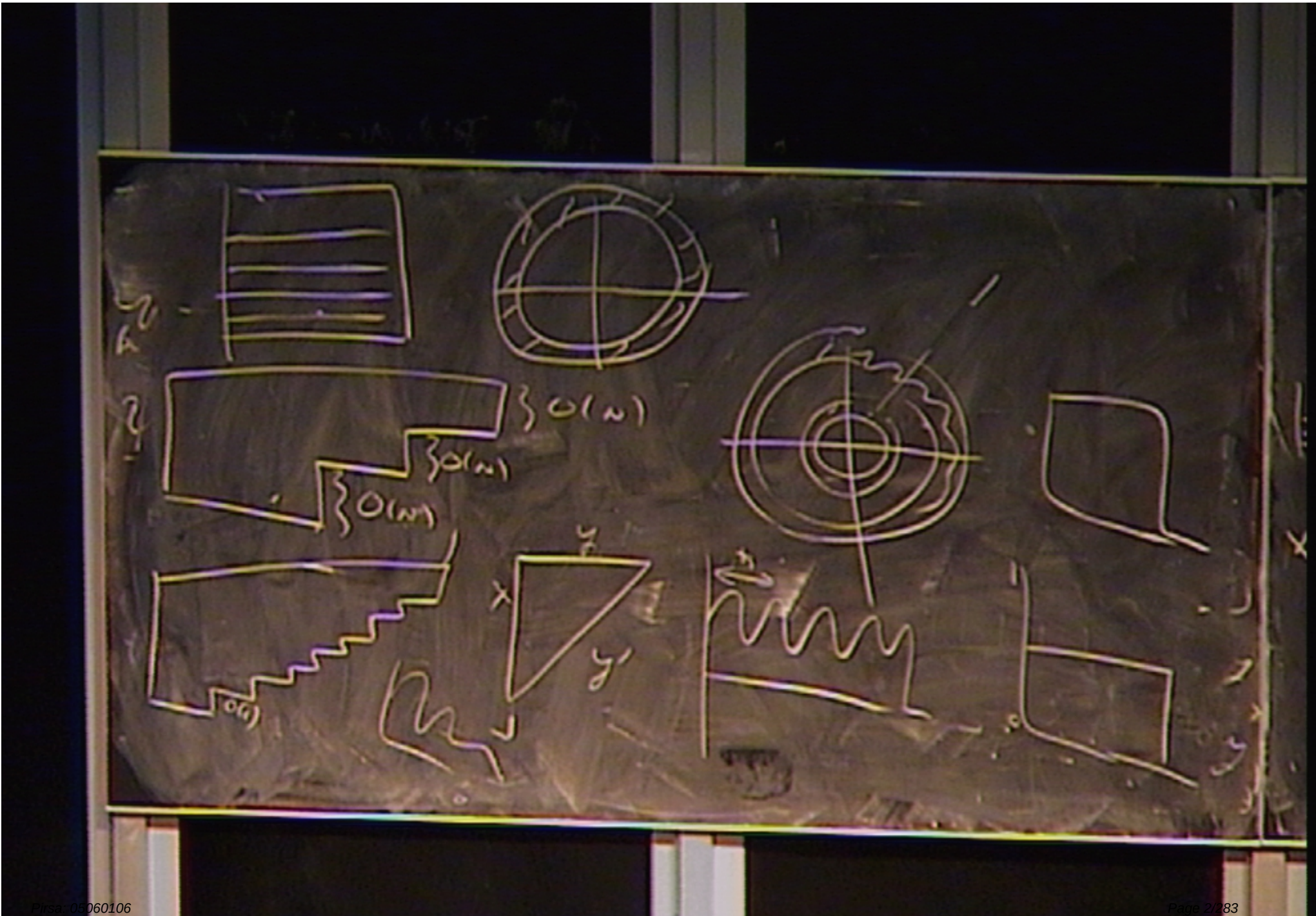


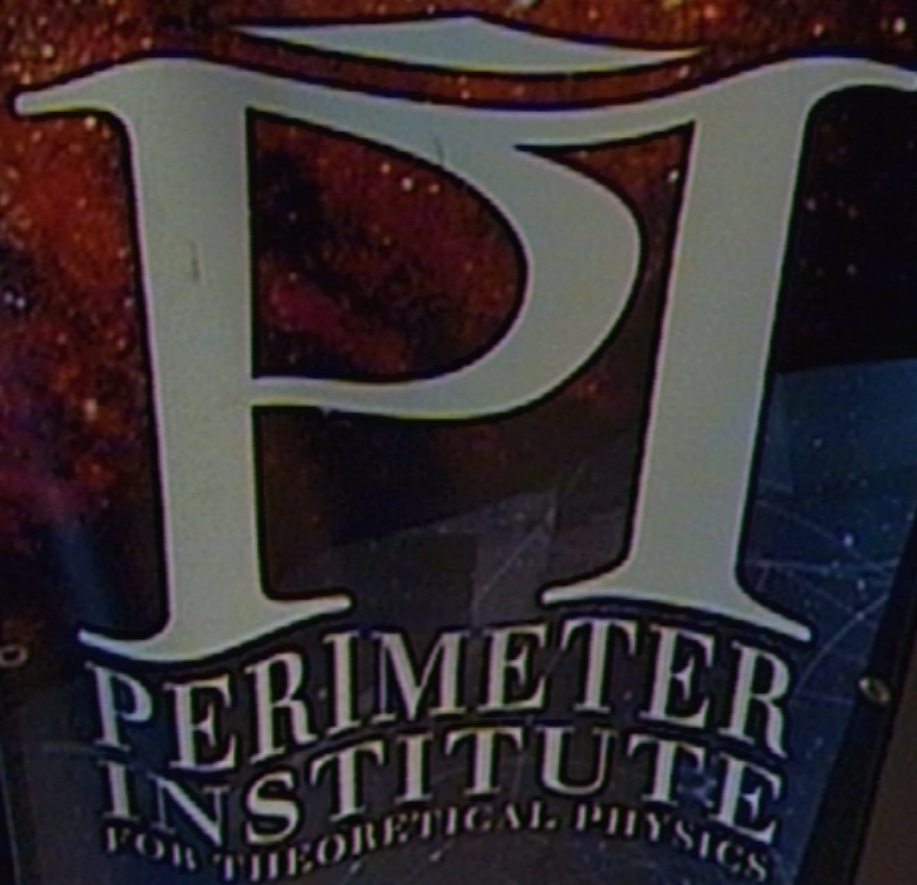
Title: SUSY Gauge Theory

Date: Jun 30, 2005 09:30 AM

URL: <http://pirsa.org/05060106>

Abstract:





II. $N=1$ SQCD - Seiberg duality



II, $N=1$ SQCD - Seiberg duality



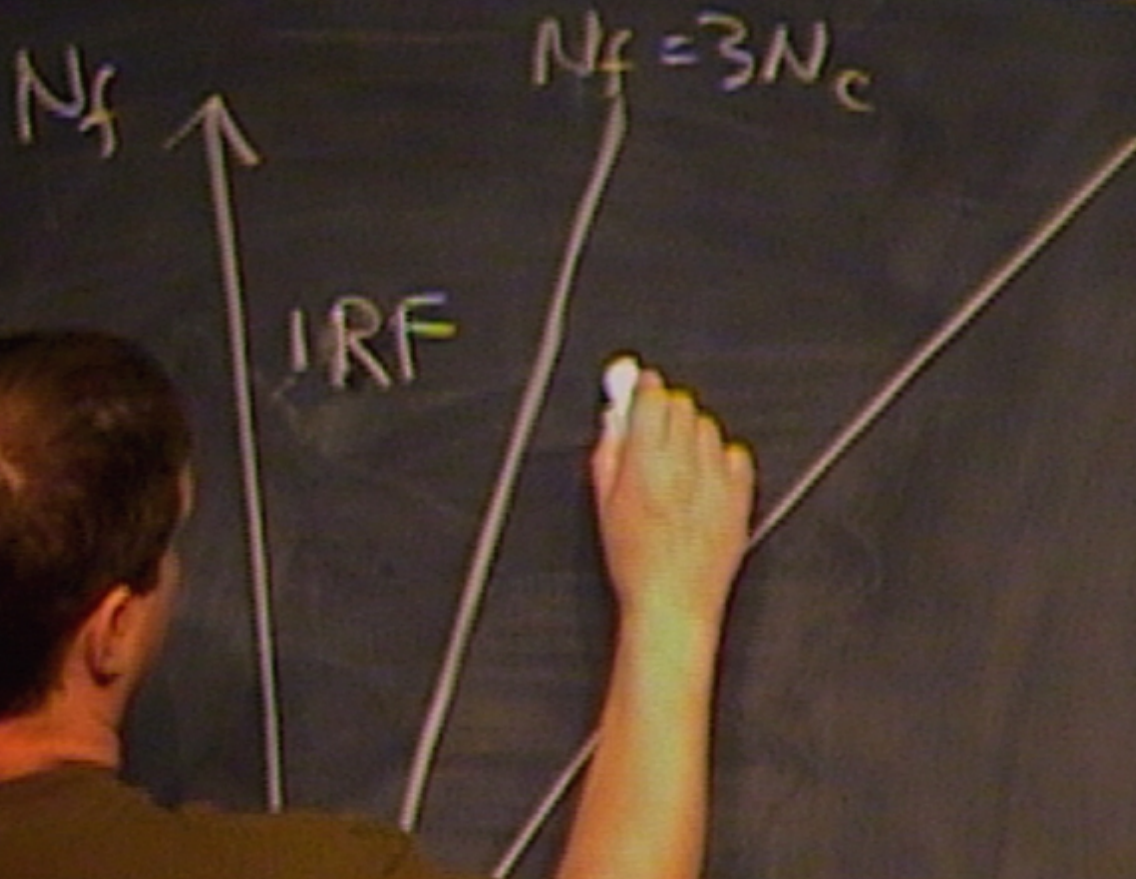
II. $N=1$ SQCD - Seiberg duality

N_f ↑

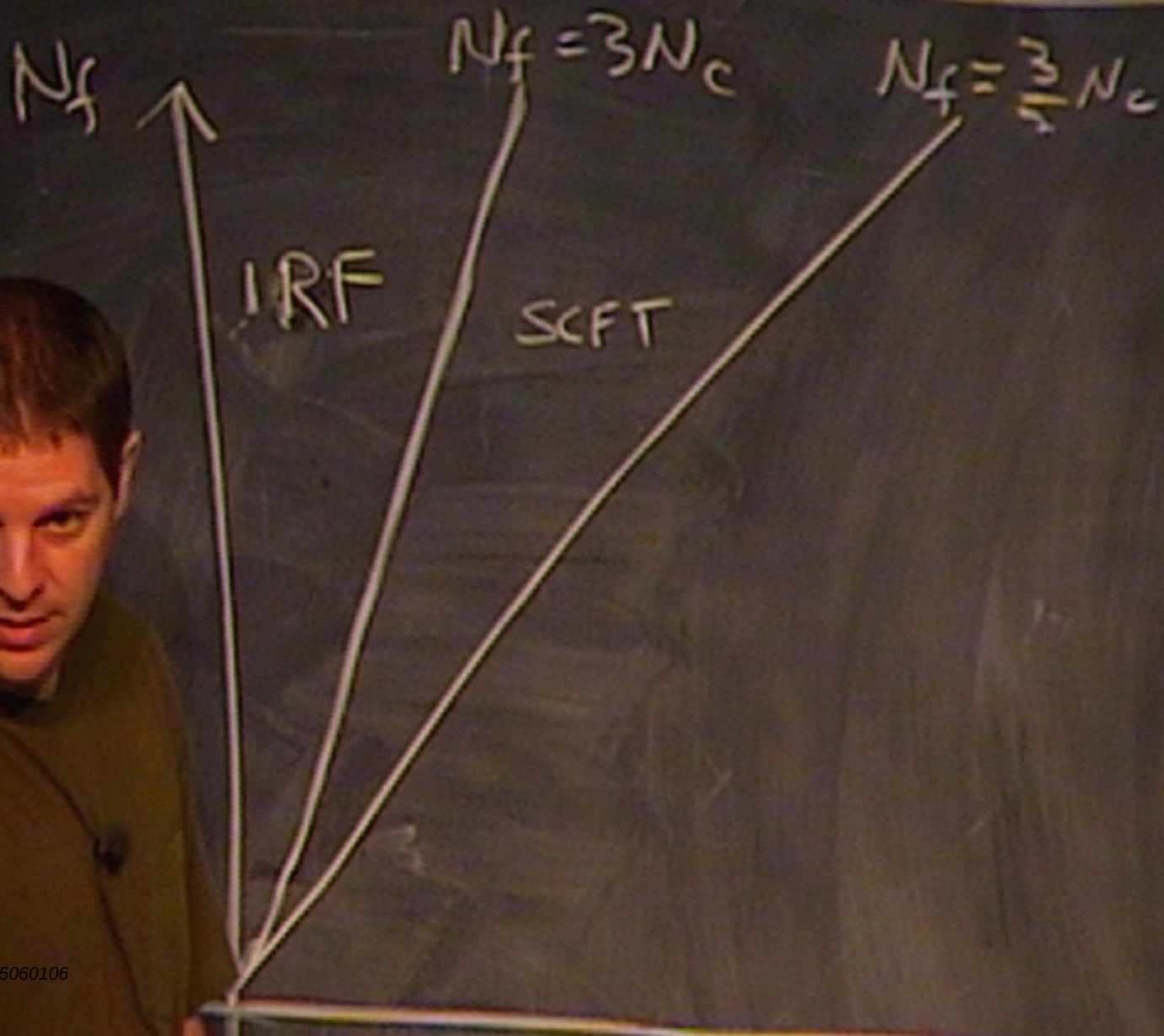
II, $N=1$ SQCD - Seiberg

$$N_f \quad N_f = 3N_c$$

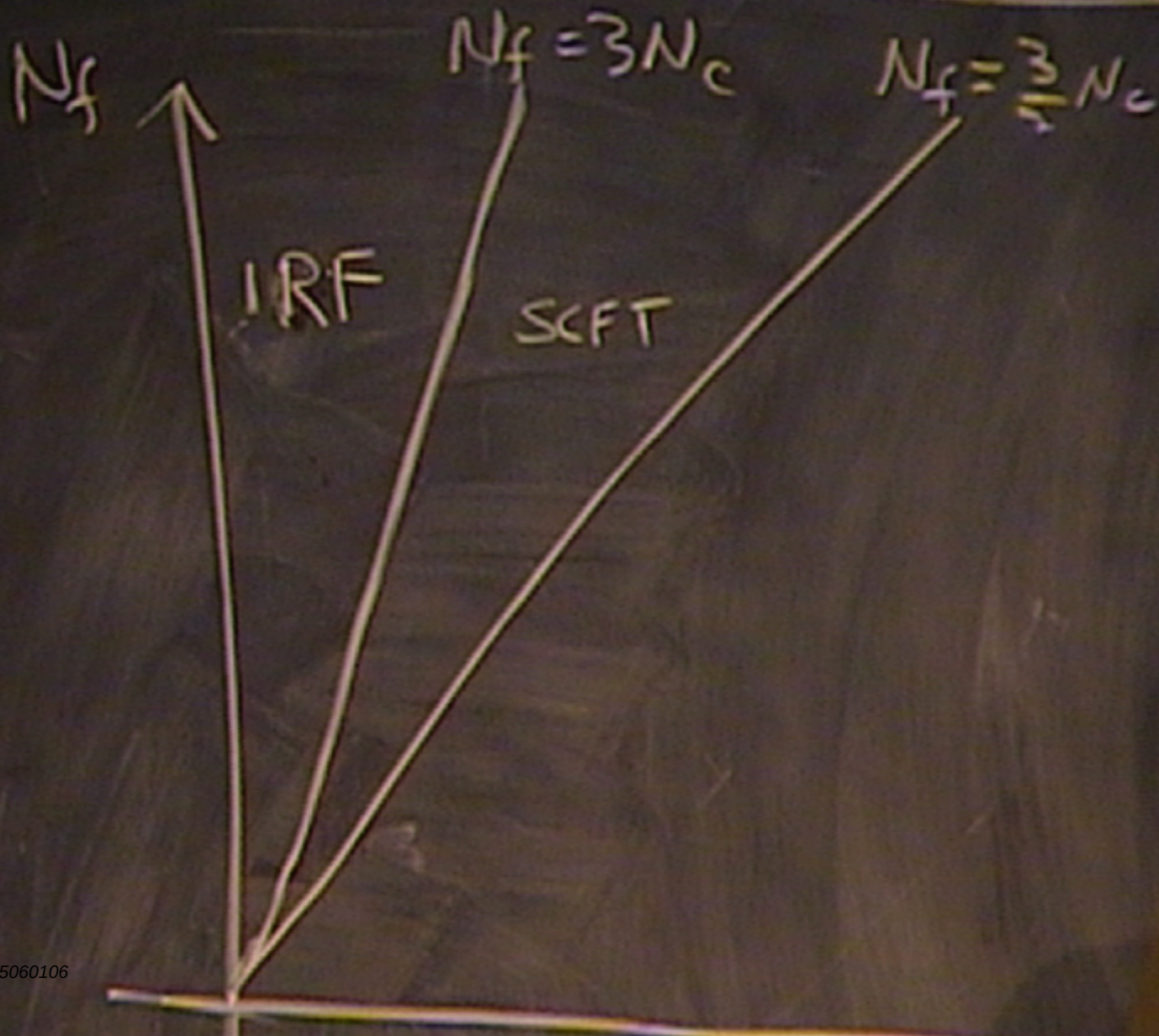
II. $N=1$ SQCD - Seiberg



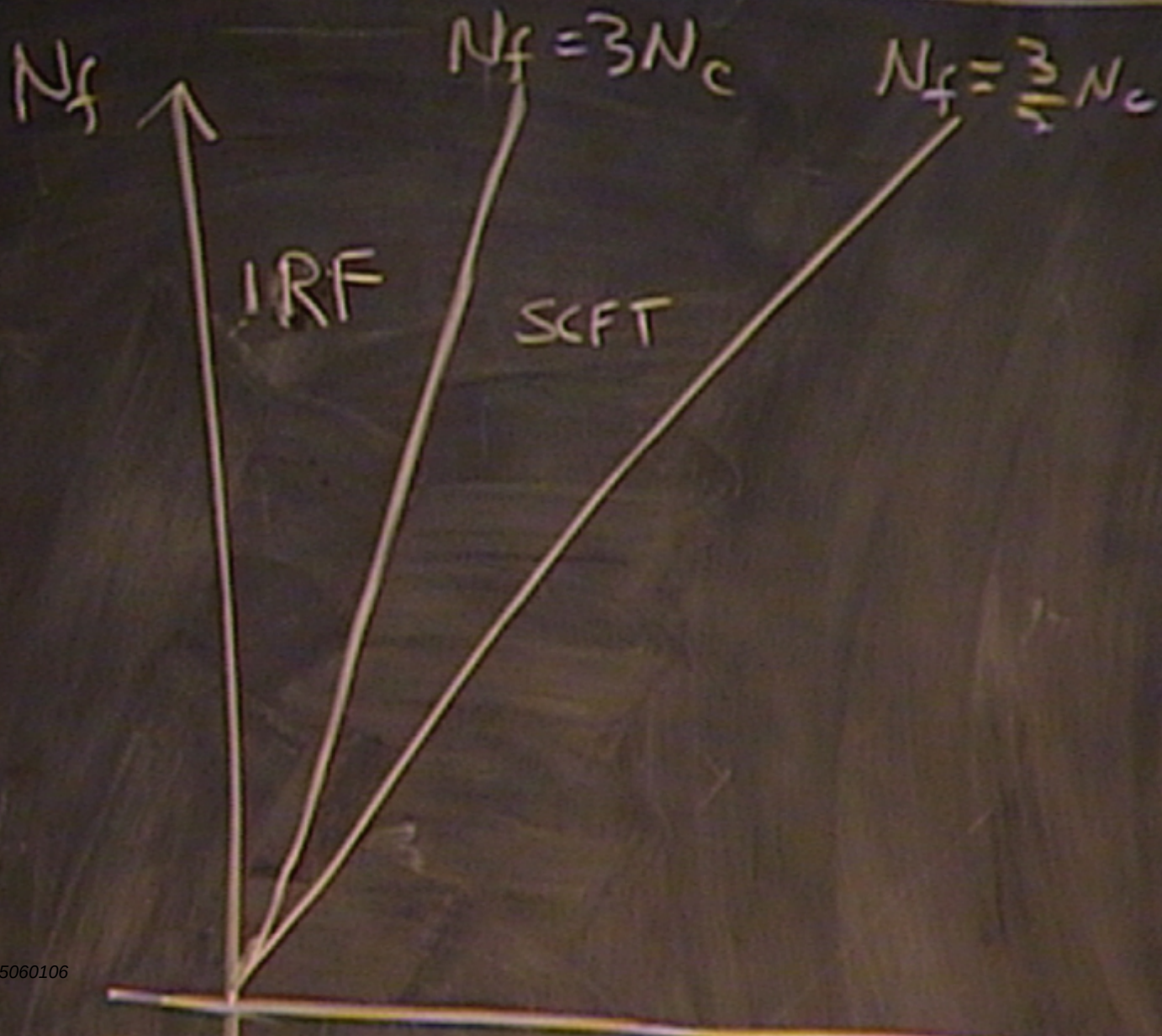
II, $N=1$ SQCD - Seiberg



II, $N=1$ SQCD - Seiberg



II, $N=1$ SQCD - Seiberg



Schubert duality

A. Classical moduli space

Seiberg duality

A. Classical moduli space

$$\bullet \quad Q_a^i \quad \tilde{Q}_a^i$$

Seiberg duality

A. Classical moduli space

$$\bullet \quad Q_a^i \quad \tilde{Q}_i^a$$

Seiberg duality

A. Classical moduli space

$$\bullet \quad Q_a^i \quad \tilde{Q}_i^a$$

Mesons:

$$M_i^i$$

$$t_{ij}^a$$

Schwarz duality

A. Classical moduli space

$$\bullet Q_a^i \quad \tilde{Q}_i^a$$

Mesons:

$$M_j^i = Q_a^i \tilde{Q}_j^a$$

Schwarz duality

A. Classical moduli space

$$\bullet \quad Q_a^i \quad \bar{Q}_i^a$$

Mesons:

$$M_j^i = Q_a^i \bar{Q}_j^a$$

Baryons:

$$B^{i_1 \dots i_N} =$$

Schwarz duality

A. Classical moduli space

$$\bullet \quad Q_a^i \quad \bar{Q}_i^a$$

Mesons:

$$M_j^i = Q_a^i \bar{Q}_j^a$$

Baryons:

$$B^{i_1 \dots i_N} = \epsilon^{a_1 \dots a_N} Q_{a_1}^{i_1} \dots Q_{a_N}^{i_N}$$

Anti-B

A. Classical moduli space

- $Q_a^i \quad \tilde{Q}_i^a$

Mes

Bary

Q_a^i

$$M_j^i = Q_a^i \tilde{Q}_j^a$$

$$B^{i_1 \dots i_N} = \epsilon^{a_1 \dots a_N} Q_{a_1}^{i_1} \dots Q_{a_N}^{i_N}$$

$$\tilde{B}_{i_1 \dots i_N} = \epsilon_{a_1 \dots a_N} \tilde{Q}_{i_1}^{a_1} \dots \tilde{Q}_{i_N}^{a_N}$$

A. Classical meson: space

- Q_a^i $\bar{Q}_i^a$

Mesons:

$$M_j^i = Q_a^i \bar{Q}_j^a$$

Baryons:

$$B^{i_1 \dots i_N} = \epsilon^{a_1 \dots a_N} Q_{a_1}^{i_1} \dots Q_{a_N}^{i_N}$$

Anti B.

$$\bar{B}_{i_1 \dots i_N} = \epsilon_{a_1 \dots a_N} \bar{Q}_{a_1}^{i_1} \dots \bar{Q}_{a_N}^{i_N}$$

$$\mathcal{M}_{cl} = \{M, B, \hat{B}\}$$

$$\mathcal{M}_{cl} = \{M, B, \hat{B}\}$$

$$M_{cl} = \{M, B, \tilde{B}\} / \langle \text{relations} \rangle$$

line
Qane

name
Qane

$$WL_{cl} = \{M, B, B\} / \langle \text{relations} \rangle$$

o Relations.

$$\mathcal{M}_{cl} = \{M, B, \tilde{B}\} / \langle \text{relations} \rangle$$

Relations:

$$B_{i_1 \dots i_n} \quad \tilde{B}_{j_1 \dots j_n} =$$

$$\mathcal{L}_{cl} = \{M, B, \tilde{B}\} / \langle \text{relations} \rangle$$

relations.

$$B^{i_1 \dots i_{n_c}} \tilde{B}^{j_1 \dots j_{n_c}} = M_{j_1}^{i_1} \dots M_{j_{n_c}}^{i_{n_c}}$$

$$\mathcal{L}_{cl} = \{M, B, \hat{B}\} / \langle \text{relations} \rangle$$

relations.

$$B^{i_1 \dots i_n} \quad \hat{B}_{j_1 \dots j_n} = M^{i_1}_{j_1} \dots M^{i_n}_{j_n}$$

$$M_{cl} = \{M, B, \tilde{B}\} / \langle \text{relations} \rangle$$

• Relations.

$$B^{i_1 \dots i_n} \tilde{B}_{j_1 \dots j_n} = M_{j_1}^{i_1} \dots M_{j_n}^{i_n}$$

$$B^{i_1 \dots i_n} M_j^{i_{n+1}} =$$

$$M_{cl} = \{M, B, \tilde{B}\} / \langle \text{relations} \rangle$$

• Relations.

$$B^{i_1 \dots i_n} \tilde{B}_{j_1 \dots j_n} = M_{j_1}^{i_1} \dots M_{j_n}^{i_n}$$

$$B^{i_1 \dots i_n} M_j^{i_{n+1}} = \tilde{B}_{[i_1 \dots i_n} M_{i_{n+1}]^j} = 0$$

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$$M_{cl} = \{M, B, \tilde{B}\} / \langle \text{relations} \rangle$$

• Relations.

$$B^{i_1 \dots i_n} \quad \tilde{B}^{j_1 \dots j_n} \quad M^{i_1 \dots i_n} \quad M^{i_n}_{j_n}$$

$$B^{[i_1 \dots i_n} M^{i_{n+1}]}_{j_1} = B^{i_1 \dots i_n}_{j_1}$$

$$M^{i_n}_{j_n}$$

j

$$] = 0$$

$$\mathcal{M}_{cl} = \{M, B, \tilde{B}\} / \langle \text{relations} \rangle$$

• Relations.

$$B^{i_1 \dots i_n} \tilde{B}_{j_1 \dots j_n} = M^{i_1 \dots i_n} M_{j_1 \dots j_n}$$

$$B^{[i_1 \dots i_n} M_{j_1}^{i_{n+1}]} = 0$$

$$\mathcal{M}_{cl} = \{M, B, \tilde{B}\} / \langle \text{relations} \rangle$$

o Relations.

$$B^{i_1 \dots i_n} \tilde{B}_{j_1 \dots j_n} = M^{[i_1} M^{i_2} \dots M^{i_n]} M_{j_n}$$

$$B^{[i_1 \dots i_n} M^{i_{n+1}]}_{j_1} = \tilde{B}_{j_1}$$

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• Relations.

$$B^{i_1 \dots i_n} \tilde{B}_{j_1 \dots j_n} = M_{j_1}^{i_1} \dots M_{j_n}^{i_n}$$

$$B^{i_1 \dots i_n} M_j^{i_{n+1}} = \tilde{B}_{i_1 \dots i_n} M_j^{i_{n+1}} = 0$$

o Relations

$B^{i_1 \dots i_n}$

$B[i_1 \dots i_n]$

$Q_{i_1 \dots i_n}$

$Q_{i_1 \dots i_n}$

formish
of $N \in M$

o Relations.

$$B^{i_1 \dots i_{N_c}} \quad \tilde{B}_{j_1 \dots j_{N_c}}$$

$$B^{[i_1 \dots i_{N_c} M_j^{i_{N_c+1}}]}$$

line
... $Q_{a_{N_c}}$

$\sim a_{N_c}$
Q

} vanish
if $N_f < N_c$

Simple cases

$$\underline{N_f < N_c}$$

$$M_{jac}^{inc}$$

$$y \{ inc \} = 0$$

Simple cases

$$\underline{N_f < N_c}$$

Simple cases

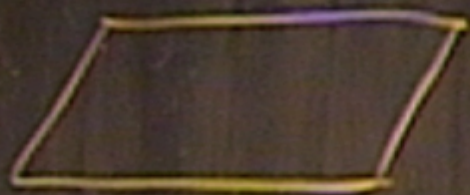
$N_f < N_c$: no violation $\mathcal{M}_{cl} = \{M\} \simeq \mathbb{C}^{N_f^2}$

Simple cases

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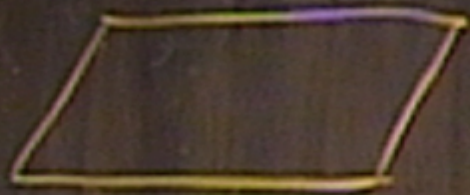
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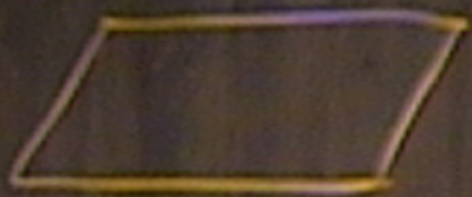
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$\langle M \rangle$

Simple cases

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$\langle M \rangle$



Simple cases

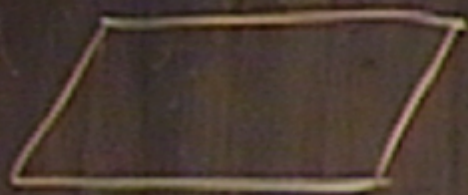
$N_f < N_c$: no violation $\mathcal{M}_{cl} = \{M\} \simeq \mathbb{C}^{N_f^2}$



$$\langle M \rangle : SU(N_c) \rightarrow SU(N_c - N_f)$$

Simple cases

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Simple cases

$N_f < N_c$: no violation $\mathcal{M}_{cl} = \{M\} \simeq \mathbb{C}^{N_f^2}$



$N_f = N_c$

$\langle M \rangle : SU(N_c) \rightarrow SU(N_c - N_f)$

Simple cases

$N_f < N_c$: no violation $\mathcal{M}_{c,2} = \{M\} \simeq \mathbb{C}^{N_f^2}$



$$\langle M \rangle : SU(N_c) \rightarrow SU(N_c - N_f)$$

$N_f = N_c$

$$B^* = \epsilon_{i_1 \dots i_{N_f}}$$

Simple cases

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$$\langle M \rangle : SU(N_c) \rightarrow SU(N_c - N_f)$$

