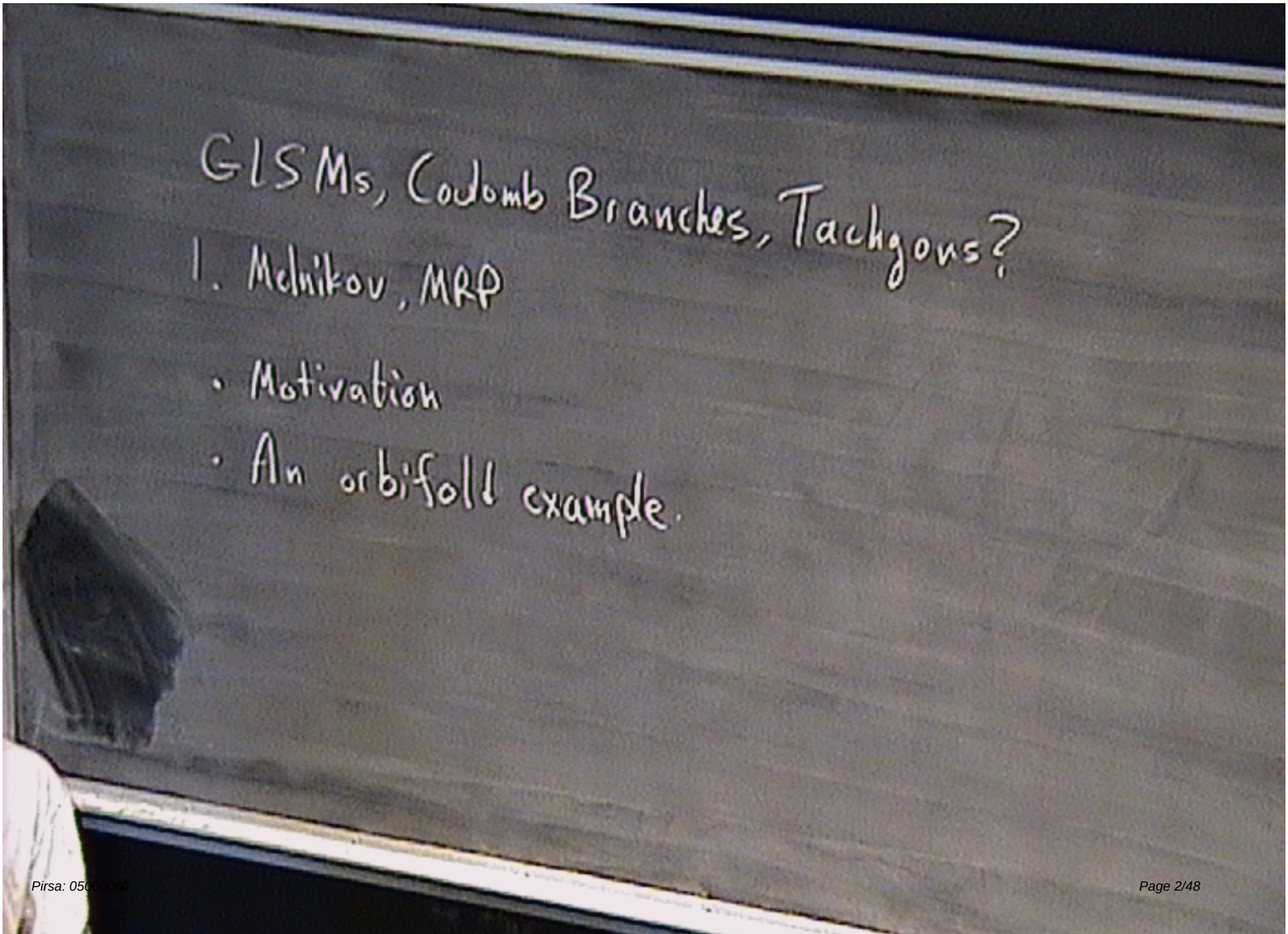
Title: GISMs, Coulomb Branches, Tachgons?

Date: Jun 07, 2005 11:00 AM

URL: http://pirsa.org/05060060

Abstract:


GLSMs, Coulomb Branches, Tachyons?
1. Melnikov, MRP
• Motivation
• An orbifold example.

GLSMs, Coulomb Branches, Tachyons?

1. Melnikov, MRP

- Motivation
- An orbifold example.
- The GLSM - relate them.
- The Coulomb branch
- Instanton Sum in hi-E phase.
- Discussion

Want:

- Localized tachyon condensation.
- Closed string tachyons @ orbifolds.

Want:

- Localized tachyon condensation.
- Closed string tachyons @ orbifolds. α'/r
  - tahyon decay resolve singularity.

Want:

- Localized tachyon condensation.
- Closed string tachyons @ orbifolds. $\mathbb{C}^3/\Gamma$
  - tahyon decay resolve singularity.
- $N=(2,2)$ SUSY.

Want:

- Localized tachyon condensation.
- Closed string tachyons @ orbifolds. $\mathbb{C}^3/\Gamma$
  - tahyon decay resolve singularity.
- $N=(2,2)$ SUSY. Chiral operators.

Want:

- Localized tachyon condensation.
- Closed string tachyons @ orbifolds. $\mathbb{C}^n/\Gamma$
  - tahyon decay resolve singularity.
- $N=(2,2)$ SUSY. Chiral operators.
- Use worldsheet RG.

Want:

- Localized tachyon condensation.
- Closed string tachyons @ orbifolds. $\mathbb{C}^3/\Gamma$.
  - tahyon decay resolve singularity.
- $N=(2,2)$ SOSY. Chiral operators.
- Use worldsheet RG.
- Apply GLSM to study.

Pirsa: 05060060

Want:

- Localized tachyon condensation
- Closed string tachyons @ orbifolds. $\mathbb{C}^n/\Gamma$
  - tahyon decay resolve singularity.
- $N=(2,2)$ SUSY. Chiral operators.
- Use worldsheet RG.
- Apply GLSM to study.



Want:

- Localized tachyon condensation.
- Closed string tachyons @ orbifolds. α'/r
  - tahyon decay resolve singularity.
- $N=(2,2)$ SUSY. Chiral operators.
- Use worldsheet RG.
- Apply GLSM to study.



Pirsa: 05060060

Want:

- Localized tachyon condensation.
- Closed string tachyons @ orbifolds. $\mathbb{C}^3/\Gamma$
  - tahyon decay resolve singularity.
- $N=(2,2)$ SUSY. Chiral operators.
- Use worldsheet RG.
- Apply GLSM to study.
- Work in twisted TFT



- Our Example $(M = 2N+1)$.

$$\mathbb{C}^3 / \mathbb{Z}_{(2N+1)}(1,2,1)$$

$$T_1 : \frac{5}{2N+1}$$

$$T_2 : \frac{N+3}{M}$$

• Our Example $(M = 2N+1)$.

$$\mathbb{C}^3/\mathbb{Z}_{(2N+1)}\,\frac{1}{(2N+1)}(2,2,1)$$

$$T_1 : \frac{5}{2N+1} \qquad T_1^M \cdot z_1^2 z_2^2 z_3$$

$$T_2 : \frac{N+3}{M}$$

• Our Example $(M = 2N+1)$.

