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山崎さん　3d N=2 SUSY gauge theory ⟷ 3d $SL(2\,\mathbb{R}/\mathbb{C})$ Chern-Simons

3-mfd (eg hyperbolic mfd) geometry

Refs
- Drukker-Gaiotto-Gomis 1003
- Hosomichi-Lee-Park 1009
- Terashima-Y 1103 1106
- Dimofte-Gukov 1106

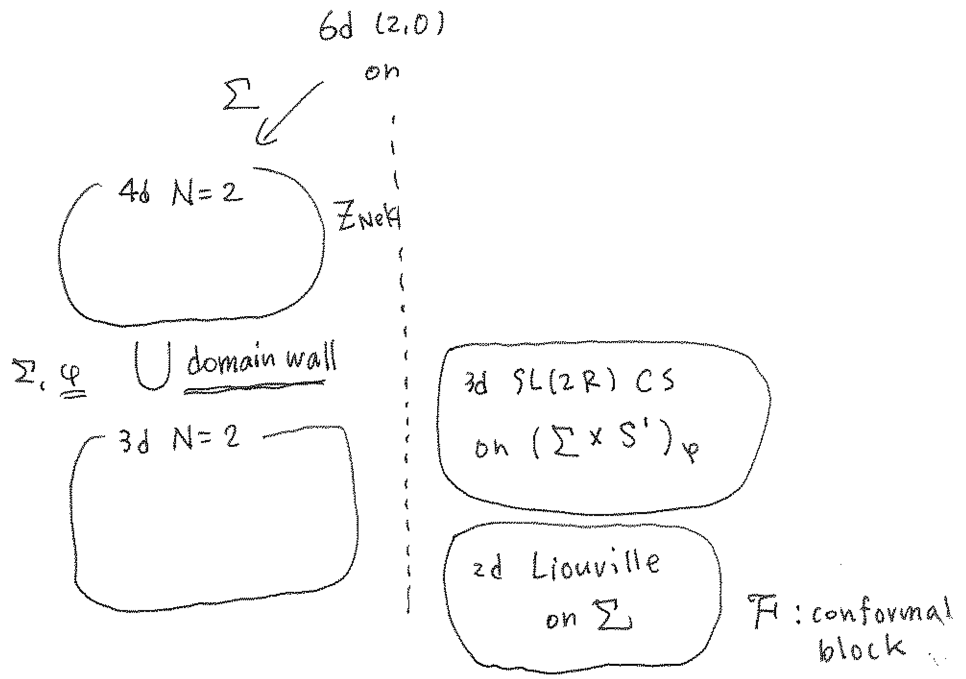
3d N=2 SUSY gauge theory ⟺ $SL(N\,\mathbb{R}/\mathbb{C})$ pure Chern-Simons
Yang-Mills (+CS) + matter　　on 3 mfd $\underline{M}$

$$Z_{3d\,N=2}[S^3] = Z_{3d\,SL(2R)\,CS}[M]$$

- exact computation of Z
  - 4d on S^4, $S^3 \times S^1$, ...
  - 3d on S^3, $S^2 \times S^1$, ...
- relation betwen SUSY / non SUSY
  - AGT, GRRY, ...

背後に 6d. (2,0) theory (M5-brane上の理論)
on $S^3 \times M$

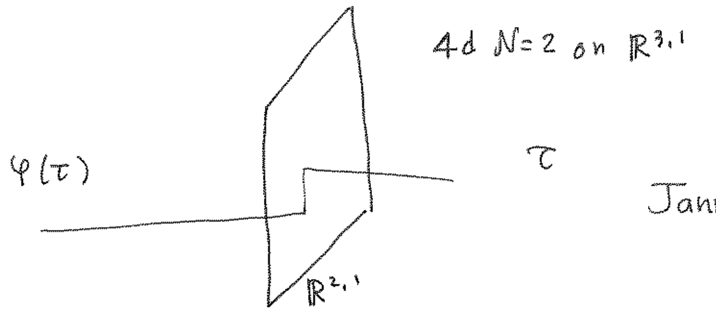
Mの例
- $\Sigma_{g,h} \times I_{[0,1]}$　$(\chi(\Sigma)<0)$
- $(\Sigma \times S^1)_\varphi$　$\varphi \in MCG(\Sigma) = Diff(\Sigma)/Diff_0(\Sigma)$



* duality domain wall

4d $\mathcal{N}=2$ SCFTの complex coupling (τ)