$N_f = N_c$

$$B^* = \epsilon_{i_1 \dots i_{N_f}} B^{i_1} \dots B^{i_{N_f}}$$

$$\mathcal{M}_c = \{M, B^*, \tilde{B}^*\} / \langle \gamma = 0 \rangle$$

$$\gamma \equiv B^* \tilde{B}^* - \det M = 0$$

Simple cases

$N_f < N_c$: no violation $\mathcal{M}_{c,2} = \{M\} \simeq \mathbb{C}^{N_f^2}$



$$\langle M \rangle : SU(N_c) \rightarrow SU(N_c - N_f)$$

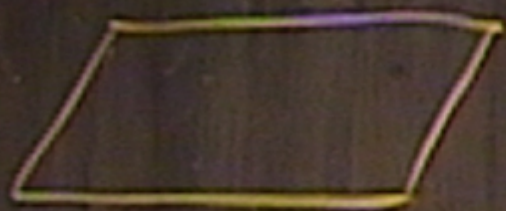
$N_f = N_c$ $B^* = \epsilon_{i_1 \dots i_{N_f}} B^{i_1 \dots i_{N_f}} \in \text{sim } \tilde{B}^*$

$$\mathcal{M}_{c,1} = \{M, B, \tilde{B}^*\} / \langle y \equiv 0 \rangle$$

$$y \equiv B^* \tilde{B}^* - \det M = 0$$

Simple cases

$N_f < N_c$: no violation $\mathcal{M}_c = \{M\} \simeq \mathbb{C}^{N_f^2}$



$$\langle M \rangle : SU(N_c) \rightarrow SU(N_c - N_f)$$

$N_f = N_c$

$$B^* = \epsilon_{i_1 \dots i_{N_f}} B^{i_1 \dots i_{N_f}} \quad \& \text{sing. } \tilde{B}$$

$$\mathcal{M}_c = \{M, B^*, \tilde{B}^*\} / \langle y = 0 \rangle$$

$$y \equiv B^* \tilde{B}^* - \det M = 0 \quad \text{sing. } y = 0$$

$$\Rightarrow B^* = \tilde{B}^* = (\det M) M^{-1}$$

$$\underline{N_f < N_c} : \text{no violation}$$

$$\langle M \rangle :$$

$$M_{j n_c}^{i n_c}$$



$$\underline{N_f = N_c}$$

$$B^* = \epsilon_{i_1 \dots i_{N_f}}$$

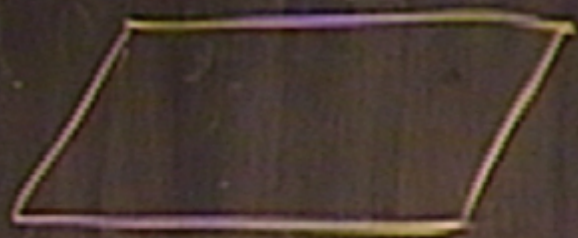
$$M_{ij} = \{M_i, B_i, \tilde{B}^*_i\}$$

$$M \in$$

$$\gamma \equiv B^* \tilde{B}^* = \det M$$

$$\Rightarrow B^* = \tilde{B}^* =$$

$N_f < N_c$: no violation $\mathcal{M}_{cl} = \{M\} \cong$



$\langle M \rangle : SU(N_c)$ —

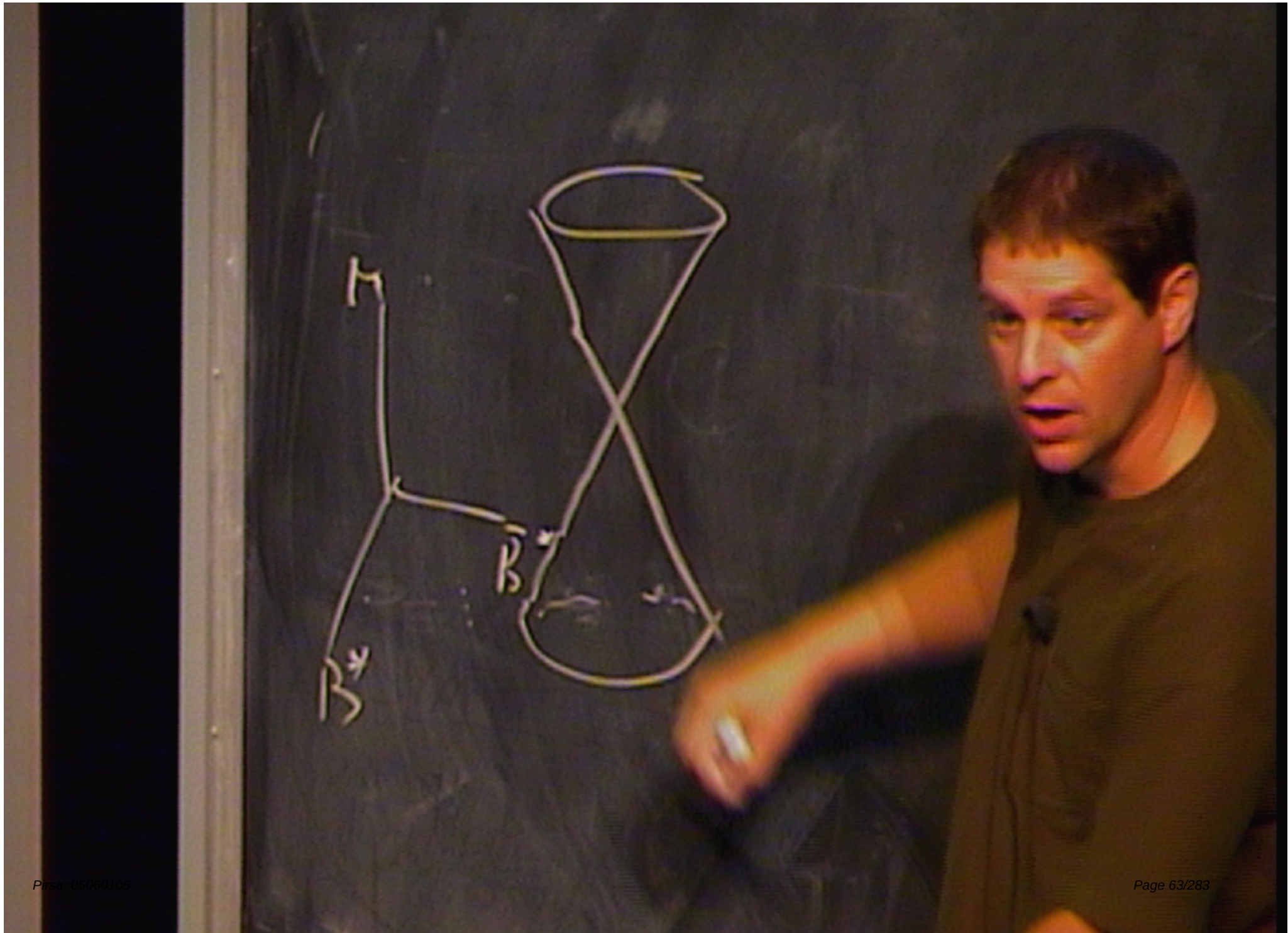
$N_f = N_c$

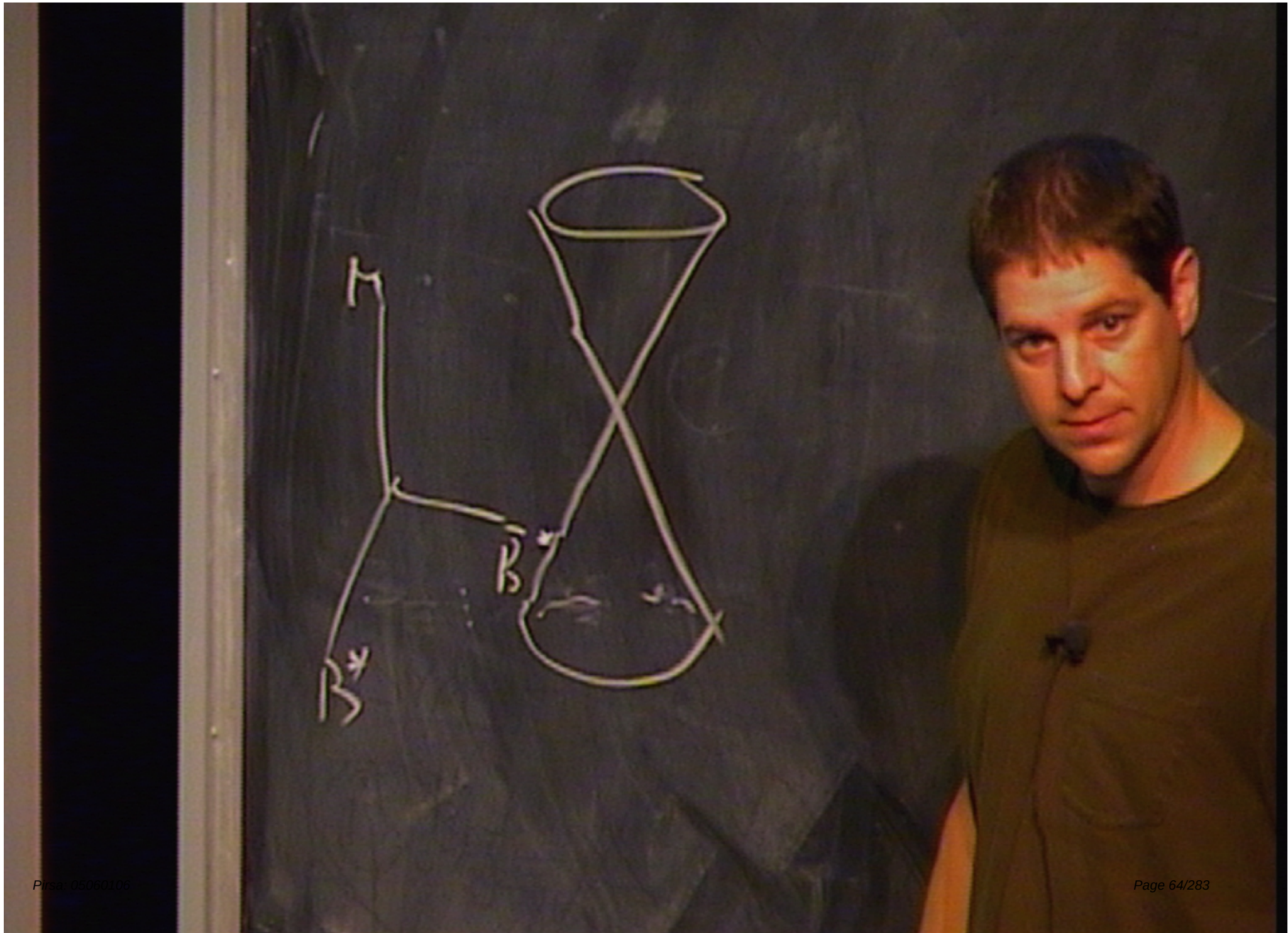
$B^* = \epsilon_{i_1 \dots i_{N_f}} B^{i_1 \dots i_{N_f}}$

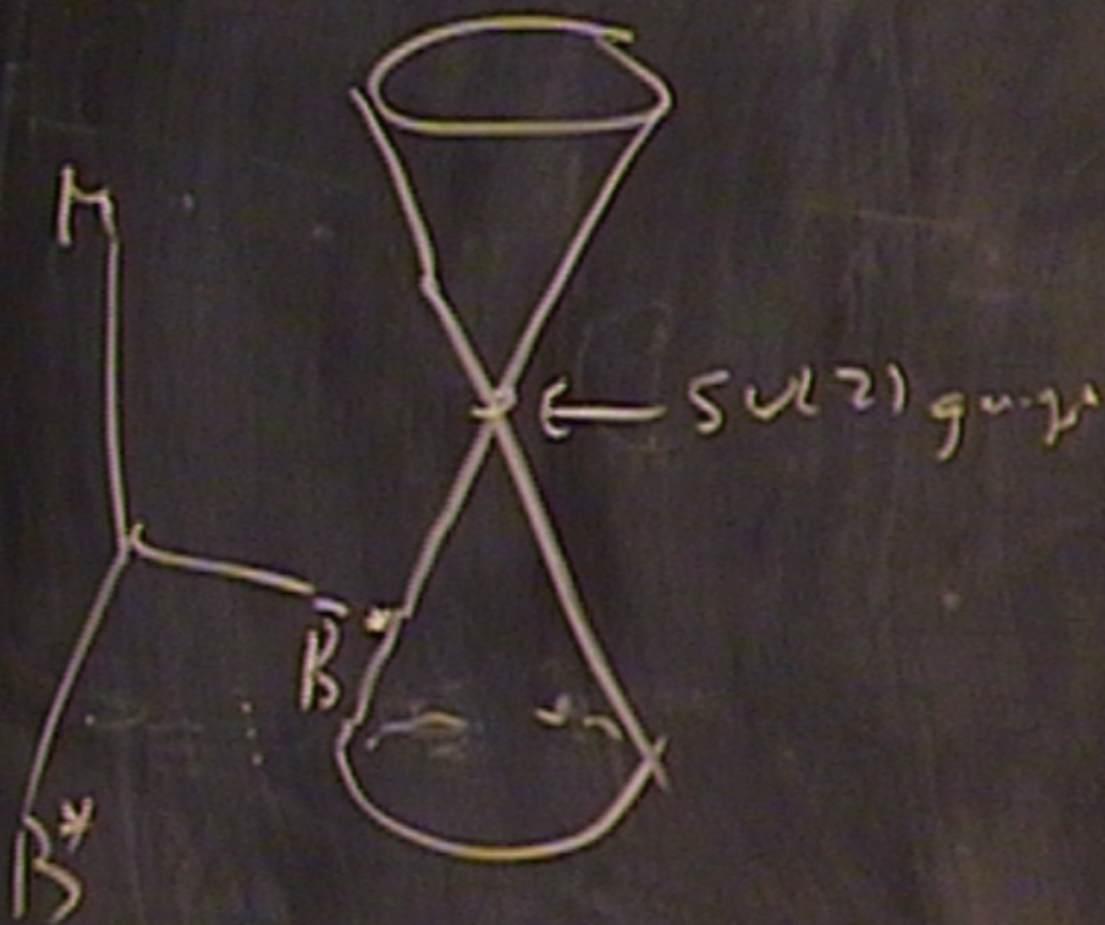
$\text{rank } M \leq N_c - 2$ $\mathcal{M}_u = \{M, B, \tilde{B}^*\} / \langle y \equiv 0 \rangle$

$y \equiv B^* \tilde{B}^* - \det M = 0$

$\Rightarrow B^* = \tilde{B}^* = (\det M) M^{-1}$







$$\underline{\underline{N_i = N_C + 1}}$$

$$\underline{N_L = N_C + 1}$$

$$B_i^* \equiv \in_{i_1, \dots, i_{N_L}} B_{i_1} \dots B_{i_{N_L}}$$



$$\underline{\underline{N_L = N_C + 1}}$$

$$B_i^* \equiv \in_{i_1, \dots, i_{N_L}} B_{i_1} \dots B_{i_{N_L}}$$

$$\underline{\underline{N_f = N_c + 1}}$$

$$B_i^* \equiv \epsilon_{i, \dots, i}$$

$$\underline{N_I = N_C + 1}$$

$$B_i^* \in \{1, \dots, i\} \quad B_i^* \dots i_{inc}$$

$$\underline{N_I = N_C + 1}$$

$$B_i^* \equiv \epsilon_{1, \dots, i} \quad B^1 \dots i_{n-1}$$

$$\underline{N_f = N_C + 1}$$

$$B_i^* \equiv \epsilon_{1, \dots, i}, B^*_{i+1} \dots i_{n_C}$$

$$\underline{N_L = N_C + 1}$$

$$B_i^* \equiv \in_{i, \dots, i}, B^i \dots i_{ii}$$

$$\underline{N_L = H_C + 1}$$

$$B_i^* \equiv \lim_{n \rightarrow \infty} B_n^*$$

$$\underline{\underline{N_I = N_C + 1}}$$

$$B_i^* \equiv \in_{i_1, \dots, i_{N_I}} B^{i_1, \dots, i_{N_I}}$$

$$B_i^* \equiv \{ \in_{i_1, \dots, i_n} B^{i_1, \dots, i_n}, \tilde{B}^{i_1, \dots, i_n} \}$$

$$\underline{N_1 = N_0 + 1}$$

$$B_i^* \equiv \in_{i_1, \dots, i_{N_1}} B^{i_1 \dots i_{N_1}}, \quad \tilde{B}^{*i} = \dots$$

$$N_1 = N_0 + 1$$

$$B_i^* \equiv \{e_1, \dots, e_{n_i}\} B^{e_1 \dots e_{n_i}}, \quad \tilde{B}^{e_i} = \dots$$

$$\tilde{B}^{e_j} = (M)(M^{-1})_i^{e_j}$$

$$\underline{N_L = N_C + 1}$$

$$D^* = \{e_1, \dots, e_{n_f}\} B^1, \dots, e_{n_f}, \tilde{B}$$

$$B_i^* \tilde{B}^{*j} = M(M^{-1})_i^j$$

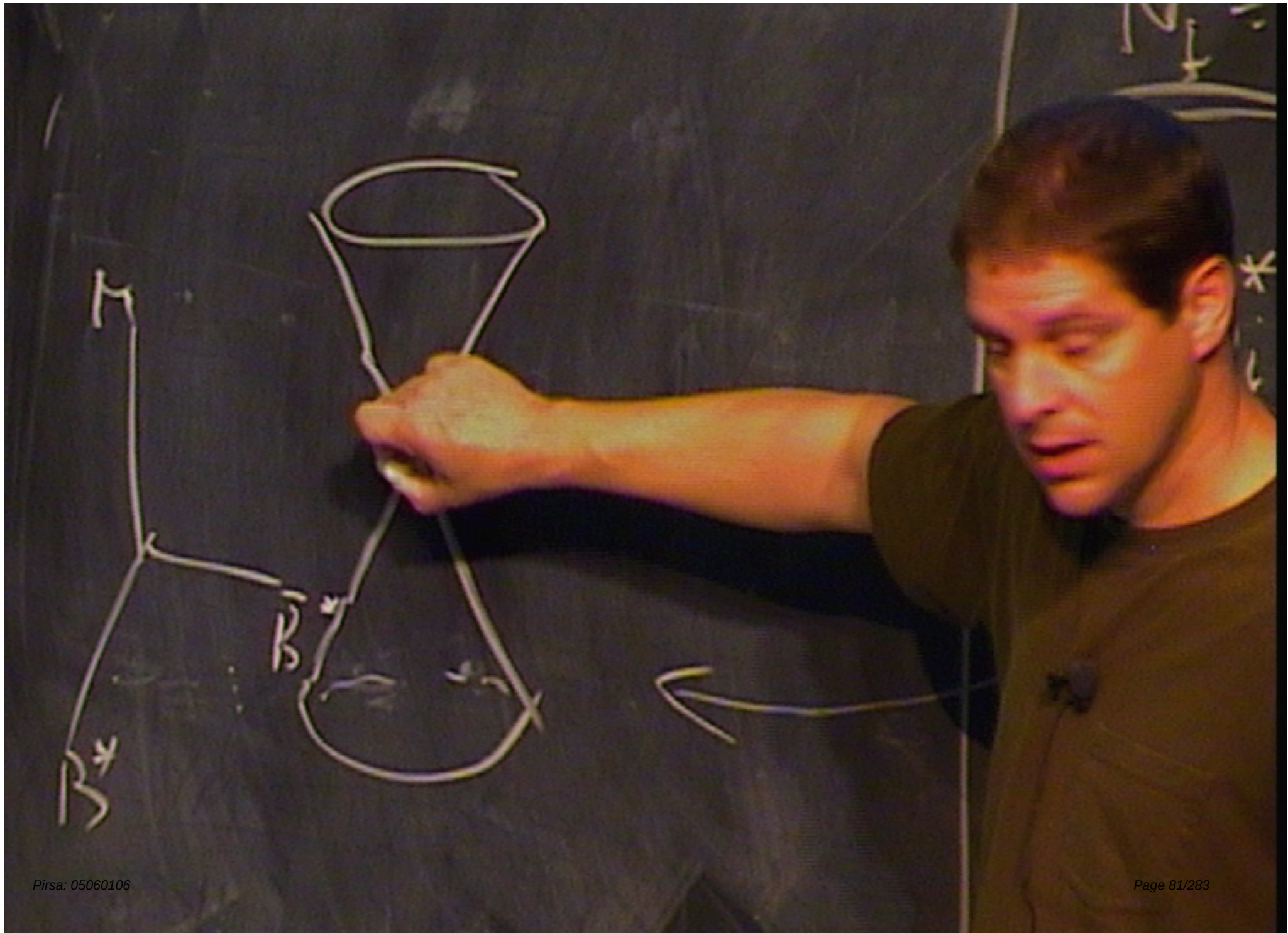
$$M_i^j B^*$$

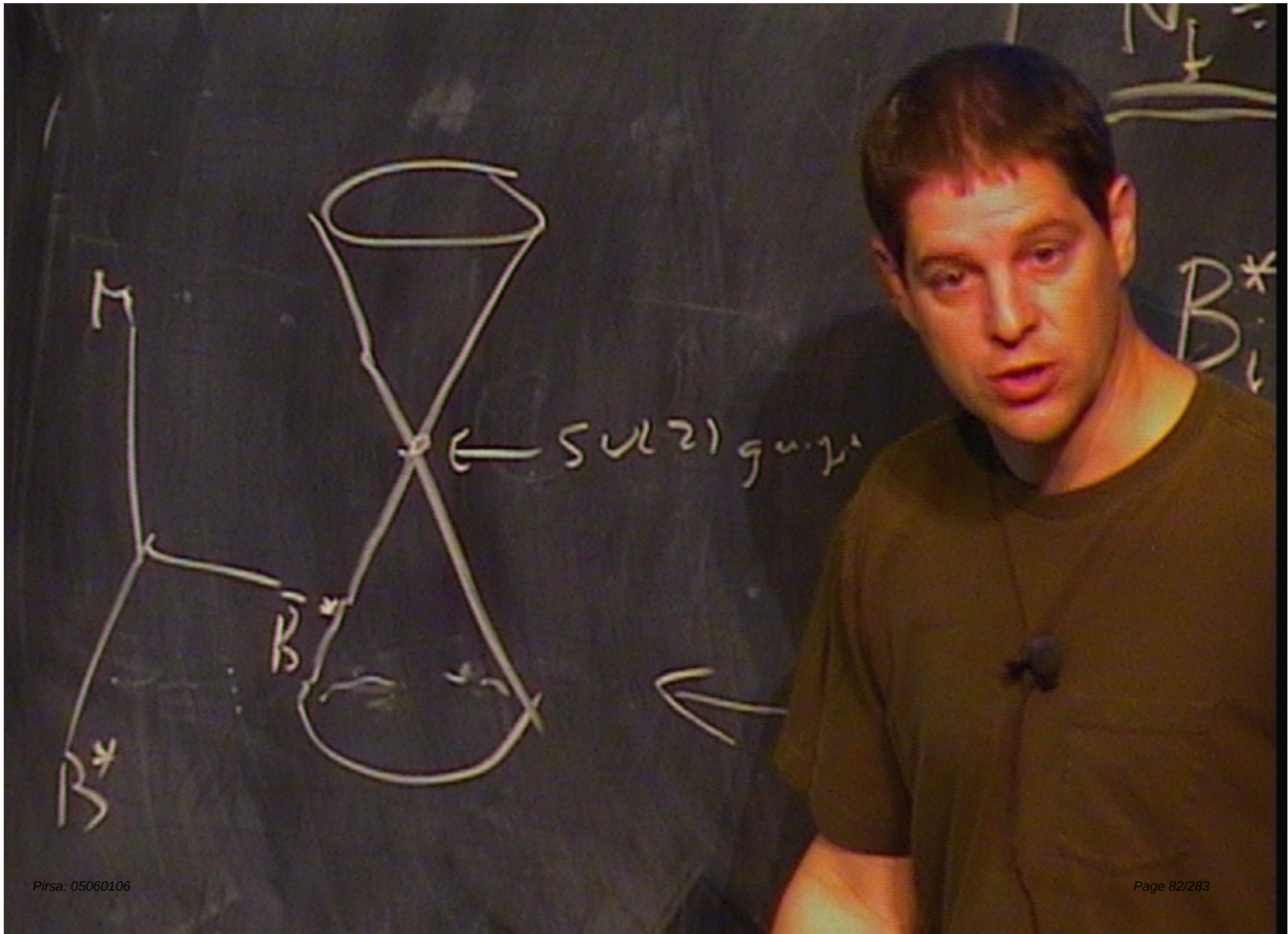
$$\underline{N_L = N_C + 1}$$

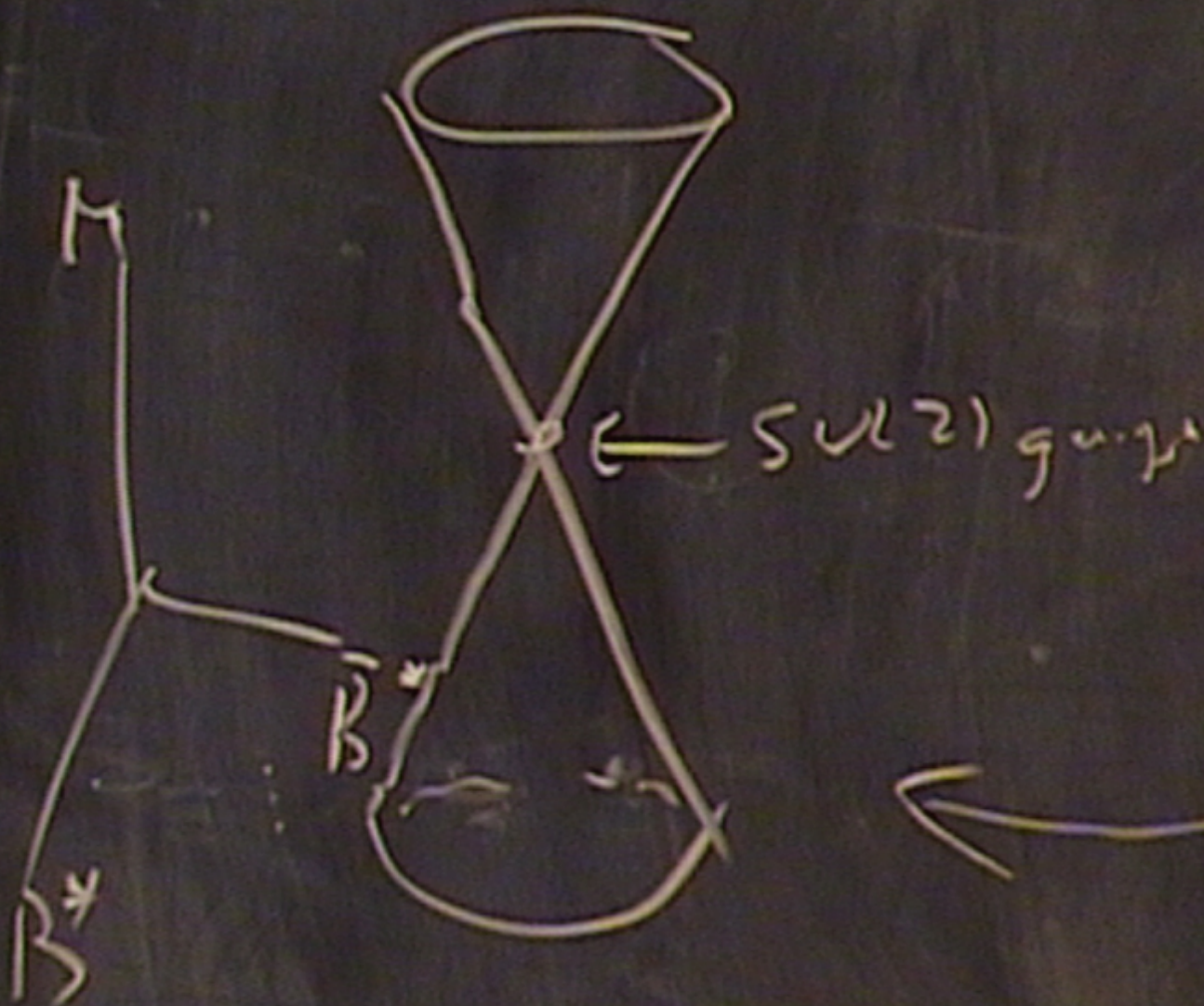
$$B_i^* = \epsilon_{i_1 \dots i_{N_L}} B^{i_1 \dots i_{N_L}}, \quad \tilde{B}$$

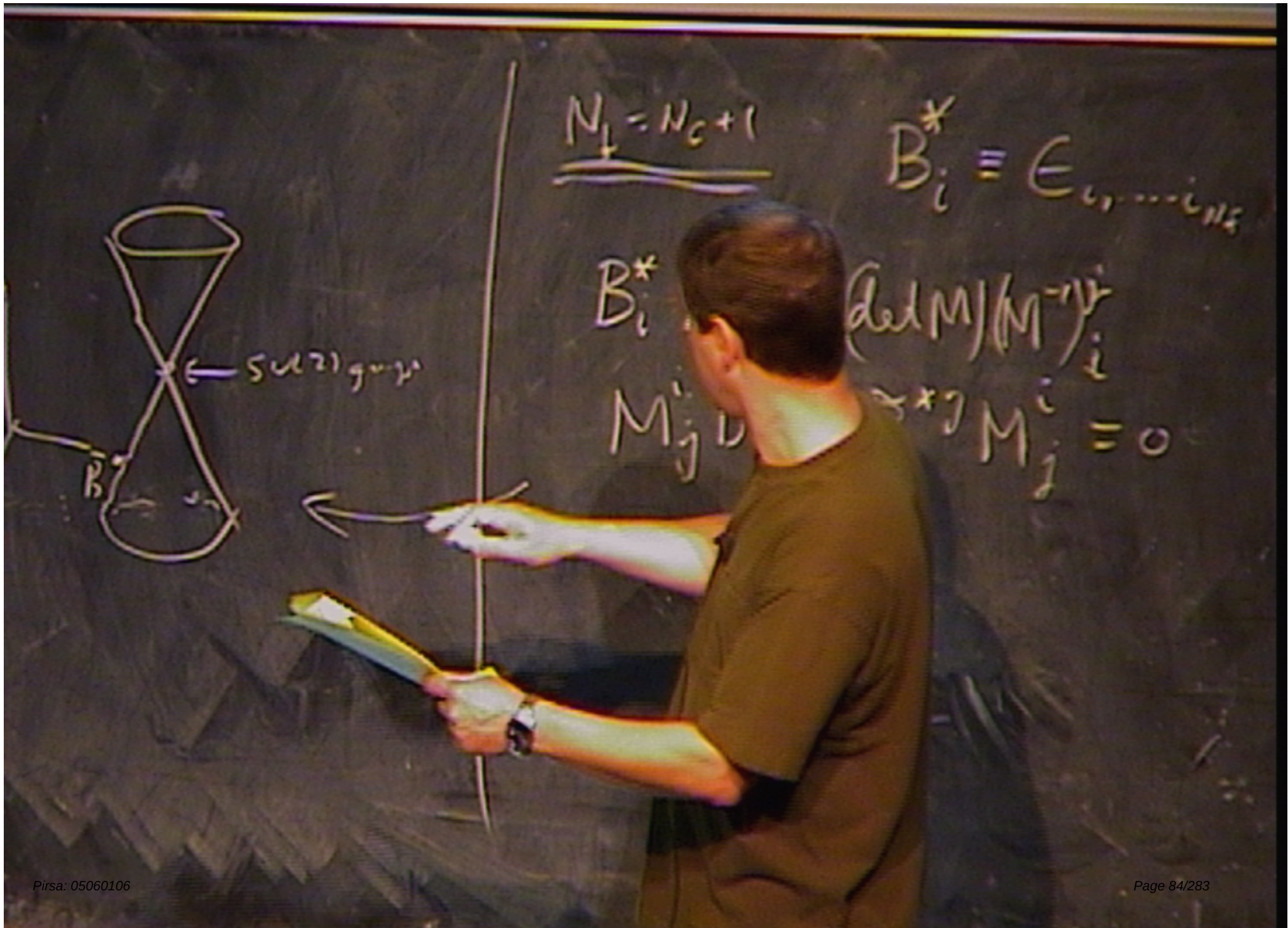
$$B_i^* \tilde{B}^{*j} = (\det M) (M^{-1})^j_i$$

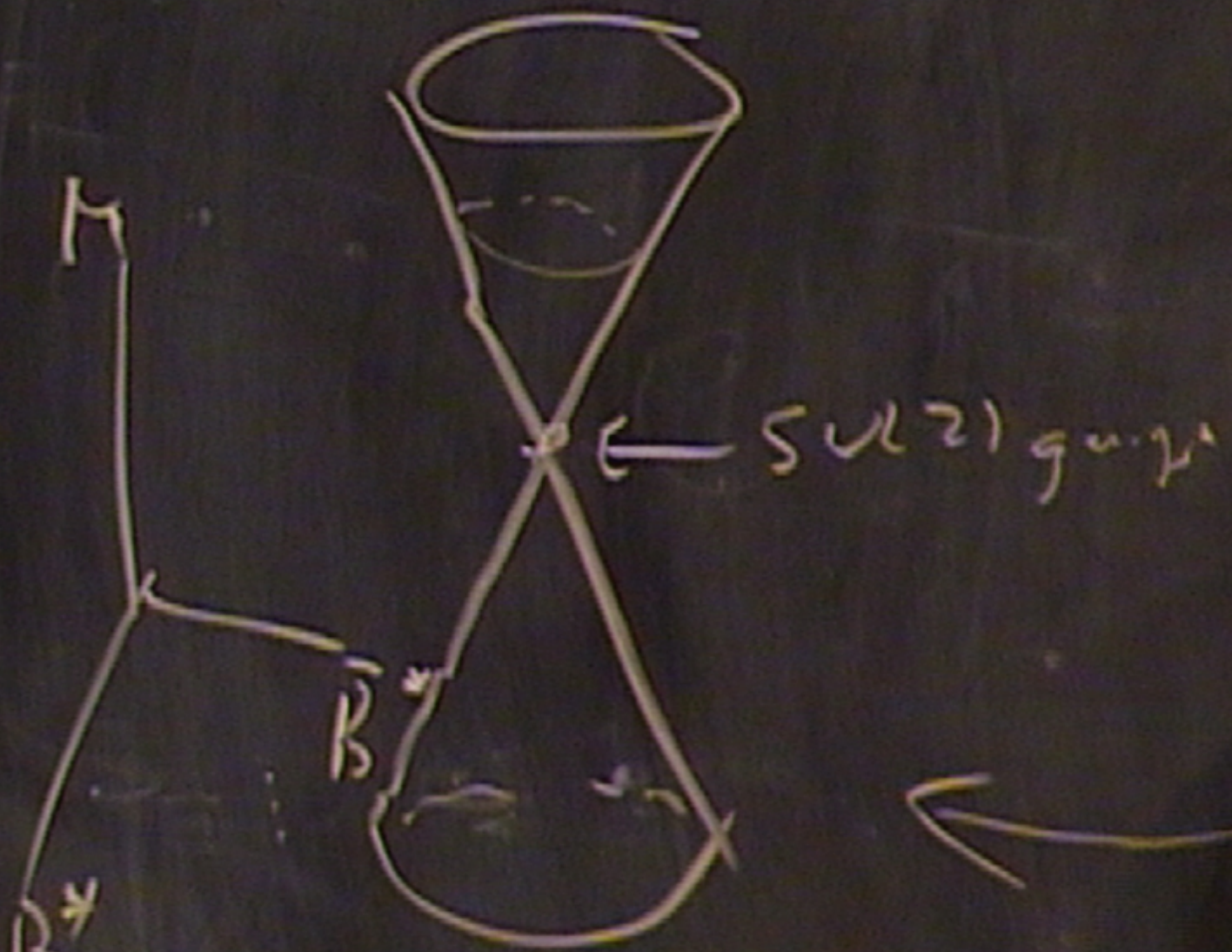
$$M^i_j B_i^* = \tilde{B}^{*j} M^i_j = 0$$

