

M5 - branes / 3d SUSY
QFT

Topological Phases of Matter

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Mar 27 - 28, 2023

Plan

§1. Introduction / overview

§2. Anyon data for 3d TQFT

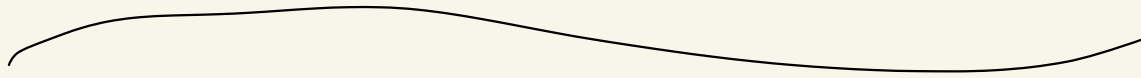
§3. 3D $N=2$ theory / 3-manifold
M5-branes

§4. 3D $N=4$ theory \leftrightarrow 3d TQFT

Gong - Kim - Lee - Shim - MY

[2103.09283]

Lec I



§1 Introduction

$(2+1)d$
" 3d

FQHE

topological phase

[e.g. no order parameter]

(ground state)

: topology-dependent

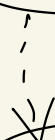


3d TQFT

$Bord_3 \rightarrow Vect_{\mathbb{C}}$



?

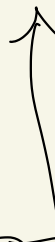


§2 anyon data

modular tensor category (MTC)

e.g. $U_q(\mathfrak{g})$
at root of unity

fusion category
Haagerup



$Z^{\mathcal{M}}$: partition function on \mathcal{M}
 computable
 • RG-inv. \uparrow matrix model

e.g. Witten index

$$\mathcal{M} = T^3 = T^2 \times S^1$$

$$\text{Tr}_{\mathcal{H}(T^2)} (-1)^F$$

$$\frac{\sinh^2 \frac{\sigma}{g}}{\cosh^2 \frac{\sigma}{g}}$$

SUSTY ($N \geq 2$) $\int d\vec{\sigma} \prod_{i < j} \sinh^2(\sigma_i - \sigma_j)$

3d QFT'

UV Z_{UV}

3d QFT

$G \supset U(1)^n$

gap

RG flow
Wilson line

RG flow
gap

RG flow
gapless

IR

3d TQFT / MTC

Z_{IR}

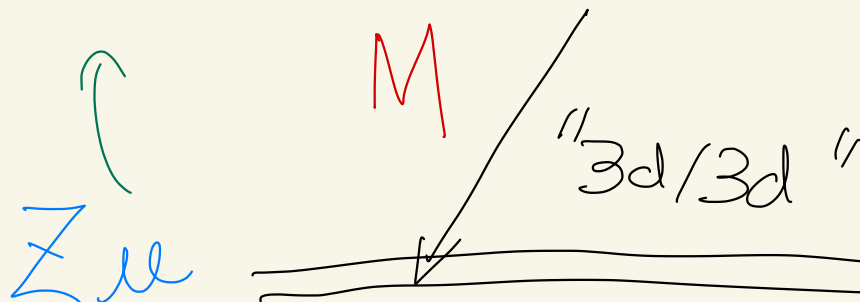
anyon / Wilson line

trivial theory

interacting CFT

$S^1 \times (S^2/\mathbb{Z}_2)$
 M/\mathbb{Z}_2

6d (0,2) theory $A_1 \rightarrow A_N$
 \approx M5-brane theory on $\mathcal{M} \times M$