$$\mathbb{C}^3 / \mathbb{Z}_{(2N+1)}(1,1,1)$$

$$T_1 : \frac{5}{2N+1}$$

$$T_2 : \frac{N+3}{M}$$

$$T_1^M = z_1^2 z_2^2 z_3$$

$$T_2^2 = z_3 T_1$$

$U(1)^2$

$$Q = \begin{pmatrix} 1 & 1 & 1 & -N & -1 \\ 0 & 0 & 1 & 1 & -2 \end{pmatrix}$$

$$\int d^2\hat{z}\, \delta(r_1 \Sigma_1 + r_2 \Sigma_2) + c.c.$$

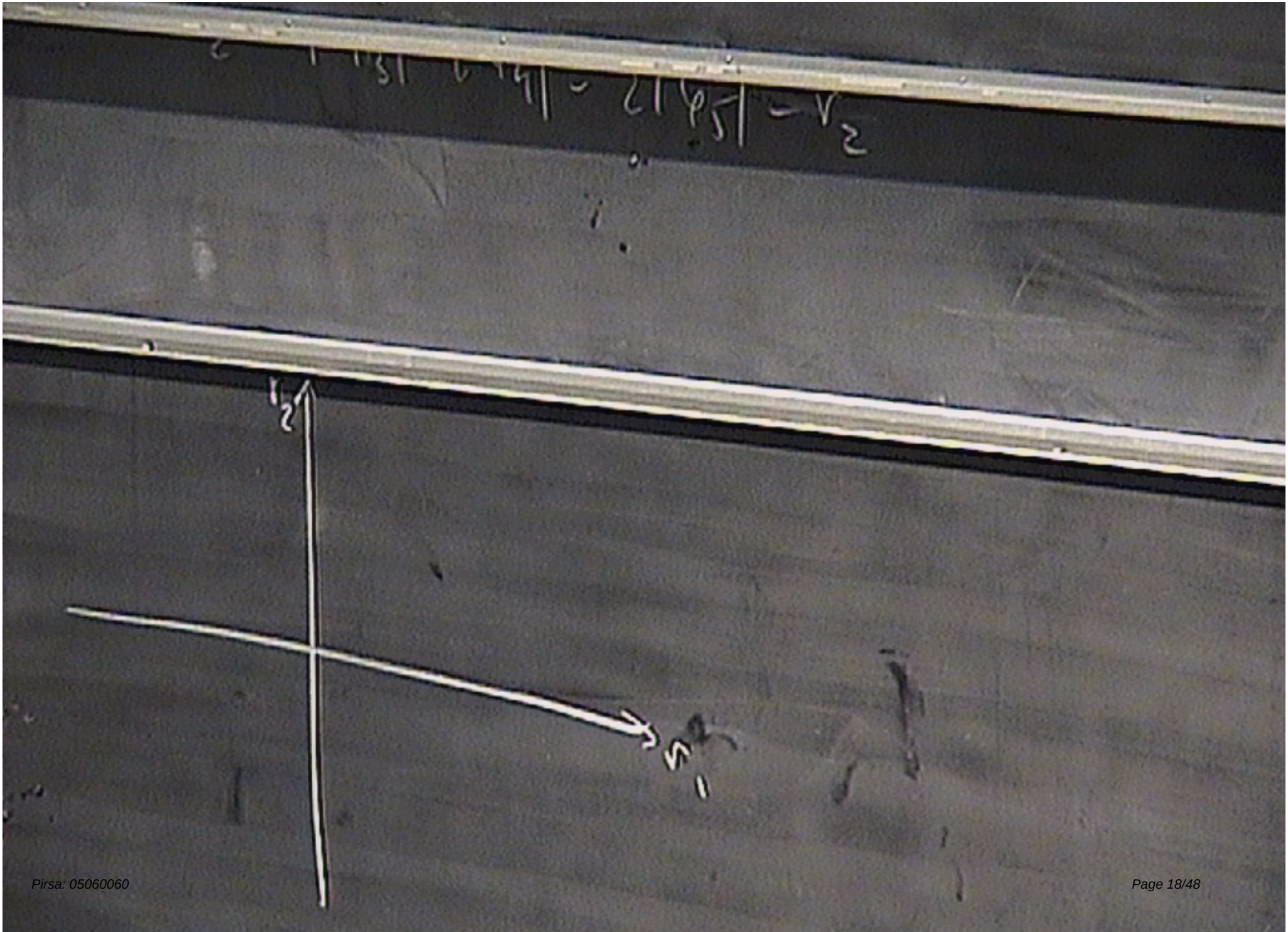
$(III)^2$

$$Q = \begin{pmatrix} 1 & 1 & 1 & -N & -1 \\ 0 & 0 & 1 & 1 & -2 \end{pmatrix}$$

$$\int d^2\hat{\theta}\, \phi(r_1 \Sigma_1 + r_2 \Sigma_2) + c.c.$$

$$U = D_1^2 + D_R^2$$

$$D_1 = |\varphi_1|^2 + |\varphi_2|^2 - |\varphi_3|^2 - N|\varphi_4|^2 - |\varphi_5|^2$$