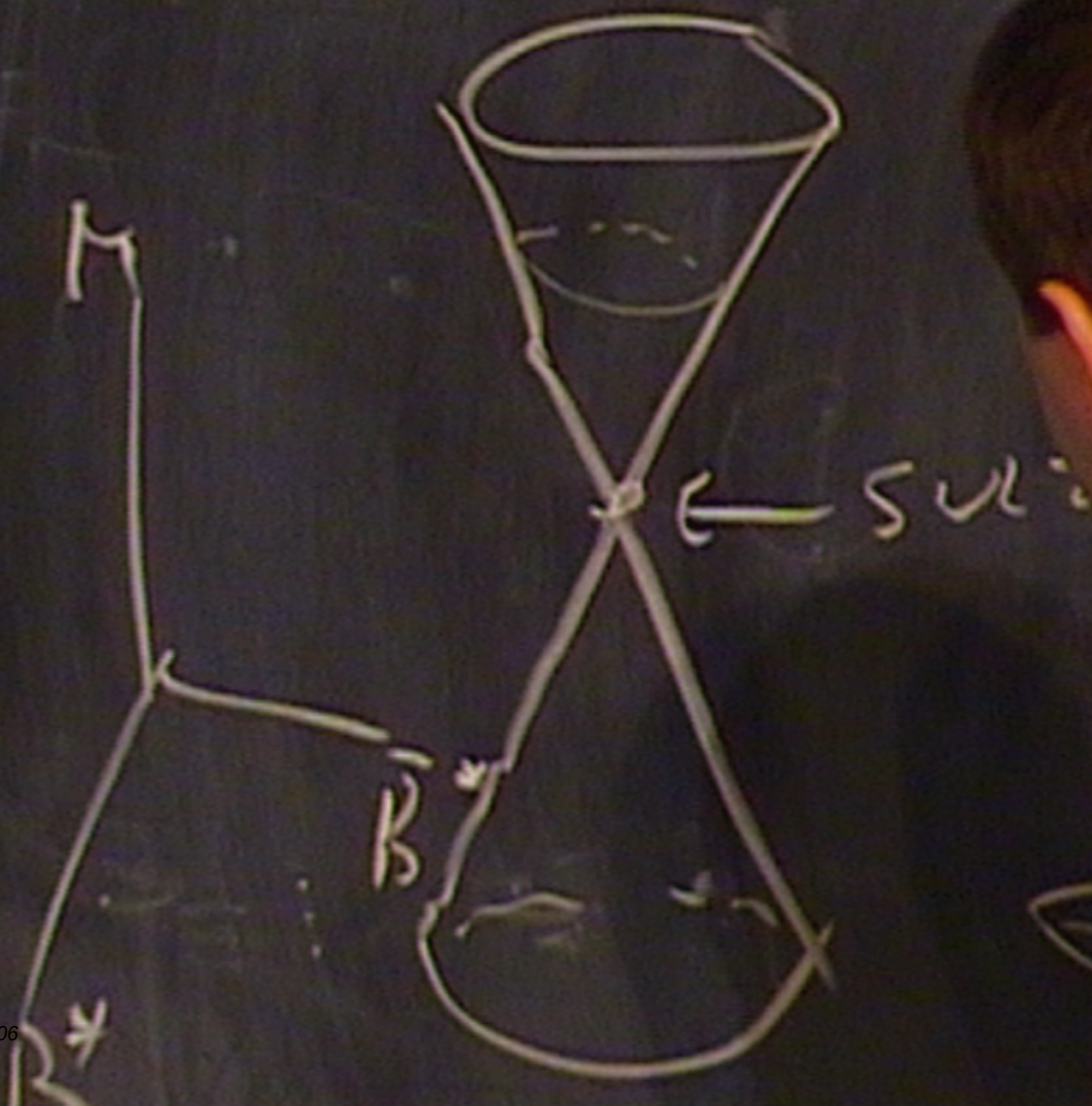


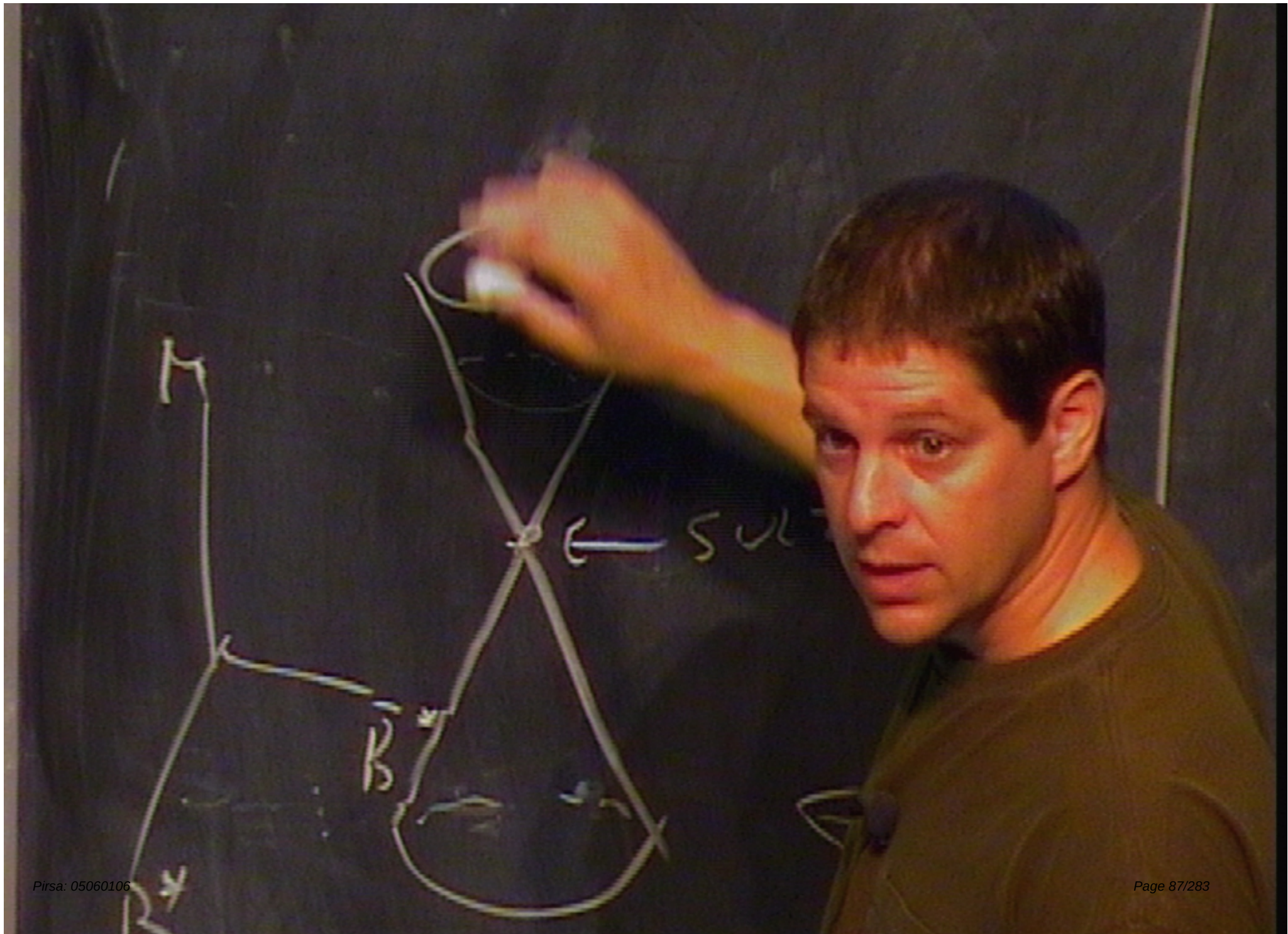


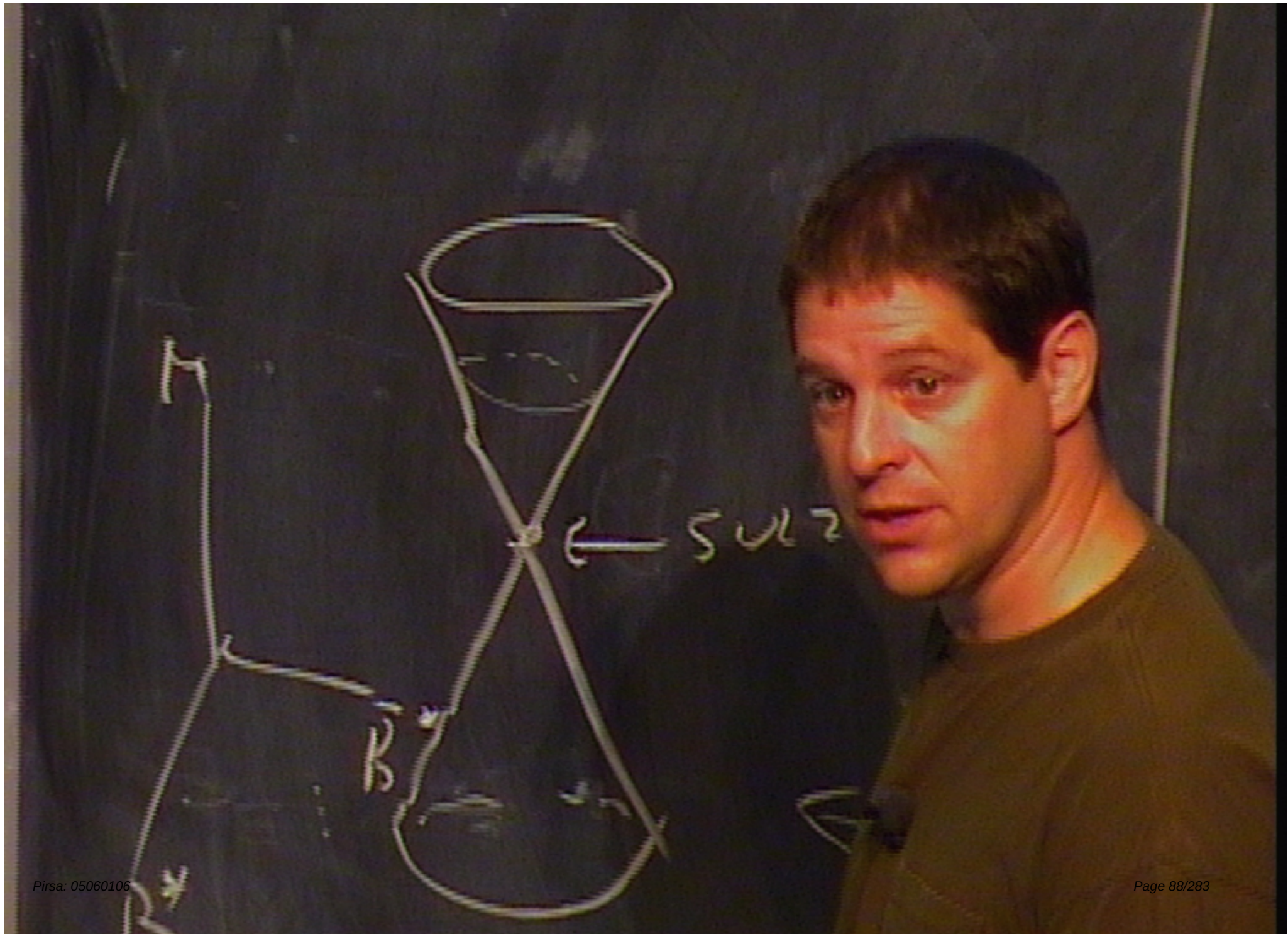


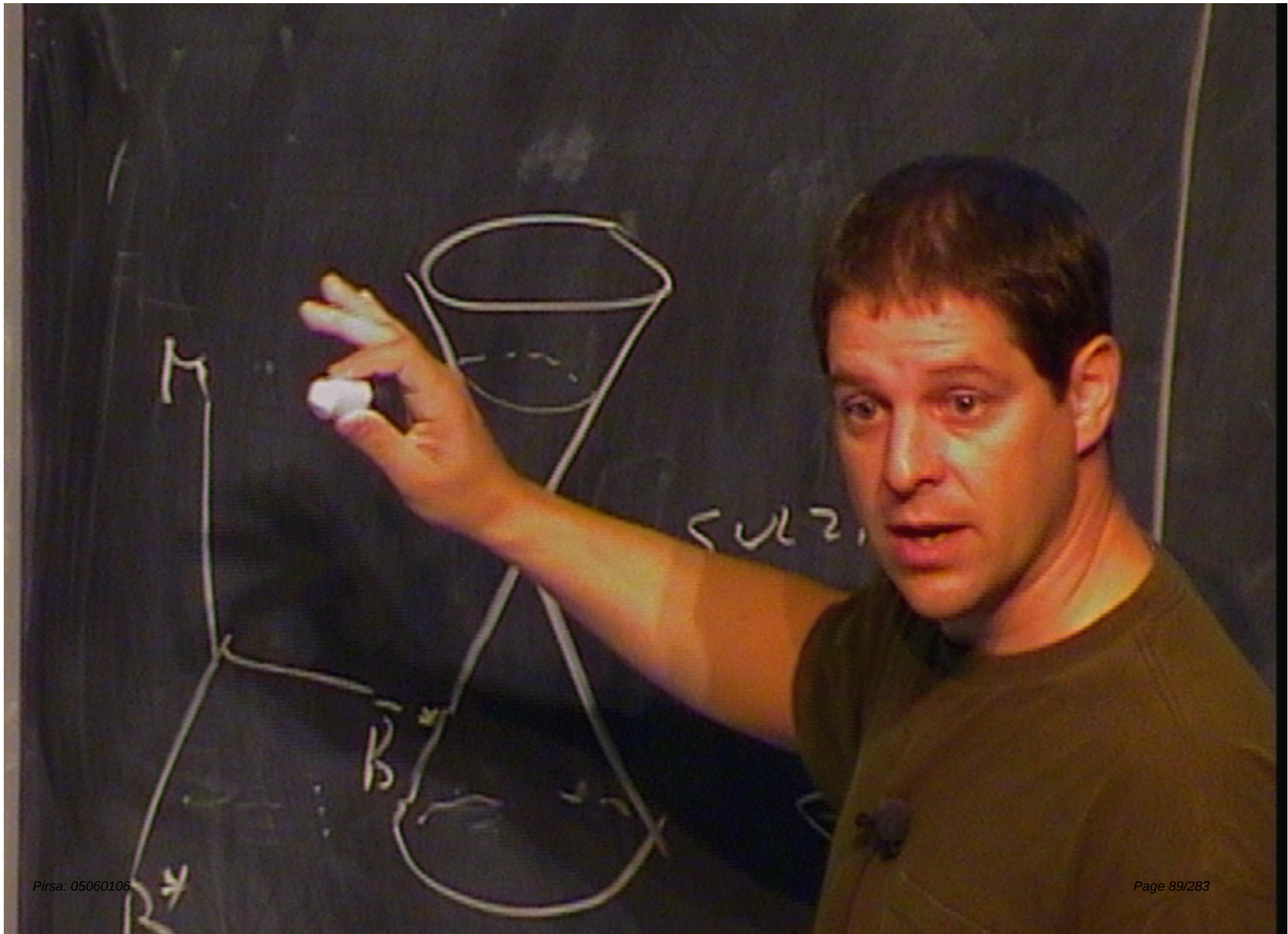


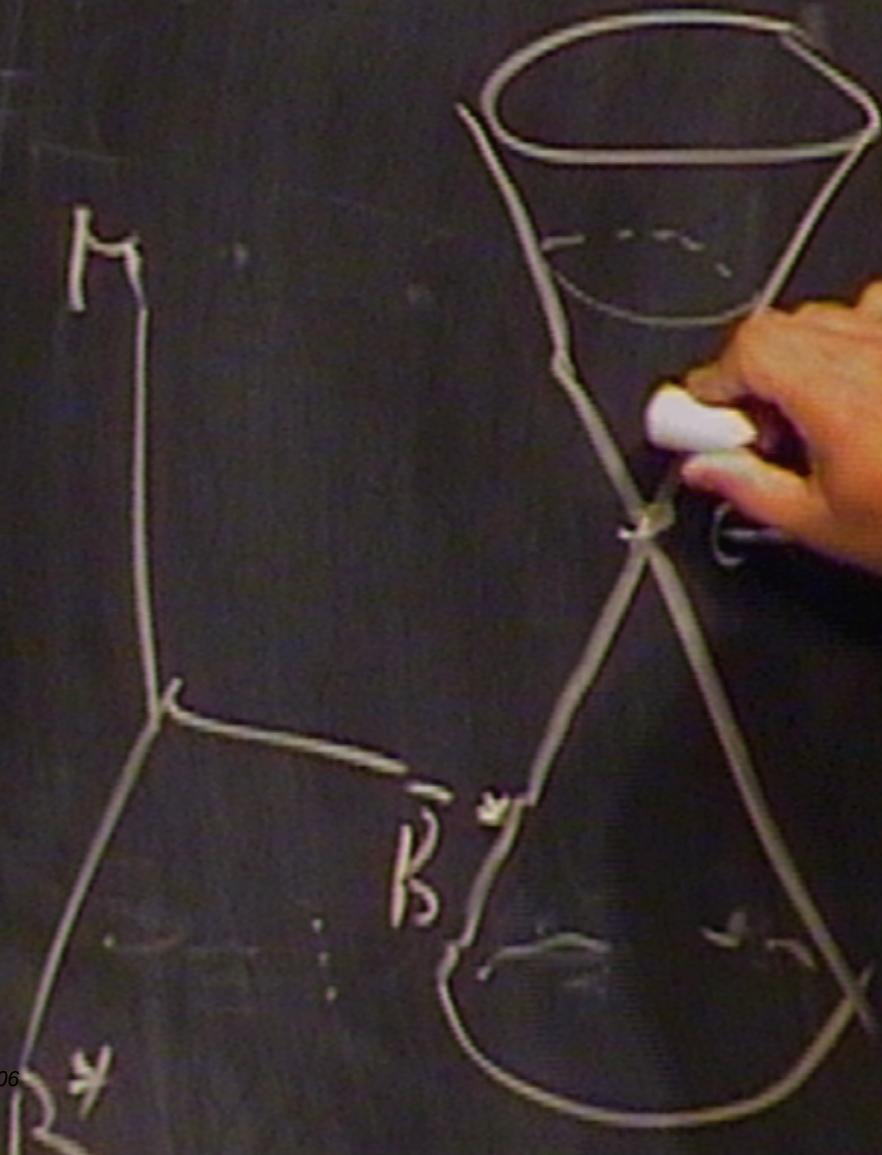


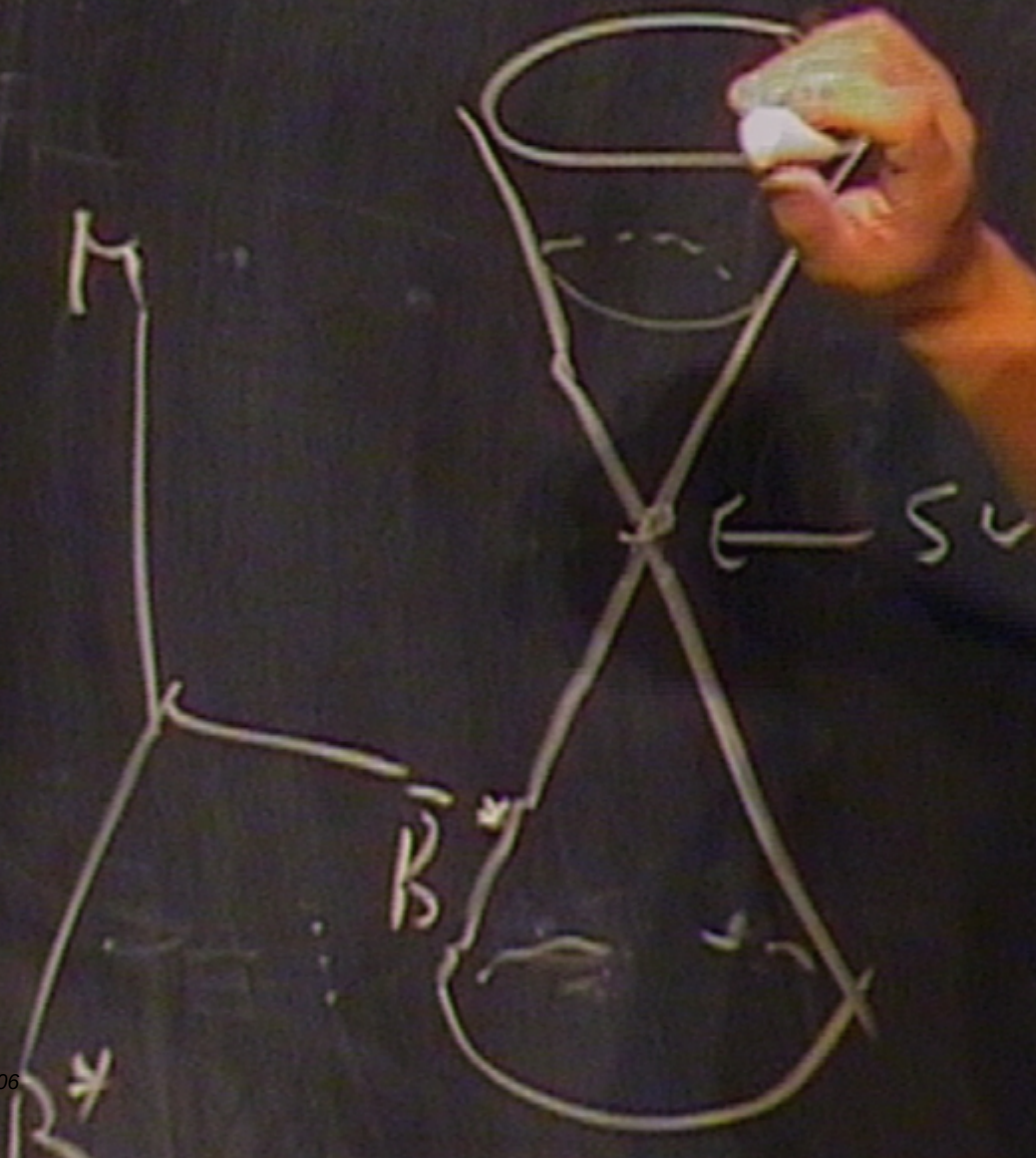


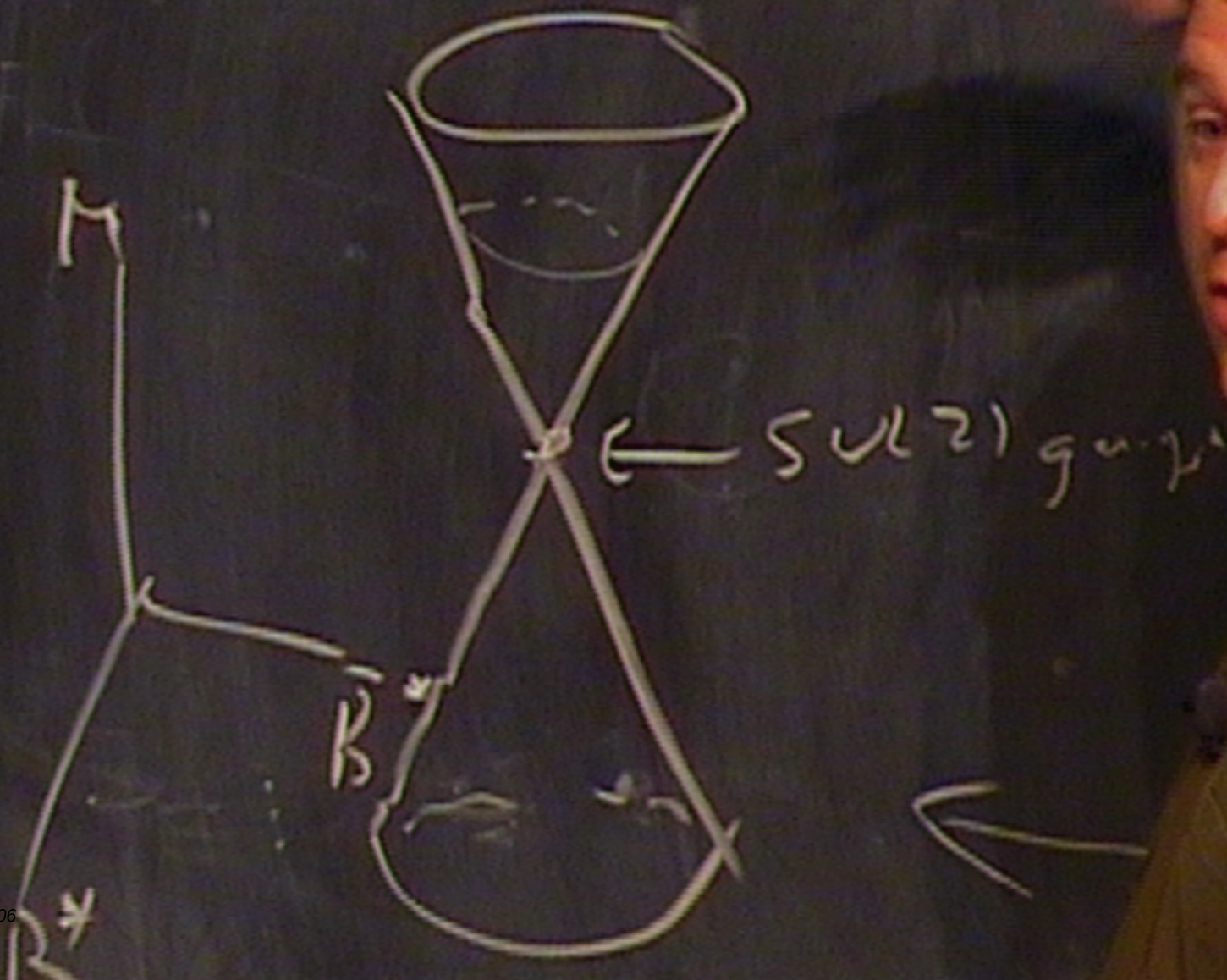


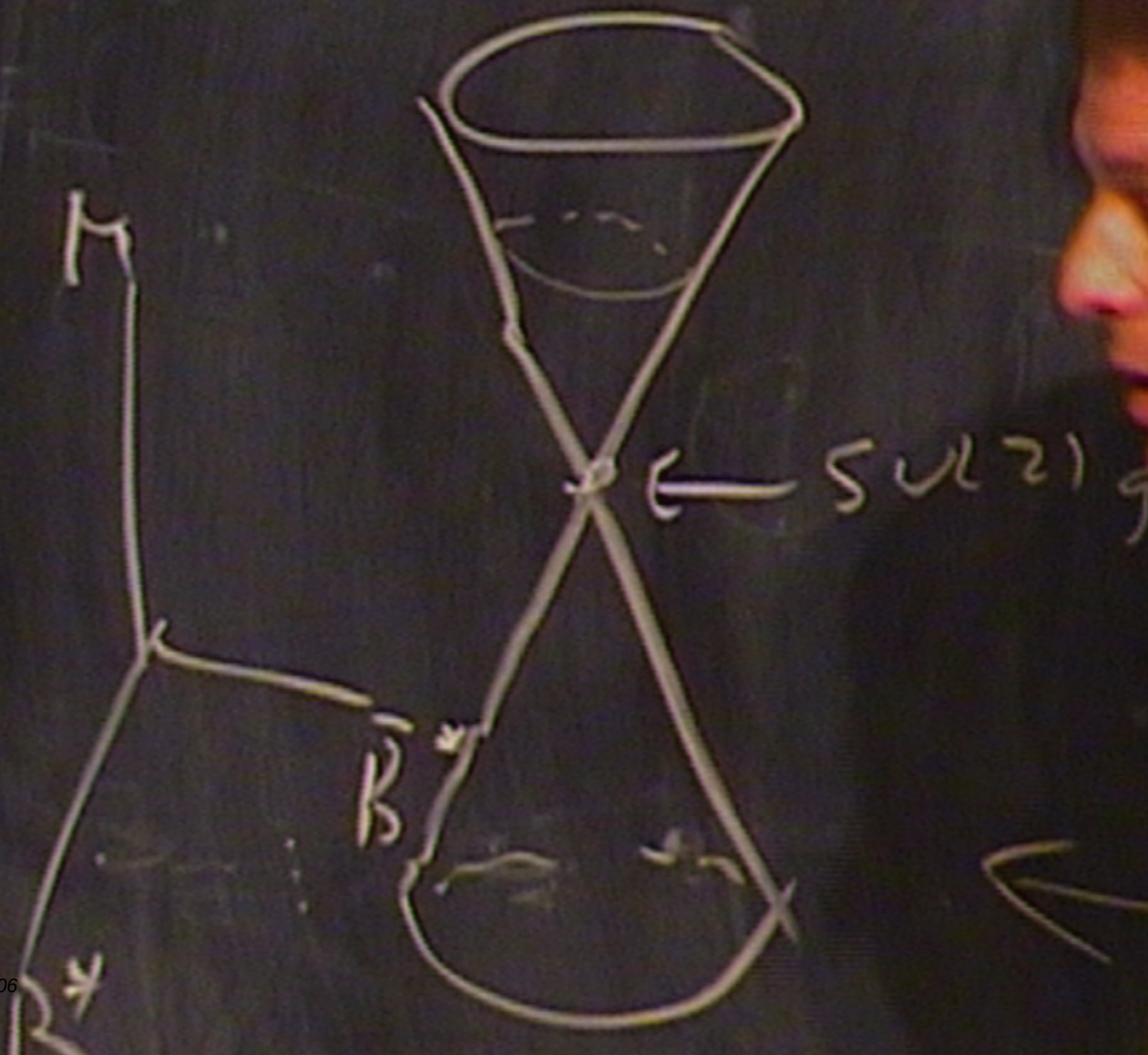


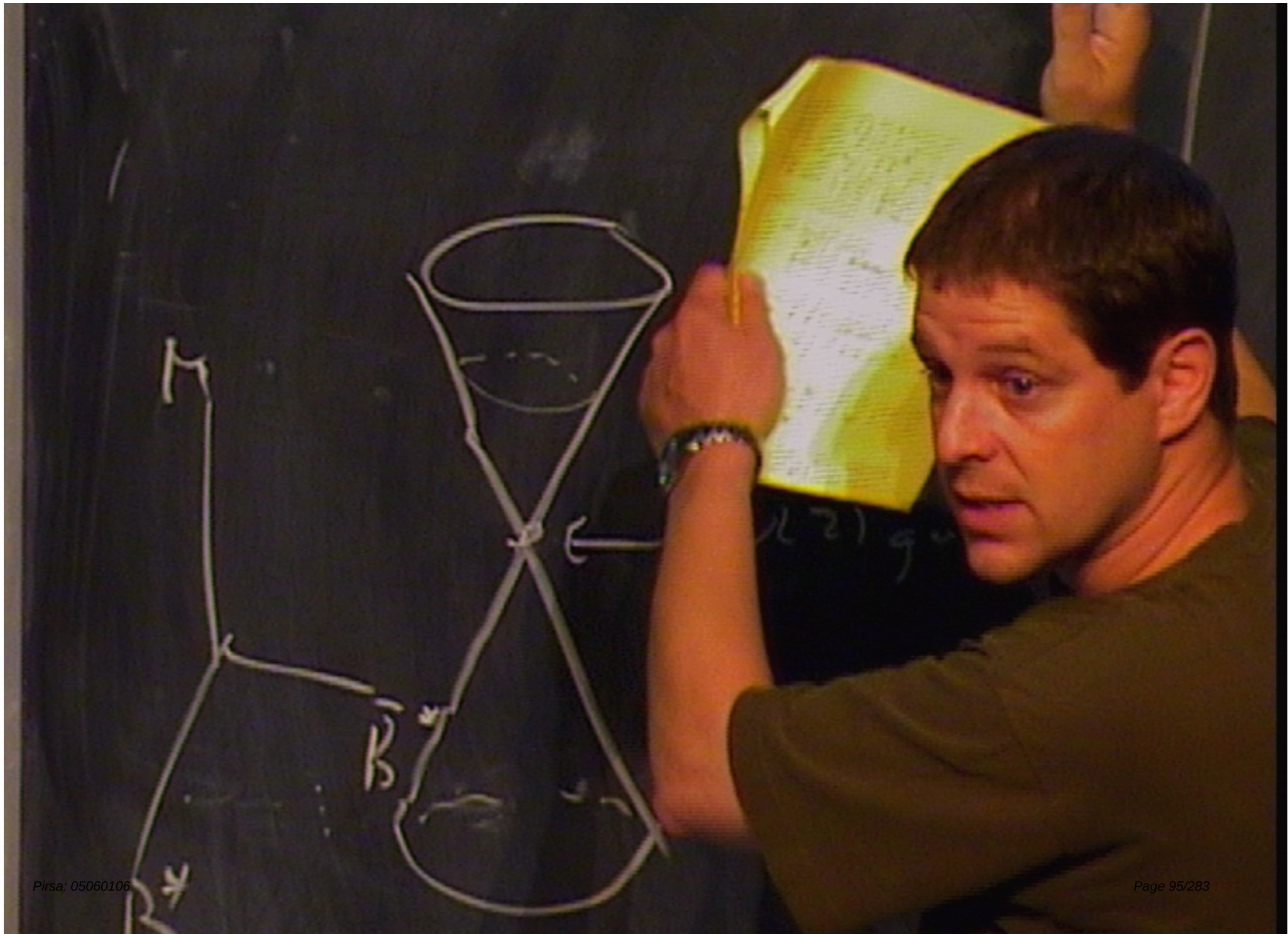


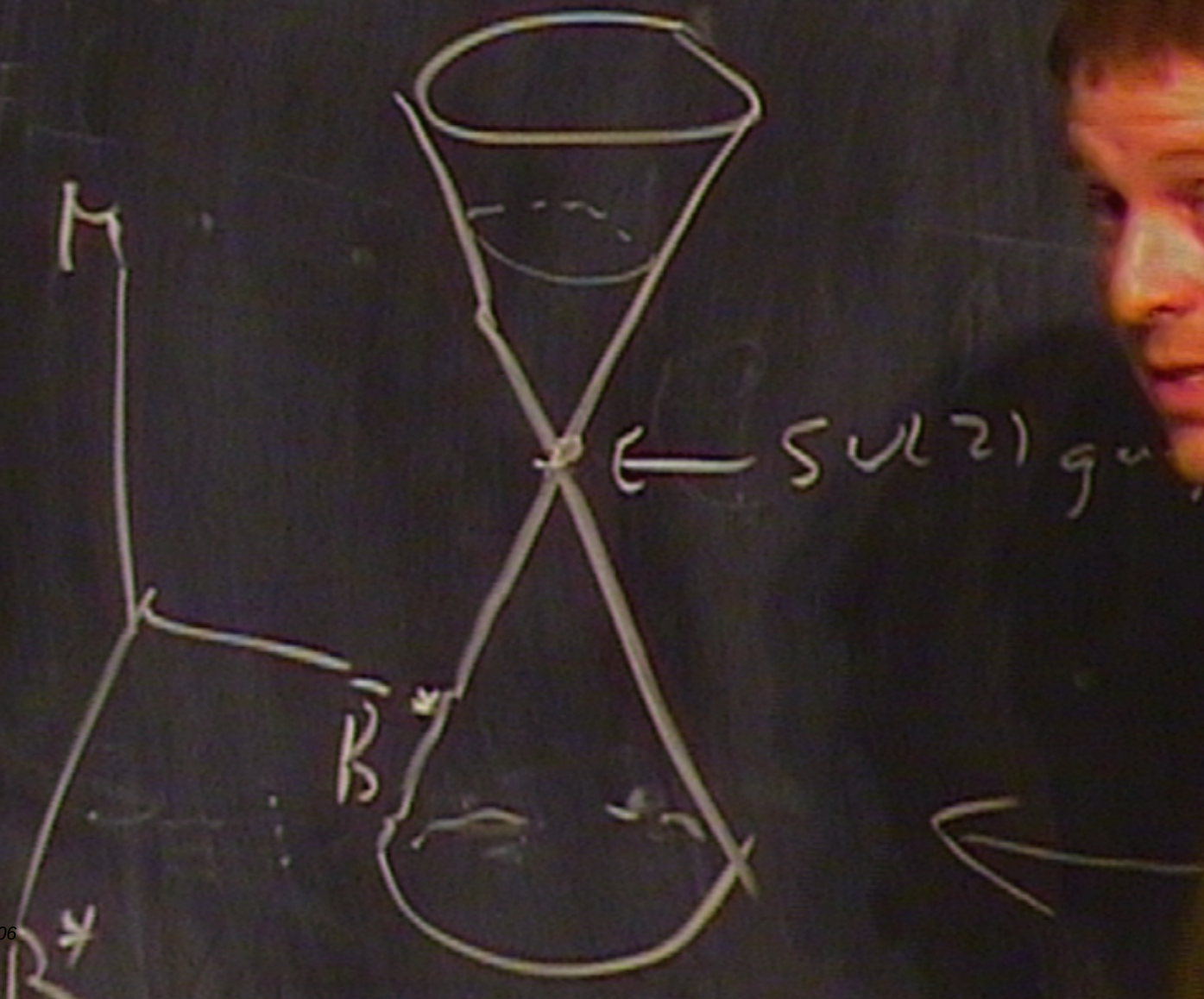


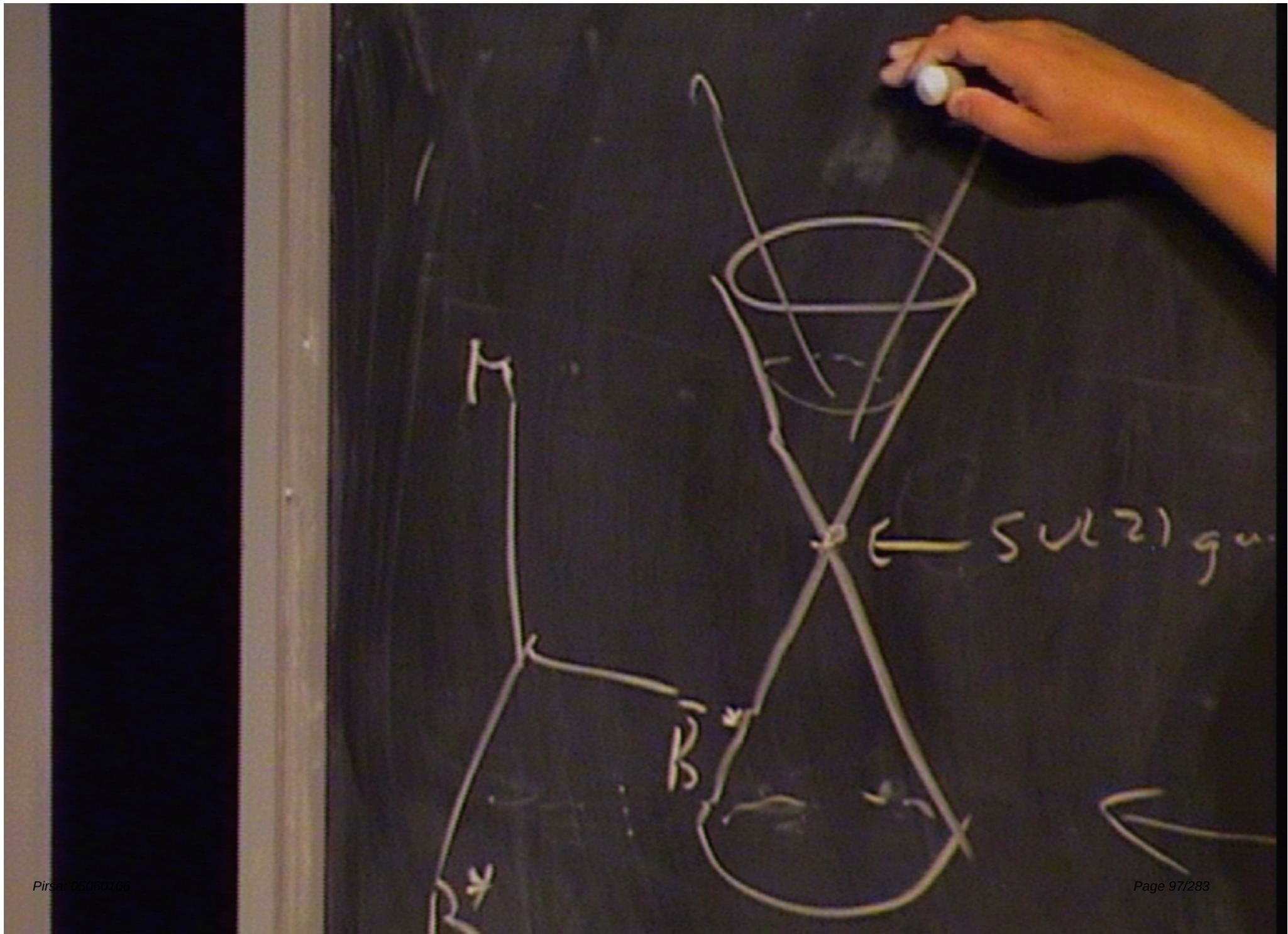


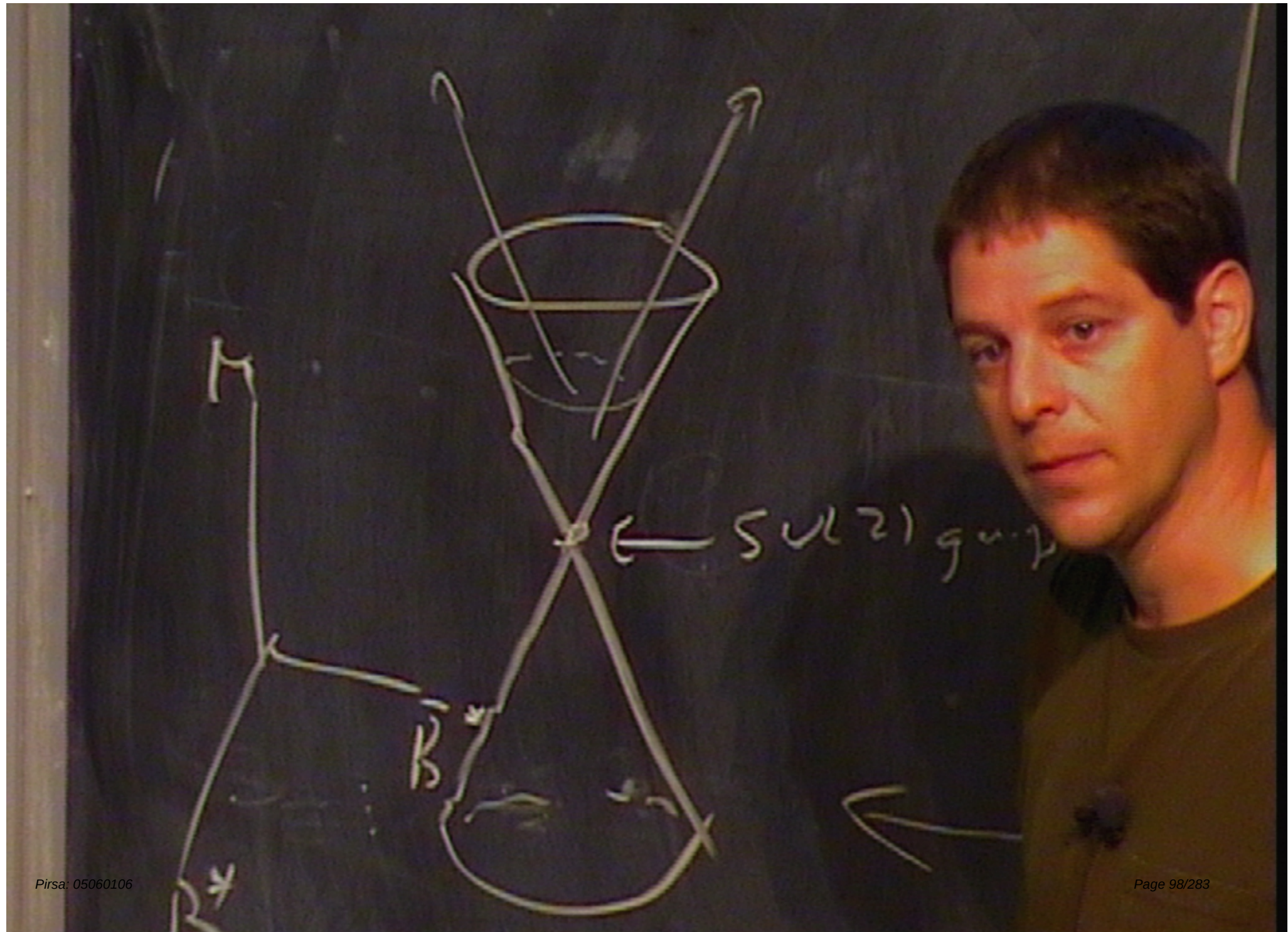












B. $N_f = N_c + 1$

guess that

$$\{M_i^i, B^{*i}, \tilde{B}_i^*\}$$

are good low energy
d.o.f.

B. $N_f = N_c + 1$

guess that

$$\{M_i, B^{\star i}, \tilde{B}^{\star i}\}$$

are good low energy
d.o.f.

Wef

level space

$$W_{\text{eff}} = f(M, B, \tilde{B}, \Lambda)$$

is a local space

$$W_{eff} = f(M, B, \tilde{B}, \Lambda)$$

$$W_{\text{eff}} = f(M, B, \tilde{B}, \Lambda)$$

field space

Global Symmetries:

$$W_{\text{eff}} = f(M, B, \tilde{B}, \Lambda)$$

Global Symms:

$$\det M, B^* \cdot M \cdot \tilde{B}^*$$

$$W_{\text{eff}} = f(M, B, \tilde{B}, \Lambda) / \mathcal{M}_{\text{cl}} = \{M, B, \tilde{B}\} / \langle \text{rel} \rangle$$

Global symmetries:

$$\det M, B^* \Lambda$$

$$f(M, B, \tilde{B}, \Lambda) \quad \mathcal{M}_{c, \Lambda} = \{M, B, \tilde{B}\} / \langle \text{relations} \rangle$$

$$U(1)_A$$

relations:

$$M, B^* M \tilde{B}^*$$

$$f(M, B, \tilde{B}, \Lambda) / \mathcal{M}_{cl} = \{M, B, \tilde{B}\} / \langle \text{relations} \rangle$$

relations:

$$M, B^* \cdot M \cdot \tilde{B}^*$$

	$U(1)_A$	$U(1)_R$
Q	1	$(N_f - 1) \frac{1}{N_f}$
$\tilde{Q}$	1	1
W	0	
Λ^b		

$$f(M, B, \tilde{B}, \Lambda) / \mathcal{M}_{c, L} = \{M, B, \tilde{B}\} / \langle \text{relations} \rangle$$

relations:

$$M, B^* \cdot M \cdot \tilde{B}^*$$

	$U(1)_A$	$U(1)_R$
Q	1	$(N_f - N_c) \frac{1}{N_f}$
$\tilde{Q}$	1	$(N_f - N_c) \frac{1}{N_f}$
W	0	
Λ^b	$2N_f$	

$$f(M, B, \tilde{B}, \Lambda) / \mathcal{M}_{cl} = \{M, B, \tilde{B}\} / \langle \text{relations} \rangle$$

relations:

$$M, B^* \cdot M \cdot \tilde{B}^*$$

	$U(1)_A$	$U(1)_R$
Q	1	$(N_f - N_c) \frac{1}{N_f}$
$\tilde{Q}$	1	$(N_f - N_c) \frac{1}{N_f}$
W	0	1
Λ^b	$2N_f$	0
$\det M$	$2N_f$	$2(N_f - N_c)$
$\tilde{B}^* \cdot M \cdot \tilde{B}^*$	$2(N_c + 1)$	

$$f(M, B, \tilde{B}, \Lambda) / \mathcal{M}_{cl} = \{M, B, \tilde{B}\} / \langle \text{relations} \rangle$$

relations:

$$M, B^* \cdot M \cdot \tilde{B}^*$$

	$U(1)_A$	$U(1)_R$
Q	1	$(N_f - N_c) \frac{1}{N_f}$
$\tilde{Q}$	1	(N_f)
W	0	
Λ^b	$2N_f$	
$\det M$	$2N_f$	$2(N_f - N_c)$
$\tilde{B}^* \cdot M \cdot \tilde{B}^*$	$2(N_c + 1)$	$\frac{2(N_c + 1)}{N_f}$

$$f(M, B, \tilde{B}, \Lambda) / \mathcal{M}_{cl} = \{M, B, \tilde{B}\} / \langle \text{relations} \rangle$$

relations:

$$M, B^* \cdot M \cdot \tilde{B}^*$$

	$U(1)_A$	$U(1)_R$
Q	1	$(N_f - N_c) \frac{1}{N_f}$
$\tilde{Q}$	1	$(N_f - N_c) \frac{1}{N_f}$
W	0	0
Λ^b	$2N_f$	0
$\det M$	$2N_f$	$2(N_f - N_c)$
$B^* \cdot M \cdot \tilde{B}^*$	$2(N_f - N_c)$	N_f

$$f(M, B, \tilde{B}, \Lambda) / \mathcal{M}_{cl} = \{M, B, \tilde{B}\} / \langle \text{relations} \rangle$$

relations:

$$M, B^* \cdot M \cdot \tilde{B}^*$$

	$U(1)_A$	$U(1)_R$
Q	1	$(N_f - N_c) \frac{1}{N_c}$
$\tilde{Q}$	1	$(N_f - N_c)$
W	0	
Λ^b	$2N_f$	0
$\det M$	$2N_f$	
$B^* \cdot M \cdot \tilde{B}^*$	$2(N_c + 1)$	$\frac{2(N_c + 1)}{N_f}$

$$f(M, B, \tilde{B}, \Lambda) / \mathcal{M}_{cl} = \{M, B, \tilde{B}\} / \langle \text{relations} \rangle$$

relations:

$$M, B^* \cdot M \cdot \tilde{B}^*$$

	$U(1)_A$	$U(1)_R$
Q	1	$(N_f - N_c) \frac{1}{N_f}$
$\tilde{Q}$	1	$(N_f - N_c)$
W	0	1
Λ^b	$2N_f$	0
$\det M$	$2N_f$	
$B^* \cdot M \cdot \tilde{B}^*$	$2(N_c + 1)$	$\frac{2(N_c + 1)}{N_f}$

$$f(M, B, \tilde{B}, \Lambda) / \mathcal{M}_{c, L} = \{M, B, \tilde{B}\} / \langle \text{relations} \rangle$$

relations:

$$M, B^* \cdot M \cdot \tilde{B}^*$$

	$U(1)_A$	$U(1)_R$
Q	1	$(N_f - N_c) \frac{1}{N_c}$
$\tilde{Q}$	1	$(N_f - 1)$
W	0	1
Λ^b	$2N_f$	(
$\det M$	$2N_f$	
$\tilde{B}^* \cdot M \cdot \tilde{B}^*$	$2(N_c + 1)$	$\frac{2(N_c - 1)}{N_f}$

$$f(M, B, \tilde{B}, \Lambda) \quad \mathcal{M}_{cl} = \{M, B, \tilde{B}\} / \langle \text{relations} \rangle$$

relations:

$$M, B^* \cdot M \cdot \tilde{B}^*$$

	$U(1)_A$	$U(1)_R$
Q	1	$(N_f - N_c) \frac{1}{N_f}$
$\tilde{Q}$	1	$(N_f - N_c) \frac{1}{N_f}$
W	0	1
Λ^b	$2N_f$	0
$\det M$	$2N_f$	$2(N_f - N_c)$
$\tilde{B}^* \cdot M \cdot \tilde{B}^*$	$2(N_c + 1)$	$\frac{2(N_c + 1)}{N_f} (N_f - N_c)$

$$f(M, B, \tilde{B}, \Lambda) / \mathcal{M}_{cl} = \{M, B, \tilde{B}\} / \langle \text{relations} \rangle$$

relations:

$$M, B^* M \tilde{B}^*$$

	$U(1)_A$	$U(1)_R$
Q	1	$(N_f - N_c) \frac{1}{N_f}$
$\tilde{Q}$	1	$(N_f - N_c) \frac{1}{N_f}$
W	0	1
Λ^b	$2N_f$	0
$\det M$	$2N_f$	$2(N_f - N_c)$