\mathcal{M} $A_1 \rightarrow SU(2) \rightarrow SO(2,1)$

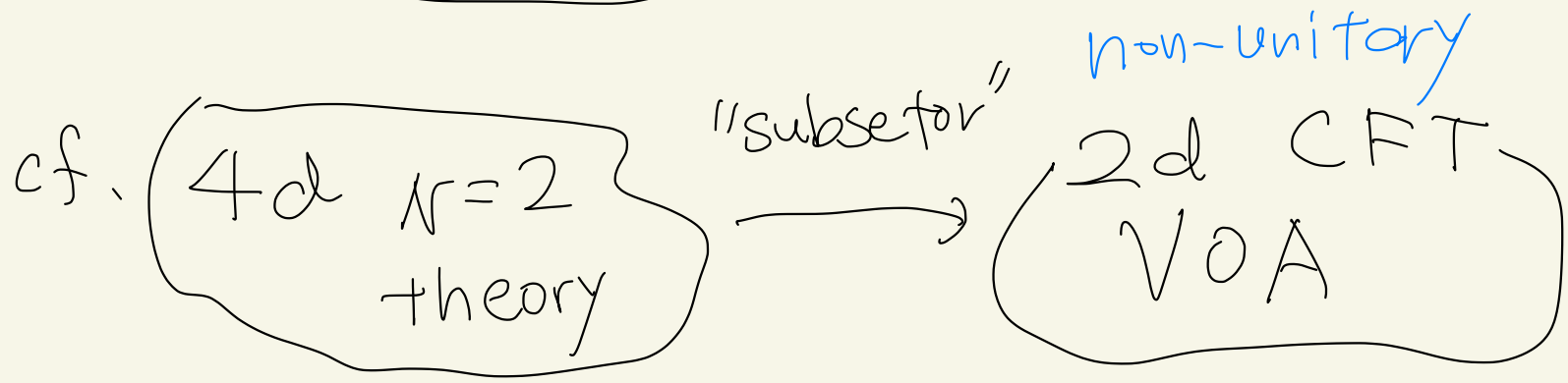
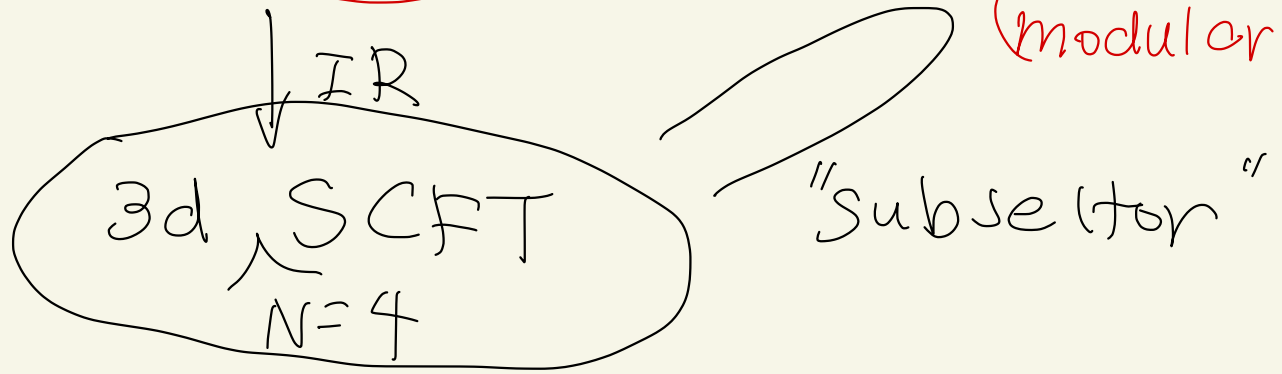
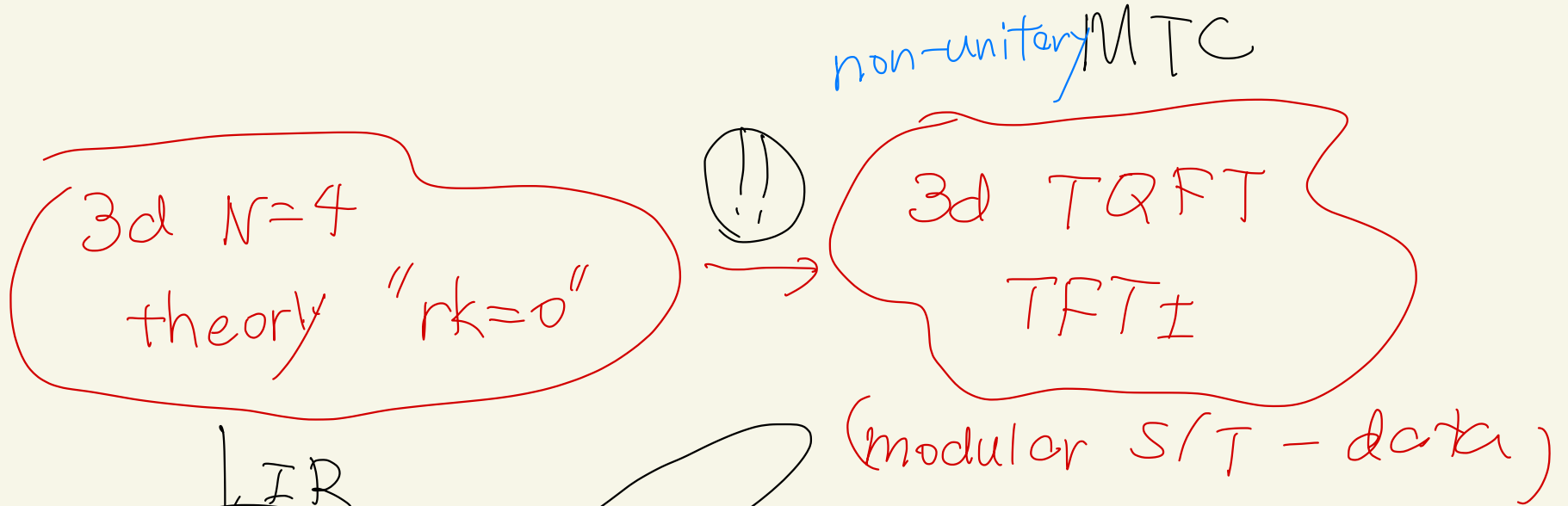
3d $N=2$ $T(M)$
SUSY QFT