$$D_1 = |\psi_1|^2 + |\psi_2|^2 + |\psi_3|^2 - N|\psi_4|^2 - |\psi_5|^2 = V_1$$

$$D_2 = |\psi_3|^2 + |\psi_4|^2 - 2|\psi_5|^2 = V_2$$



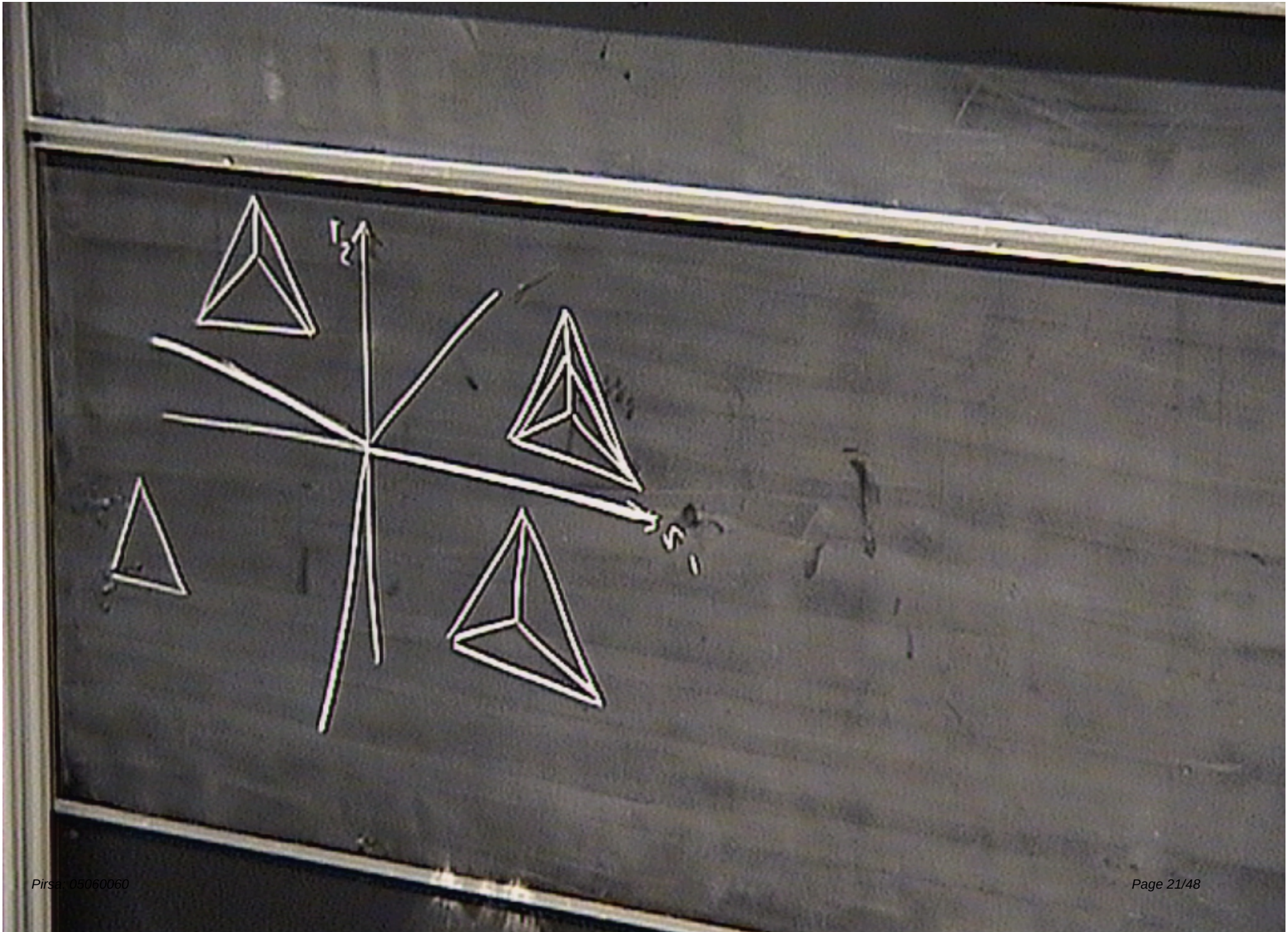
$Q = (0\ 0\ 1\ 1\ -2)$

$\int d^2\hat{z}\, \theta(r_1 \Sigma_1 + r_2 \bar{\Sigma}_2) + c.c.$

$U = D_1^2 + D_2^2$

$D_1 = |\psi_1|^2 + |\psi_2|^2 - |\psi_3|^2 - N(|\psi_4|^2 - |\phi_5|^2 - v_1$

$D_2 = |\psi_3|^2 + |\psi_4|^2 - 2|\phi_5|^2 - v_2$



$$Q = \begin{pmatrix} 1 & 1 & 1 & -N & -1 \\ 0 & 0 & 1 & 1 & -2 \end{pmatrix}$$

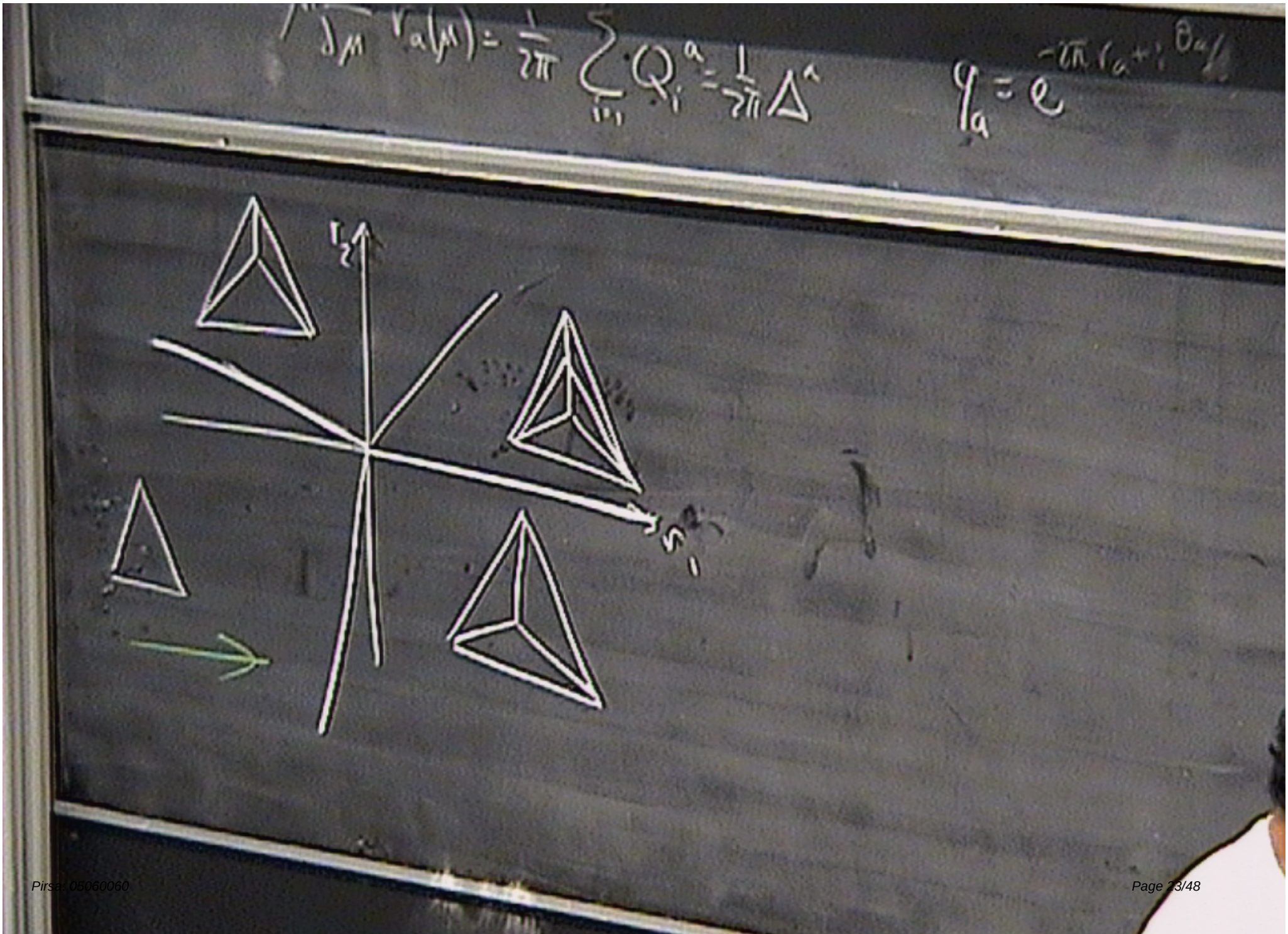
$$\int d^2\theta\, \Phi(r_1 \Sigma_1 + r_2 \bar{\Sigma}_2) + \text{c.c.}$$

$$U = D_1^2 + D_2^2$$

$$D_1 = |\varphi_1|^2 + |\varphi_2|^2 - |\varphi_3|^2 - N|\varphi_4|^2 - |\varphi_5|^2 - r_1$$

$$D_2 = |\varphi_3|^2 + |\varphi_4|^2 - 2|\varphi_5|^2 - r_2$$

$$M\frac{d}{dM} r_a(M) = \frac{1}{2\pi} \sum_{i=1}^{5} Q_i^a$$


$\partial_\mu r_a(\mu) = \frac{1}{2\pi} \sum_{i=1}^{n} Q_i^a = \frac{1}{2\pi} \Delta^a$
$\gamma_a = e^{-i\pi r_a + i\theta_a}$
r_2
s_1

$$Q = \begin{pmatrix} 1 & 1 & 1 & -N & -1 \\ 0 & 0 & 1 & 1 & -2 \end{pmatrix} \begin{matrix} \in N \\ \in 0 \end{matrix}$$