$B^* M \tilde{B}^*$	$2(N_c + 1)$	$\frac{2(N_c + 1)}{N_f} (N_f - N_c)$

$$W_{\text{eff}} = \frac{\alpha \det M + \beta \tilde{B} \cdot M \cdot \tilde{B}}{\Lambda^6}$$

$$W_{\text{eff}} = \frac{\alpha \det M + \beta B^* \cdot M \cdot \tilde{B}}{\Lambda^6}$$

$$W_{\text{eff}} = \frac{\alpha \det M + \beta B^* \cdot M \cdot B}{\Lambda^6}$$

$$W_{\text{eff}} = \frac{\alpha \det M + \beta B^* \cdot M \cdot \bar{B}}{\Lambda^6}$$

Λ^6

$\nearrow$

$\langle M \rangle$

(?) $\therefore M_{\text{eff}} = 0$

$$W_{\text{eff}} = \frac{\alpha \det M + \beta B^* \cdot M \cdot \bar{B}}{6}$$

↑⁶

↖

:

$\langle M \rangle$

SU

(?)! $M_{\text{eff}} = 0$

$M = 11$

$B = 5$

$\det M = 11 - 2$

$\text{Tr} M = 11$

$B \cdot B = 11$

$B^* B^* = \det M$

$$B_i^* = \epsilon_{i_1 \dots i_n} B^{i_1 \dots i_n}, \quad \tilde{B}^{*i} = \dots$$

$$x_j = (\det M) (M^{-1})^j_i \Rightarrow B^* \cdot M \cdot \tilde{B}^* = \det M$$

$$B_i^* = \tilde{B}^{*j} M_j^i = 0$$

$$W_{\text{eff}} = \frac{\alpha \det M + \beta B^* \cdot M \cdot \tilde{B}^*}{1}$$

$\uparrow^6$



$\langle M \rangle$

~~(?)~~ $W_{\text{eff}} = 0$ if $\alpha = -\beta \Rightarrow$ then W_{eff}

$$W_{eff} = \frac{\alpha \det M + \beta B \cdot M \cdot B}{\Lambda^6}$$

Λ^6



$\langle M \rangle$

~~(?) $W_{eff} = 0$~~

if $\alpha = -\beta \Rightarrow$ then $W_{eff} = 0$

$$W_{\text{eff}} = \frac{\alpha \det M + \beta B \cdot M \cdot B}{6}$$

↑⁶



: $\langle M \rangle = 3(2n-1)$

(?): $W_{\text{eff}} = 0$ if $\alpha = -\beta \Rightarrow$ then $W_{\text{eff}} = 0$ on

$$W_{\text{eff}} = \frac{\alpha \det M + \beta B \cdot M \cdot B}{6}$$

↑⁶



: <M>

~~(?)~~ ~~$W_{\text{eff}} = 0$~~ if $\alpha = -\beta \Rightarrow W_{\text{eff}} = 0$ on $\mathcal{M}_1$

$$W_{\text{eff}} = \frac{\alpha \det M + \beta B \cdot M \cdot B}{6}$$

↑⁶



: $\langle M \rangle = \frac{1}{6} \text{Tr}(M)$

(?): $W_{\text{eff}} = 0$ if $\alpha = -\beta \Rightarrow$ then $W_{\text{eff}} = 0$ on $\mathcal{M}_1$

$$W_{\text{eff}} = \frac{\alpha \det M + \beta B \cdot M \cdot B}{6}$$

↑⁶



$\langle M \rangle = \text{sum of } M$

~~(?) $N_{\text{eff}} = 0$~~ if $\alpha = -\beta \Rightarrow$ then $W_{\text{eff}} = 0$ or M_{eff}

$$W_{\text{eff}} = \frac{\alpha \det M + \beta B \cdot M \cdot B}{\Lambda^6}$$

 Λ^6

 $\langle M \rangle = \frac{1}{3} \text{Tr}(M)$

~~$W_{\text{eff}} = 0$~~ if $\alpha = -\beta \Rightarrow$ then $W_{\text{eff}} = 0$ on $\mathcal{M}_1$

$$\frac{(2)'}{N_H = 0} \text{ if } \alpha = -\beta \Rightarrow$$

$$0 = 2qN_H \Rightarrow$$

$$\text{rank}(M) \leq n-2$$

$$qM_1 = \dots = M_1$$

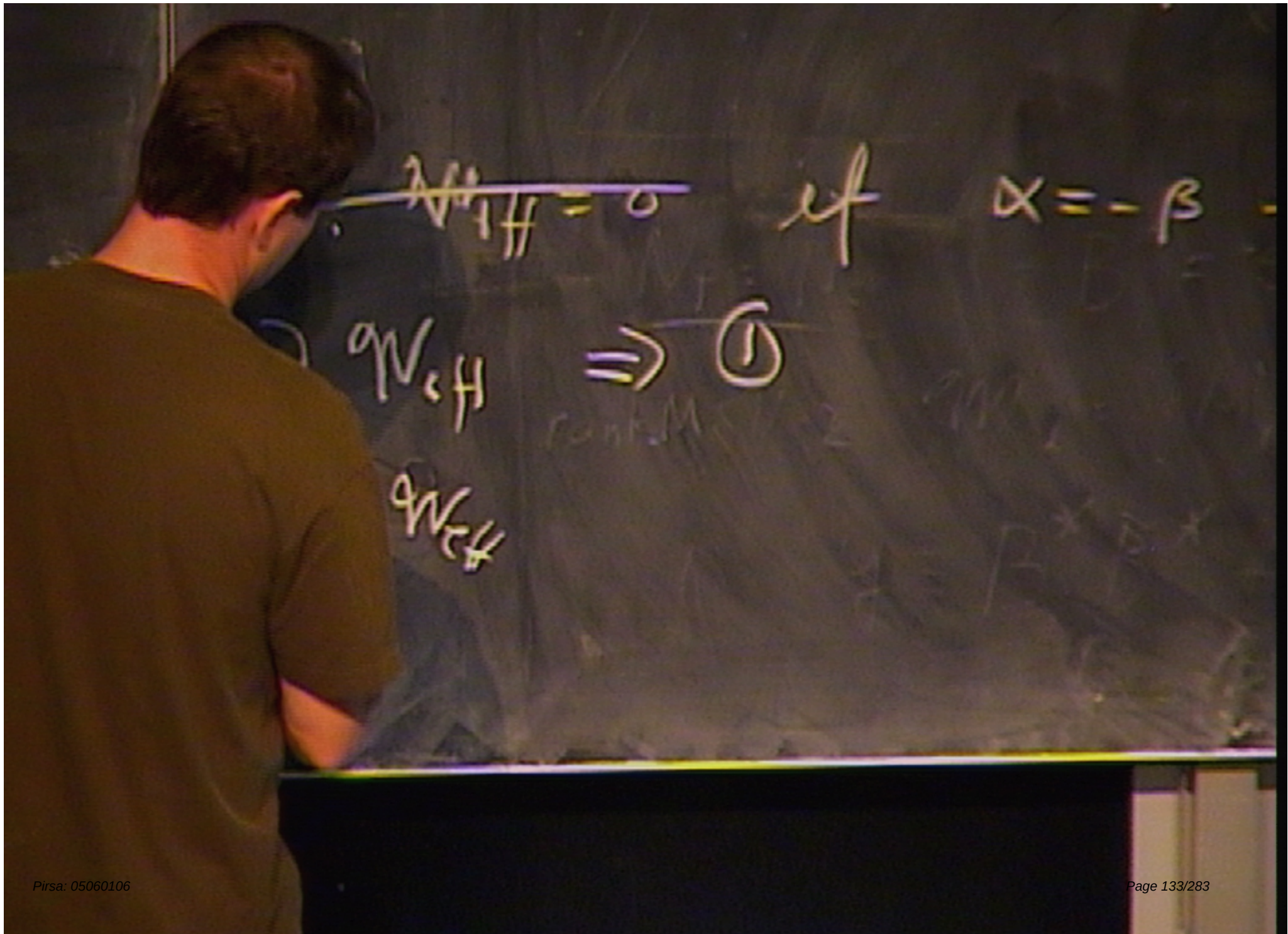
$$z \in \mathbb{R}^* \times \mathbb{R}^*$$

1.1.1

$$B_i = \epsilon_{i_1 \dots i_n} B^{i_1 \dots i_n}$$

$$\textcircled{1} B_i^* B^{*j} = (\det M) (M^{-1})^j_i \Rightarrow B \cdot \text{t}$$

$$\textcircled{2} M_j^i B_i^* = B^{*j} M_j^i = 0$$



~~$N_{1H} = 0$~~ if $\alpha = -\beta$

$N_{1H} \Rightarrow \textcircled{1}$

N_{1H}

$$\frac{\partial}{\partial \alpha} N_{\alpha\beta} = 0 \quad \text{if} \quad \alpha = -\beta$$

$$0 = \frac{\partial}{\partial \alpha} N_{\alpha\beta} \Rightarrow \textcircled{1}$$

$$0 = \frac{\partial}{\partial \beta} N_{\alpha\beta}$$

$$\frac{(2)'}{N_H} = 0 \quad \text{if} \quad \alpha = -\beta$$

$$0 = \partial_M N_H \Rightarrow \textcircled{1}$$

$$0 = \partial_\beta N_H \Rightarrow \textcircled{2}$$

$$\frac{(\gamma)'}{N_H} = 0 \quad \text{if} \quad \alpha = -\beta$$

$$0 = \partial_M N_H \Rightarrow \textcircled{1}$$

$$0 = \partial_B N_H \Rightarrow \textcircled{2} \quad \checkmark$$

$$W_{\text{eff}} = \frac{\alpha (\det M - B^* \cdot M \cdot \tilde{B}^*)}{\Delta^6}$$

~~$W_{\text{eff}} = 0$~~ if $\alpha = -\beta \Rightarrow$

$$\frac{\partial W_{\text{eff}}}{\partial M} \Rightarrow \textcircled{1}$$

$$\frac{\partial W_{\text{eff}}}{\partial B} \Rightarrow \textcircled{2} \checkmark$$

$$W_{\text{eff}} = \frac{\alpha (\det M - B^* \cdot M \cdot \tilde{B}^*)}{\Lambda^6}$$

Λ^6

~~$W_{\text{eff}} = 0$~~ if $\alpha = -\beta \Rightarrow W_{\text{eff}} = 0$

$\partial_M W_{\text{eff}} \Rightarrow \textcircled{1}$

$\partial_M W_{\text{eff}} \Rightarrow \textcircled{2} \checkmark$

$$W_{\text{eff}} = \frac{\alpha (\det M - B^* \cdot M \cdot \tilde{B}^*)}{\Lambda^6}$$

Λ^6
 $\nwarrow$
 $\nearrow$

(M)

~~$W_{\text{eff}} = 0$~~ if $\alpha = -\beta \Rightarrow$ then W_{eff}

$\partial_M W_{\text{eff}} \Rightarrow$ ①

$\partial_M W_{\text{eff}} \Rightarrow$ ② ✓

$$W_{\text{eff}} = \frac{\alpha (\det M - B^* \cdot M \cdot \tilde{B}^*)}{\Lambda^6}$$

Λ^6
 $\uparrow$
 $:(M) = \text{SOL}(M)$

~~$W_{\text{eff}} = 0$~~ if $\alpha = -\beta \Rightarrow \text{then } W_{\text{eff}} = 0$

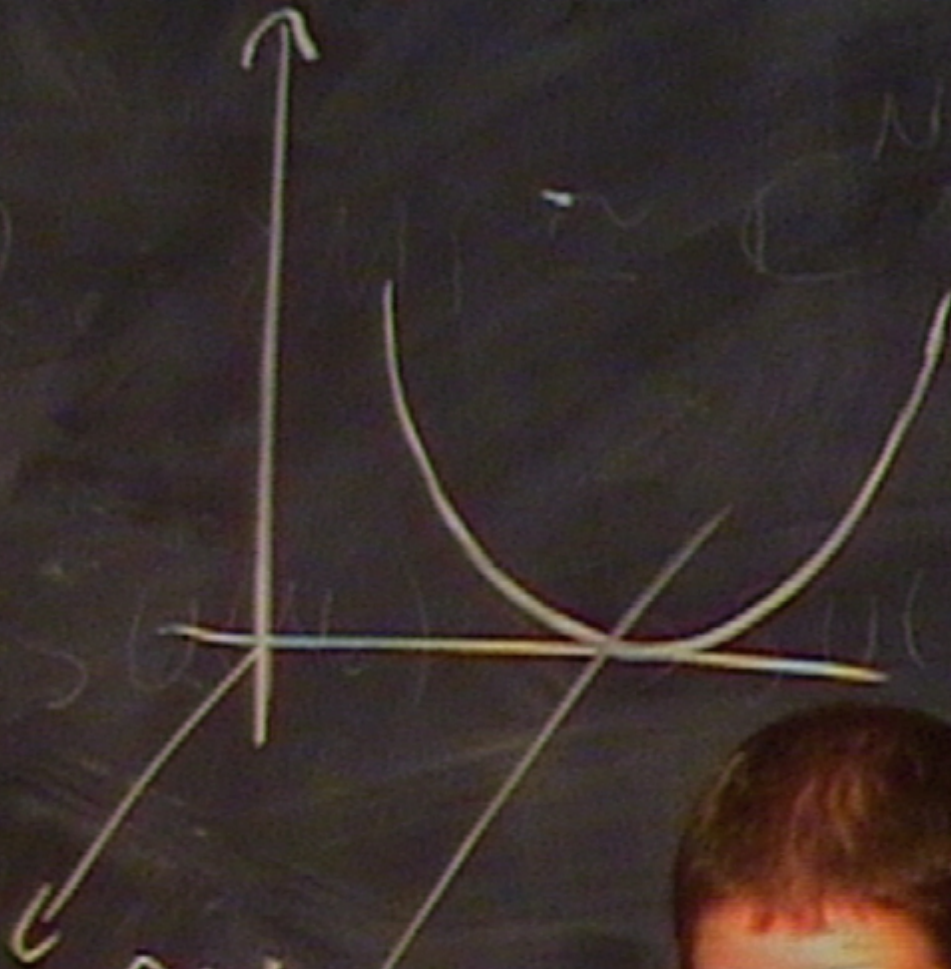
$\partial_M W_{\text{eff}} \Rightarrow \textcircled{1}$