3d pure complex
Chern-Simons on M

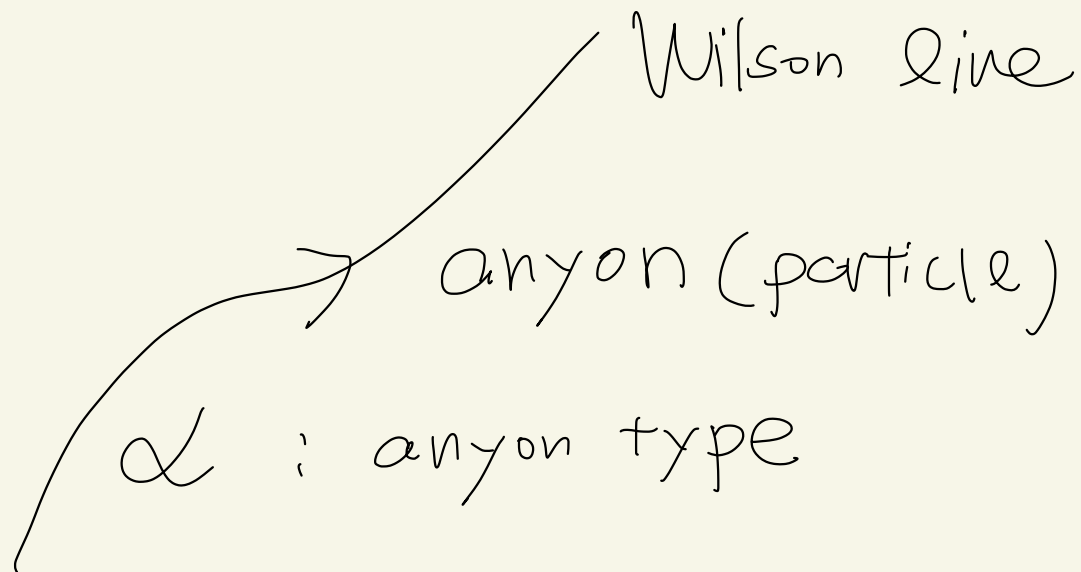
contour choice
" \mathcal{M} "



"M: non-hyperbolic" "M: hyperbolic" \mathbb{H}^3/Γ



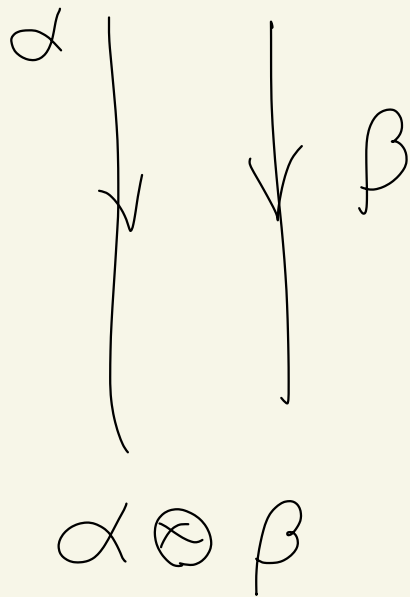
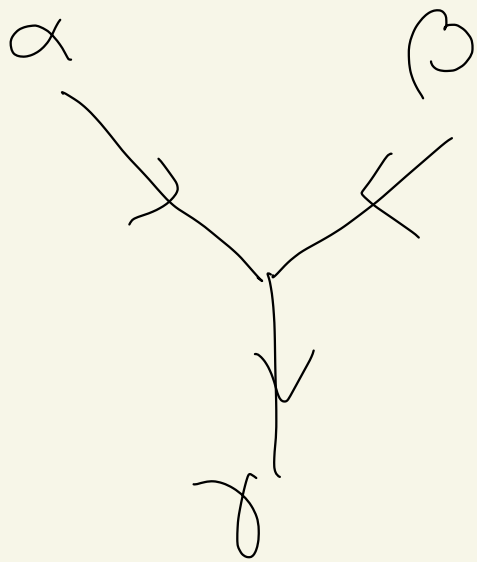
§2, Anyon data