$$\int d^2\theta \left(r_1 \Sigma_1 + r_2 \Sigma_2 \right) + c.c.$$

$$U = D_1^2 + D_2^2$$

$$D_1 = |\varphi_1|^2 + |\varphi_2|^2 - |\varphi_3|^2 - N|\varphi_4|^2 - |\varphi_5|^2 = r_1$$

$$D_2 = |\varphi_3|^2 + |\varphi_4|^2 - 2|\varphi_5|^2 = r_2$$

$$M \frac{\partial}{\partial M} r_a(M) = \frac{1}{2\pi} \sum_{i=1}^{5} Q_i^a = \frac{1}{2\pi} \Delta^a$$

$$q_a = e^{-2\pi r_a + i\theta_a}$$

$U(1)^2$

$$Q = \begin{pmatrix} 1 & 1 & 1 & -N & -1 \\ 0 & 0 & 1 & 1 & -2 \end{pmatrix} \quad \Delta_a = 2-N \quad 0$$

$$U = D_1^2 + D_2^2$$

$$\int d^2\theta\, \phi(r_1 \Sigma_1 + r_2 \Sigma_2) + c.c.$$

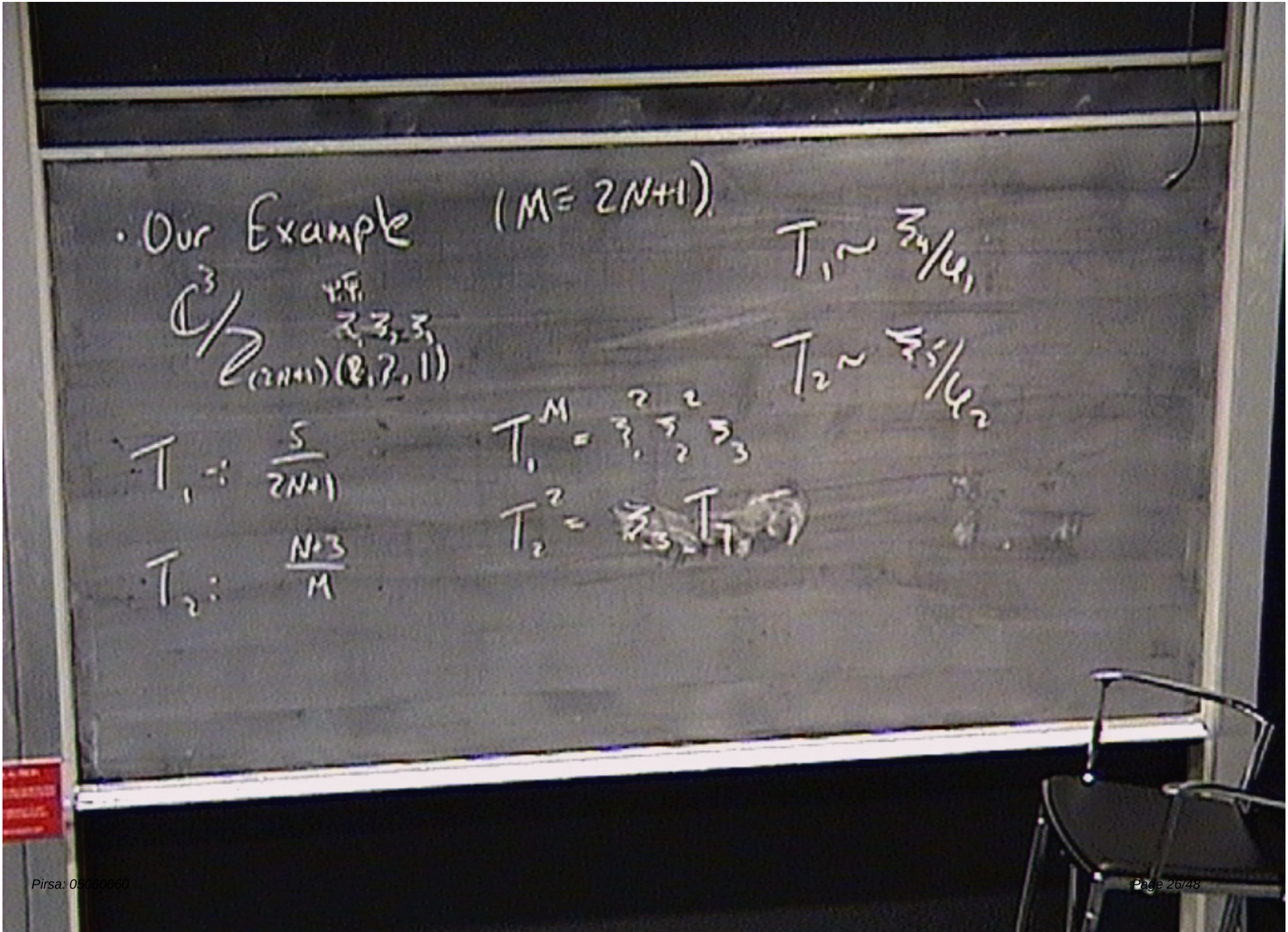
$$\Sigma_i = \sum_a Q_i^a \Sigma_a$$

$$D_1 = |\varphi_1|^2 + |\varphi_2|^2 - |\varphi_3|^2 - N|\varphi_4|^2 - |\varphi_5|^2 - r_1$$

$$D_2 = |\varphi_3|^2 + |\varphi_4|^2 - 2|\varphi_5|^2 - r_2$$

$$M\frac{\partial}{\partial M} r_a(M) = \frac{1}{2\pi} \sum_i Q_i^a = \frac{1}{2\pi}\Delta^a$$

$$q_a = e^{-2\pi r_a + i\theta_a}$$


· Our Example (M = 2N+1)
$\mathbb{C}^3/\mathbb{Z}_{(2N+1)}$ with $z_1 z_2 z_3$ $(1,?,?)$
$T_1 : \frac{S}{2N+1}$
$T_2 : \frac{N+3}{M}$
$T_1^M = z_1^? z_2^? z_3$
$T_2^? = z_3 T_?$
$T_1 \sim \mathbb{Z}_4/\mathbb{Z}_1$
$T_2 \sim \mathbb{Z}_5/\mathbb{Z}_2$

• Our Example $(M = 2N+1)$

$\mathbb{C}^3/\mathbb{Z}_{(2N+1)}(1,2,-1)$ with x, y, z

$T_1 : \frac{5}{2N+1}$

$T_2 : \frac{N+3}{M}$

$T_1 \sim \Sigma_4/\mathbb{Z}_{M}$

$T_2 \sim \Sigma_5/\mathbb{Z}_{M}$

$T_1^M = x^2 y^2 z$

$T_2^2 = xyz$

$q_1 = u_1^{-N} u_2^{-1}$

$q_2 = u_1 u_2^{-2}$

$u_1 = (q_2 q_1^{-2})^{\frac{1}{M}}$

• Our Example $(M = 2N+1)$

$\mathbb{C}^3/\mathbb{Z}_{(2N+1)}(1,1,-2)$ with x, y, z

$T_1 \sim x/y$

$T_2 \sim z^2/xy$

$T_1 : \frac{2}{2N+1}$

$T_2 : \frac{N+3}{M}$

$T_1^M = x^2 y^2 z^2$

$T_2^2 = z^3 \cdot T_1^{-1}$

$q_1 = y^{-N} x^{-1}$

$q_2 = y x^{-2}$

$y = (q_2 q_1^2)^{\frac{1}{M}}$

- Apply GLSM to study.
- Work in twisted TFT



$$Y_{a_1 \cdots a_s} = \langle \sigma_{a_1} \cdots \sigma_{a_b} \rangle \neq 0$$

$s - 3 = n(N-2)$

- Apply GLSM to study.
- Work in twisted TFT



$$Y_{a_1 \cdots a_5} = \langle \sigma_{a_1} \cdots \sigma_{a_{15}} \rangle \neq 0$$