$\partial_M W_{\text{eff}} \Rightarrow \textcircled{2} \checkmark$

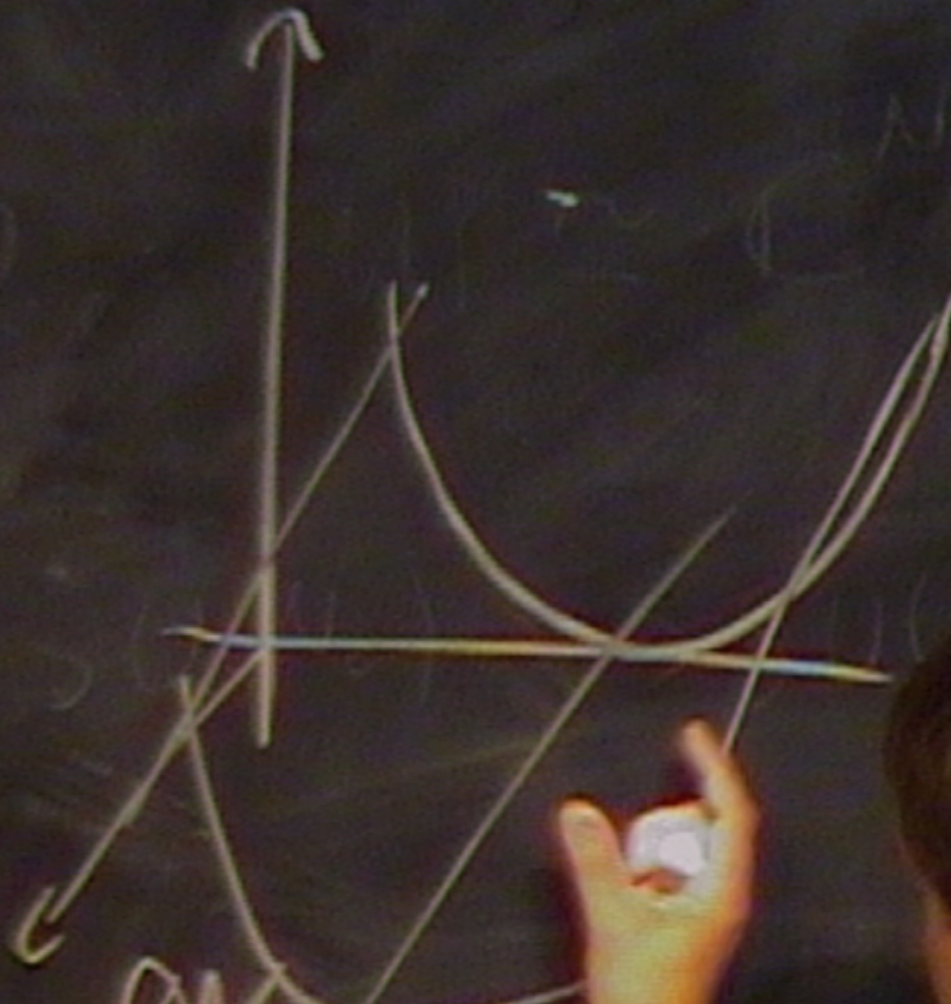
$$u = |w'|$$

M, B, B

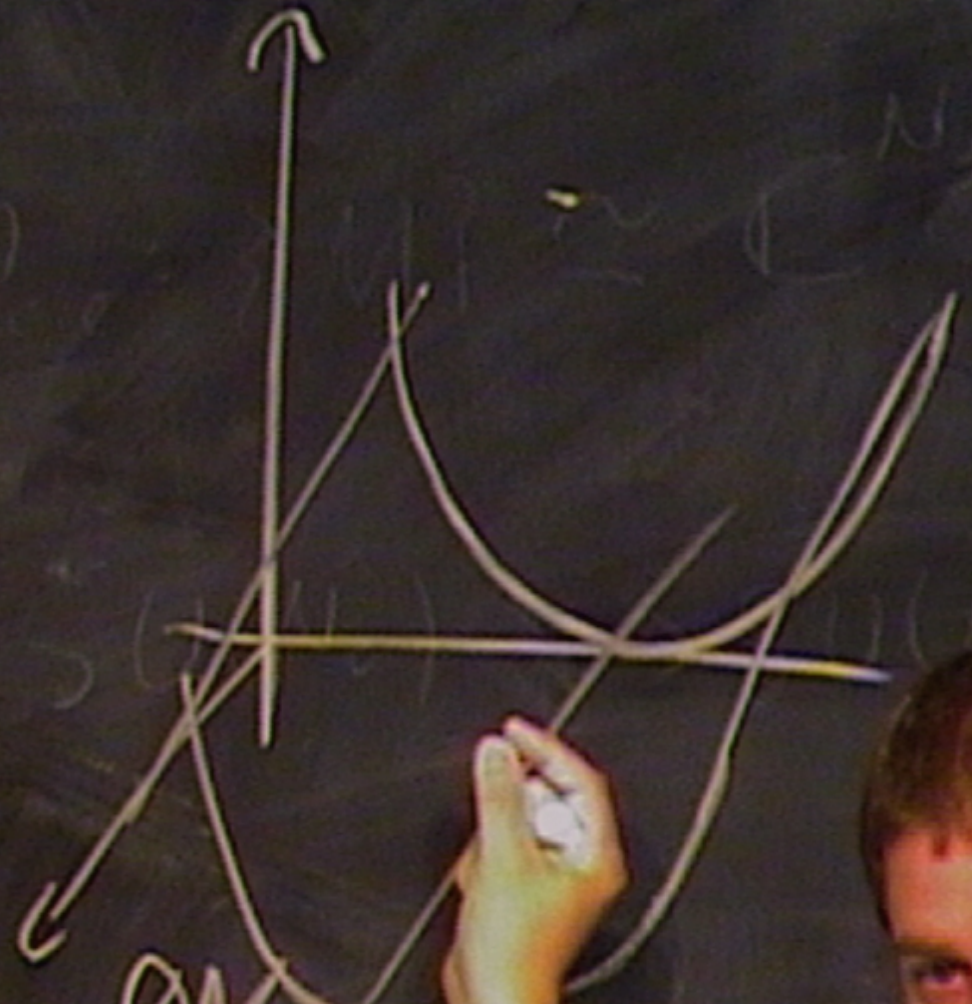
$$v = |w'|$$



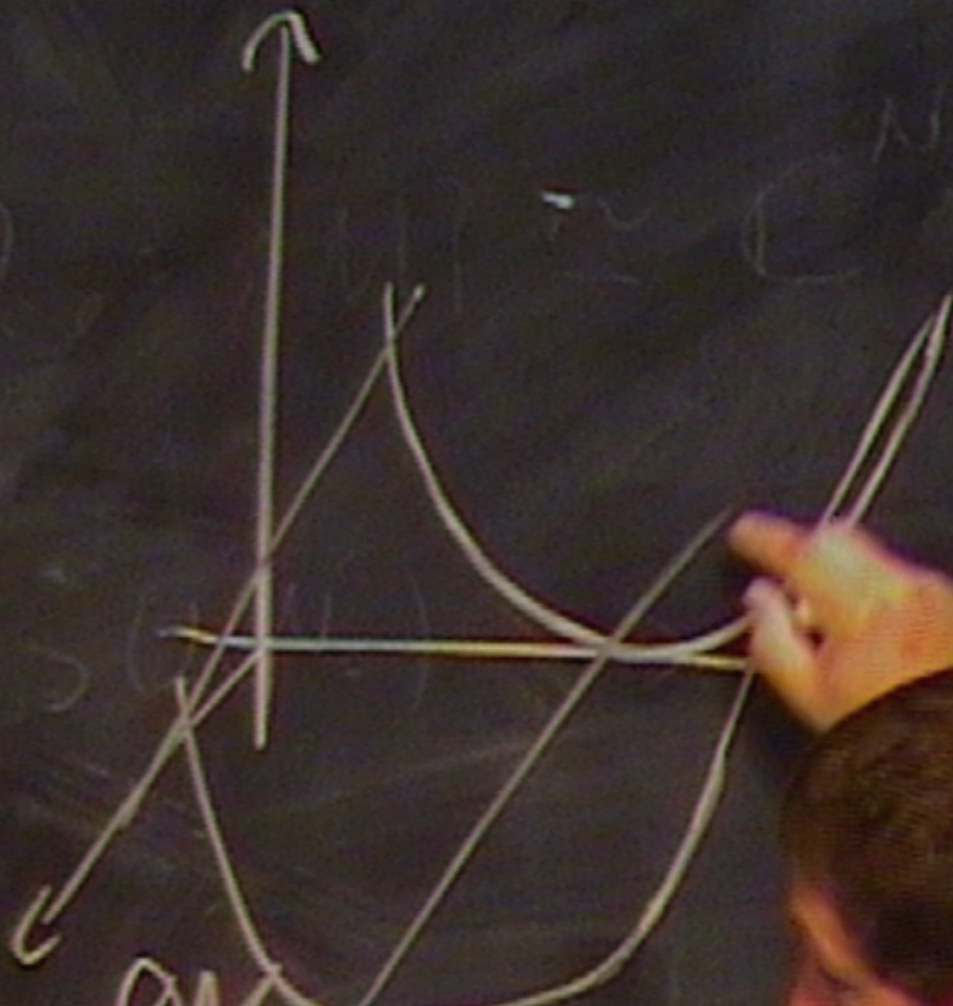
$$v = |w'|$$



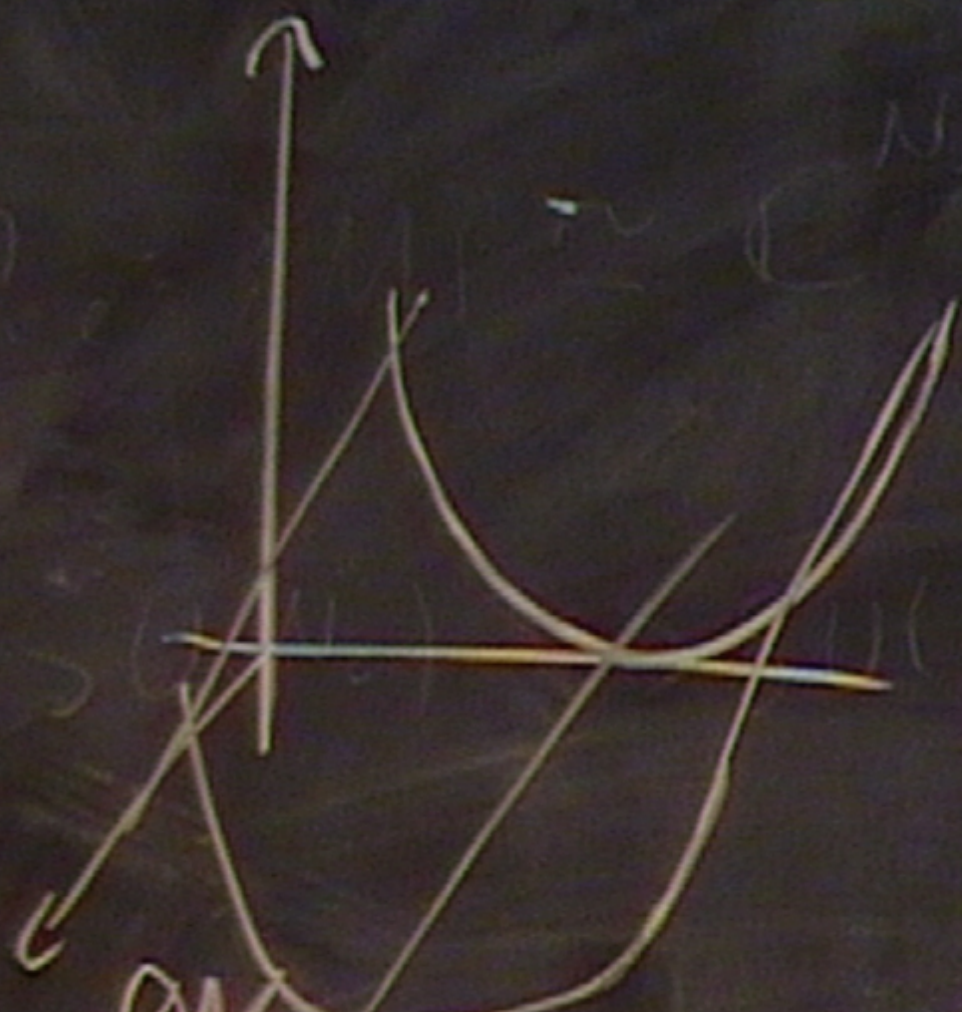
$$v = |w'|$$



$$v = |w'|$$

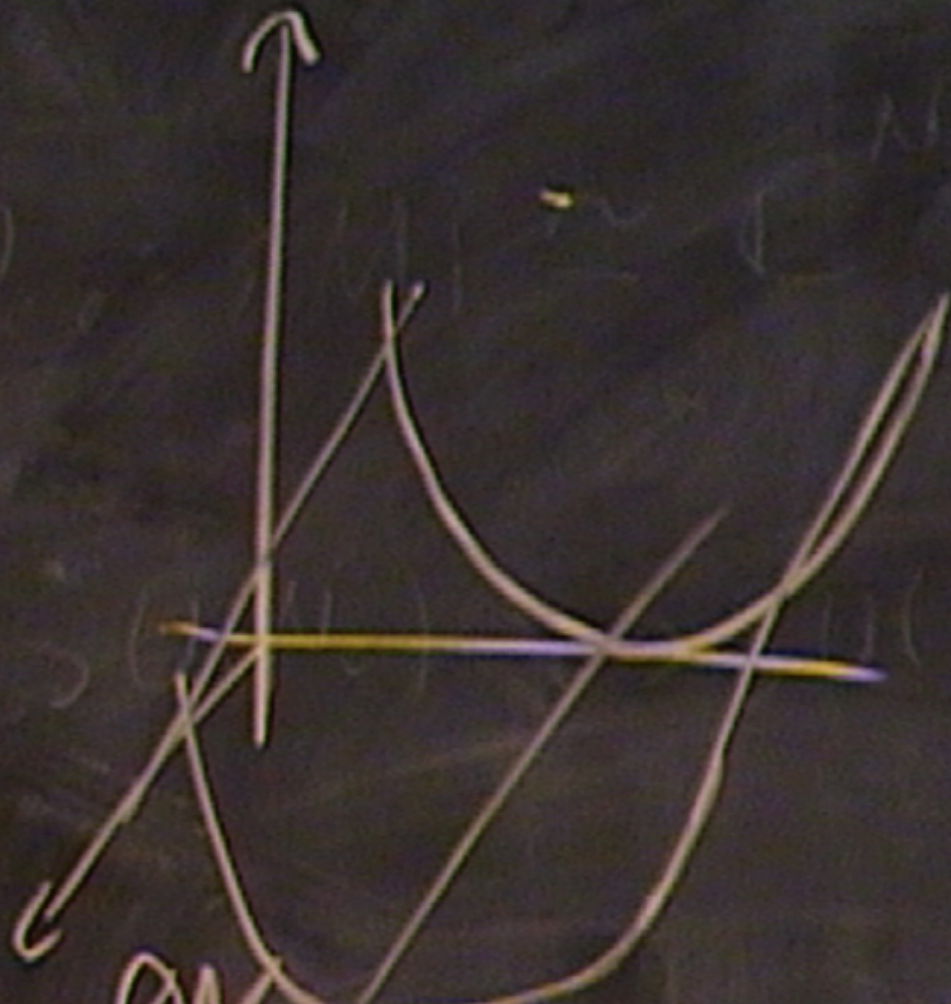


$$v = |w'|$$



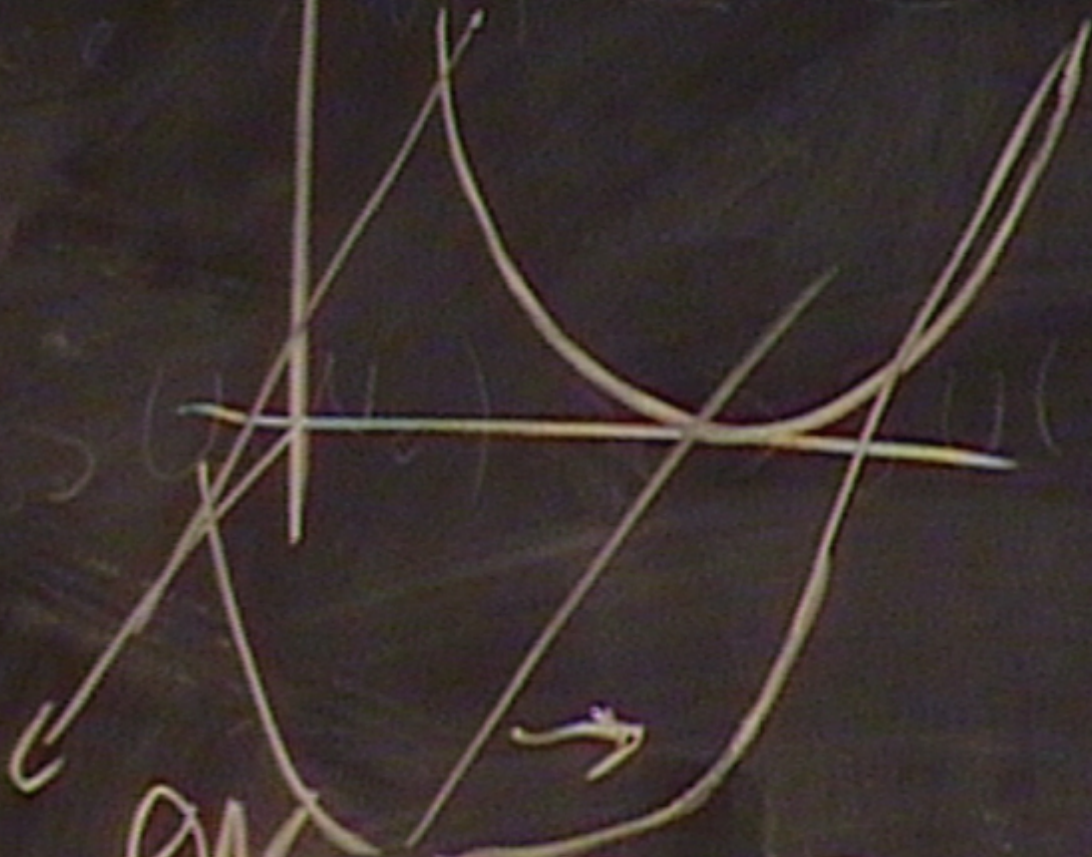
M, B, B

$$v = |w'|$$



M. B. B

$$v = |w|$$

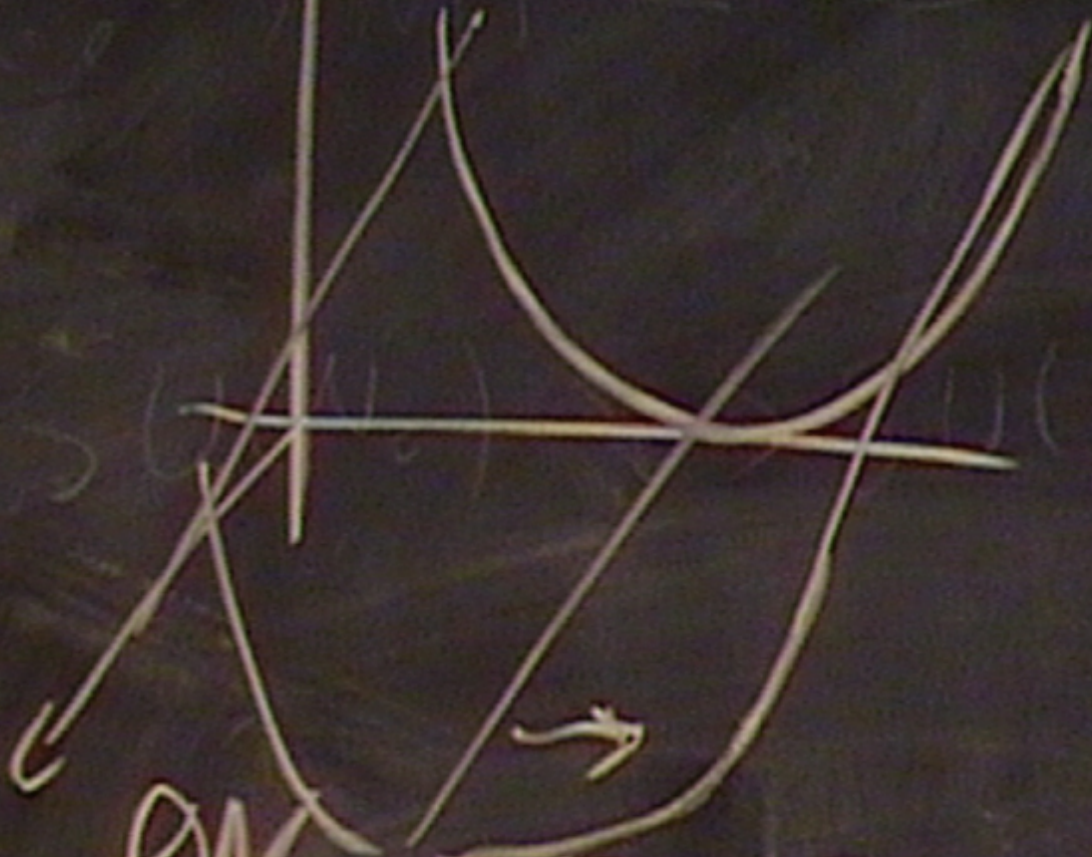


M.B.B

on M_{cl}

on M_{cl}

$$v = |w|$$



M, B, B

$M_{eff} = 0$

on M_{eff}

Seiberg duality

$$C. \quad \underline{N_f \leq N_c}$$

Seiberg duality

$$C: \underline{N_f \leq N_c}$$

guess that

Seiberg duality

$$C: N_f \leq N_c$$

$$SW_u = m_i \tilde{Q}_i Q_i$$

Seiberg duality

$$C: N_f \leq N_c$$

$$SW_u = m_i \tilde{Q}_i Q_i$$

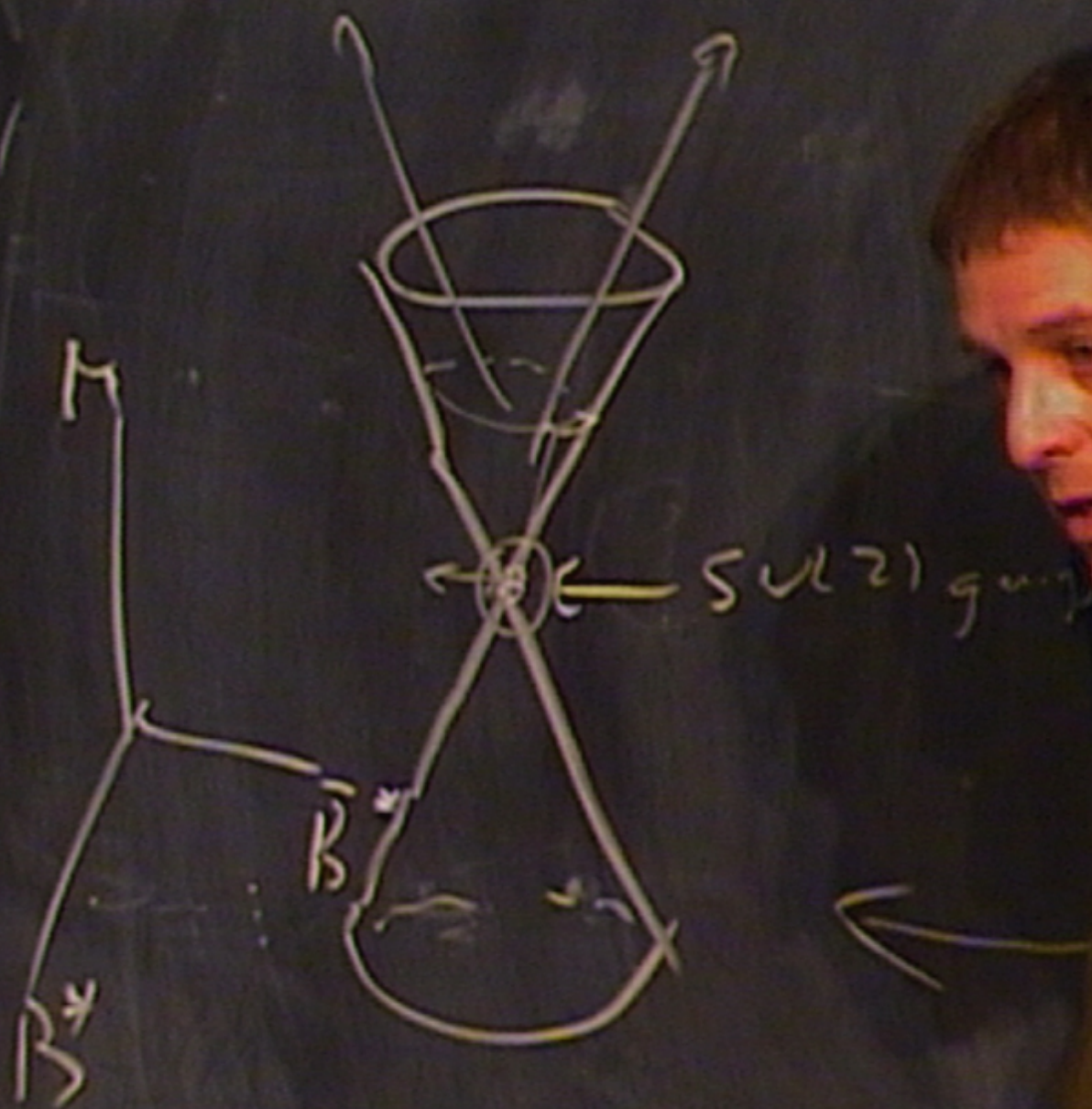
Seiberg duality

$$C: N_f \leq N_c$$

$$SW_u = m_i \tilde{Q}_a Q_i$$



$$SW_{eff} = m_i M_i$$





$$\downarrow$$

$$q_{\text{eff}} = X \cdot (\det M - \tilde{B}^* B^* - \Lambda^4)$$

$$g_{\text{eff}} = X \cdot (\det M - \tilde{B}^* B^* - 1^4)$$

$$q_{W_{eff}} = X \cdot (\det M - \tilde{B}^* B^* - 1^L)$$



$$\downarrow$$

$$q_{\text{eff}} = X \cdot (\det M - B^* \tilde{B}^* - \Lambda^4)$$

$$\downarrow$$

$$q_{W_{eff}} = X \cdot (\det M - \tilde{B}^* B^* - \Lambda^L)$$



$$q_{\text{eff}} = X \cdot (\det M - \tilde{B}^* B^* - 1^L)$$

$$W_{\text{eff}} = X \cdot (\det M - \vec{B} \vec{B}^* - \Lambda^4)$$

$$q_{W_{\text{eff}}} = X \cdot (\det M - B^* \tilde{B}^* - \Lambda^6)$$

but some
potential systems

$U(1) \times$

$U(1)$

$\det M, B^* \tilde{B}^*$

$$g_{\text{eff}} = X \cdot (\det M - \tilde{B}^* B^* - \Lambda^4)$$

$$q_{\text{eff}} = X \cdot (\det M - B^* \tilde{B}^* - \Lambda^4)$$

$$q_{W_{eff}} = X \cdot (\det M - \tilde{B}^* B^* - \Lambda^4)$$

$$q_{\text{eff}} = X \cdot (\det M - B^* \tilde{B}^* - \Lambda^4)$$

$$\downarrow$$

$$q_{\text{eff}} = X \cdot (\det M - \tilde{B}^* B^* - 1^L)$$

$$g_{\text{eff}} = X \cdot (\det M - B^* \tilde{B}^* - 1^L)$$

gauge space
 global symmetries

$U(1)_A$

$\det M$, $B^* \tilde{B}^*$
 $U(1)_A$

$$\begin{array}{l}
 \vec{M} \\
 N_f = N(u) \\
 U(1)_R
 \end{array}
 = \left(\begin{array}{c|c}
 & \\
 \hline
 & X
 \end{array} \right)$$

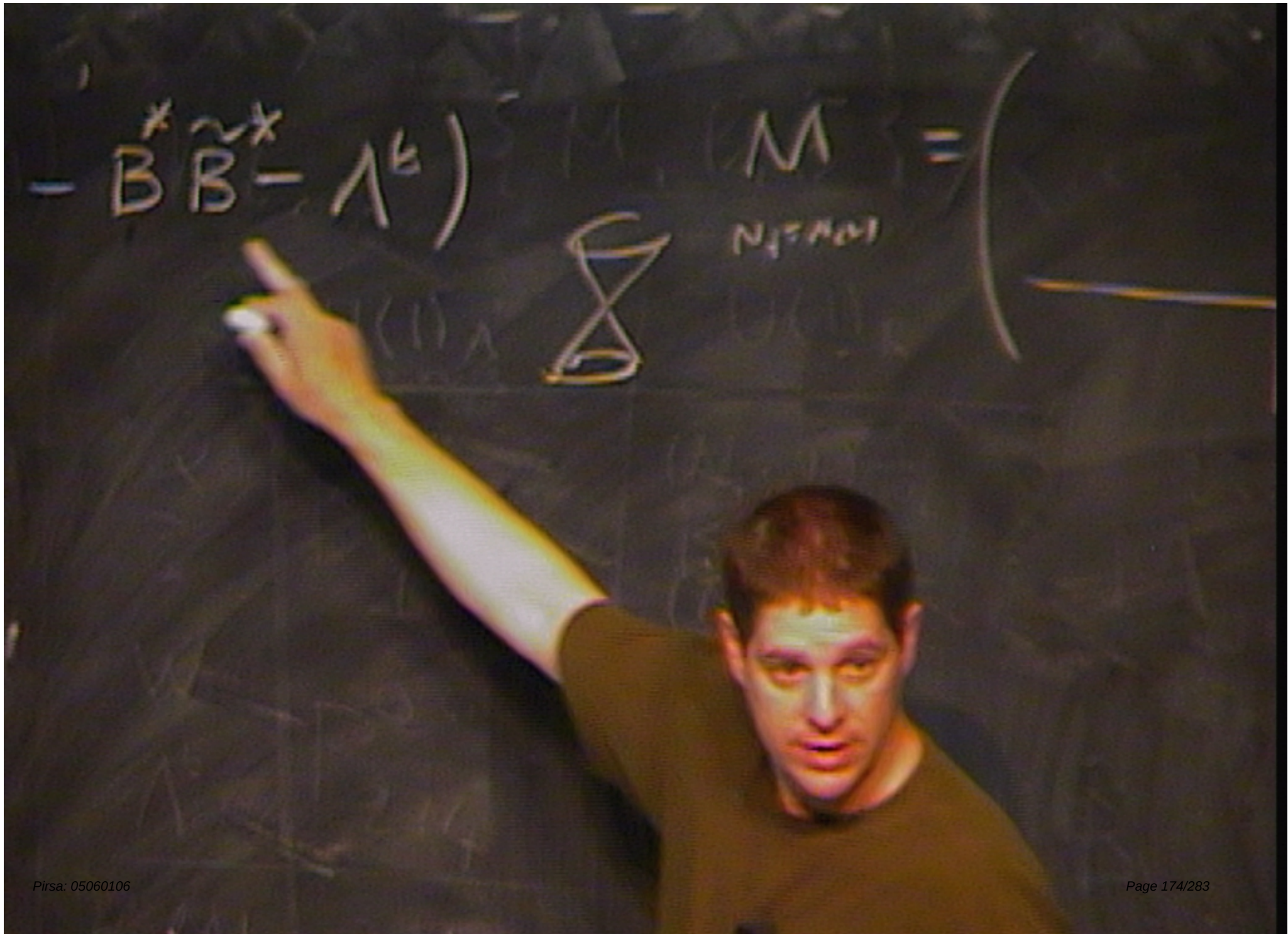
$$q_{W_{eff}} = X \cdot (\det M - \tilde{B}^* B^* - 1^{\epsilon})$$

local space
 global symmetries

$$q_{W_{eff}} = X \cdot (\det M - B^* \tilde{B}^* - 1^k)$$

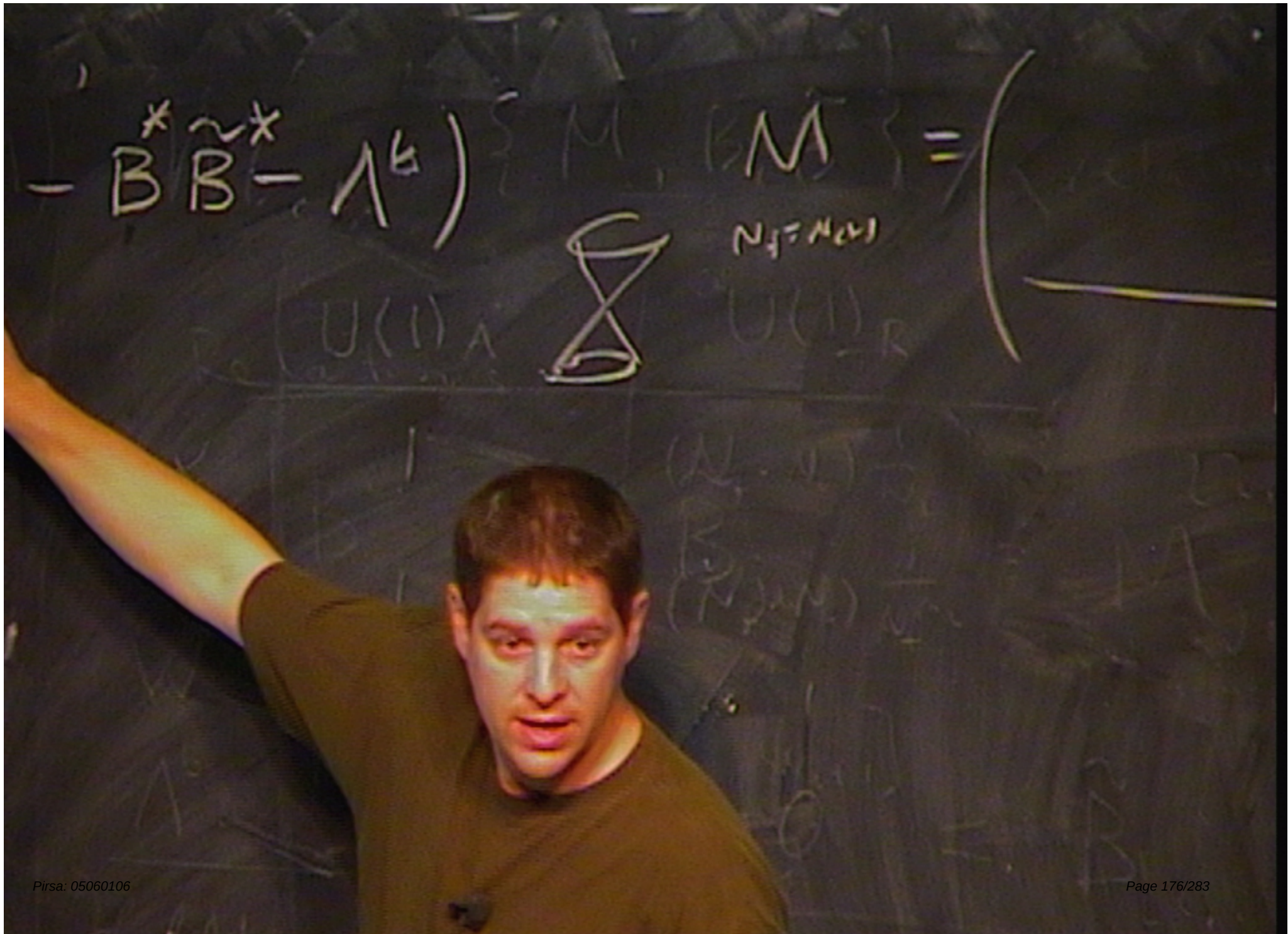
local space
 isolated systems

$$M, B^* \tilde{B}^*$$



$$- \begin{pmatrix} \bar{B}^* & \bar{B}^* \\ B & -1^k \end{pmatrix} \begin{pmatrix} M & BM \\ N & N \end{pmatrix} = \begin{pmatrix} \vdots \\ \vdots \end{pmatrix}$$

$\triangle$ $N_f = N_{ch}$
 $U(1)_A$ $U(1)_R$



$$q_{W_{\text{eff}}} = X_i (\det M - B^* \tilde{B}^* - \Lambda^L)$$

↓
 full space
 central systems

$q_{W_{\text{eff}}}$

$$\downarrow$$

$$q_{W_{\text{eff}}} = X \cdot (\det M - \tilde{B}^* B^* - 1^L)$$

field space
 ↓
 central singularity

$$q_{W_{\text{eff}}} =$$

$$W_{eff} = \frac{\frac{1}{2} \det M - B^* \cdot M}{\Lambda^6}$$

~~(2) $W_{eff} = 0$ if $\alpha = -\beta \Rightarrow$~~

$$0 = 2 \eta_{eff} \Rightarrow \textcircled{1}$$

$$= N_c \quad \downarrow \quad \mathcal{W}_{\text{eff}} = X \cdot (\det M - \tilde{B}^* B^* - \Lambda^L)$$

field space
 ↓
 physical solutions

$$\mathcal{W}_{\text{eff}} =$$

$$-N_c \quad \downarrow \quad g_{W_{\text{eff}}} = X / \det M - \tilde{B}^* B^* - 1^k$$

↓
initial operators

$$g_{W_{\text{eff}}} =$$

$$N_f = N_c$$

$$a_{W_{eff}} = X / (\det M - B^*)$$

$$a_{W_{eff}} =$$

$$N_f < N_c$$

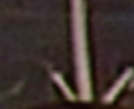
$$N_f = N_c$$

$$a_{W_{eff}} = X \cdot (\det M - B^*)$$



$$a_{W_{eff}} =$$

$$N_f = N_i \quad a_{W_{eff}} = X / (\det M - B^*)$$



$$ff = (N_f - N_i)$$

$$N_f = N_c$$

$$a_{W_{eff}} = X \cdot (\det M - B^*)$$



$$0 < N_f < N_c$$

$$= (N_f - N_c)$$

$$N_f = N_c$$

$$a_{W_{eff}} = X \cdot (\det M - B^*)$$



$$(N_f - N_c)$$

$$0 < N_f < N_c$$

Φ

$$N_f = N_c$$

$$a_{W_{eff}} = X \cdot (\det M - B^*)$$

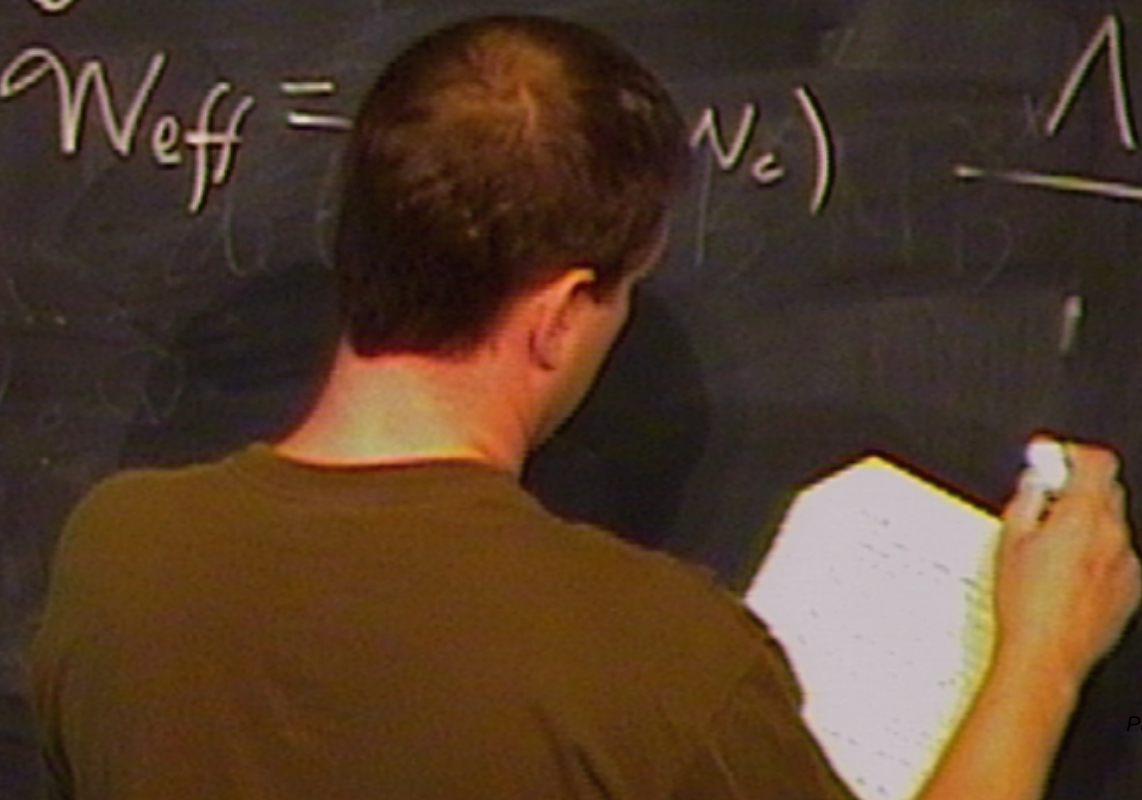
↓
 full space
 ↓
 central singularity

$$a_{W_{eff}} = (N_c)$$

$$\frac{\Lambda^b}{\Lambda^b}$$

$$0 < N_f < N_c$$

$$Q_i$$



$$q_{W_{\text{eff}}} = X \cdot (\det M - \tilde{B}^* B^* - 1^6)$$

$\downarrow$
 full space
 $\downarrow$
 initial system

$$q_{W_{\text{eff}}} = \left(\frac{1^b}{\det M} \right)$$

$$g_{W_{\text{eff}}} = X \cdot (\det M - \tilde{B}^* B^* - 1^L)$$

↓
field space
initial conditions

$$g_{W_{\text{eff}}} = (N_f - N_c) \left(\frac{\Lambda^b}{\det M} \right)^{\frac{1}{N_c - N_f}}$$

↓

$$g_{W_{eff}} = X \cdot (\det M - \tilde{B}^* B^* - 1^L)$$

↓ field space
↓ initial conditions

$$g_{W_{eff}} = (N_f - N_c) \left(\frac{\Lambda^b}{\det M} \right)^{\frac{1}{N_c - N_f}}$$

↓

$$g_{W_{eff}} = X \cdot (\det M - \tilde{B}^* B^* - 1^L)$$

↓
full space
↓
field equations

$$g_{W_{eff}} = \underbrace{(N_f - N_c)}_{\text{det } M} \left(\frac{1^b}{\det M} \right)^{\frac{1}{N_c - N_f}}$$