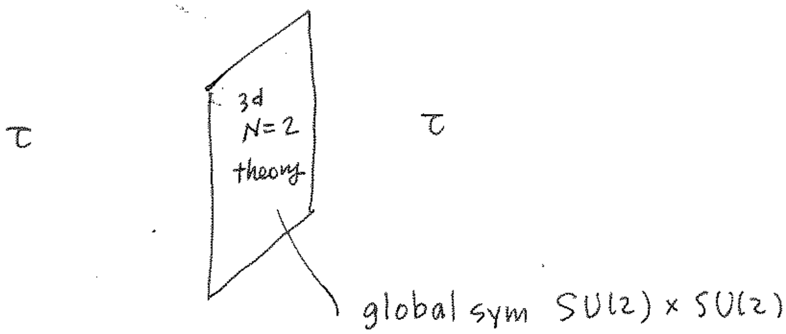
= Σ上の complex structure (Gaiotto)



Janus Domain Wall

$\varphi \in MCG(\Sigma)$ $\Leftrightarrow$ $\varphi \in$ S-duality of 4d SCFT

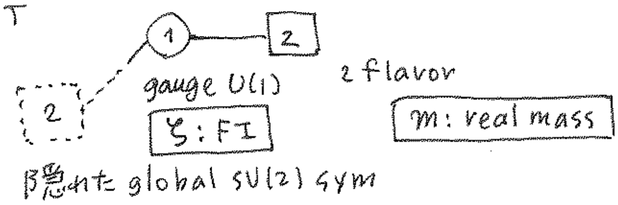
↓ φ^{-1} on LHS



eg. $\Sigma = \Sigma_{1,1}$ (1点付トーラス)

$\longrightarrow$ 4d $\mathcal{N}=2^*$, $\varphi = PSL(2,\mathbb{Z}) \ni S = \begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix}$

$\longrightarrow$ 3d $\mathcal{N}=4$ SCFT



m, ξ $\Longleftrightarrow$ mapping cylinder上の CS theoryの boundary condition

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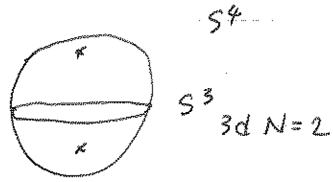
generalization of AGT



$$Z[S^4] = \int [da]\, Z_{Nek}(a) \qquad Z_{Nek}(a)$$

$$\to \int [da][da']\, Z_{Nek}(a)\, Z_{3d}(a,a')\, Z_{Nek}(a')$$

$\Rightarrow m, \xi$

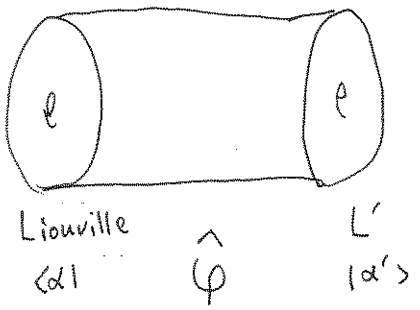
Coulomb br パラメータ

$$= \int_{d\alpha\, d\alpha'} F_\alpha\, \boxed{\varphi_{\alpha,\alpha'}}\, F_{\alpha'}$$

↑ conformal block

$\varphi \in MCG(\Sigma)$ の F への作用

$$F_\alpha(\varphi(\tau)) = \int d\alpha'\, \varphi_{\alpha\alpha'}\, F_{\alpha'}(\tau)$$



$|\alpha\rangle, |\alpha'\rangle \in \mathcal{H}_{CS}(\Sigma)$

↻

$MCG(\Sigma)$

CS 理論の古典極限

CS level $k = b^{-2}$ だいたい, b は S^3 の squashing パラメータ

$Z_{3d\ N=2}[S^3_b]$ $\quad b^2(x_1^2+x_2^2)+b^{-2}(x_3^2+x_4^2)=1$

3-manifold の geometry $\quad \mathbb{H}^3/\Gamma$ (hyperbolic 3-mfd)
$\quad M_3$ ″

$\mathrm{Vol}(M_3)$
$\quad + i\, CS(M_3)$

$k \to \infty$ で $Z_{CS} \sim \exp\left[k(\mathrm{Vol} + i CS)\right]$

S^3_b で $b \to 0$ ⇢ 2d (2,2) theory, $\widetilde{W}_{eff} \leftrightarrow$ QIM, YY function