$\therefore S-3 = m(N-2)$ then $Y \sim q_1^m$

$(4|11)^2$

$$Q = \begin{pmatrix} 1 & 1 & 1 & -N & -1 \\ 0 & 0 & 1 & 1 & -2 \end{pmatrix} \begin{matrix} 2-N \\ 0 \end{matrix} \qquad \Delta$$

$$U = D_1^2 + D_2^2 + \sum_{i,a,b} \zeta_a q_b Q_i^a Q_i^b |\sigma_i|^2 \qquad \int d^2\theta \, \Phi(r_1 \Sigma_1 + r_2 \Sigma_2) + \text{c.c.}$$

$$\Sigma_i = \sum_a Q_i^a \Sigma_a$$

$$D_1 = |\varphi_1|^2 + |\varphi_2|^2 - |\varphi_3|^2 - N|\varphi_4|^2 - |\varphi_5|^2 - r_1$$

$$D_2 = |\varphi_3|^2 + |\varphi_4|^2 - 2|\varphi_5|^2 - r_2$$

$$M \frac{\partial}{\partial M} r_a(M) = \frac{1}{2\pi} \sum_{i=1}^{5} Q_i^a = \frac{1}{2\pi} \Delta^a \qquad q_a = e^{-2\pi r_a + i\theta_a}$$

$U(1)^2$

$$Q = \begin{pmatrix} 1 & 1 & 1 & -N & -1 \\ 0 & 0 & 1 & 1 & -2 \end{pmatrix} \begin{matrix} 2-N \\ 0 \end{matrix} \qquad \Delta$$

$$U = D_1^2 + D_2^2 + \sum_{i,a,b} \sigma_a \sigma_b Q_i^a Q_i^b |\phi_i|^2 \qquad \int d^2\theta \, \Phi(r_1 \Sigma_1 + r_2 \Sigma_2) + \text{c.c.}$$

$$\Sigma_i = \sum_a Q_i^a \Sigma_a .$$

$$D_1 = |\phi_1|^2 + |\phi_2|^2 - |\phi_3|^2 - N|\phi_4|^2 - |\phi_5|^2 - r_1$$

$$D_2 = |\phi_3|^2 + |\phi_4|^2 - 2|\phi_5|^2 - r_2$$

$$M \frac{\partial}{\partial M} r_a(M) = \frac{1}{2\pi} \sum_{i=1}^{5} Q_i^a = \frac{1}{2\pi} \Delta^a \qquad q_a = e^{-2\pi r_a + i\theta_a}$$

- Apply GLSM to study.
- Work in twisted TFT

$$Y_{a_1 \cdots a_s} = \langle \sigma_{a_1} \cdots \sigma_{a_b} \rangle \neq 0$$

$s - 3 = k(N-2)$ then $Y \sim q_i^m$

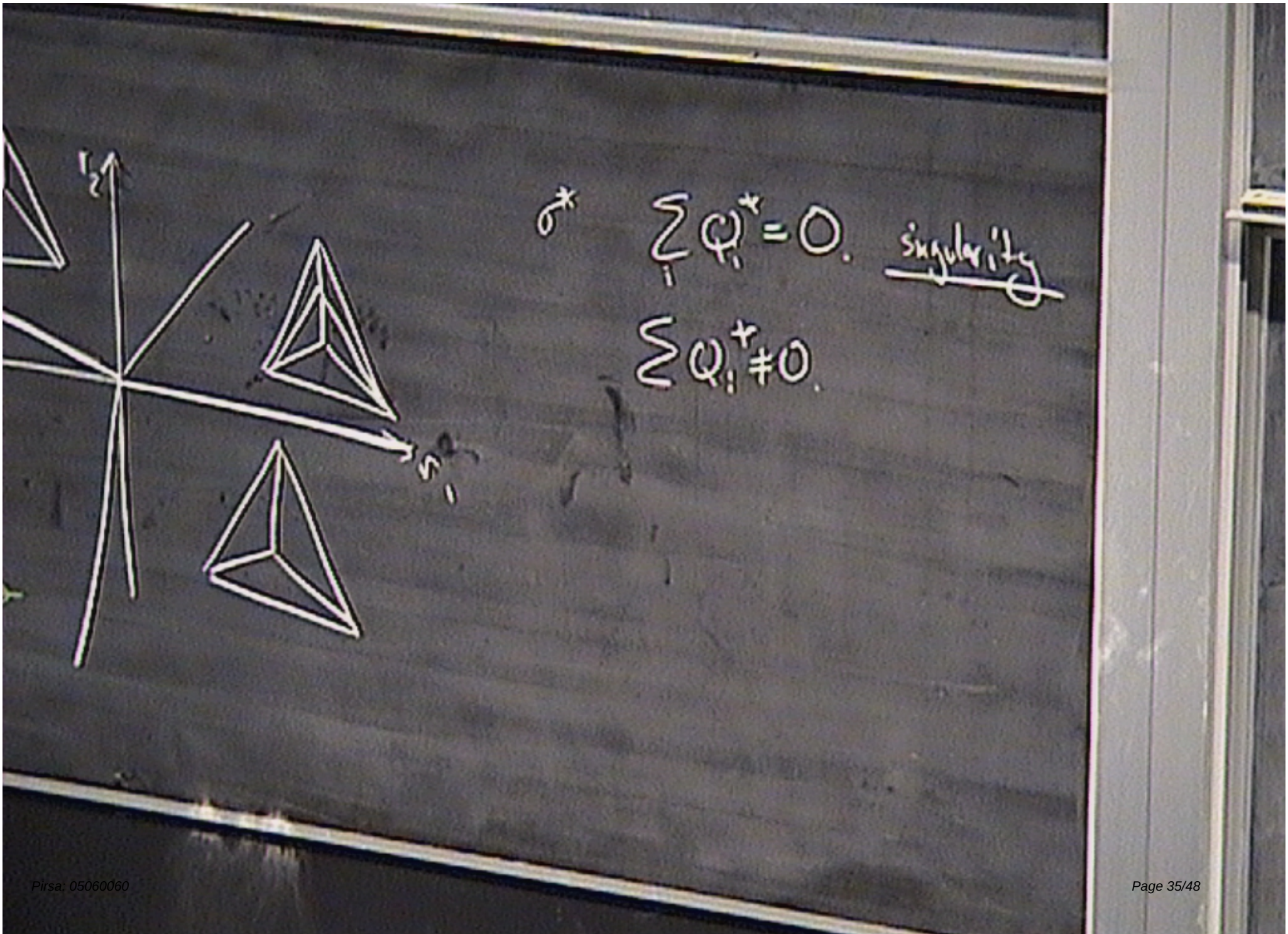
$$\tilde{W}_{eff} = -\frac{1}{4\pi\sqrt{2}} \sum_a \Sigma_a \left(\log \left(\prod_{i=1}^{r} \frac{\pi}{2\mu} \sum_b Q_i^b \varepsilon_b / q_a \right) \right)$$

