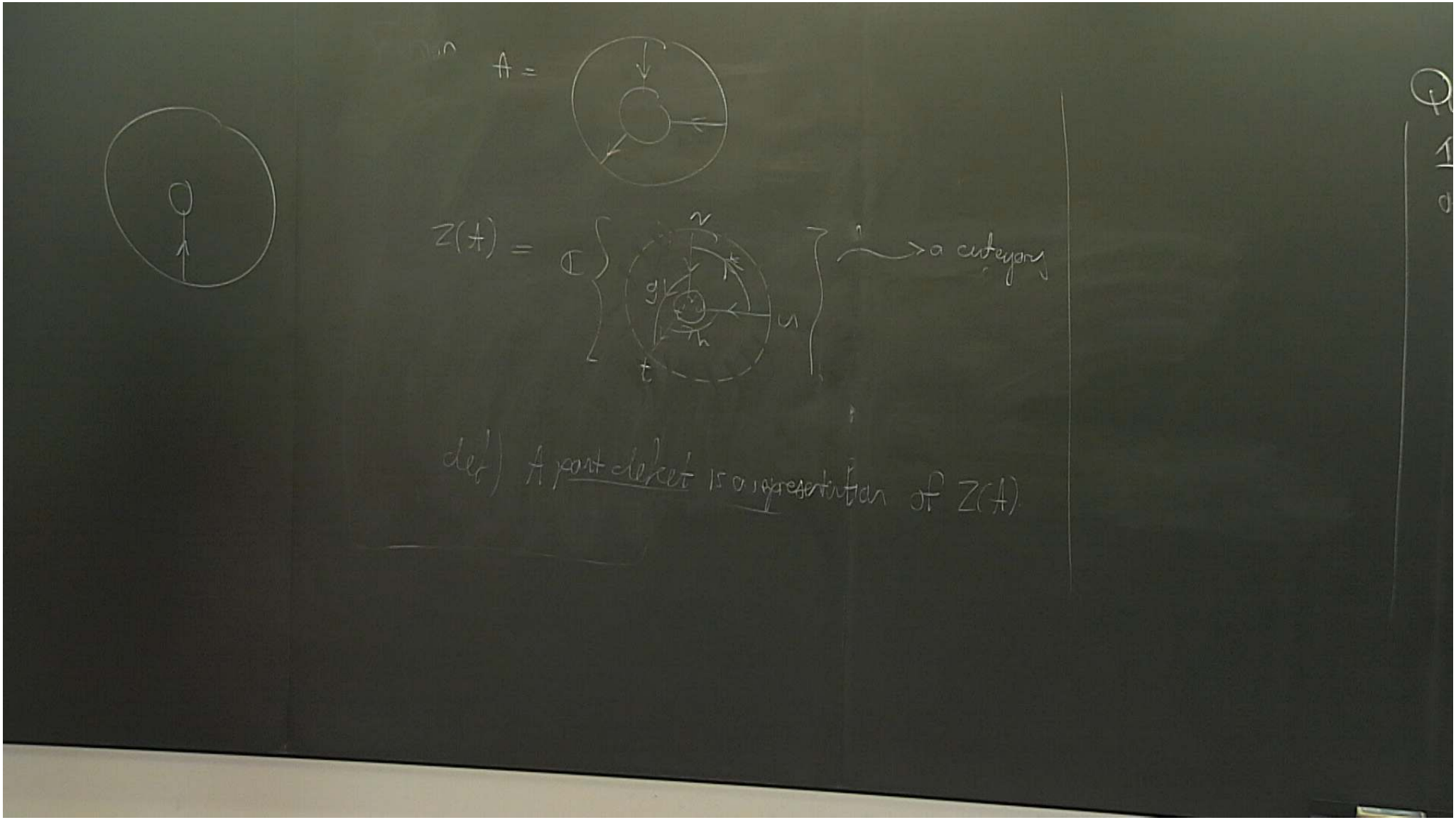
flipping orientation on S, $g \mapsto g^{-1}$








local relations
flipping orientation of S, g ↦ g⁻¹
= ω(g1, g2, S, 1, 1)
= LG
each edge
labeled with a group
element
of D is labelled
an element of S
g1 g2 g3 g4 = 1
g5 = t


A =
Z(A) =
v
g
u
t
→ a category
def) A point defect is a representation of Z(A)

def) A compound

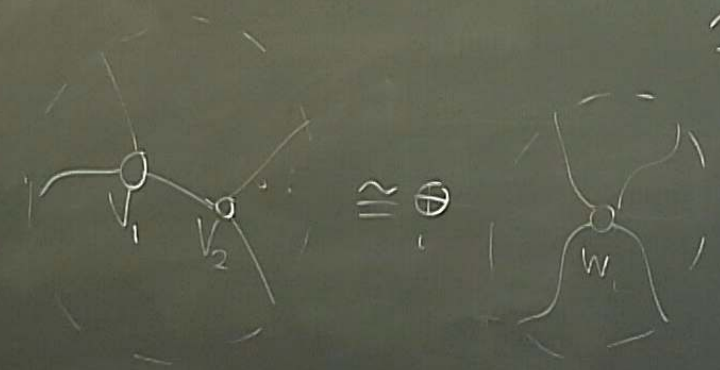
object is a DWS

and a choice of point

object for each

boundary component

$= \frac{\text{stem vector}}{\text{braid relation}}$



2

Given numerical data f

a fusion category and

how do you do physically

computations?

$\mathbb{Q}(\sqrt{13}, e^{2\pi i/26}, e^{2\pi}$

We can reproduce Izu

upto machine error in <

Yes