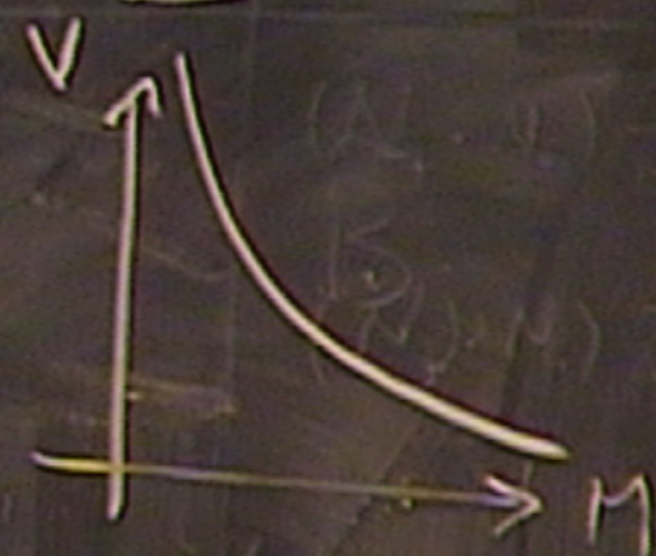
↓

↑
V

$$(M - B^* \tilde{B}^* - \Lambda^6) \{M, M\} = \left(\begin{array}{c} \text{...} \\ N_f = N_{\text{color}} \end{array} \right)$$



$$\frac{\Lambda^6}{\text{Let } M} \left(\frac{1}{N_c - N_f} \right)$$



$$g_{W_{\text{eff}}} = X \cdot (\det M - \tilde{B}^* B^* - 1^b)$$

↓

$$g_{W_{\text{eff}}} = \underbrace{(N_f - N_c)}_{(N_f - N_c)} \left(\frac{1^b}{\det M} \right)^{\frac{1}{N_c - N_f}}$$

(det M)

SYM $\Rightarrow N_c$ discrete vacua

$$\Rightarrow \text{tr}(-1)^F =$$

$N=1$ SQCD - Seiberg dual

$$N_f = 3N_c$$

$$N_f = \frac{3}{2}N_c$$

IRF

SCFT

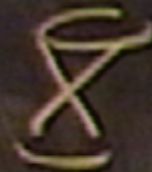
$$N_f = N_c + 1$$

$$N_f = N_c$$

No vacuum

N_c discrete vacua

N_c



$$m_{\text{eff}} = m$$



$N=1$ SQCD - Seiberg dual

$$N_f = 3N_c$$

$$N_f = \frac{3}{5}N_c$$

IRF

SC

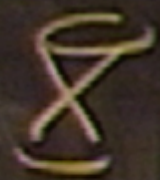
$$N_f = N_c + 1$$

$$N_f = N_c$$

No vacuum

N_c different vacua

$$N_c$$



$$M_{\text{eff}} = 9N_c$$



$N=1$ SQCD - Seiberg dual

$$N_f = 3N_c$$

$$N_f = \frac{3}{2}N_c$$

IRF

SCFT

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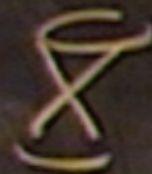
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No vacuum

N_c discrete vacua

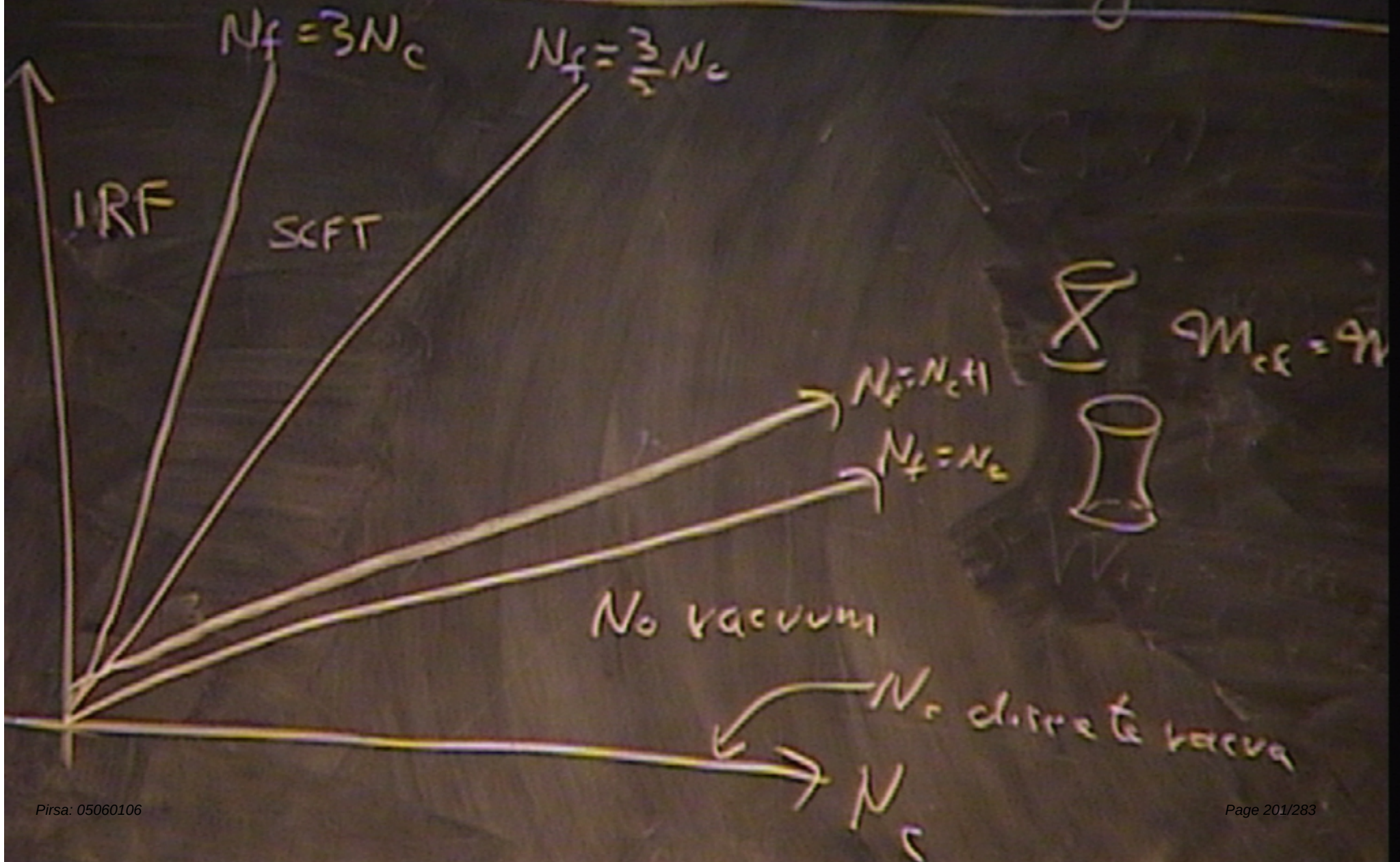
$$N_c$$



$$M_{eff} = 9M$$



$N=1$ SQCD - Seiberg dual



$N=1$ SQCD - Seiberg dual

$$N_f = 3N_c$$

$$N_f = \frac{3}{2}N_c$$



SCFT



$$M_{eff} = 9N$$



$$N_f = N_c + 1$$

$$N_f = N_c$$

No vacuum

N_c directions to vacuum

$$N_c$$

$$N_f = 3N_c$$

$$N_f = \frac{3}{2} N_c$$

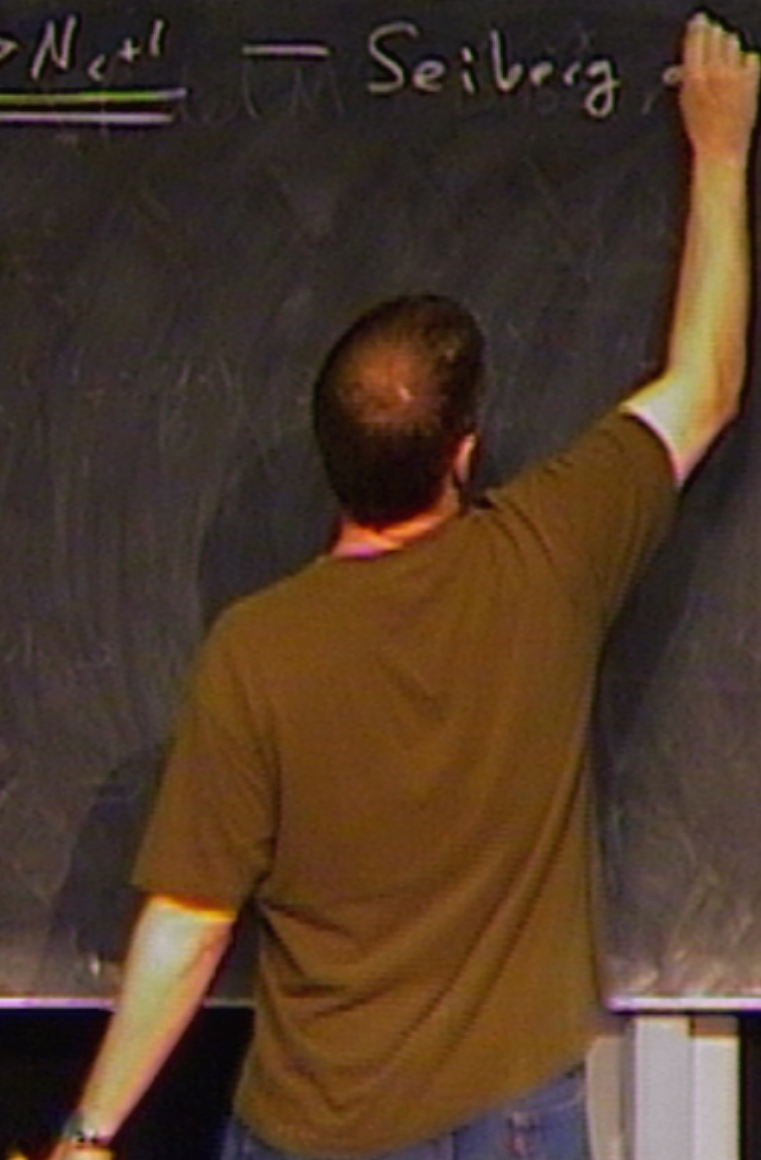
$$N_f = N_c + 1$$

$$N_4 = N_2$$

$$I_{CE} = 9\mu$$

directly vacua

N 5

A man with short dark hair, wearing a brown t-shirt, is seen from the back, standing in front of a large black chalkboard. He is reaching up with his right arm, holding a piece of chalk, to write on the board. The chalkboard is filled with faint, mostly illegible chalk markings, including some mathematical symbols and diagrams. The lighting is somewhat dim, typical of a lecture hall.
$$\underline{\underline{N_f > N_c + 1}} \quad \text{--- Seiberg}$$

$N_f > N_c + 1$ — Seiberg duality

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$N_f > N_c + 1$ — Seiberg duality



$N_f > N_c + 1$ — Seiberg duality

$N_f > N_c + 1$ — Seiberg duality

$N_f > N_c + 1$ — Seiberg duality

$N_f > N_c + 1$ — Seiberg duality

$N_f > N_c + 1$ — Seiberg duality

Seiberg duality (9411149)

$N_f > N_c + 1$ — Seiberg duality

Proposal:

$$SU(\tilde{N}_c) \quad \tilde{N}_c = N_f - 1$$

$$SU(\tilde{N}_c) \quad \tilde{N}_c = N_f - N_c$$

$$SU(\tilde{N}_c) \quad \tilde{N}_c = N_f - N_c$$

$$SU(\tilde{N}_c)$$

$$\tilde{N}_c = N_f - N_c$$

$$N_f$$

$$\tilde{q}^i$$

fund

$$N_f^2$$

Seiberg duality (11111)

$$SU(\tilde{N}_c)$$

$$\tilde{N}_c = N_f - N_c$$

$$N_f$$

$$q_i, \tilde{q}^i$$

fund

$$N_f^2$$

$$n_i^j$$

singlets

Seiberg duality

proposal:

$$SU(\tilde{N}_c)$$

$$\tilde{N}_c = N_f - N_c$$

$$N_f$$

$$q_i$$

$$\tilde{q}^i$$

fund

$$N_f^2$$

$$n_i^j$$

singlets

$$+ \mathcal{W} = n_i^j q_i^a \tilde{q}_a^j$$

① Global system same

② 't Hoofst matching ✓

① Global system same

② 't Hoofst matching ✓

Global system same

't Hoof $\perp$ matching $\checkmark$

① Global system same

② 't Hoof + matching

① Global Symm same

② 't Hooft matching

③ $N_f < \frac{3}{2} N_c \Rightarrow N_f > \frac{3}{2} N_c$

① Global sym same

② 't Hooft matching ✓

③ $N_f < \frac{3}{2} N_c \Rightarrow N_c > 3 \tilde{N}_c$
 $\Rightarrow$ dual R

① Global sym same

② 't Hooft matching ✓

$$\textcircled{3} \quad N_f < \frac{3}{2} N_c \Rightarrow N_f > 3 \tilde{N}_c$$

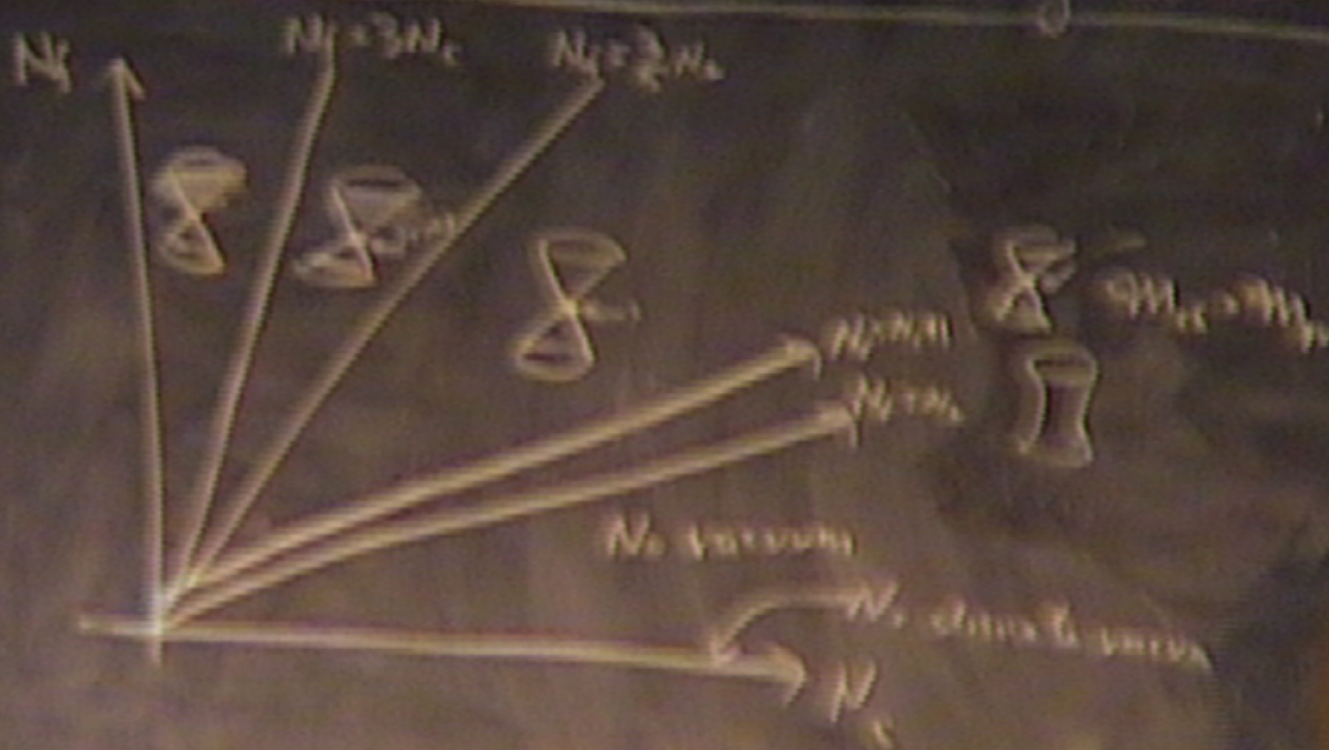
$\Rightarrow$ dual IRF

① Global sym same

② 't Hooft matching ✓

③ $N_f < \frac{3}{2} N_c \Rightarrow N_f > 3\tilde{N}_c$
 $\Rightarrow$ dual is IRF ✓

II. $N=1$ SQCD - Seiberg duality



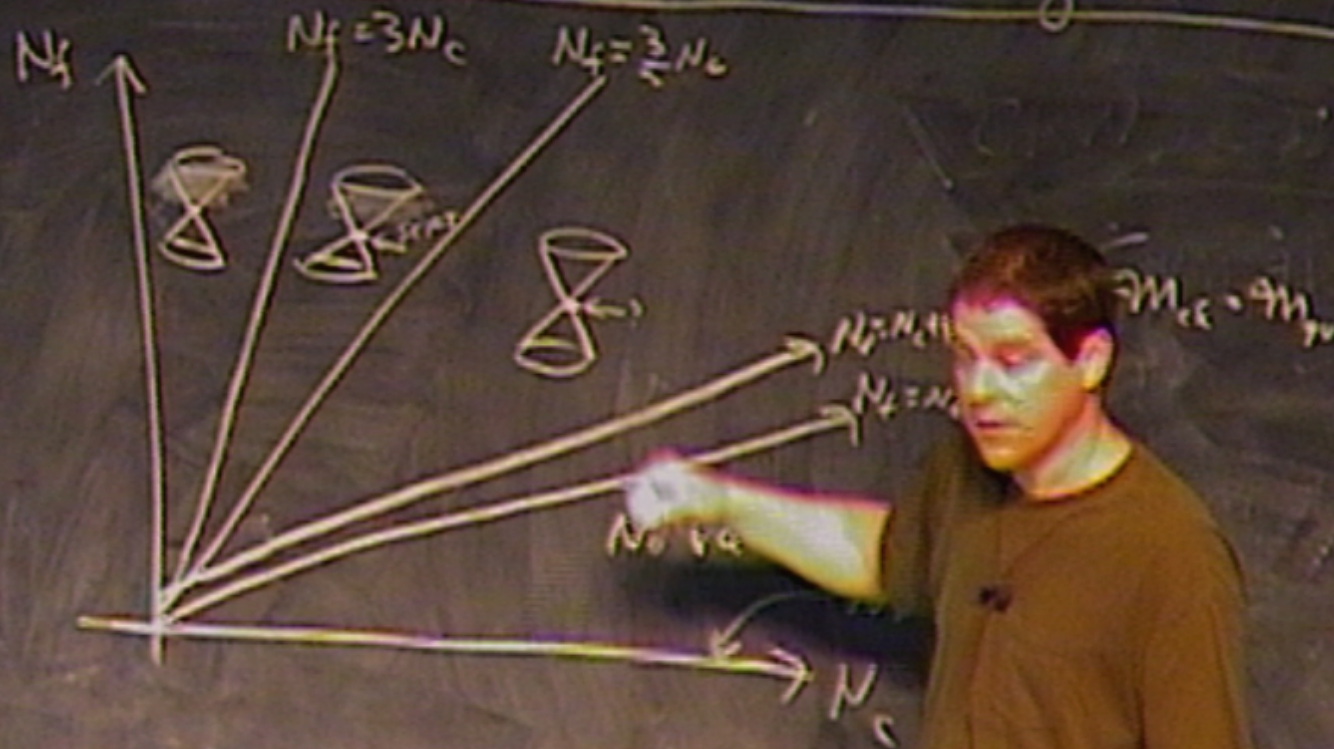
① Global sym same

② 't Hooft matching ✓

③ $N_f < \frac{3}{2} N_c \Rightarrow N_f > 3\tilde{N}_c$
 $\Rightarrow$ dual is IRF ✓

④ Moduli spaces are the same

II. $N=1$ SQCD - Seiberg duality



① Global symm same

② 't Hooft matching ✓

③ $N_f < \frac{3}{2} N_c \Rightarrow N_f > 3 \tilde{N}_c$

$\Rightarrow$ dual is IRF ✓

④ Moduli space are the same ✓

⑤ Mass d

① Global symm same

② 't Hooft matching ✓

③ $N_f < \frac{3}{2} N_c \Rightarrow N_f > 3\tilde{N}_c$

$\Rightarrow$ dual RF ✓

④ Modul. spaces the same ✓

⑤ Mass deform

① Global symm same

② 't Hooft matching ✓

③ $N_f < \frac{3}{2} N_c \Rightarrow N_c > 3\tilde{N}_c$
 $\Rightarrow$ dual RF ✓

④ Modul. spaces the same ✓

⑤ Mass deform

① Global symm same

② 't Hooft matching ✓

③ $N_f < \frac{3}{2} N_c \Rightarrow N_f > 3\tilde{N}_c$
 $\Rightarrow$ dual is IRF ✓

④ Modul. spaces are the same ✓

⑤ Mass deformations

① Global symm same

② 't Hooft matching ✓

③ $N_f < \frac{3}{2} N_c \Rightarrow N_f > 3\tilde{N}_c$
 $\Rightarrow$ dual is IRF ✓

④ Modul. spaces are the same ✓

⑤ Mass deformations

① Global symm same

② 't Hooft matching ✓

③ $N_f < \frac{3}{2} N_c \Rightarrow N_f > 3\tilde{N}_c$
 $\Rightarrow$ dual is IRF ✓

④ Modul. spaces are the same ✓

⑤ Mass deformations

→ $b = B^*$

① Global symm same

② 't Hooft matching ✓

③ $N_f < \frac{3}{2} N_c \Rightarrow N_f > 3 \tilde{N}_c$

$\Rightarrow$ is IRF ✓

④ Modul. are the same ✓

⑤ Mass defo.

$b = R^*$

① Global symm same

② 't Hooft matching ✓

③ $N_f < \frac{3}{2} N_c \Rightarrow N_f > 3 \tilde{N}_c$
 $\Rightarrow$ dual IRF ✓

④ Modul. spaces the same ✓

⑤ Mass deformation

→ $b = B^*$ $\uparrow \sim$

① Global symm same

② 't Hooft matching ✓

③ $N_f < \frac{3}{2} N_c \Rightarrow N_f > 3\tilde{N}_c$
 $\Rightarrow$ dual is IRF ✓

④ Modul. spaces are the same ✓

⑤ Mass deformations

$b = B^* \quad \tilde{b} = \tilde{B}^* \quad n = M$

① Global symm same

② 't Hooft matching ✓

③ $N_f < \frac{3}{2} N_c \Rightarrow N_f > 3\tilde{N}_c$
 $\Rightarrow$ dual is IRF ✓

④ Modul. spaces are the same ✓

⑤ Mass deformations

$b = B^* \quad \tilde{b} = \tilde{B}^* \quad n = M$

① Global symm same

② 't Hooft matching ✓

reg
(")

$$\textcircled{3} \quad N_f < \frac{3}{2} N_c \Rightarrow N_f > 3 \tilde{N}_c$$
$$\Rightarrow \text{dual is IRF} \quad \checkmark$$

④ Modul. spaces are the same ✓

⑤ Mass deformations

→

$$b = B^* \quad \tilde{b} = \tilde{B}^* \quad n = M$$

① Global symm same

② 't Hooft matching ✓

③ $N_f < \frac{3}{2} N_c \Rightarrow N_f > 3\tilde{N}_c$
 $\Rightarrow$ dual is IRF ✓

④ Modul. spaces are the same ✓

⑤ Mass deformations

$b = B^* \quad \tilde{b} = \tilde{B}^* \quad n = M$

① Global symm same

② 't Hooft matching ✓

$$\textcircled{3} \quad N_f < \frac{3}{2} N_c \Rightarrow N_f > 3\tilde{N}_c^M \\ \Rightarrow \text{dual is IRF} \quad \checkmark$$

④ Modul. spaces are the same ✓

⑤ Mass deformations

$$\rightarrow b = B^* \quad \tilde{b} = \tilde{B}^* \quad n = M \quad m =$$

$$SU(N_c) \quad N_c = N_f - N_c \quad \text{Dirac}$$

$$q_i, \tilde{q}^i \quad \text{fund}$$

$$n_i^j \quad \text{singlets}$$

$$= n_i^j q_a^i \tilde{q}^j_a$$

$$i, j, a$$

$$\partial_n W = 0$$

$$SU(N_c)$$

$$N_c = N_f - N_c$$

Deriv

d.