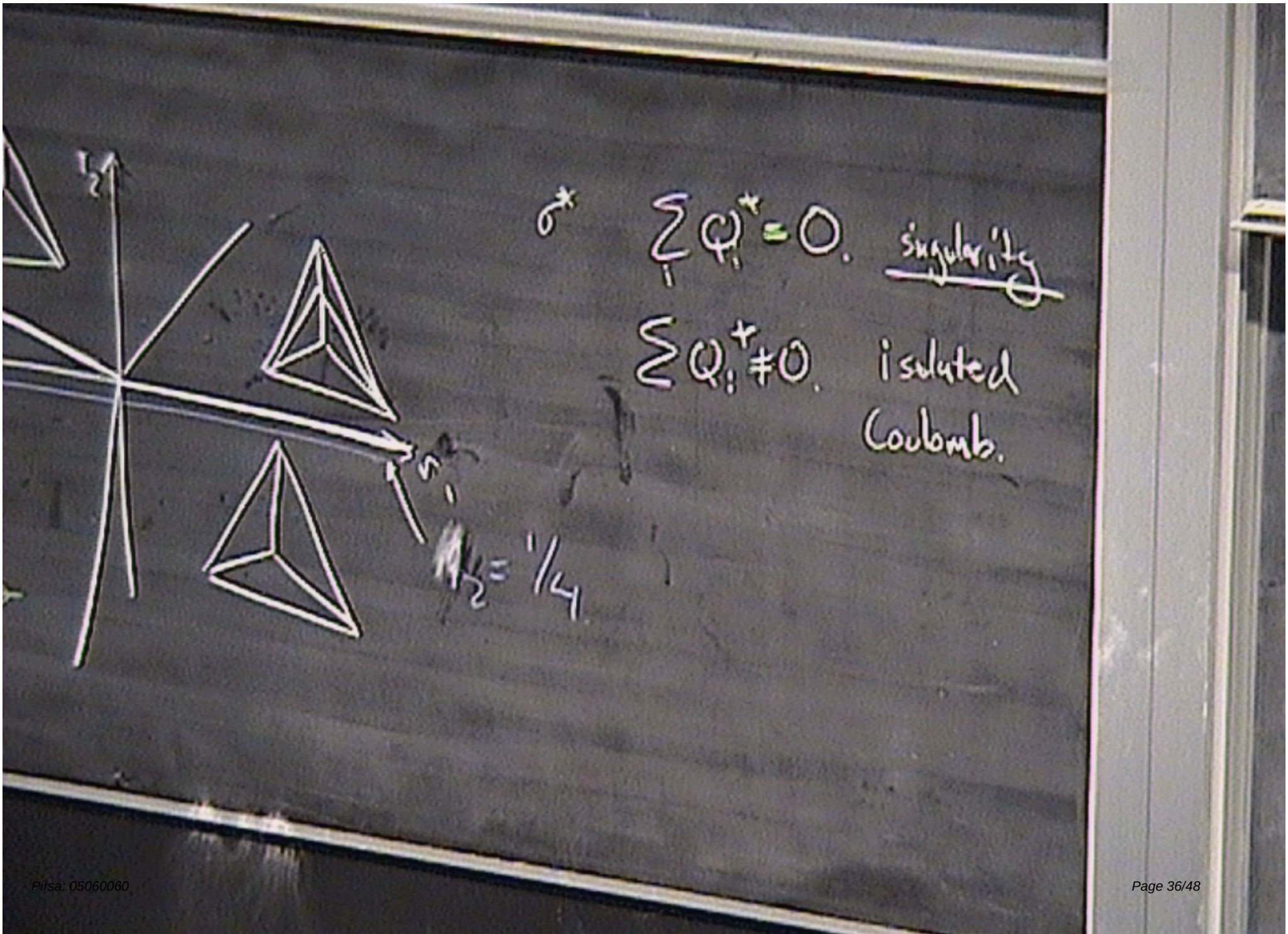
- Apply GLSM to study.
- Work in twisted TFT

$$Y_{a_1 \cdots a_s} = \langle \sigma_{a_1} \cdots \sigma_{a_s} \rangle \neq 0$$

$s - 3 = m(N-2)$ then $Y \sim q^m$

$$\tilde{W}_{eff} = -\frac{1}{4\pi i\tau_2} \sum_a \Sigma_a \left(\log \left(\prod_{i=1}^{r} \left(\frac{1}{2\pi i} \sum_b Q_i^b \varepsilon_b \right)^{Q_a^i} / q_a \right) \right)$$


σ^*
$\sum_i Q_i^* = 0$. singularity
$\sum Q_i^* \neq 0$.


σ^* $\sum_i Q_i^* = 0$. singularity
$\sum Q_i^* \neq 0$. isolated
Coulomb.
s_1
s_2
$\frac{1}{4}$

- Apply GLSM to study.
- Work in twisted TFT



- S-3- $SO(N-2)$ then $Y \sim q^m$

$$\tilde{W}_{eff} = -\frac{1}{4\pi i\tau_2}\sum' \Sigma_a \left(\log\left(\prod_{i=1}^{5} \left(\frac{1}{\sqrt{2}\mu} \sum_b Q_i^b \varepsilon_b \right)^{Q_a^i} / q_a \right) \right)$$

$$\boxed{\prod_i (\xi_i)^{Q_a^i} = \mu^{\Delta} q_a}$$

- Apply GLSM to study.
- Work in twisted TFT

$S-3-$ $U(N-2)$ then $Y \sim$

$$\tilde{W}_{eff} = -\frac{1}{4\pi i\tau_2}\sum_i \Sigma_a \left(\log\left(\prod_{i=1}^{5} \left(\frac{1}{\mu} \sum_b Q_i^b \varepsilon_b \right)^{Q_a^i} / q_a \right) \right)$$

$$\prod_i \left(\sum_b Q_i^b \varepsilon_b \right)^{Q_a^i} = \mu^{\Delta} q_a$$

$\lambda_1 = z_4$, $\lambda_2 = z_5$

$(-M)^3 (2\lambda_1 + \lambda_2)^2 (\lambda_1 + (N-1)\lambda_1) = q_1 \lambda_1^N \lambda_2$

$(-M)^1 \lambda_1 (\lambda_1 + (N-1)\lambda_2) = q_2 \lambda_2^2$

- Apply GLSM to study.
- Work in twisted TPT

$$Y_{a_1 \cdots a_s} = \langle \sigma_{a_1} \cdots \sigma_{a_s} \rangle = \sum_{\text{all } A} f_A \prod \sigma_{a_1}^{\wedge} \cdots \sigma_{a_s}^{\wedge}$$