MTC nk

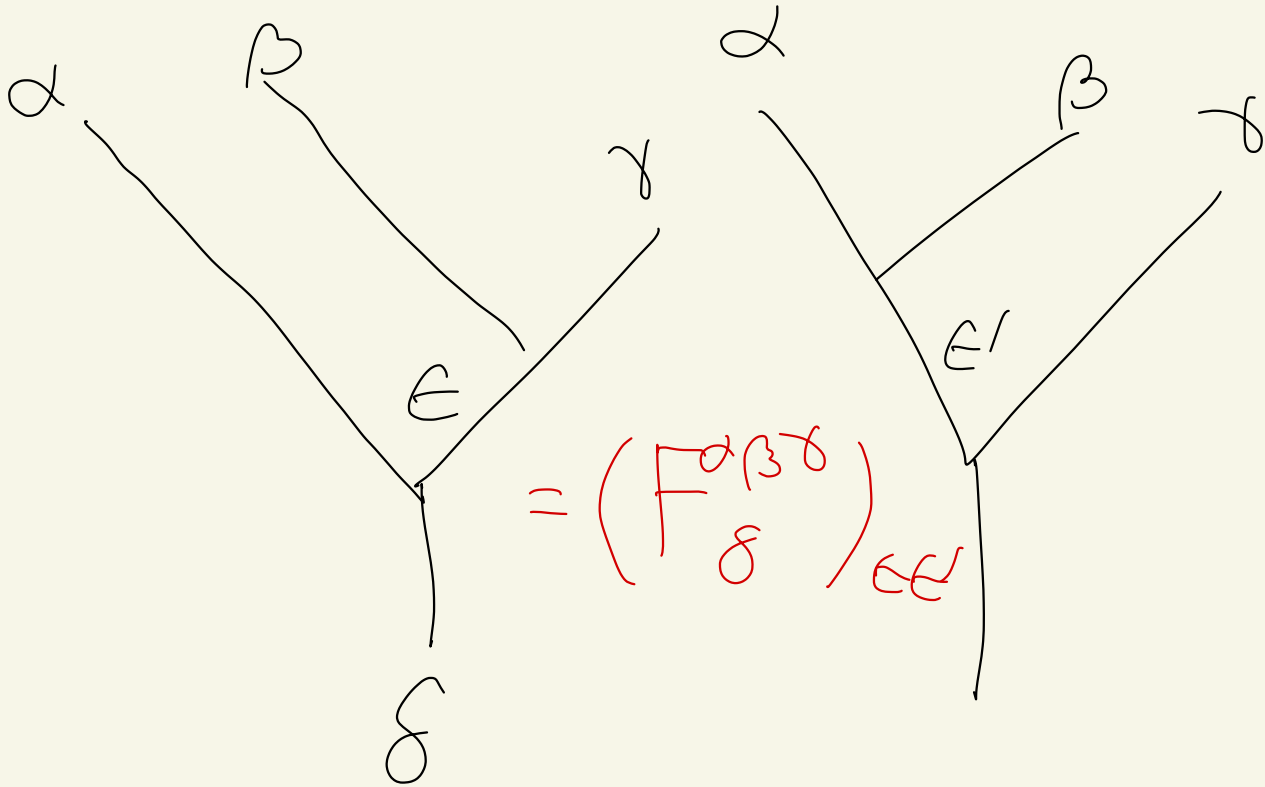
$\{a\} \alpha=0, \dots, nk-1$

trivial anyon



$$\alpha \otimes \beta = \bigoplus_{\gamma} N_{\alpha \beta}^{\gamma} \gamma$$

fusion



braiding