$$q_i, \tilde{q}^i$$

fund

$$n_i^j$$

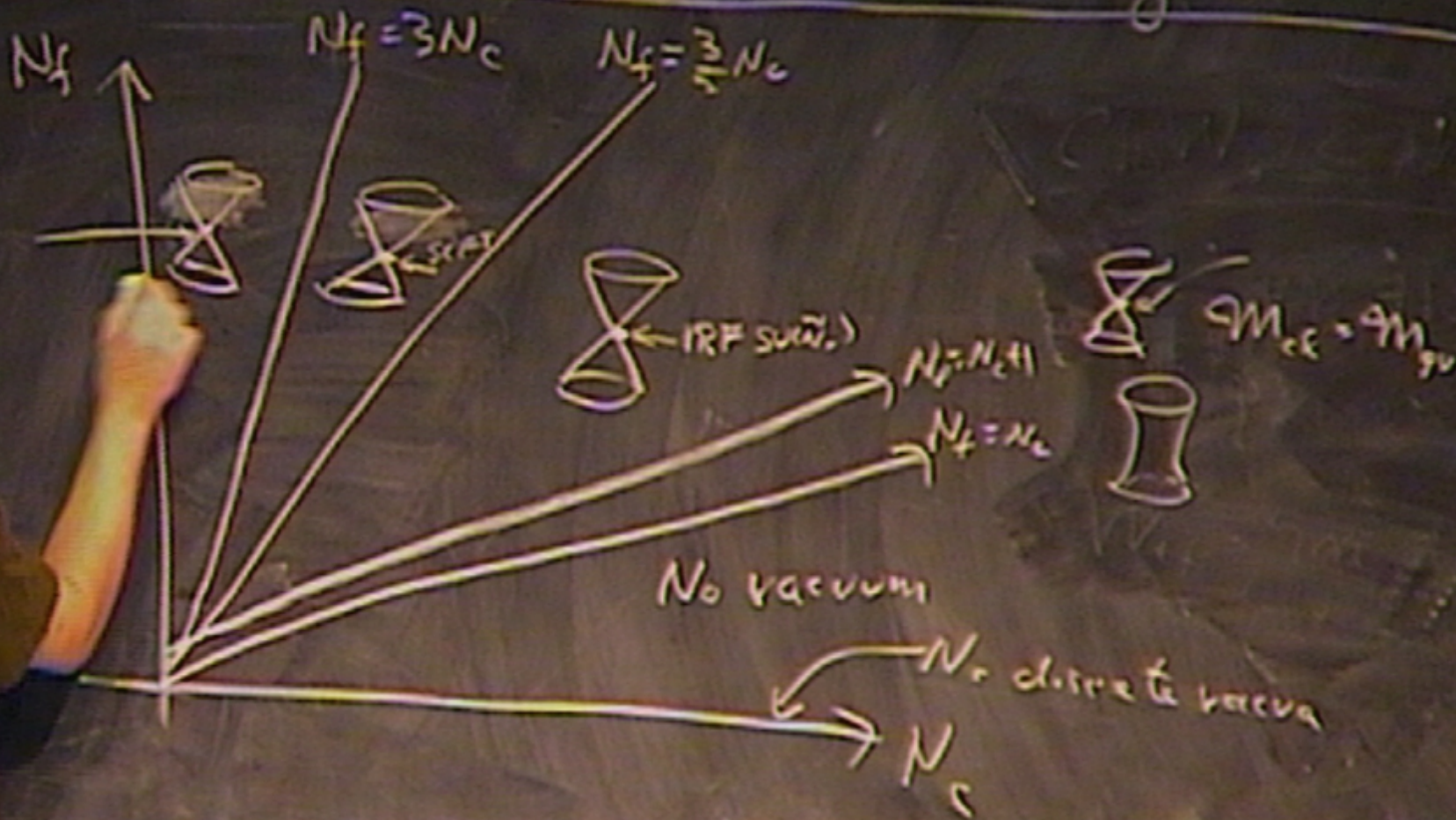
singlets

$$= n_i^j q_i^a \tilde{q}_a^i$$

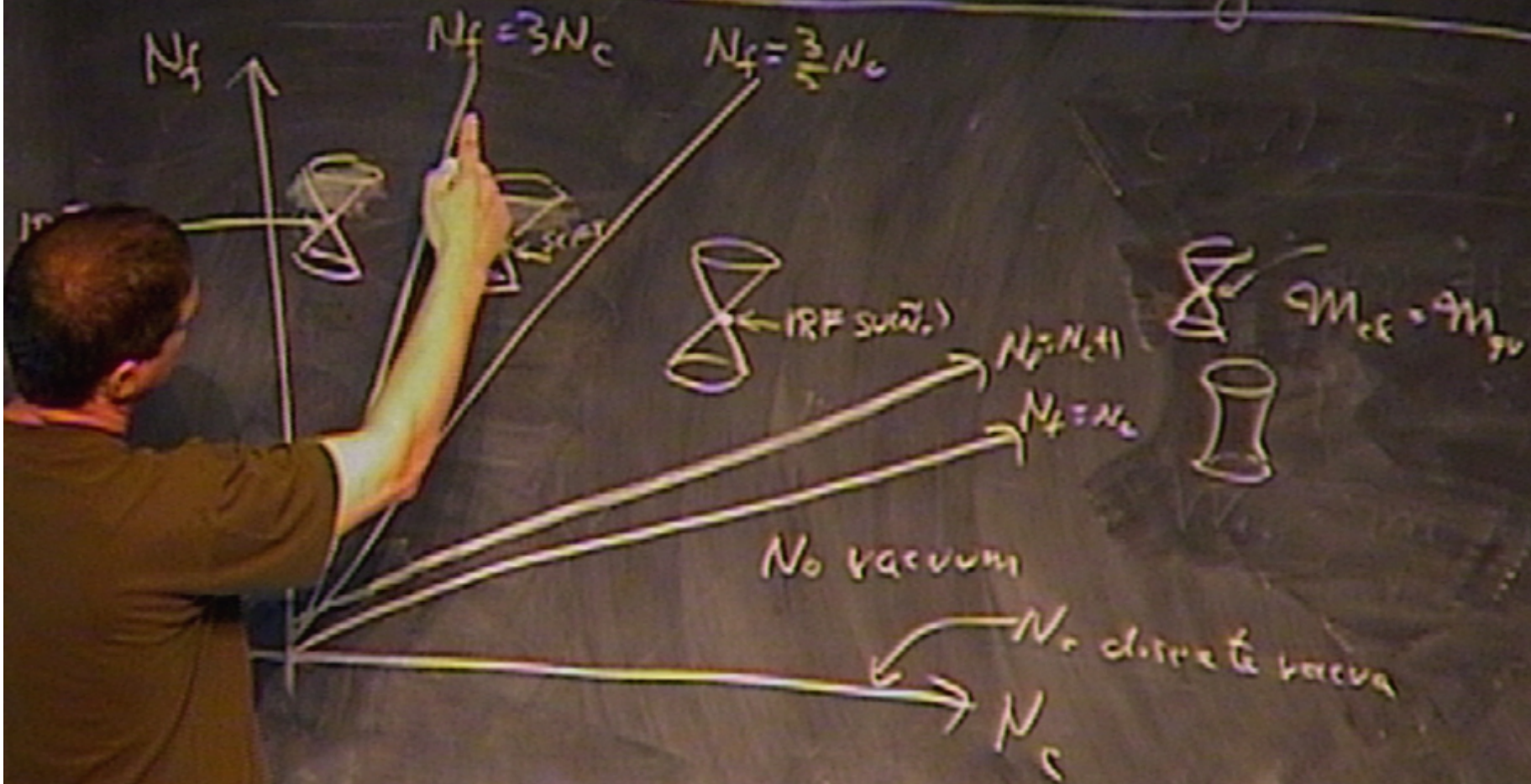
$$= n_i^j m_j^i$$

$$\partial_n W = 0 \neq m$$

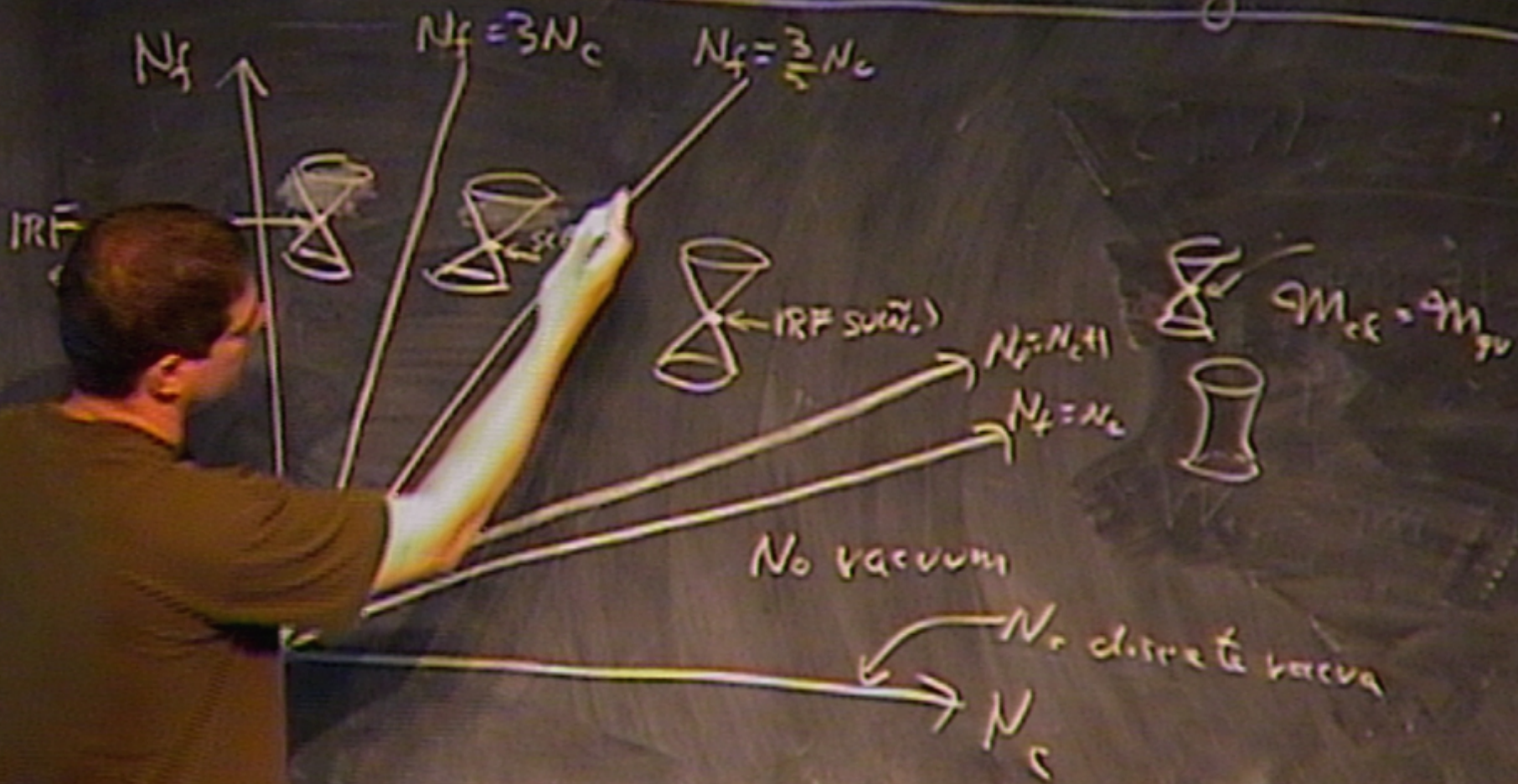
II. $N=1$ SQCD - Seiberg duality



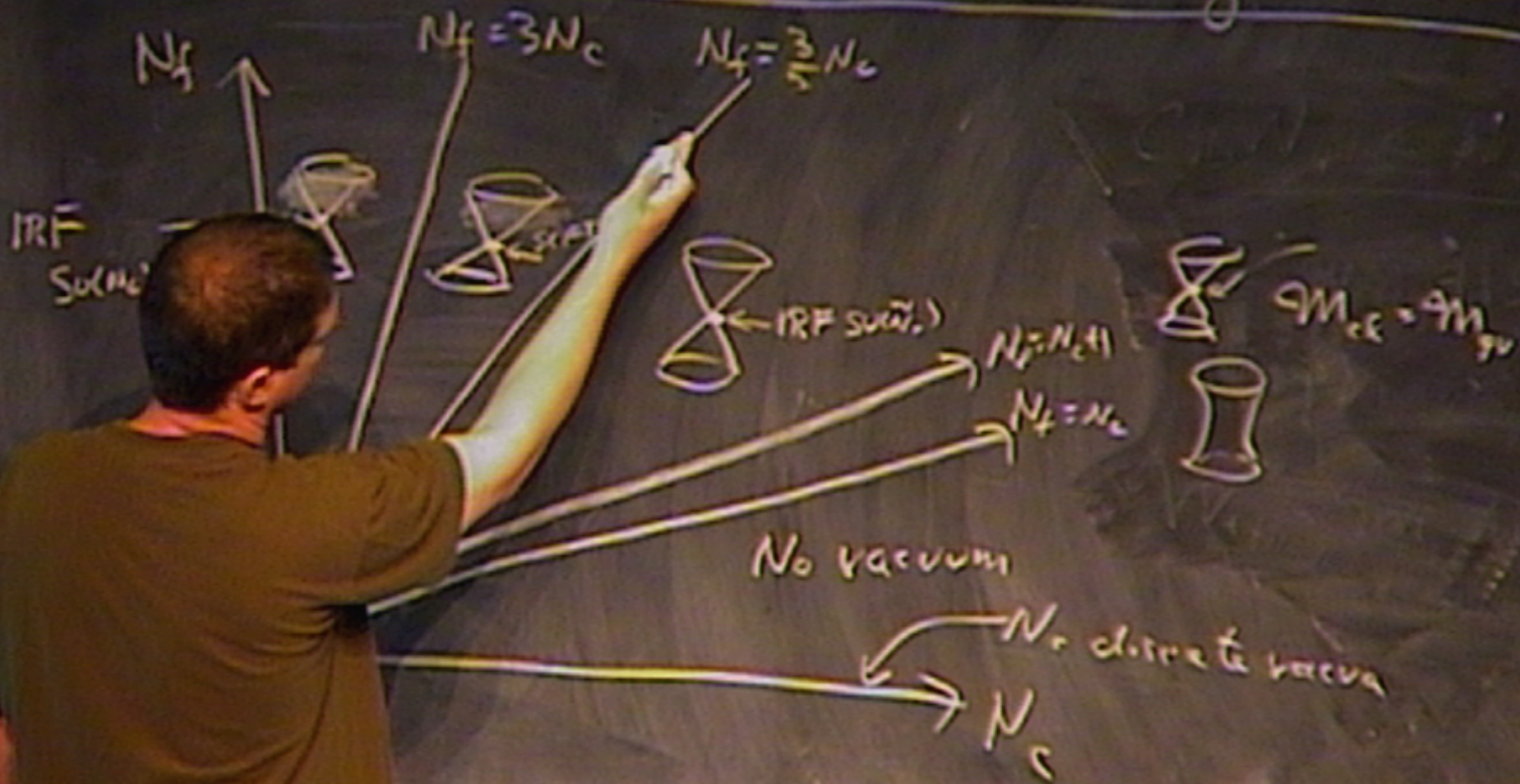
II. $N \geq 1$ SQCD - Seiberg duality



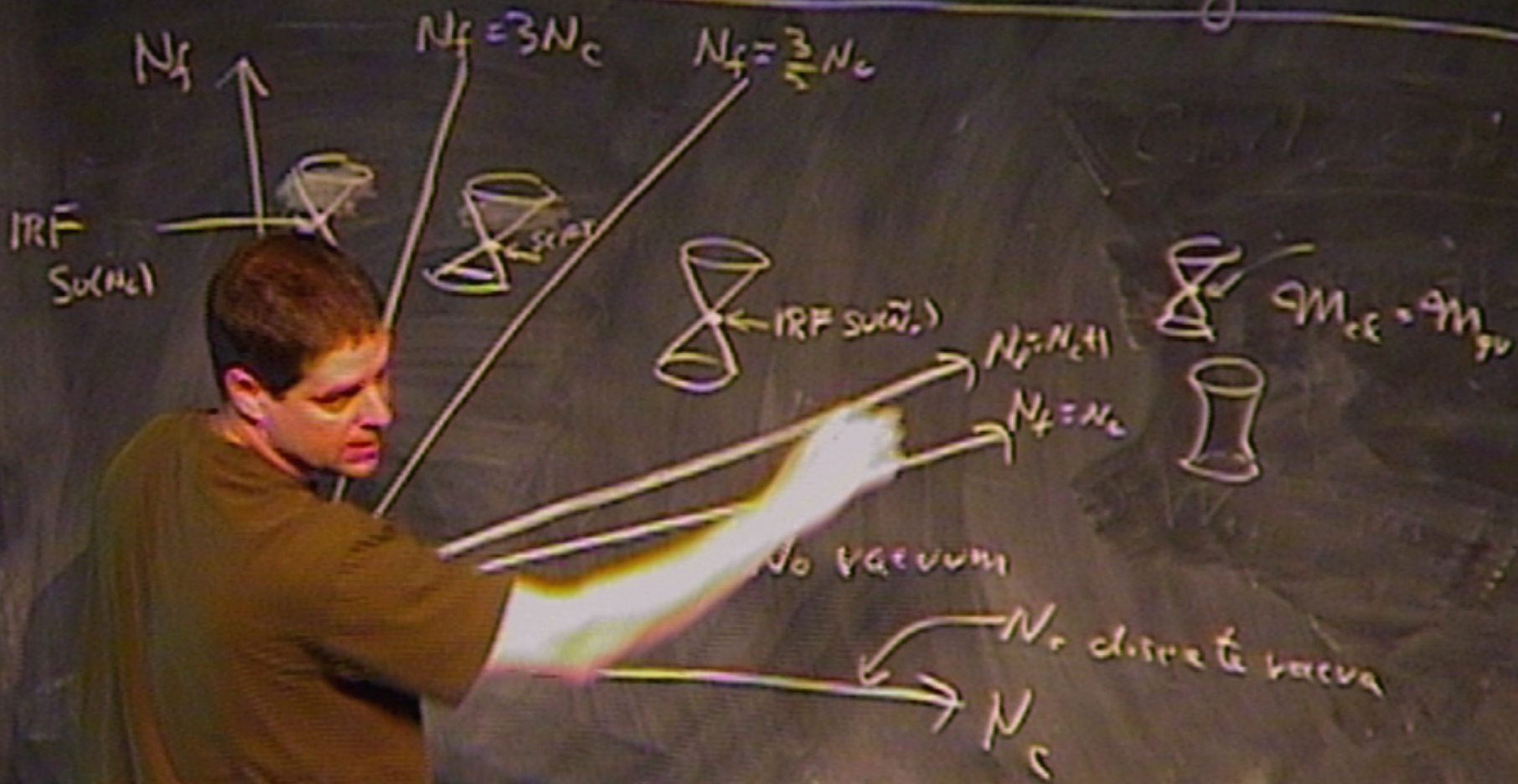
II. $N=1$ SQCD - Seiberg duality



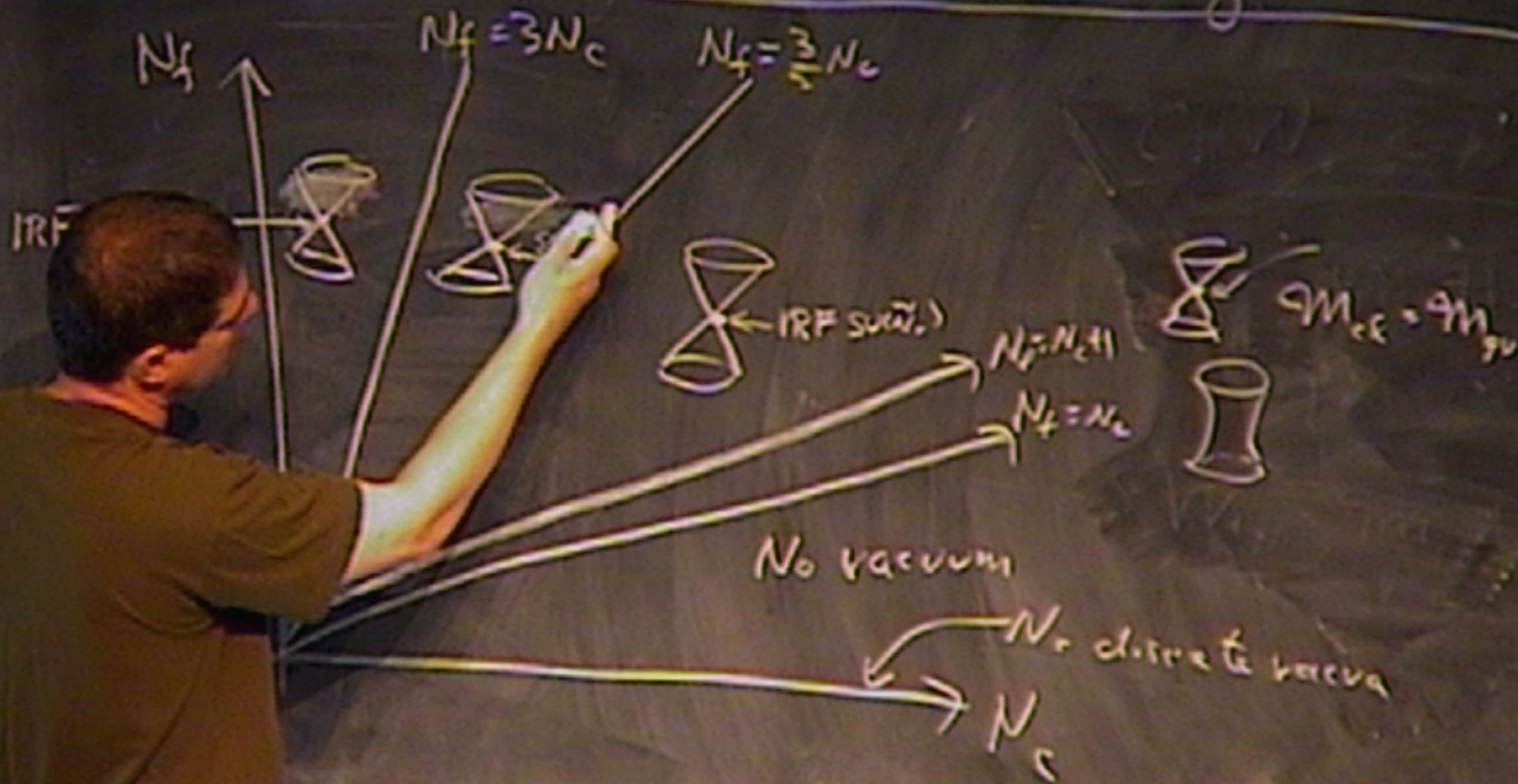
II. $N=1$ SQCD - Seiberg duality



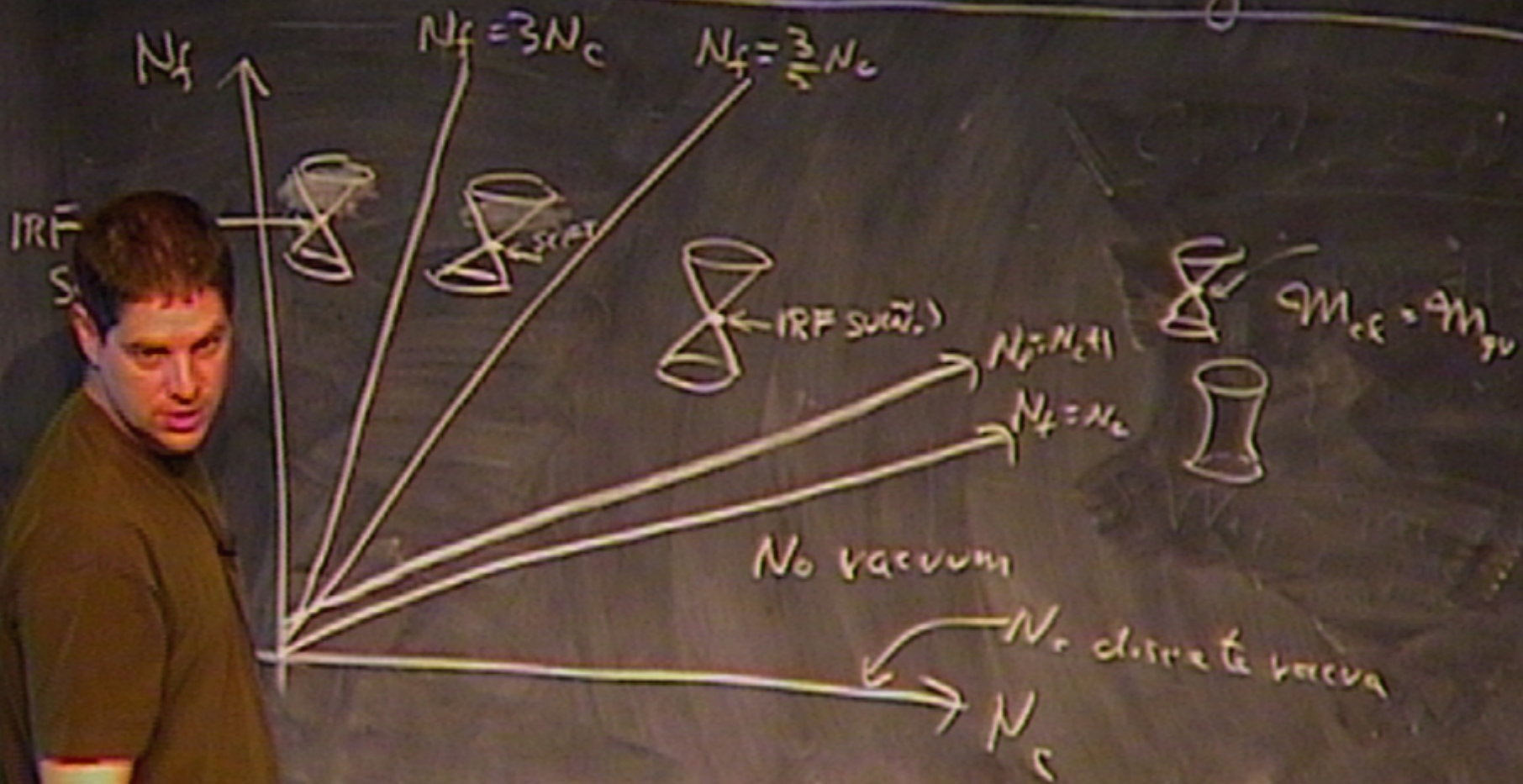
II. $N=1$ SQCD - Seiberg duality



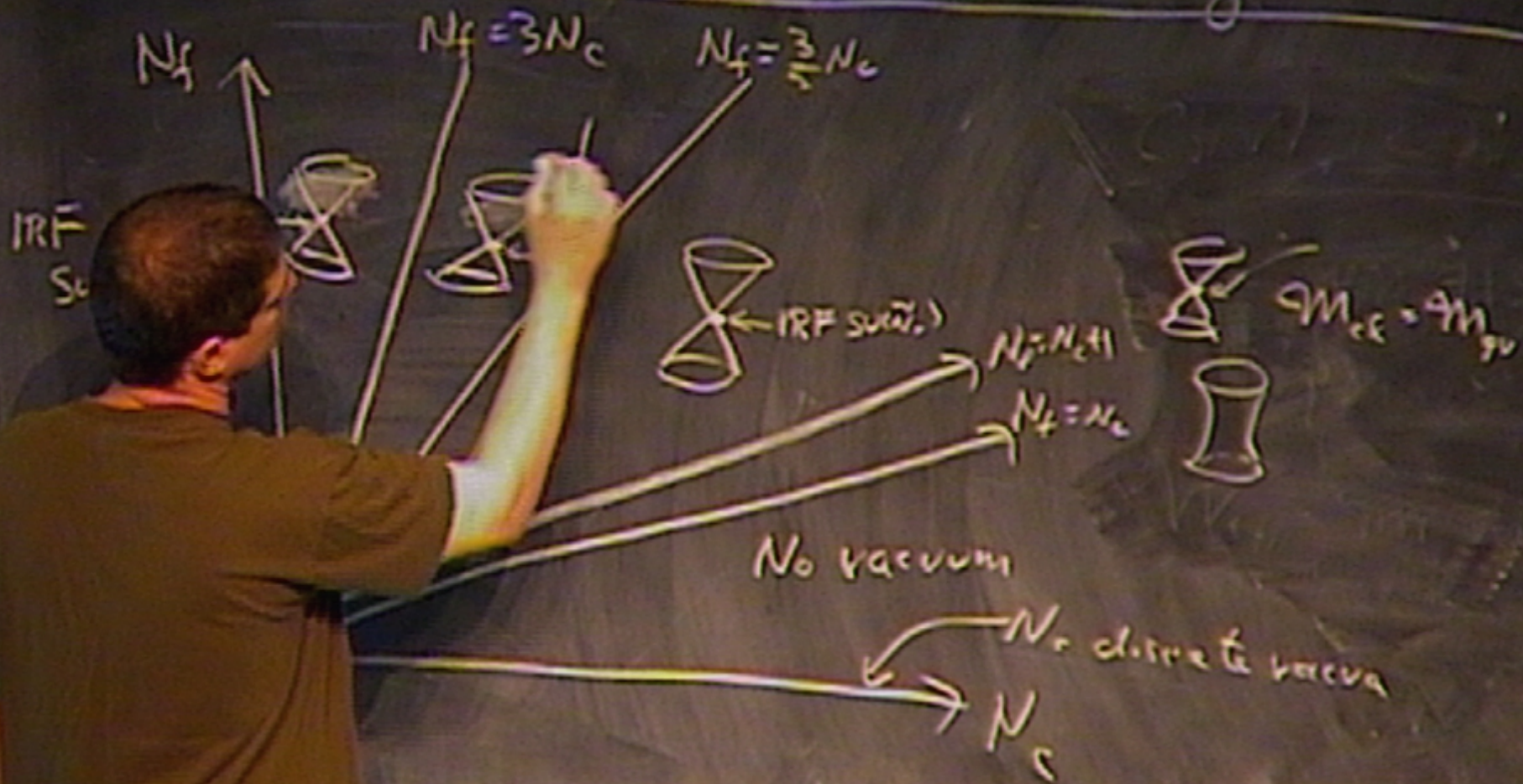
II. $N=1$ SQCD - Seiberg duality



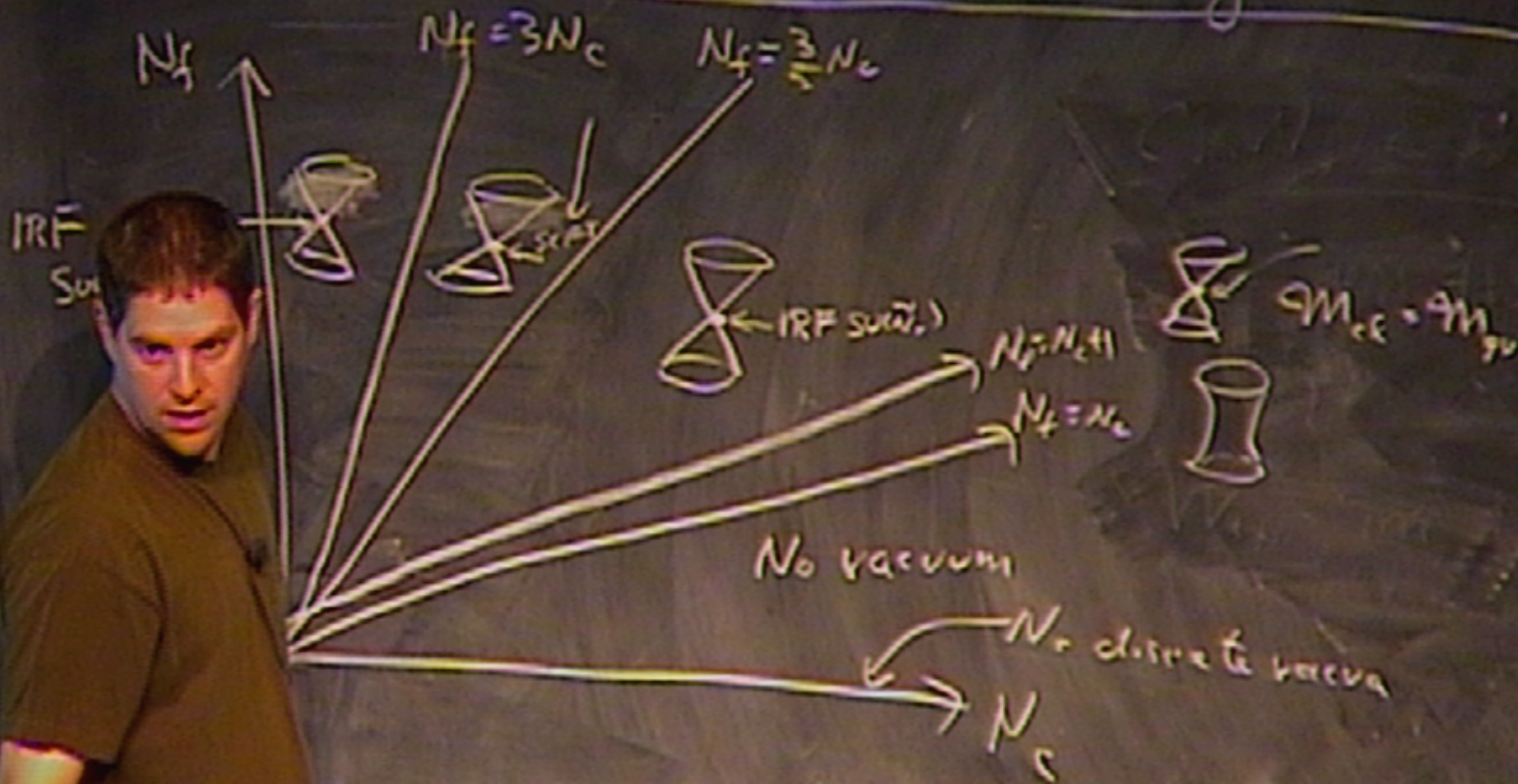
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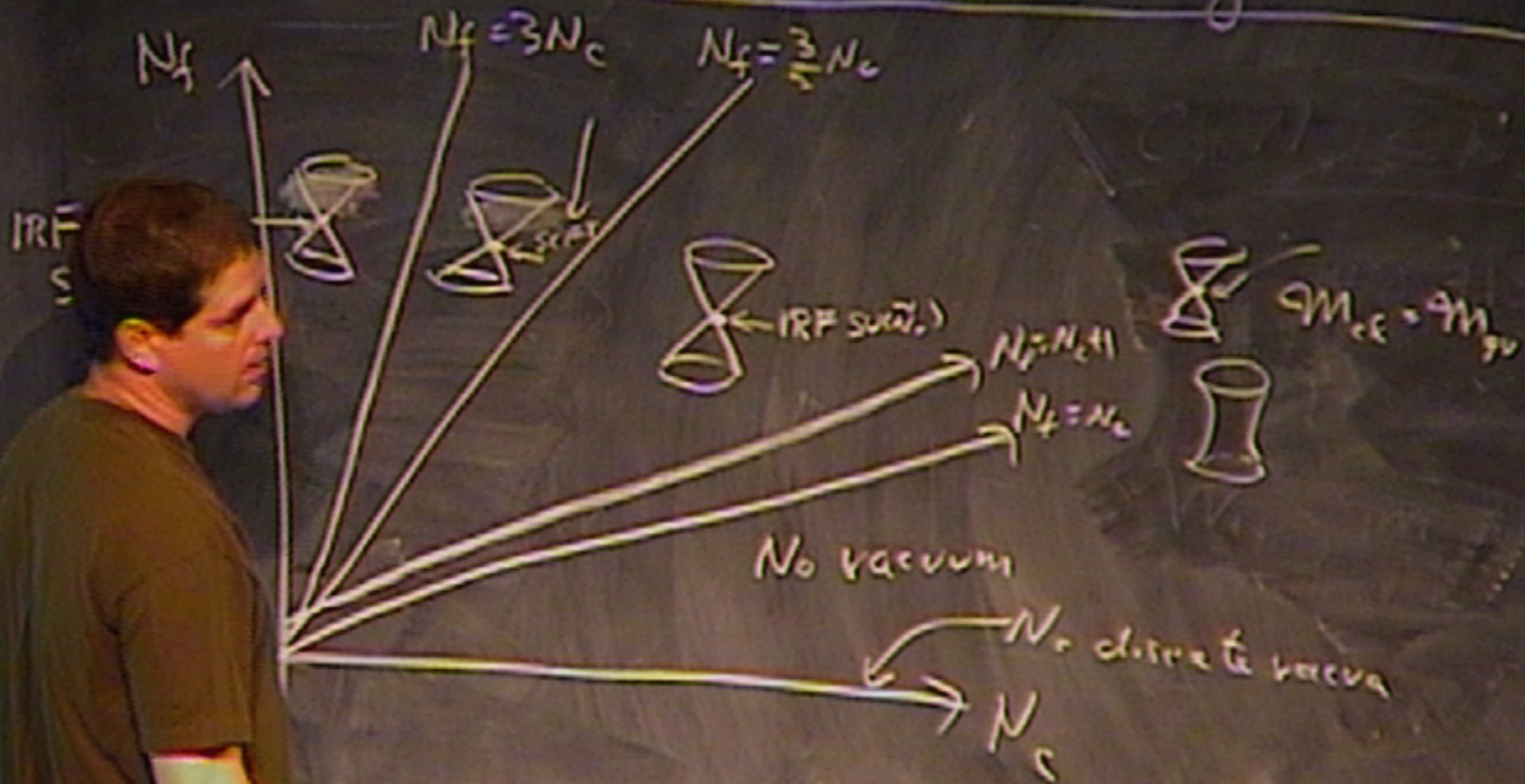
II. $N=1$ SQCD - Seiberg duality



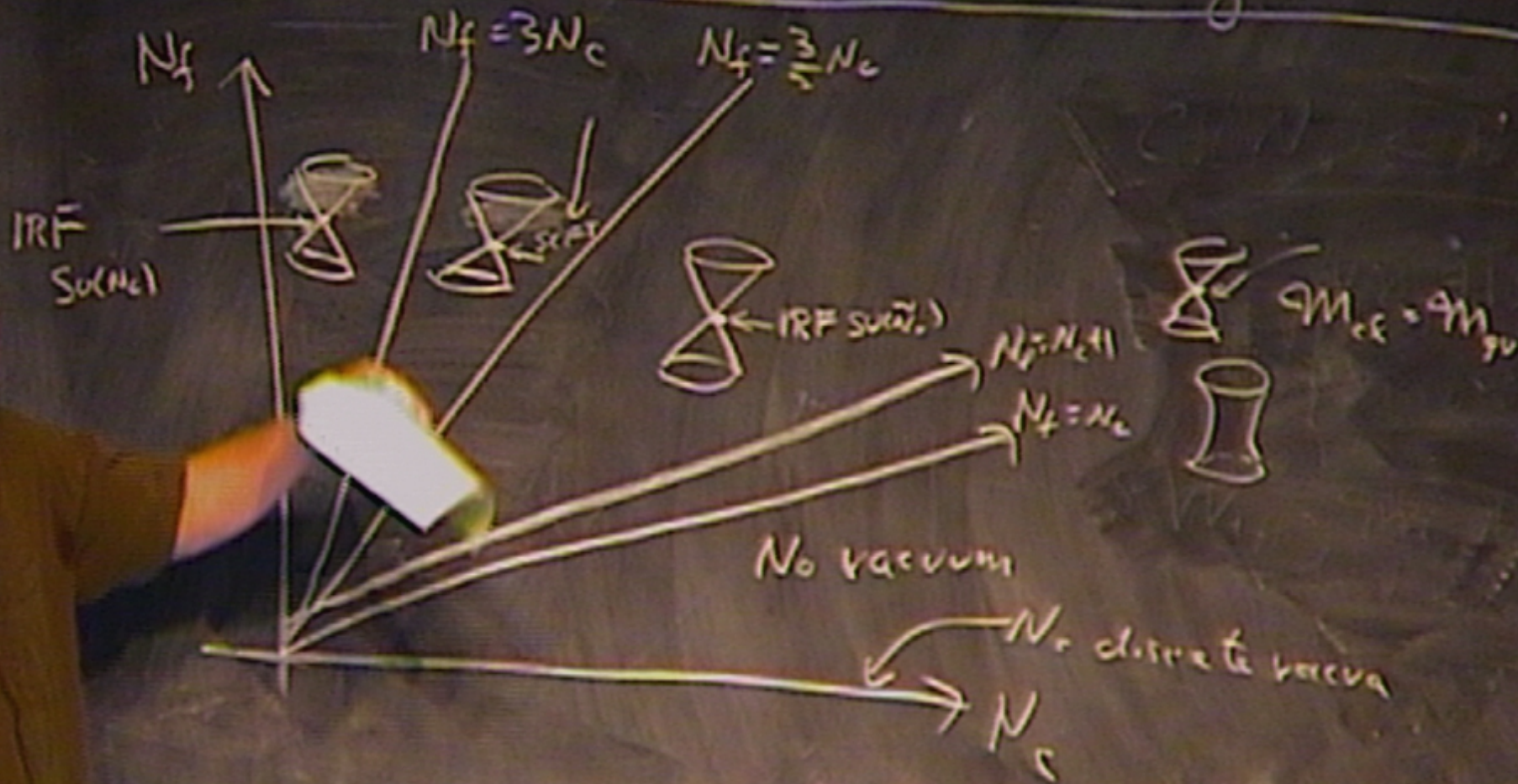
II. $N=1$ SQCD - Seiberg duality



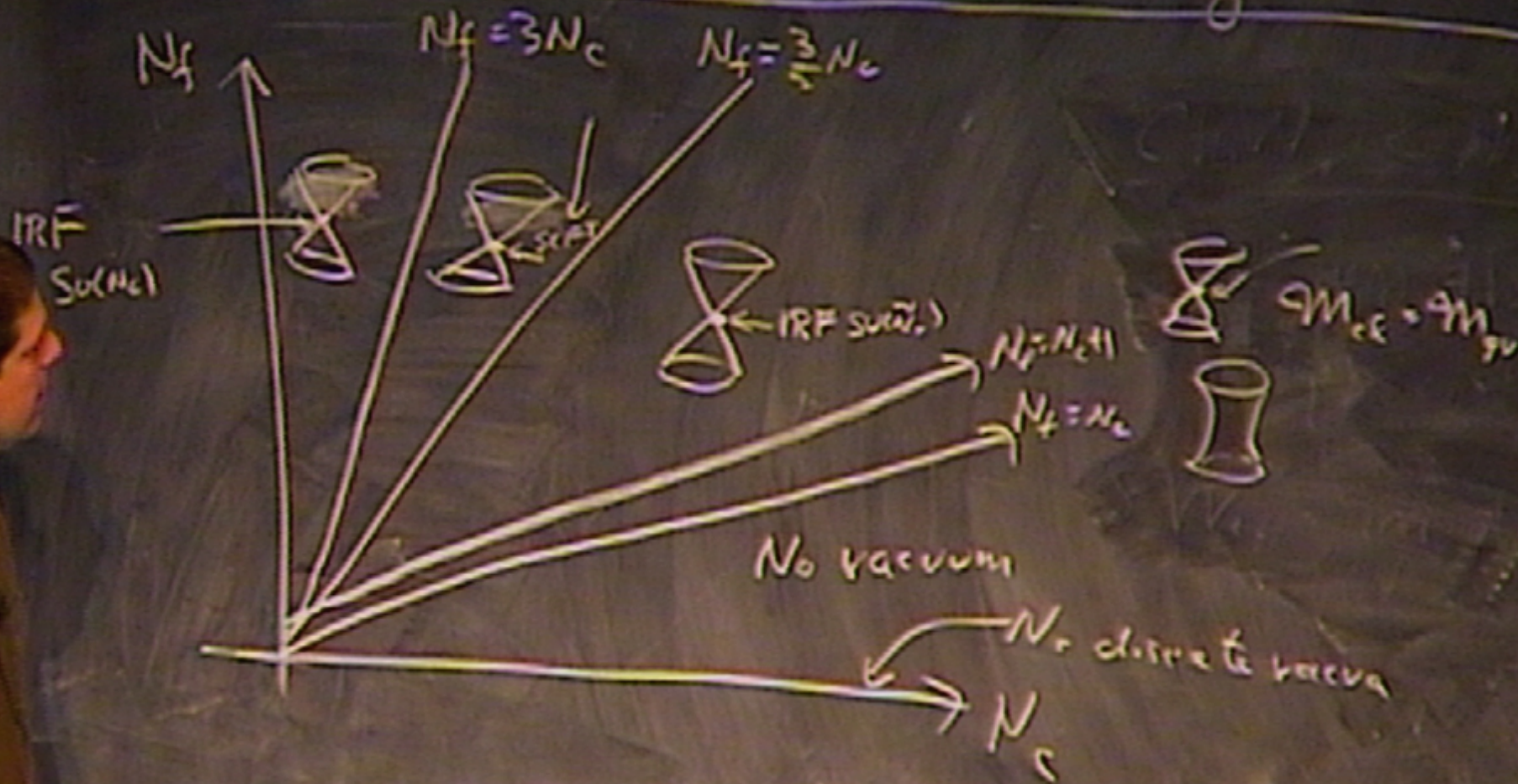
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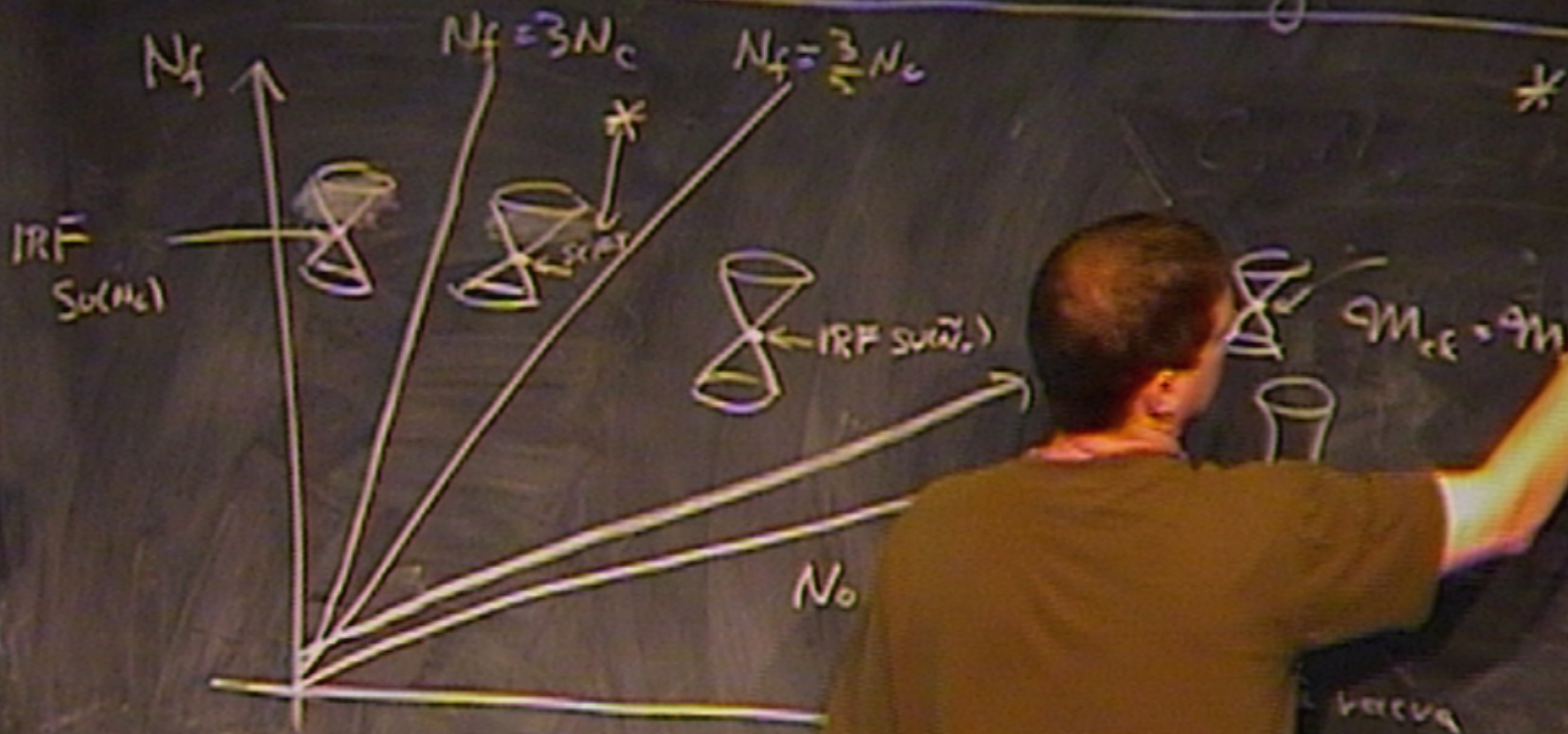
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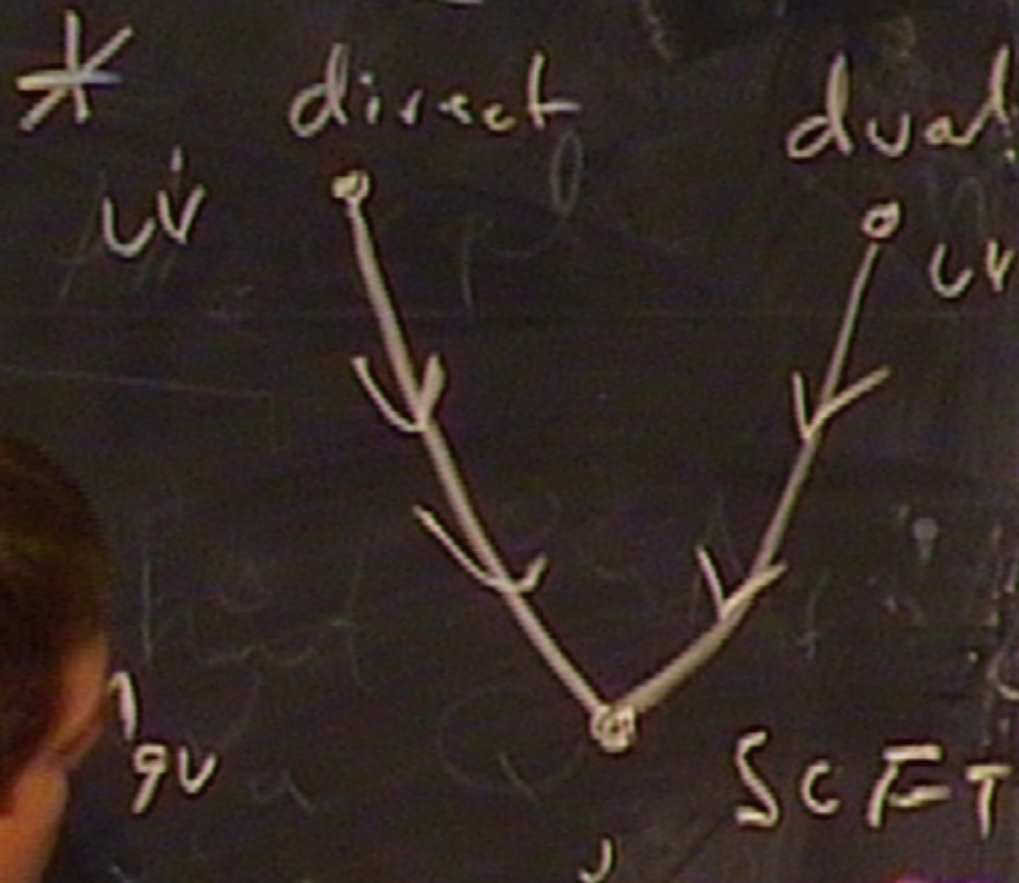