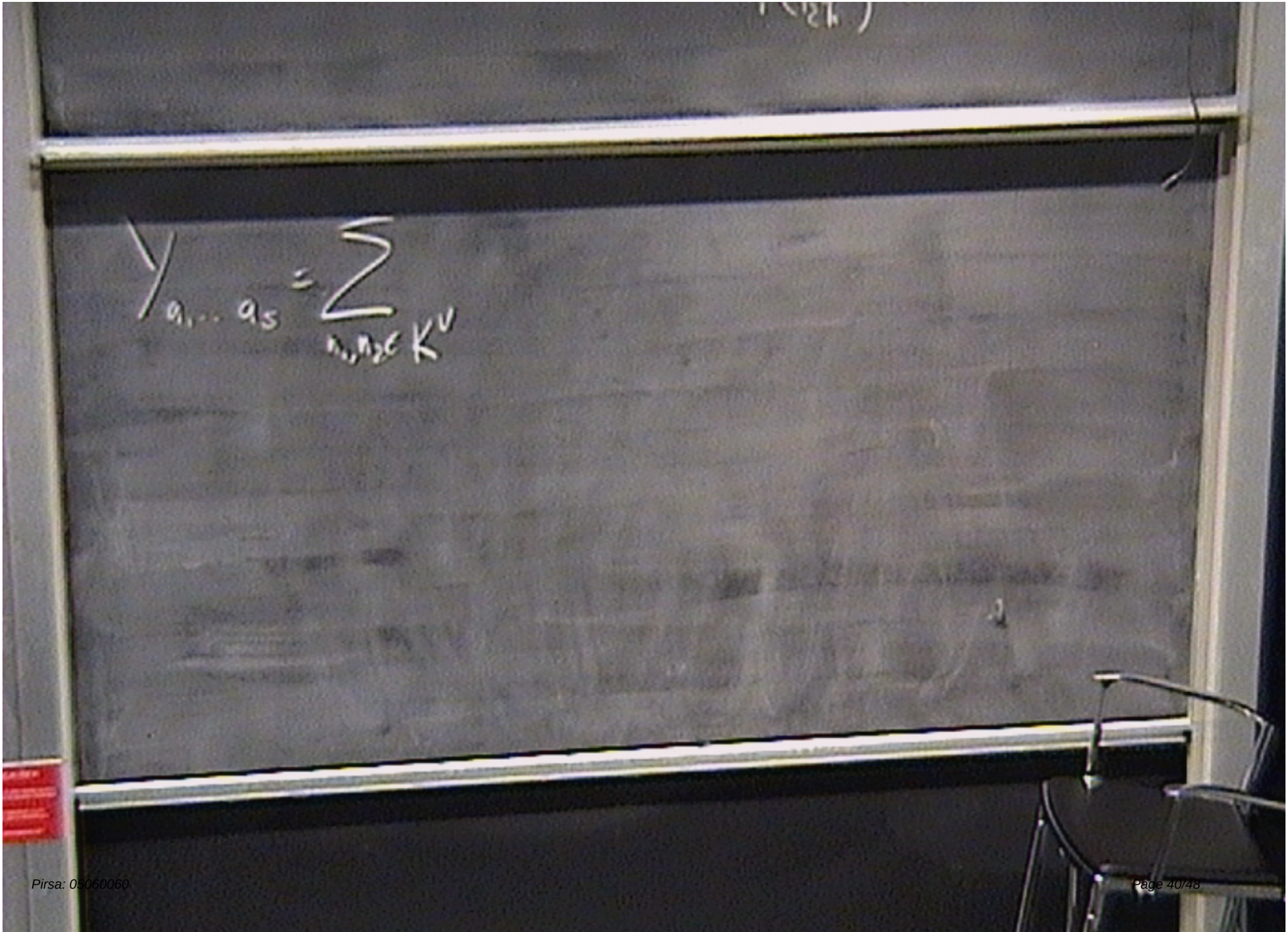
$s-3 = \dim(N-2)$ then $Y \sim q^m$

$$\tilde{W}_{\text{eff}} = -\frac{1}{4\pi\sqrt{2}} \sum{}' \Sigma_a \left(\log \left(\prod_{i=1}^{r} \left(\frac{1}{2\pi i} \sum_b Q_i^b \varepsilon_b \right)^{Q_a^i} / q_a \right) \right)$$

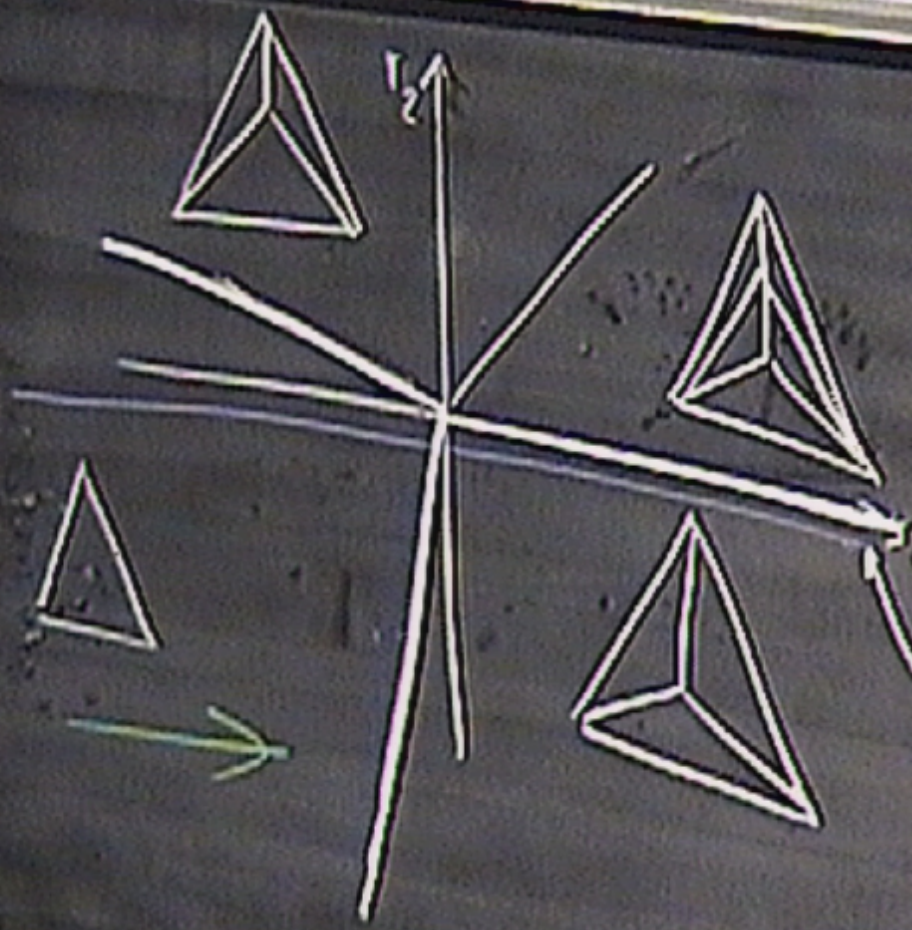
$$\prod_i \left(\xi_i \right)^{Q_a^i} = \mu^{\Delta} q_a$$

$\lambda_1 = \Sigma_1$, $\lambda_2 = \Sigma_2$

$$\begin{cases} (-M)^{-2} (2\lambda_1 + \lambda_2)^2 \left(\lambda_1 \pi (N+1) \lambda_1 \right) = q_1 \lambda_1^N \lambda_2 \\ (-M) \lambda_1^{-1} \left(\lambda_1 \pi (N+1) \lambda_2 \right) = q_2 \lambda_2^2 \end{cases}$$


$Y_{a_1 \ldots a_s} = \sum_{n_1, n_2 \in K^V}$

$$\frac{M}{\partial M} r_a(M) = \frac{1}{2\pi} \sum_{i=1}^{s} Q_i^a = \frac{1}{2\pi} \Delta^a \qquad q_a = e^{-i\pi r_a + i\theta_a}$$