II. $N=1$ SQCD - Seiberg duality

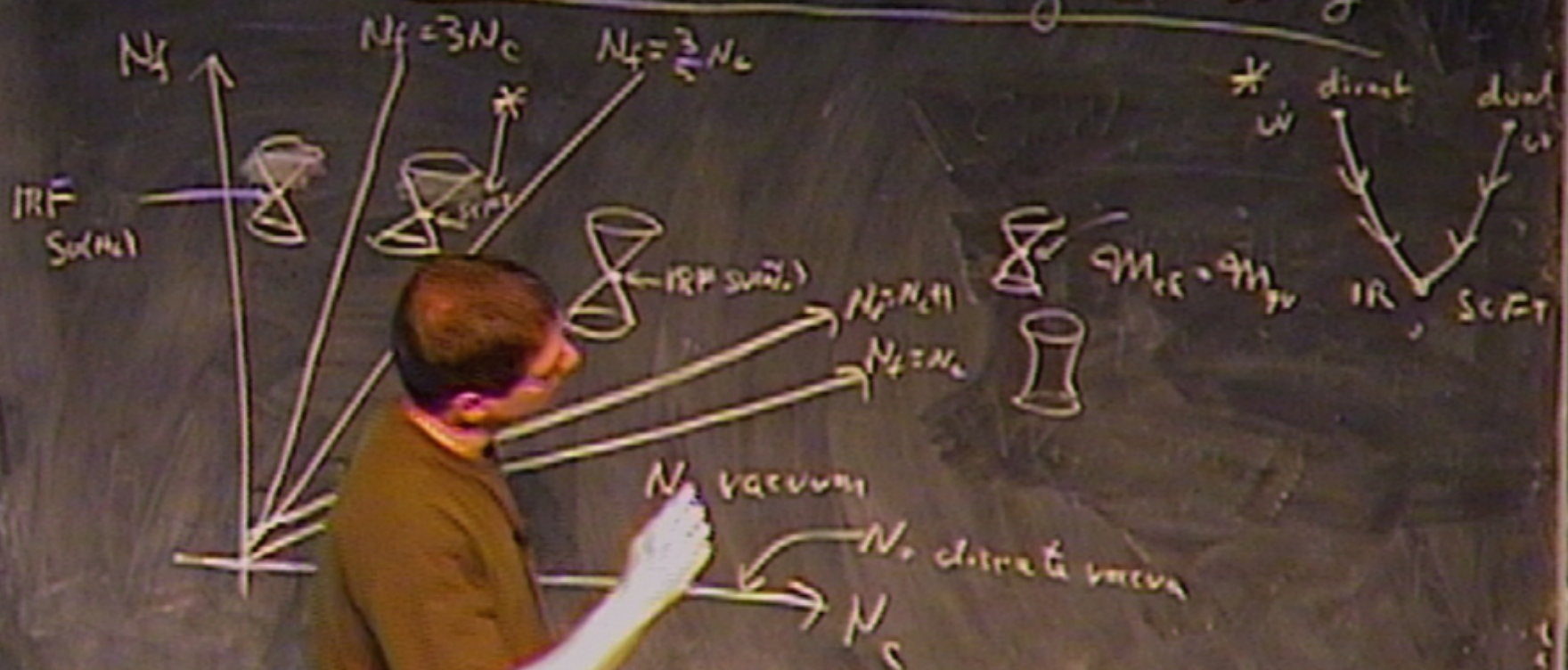


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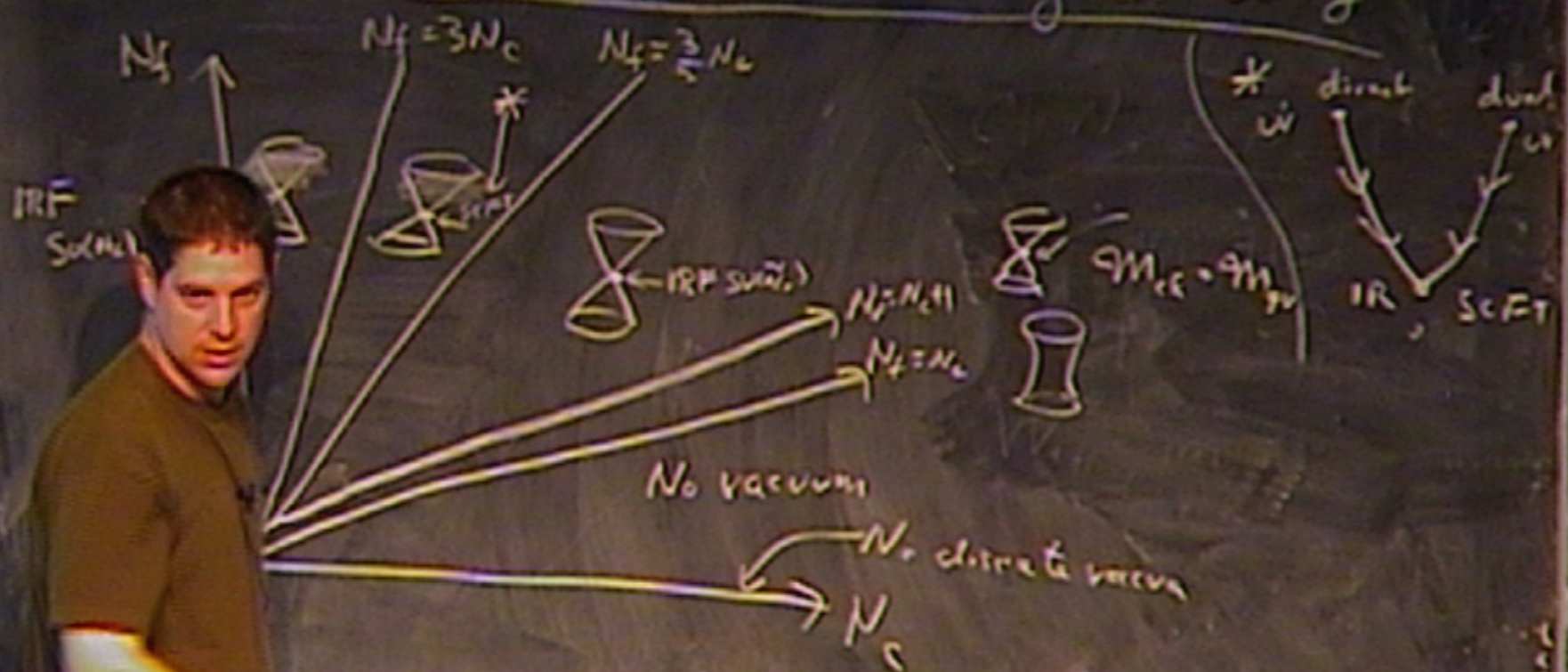




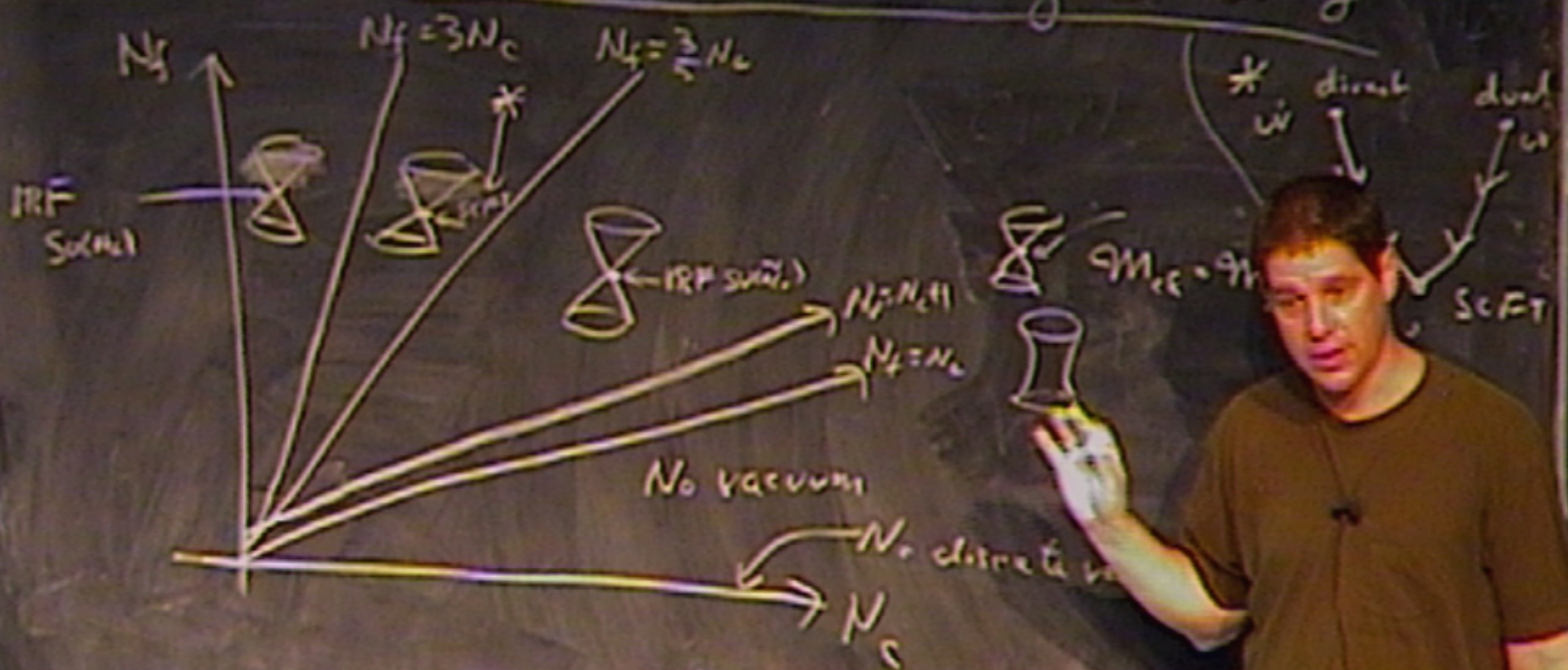
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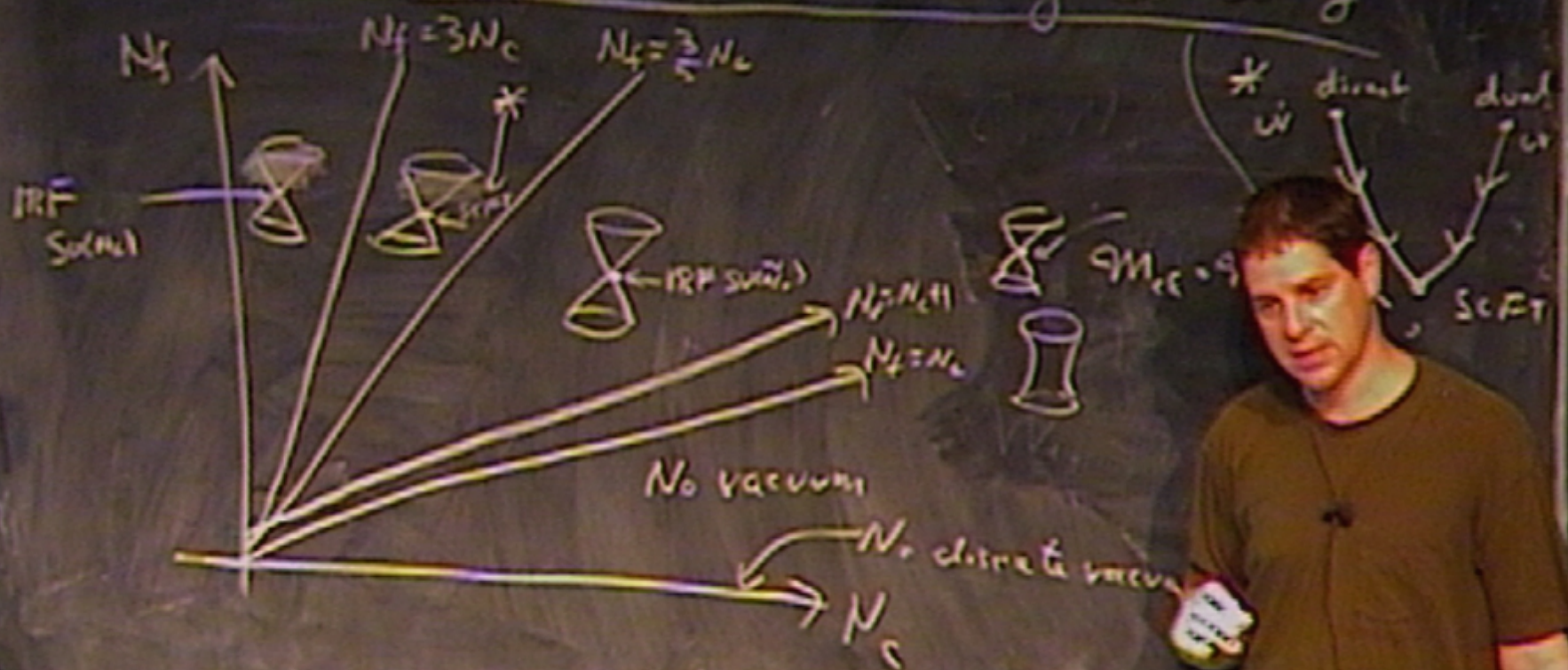
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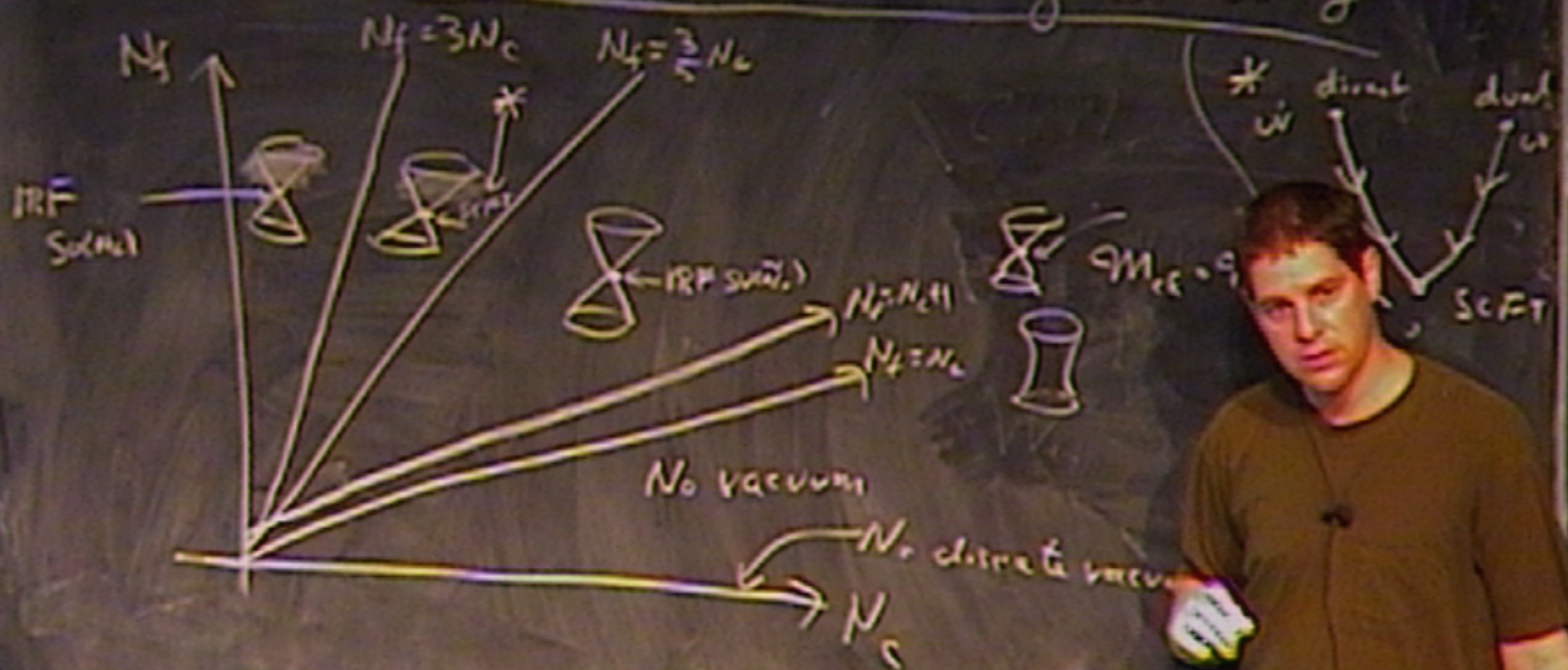
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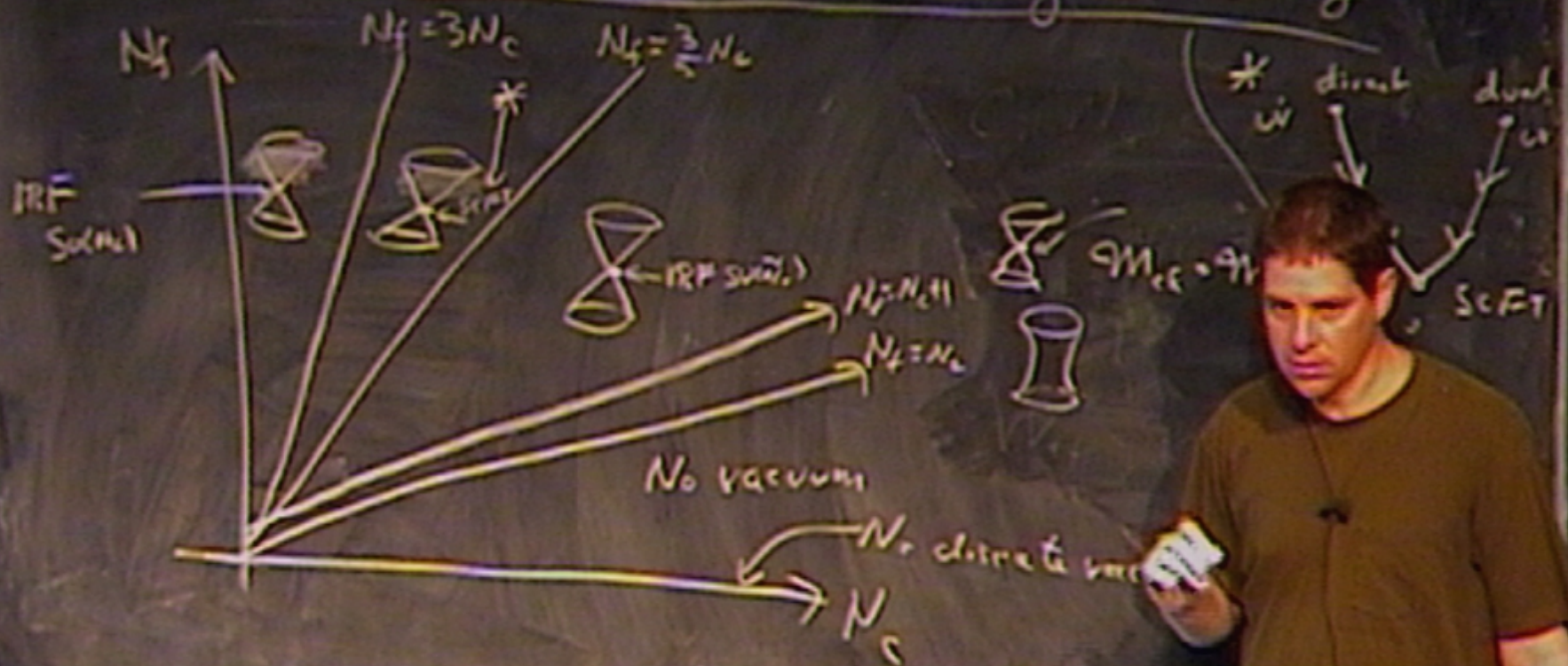
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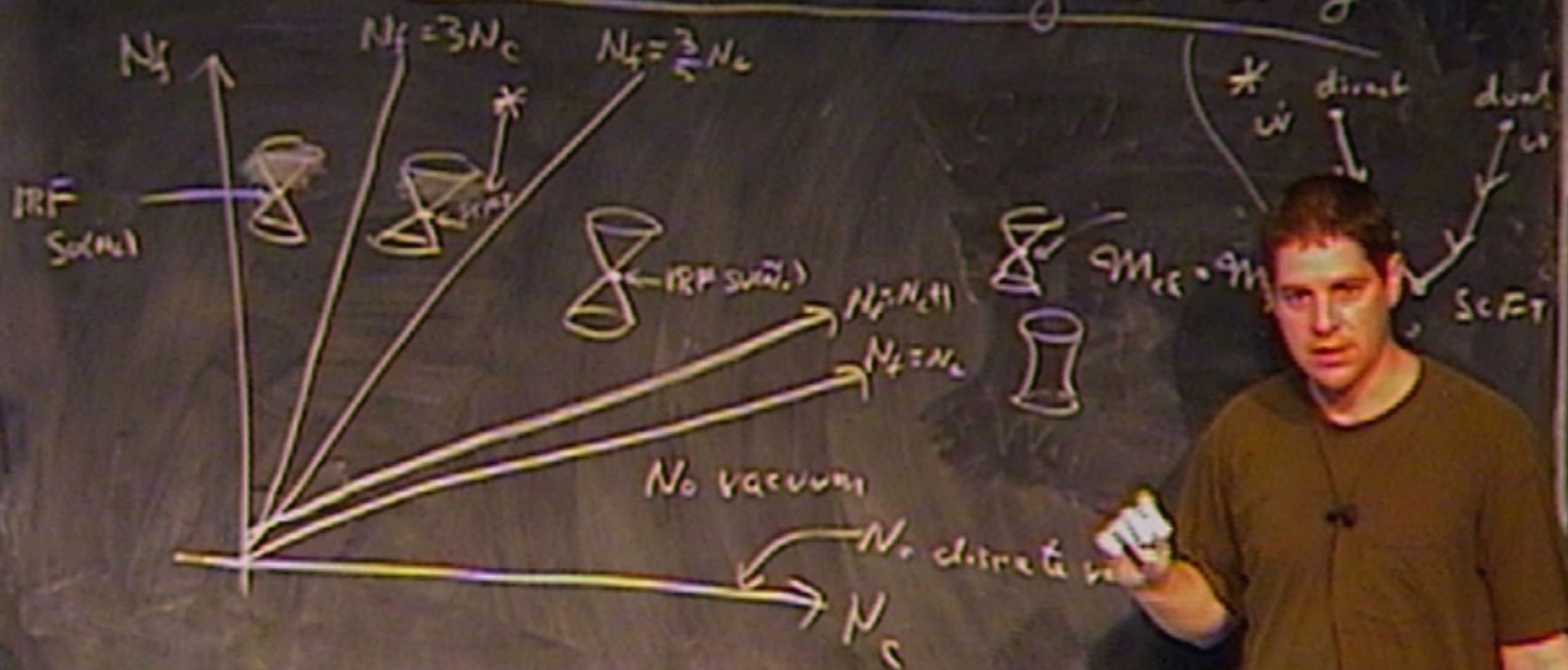
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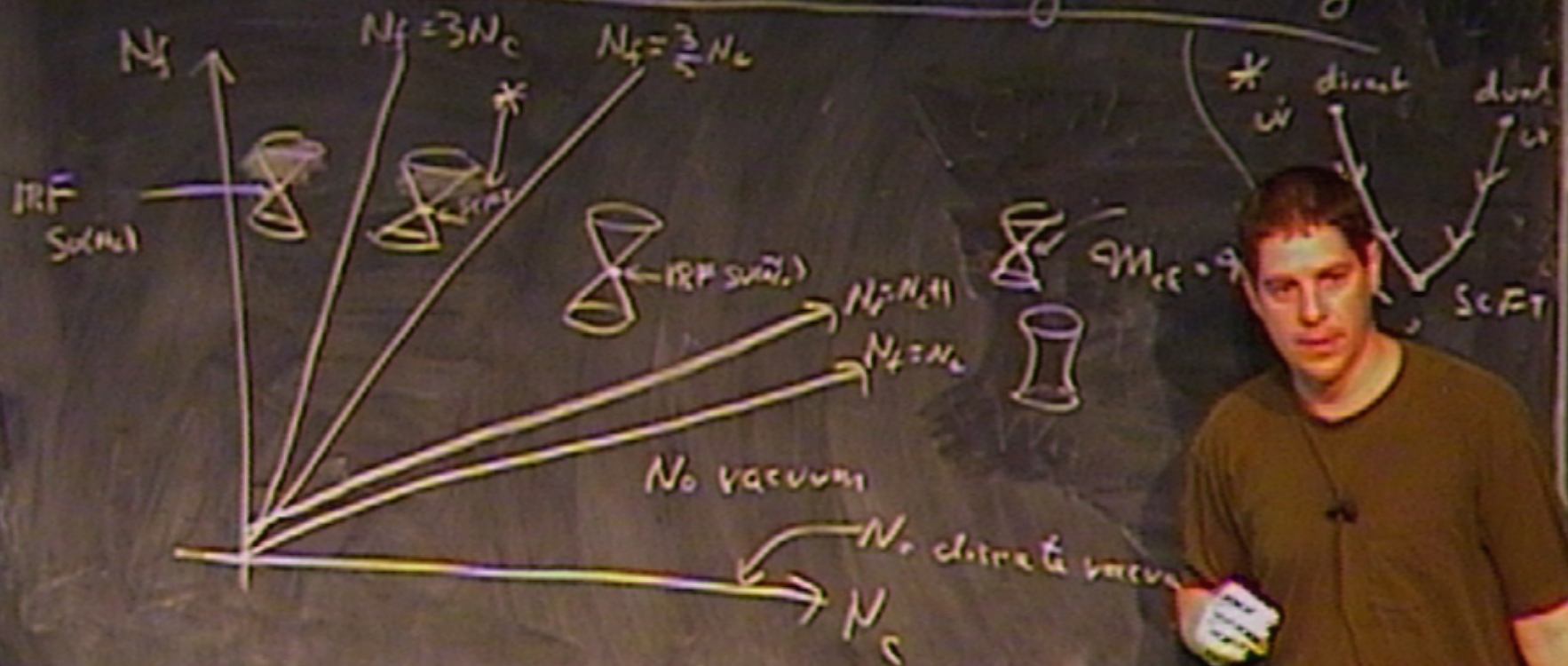
II. $N=1$ SQCD - Seiberg duality



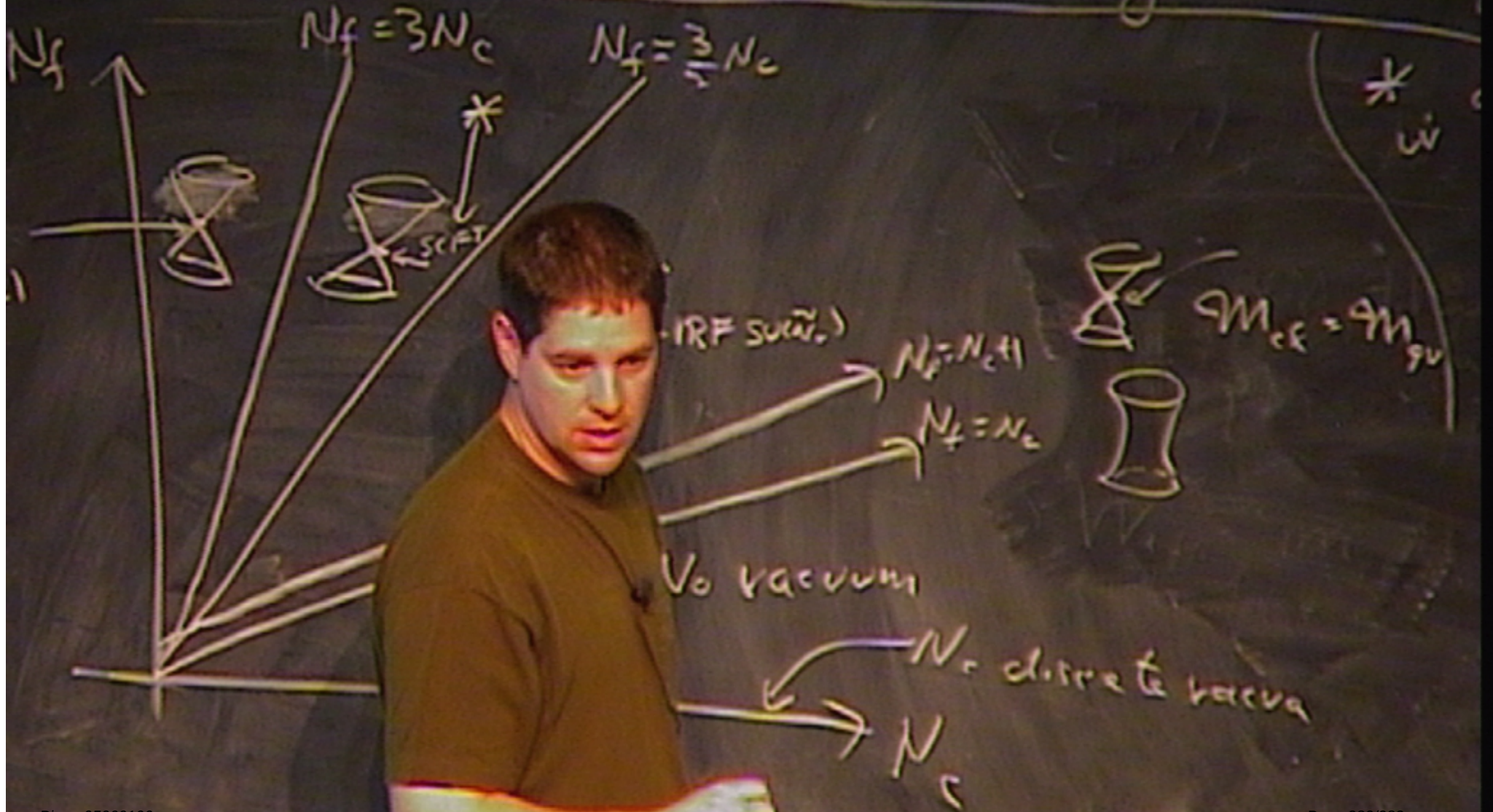
II. $N=1$ SQCD - Seiberg duality



II. $N=1$ SQCD - Seiberg duality



I. $N=1$ SQCD - Seiberg duality





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