σ^* $\sum_i Q_i^* = 0$. singularities

$\sum Q_i^* \neq 0$. isolated

Coulomb.

n_i

$n_2 = 1/4$

- Apply GLSM to study.
- Work in twisted TFT

$$Y_{q_1 \cdots q_s} = \langle \sigma_{a_1} \cdots \sigma_{a_k} \rangle = \sum_{\text{vacua}} (f_A) \prod \sigma_{a_1}^{\lambda} \cdots \sigma_{a_k}^{\lambda}$$

$$\boxed{s-3 = \sum_i (N-2)} \quad \text{then } Y \sim q^{-m}$$

$$\tilde{W}_{\text{eff}} = -\frac{1}{4\pi i \tau} \sum_a \Sigma_a \left(\log \left(\prod_{i=1}^{r} \left(\frac{1}{2\pi i} \sum_b Q_i^b \Sigma_b \right)^{Q_i^a} / q_a \right) \right)$$

$$\boxed{\prod_i \left(\sum_a \right)^{Q_i^a} = \mu^{\Delta} q_a}$$

$$\begin{cases} (-m)^{-2} (2\lambda_1 + \lambda_2)^2 (\lambda_1 \tau (N+1)\lambda_1) = q_1 \lambda_1^N \lambda_2 \\ (-m)^{-1} \lambda_1^{-1} (\lambda_1 \tau (N+1)\lambda_2) = q_2 \lambda_2^2 \end{cases}$$

$\lambda_1 = \Sigma_4, \lambda_2 = \Sigma_5$

$$Y_{a_1 \ldots a_s} = \sum_{n_1, n_2 \in K^V} q_1^{n_1} q_2^{n_2} \langle Y^{n_1, n_2}_{a_1 \ldots a_s} \quad Y_{ab} = \langle \lambda_1^a \lambda_2^b \rangle$$

$$Y^{\vec{n}}_{ab} = \epsilon(N)^{3n_1 n_2 - 2} \lambda_1^a \lambda_2^b (2\lambda_1 + \lambda_2)^{-2n_1 - 2} (\lambda_1 + (N+1)\lambda_2)^{-n_1 - n_2 - 1} \Big|_{\substack{n_1 - N n_2 \\ \lambda_1^{\ldots} \\ \lambda_2^{-n_1 - 2n_2}}}$$

$$Y_{q_1 \dots q_5} = \sum_{n_1, n_2 \in K^V} q_1^{n_1} q_2^{n_2} \, Y^{n_1, n_2}_{q_1 \dots q_5} \qquad Y_{ab} = \langle \lambda_1^a \lambda_2^b \rangle$$

$$Y^{\vec{n}}_{ab} = (-M)^{3n_1+n_2-2} \int \lambda_1^a \lambda_2^b (2\lambda_1+\lambda_2)^{-2n_1-2} \left(\lambda_1+(N-1)\lambda_2\right)^{-n_1-n_2-1} \Big|_{\lambda_2^{n_2-Nn_1}}^{\lambda_1^{n_1-2n_2}}$$

$$Y_{ab} = -M^2 \oint \frac{d\lambda_1}{2\pi i} \frac{d\lambda_2}{2\pi i} \lambda_1^{a-1} \lambda_2^{b-1} (2\lambda_1+\lambda_2)^{-2} \left(\lambda_1+(N+1)\lambda_2\right)^{-1} \times (1-R_2)^{-1} (1-R_1)^{-1}$$

$$R_2 = (\cdot M) q_2 \lambda_1^{-1} \lambda_2^2 (\lambda_1 + (M \cdot 1)\lambda_2)^{-1}$$

$$R_2 = (\cdot M) q_2 \lambda_1^{-1} \lambda_2^2 (\lambda_1 + (N_3 \cdot 1)\lambda_2)^{-1}$$

$$R_1 \qquad q_1 q_2^N$$

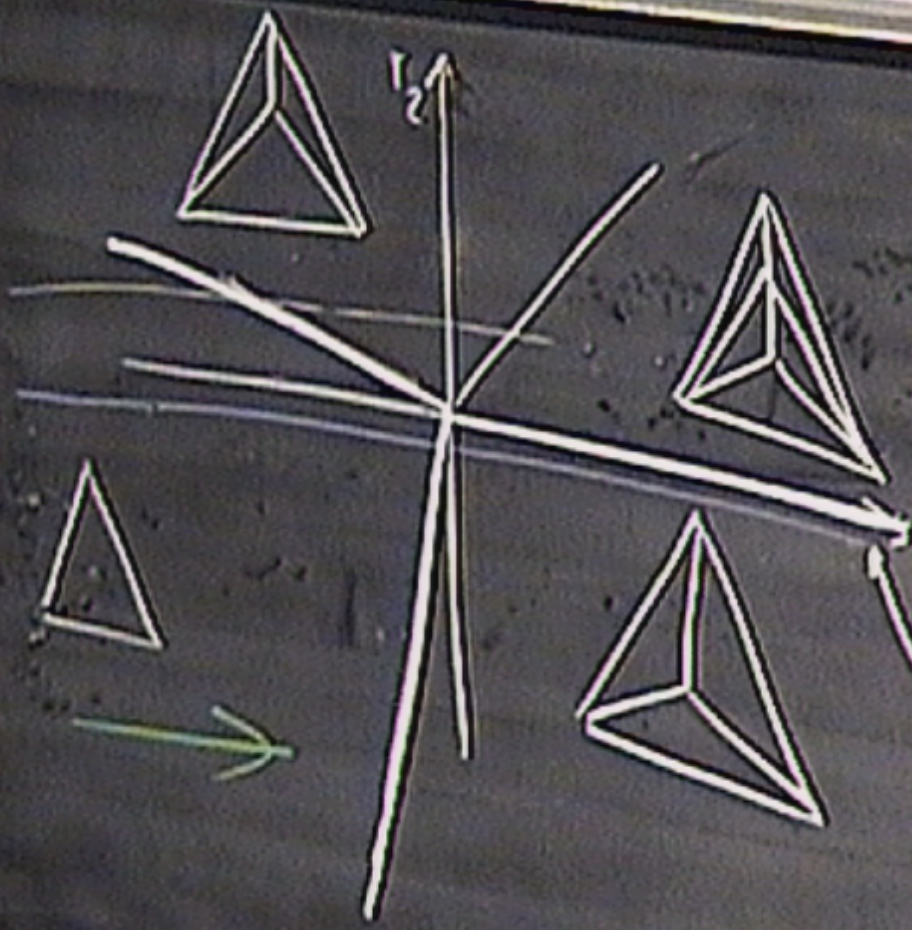
$\times (1 - R_2)^{-1} (1 - R_1)^{-1}$

$R_2 = (\cdot M) q_2 \lambda_1 \lambda_2 (\lambda_1 + (M-1)\lambda_2)^{-1}$

$R_1 \qquad q_1 q_2^N$

$f(x_1, x_2)$

$$\frac{M}{\int_M} r_a(\mu) = \frac{1}{2\pi} \sum_{i=1}^{s} Q_i^a = \frac{1}{2\pi} \Delta^a \qquad q_a = e^{-2\pi r_a + i\theta_a}$$



σ^* $\sum_i Q_i^* = 0$. singular

$\sum Q_i^* \neq 0$ isolated Coulomb.

$r_2 = 1/4$

$s = 3$

$\langle \lambda_1^3 \rangle \sim \frac{1}{(4r_2 - 1)^2}$