

Title: Non AdS/nonCFT correspondence

Date: Jul 04, 2005 09:30 AM

URL: <http://pirsa.org/05070067>

Abstract:

The non-AdS/non-CFT correspondence

- 1) Introduction
- 2) Deformations
- 3) Compactifications
- 4) Cascades

hep-th/0212193 ← References + ~70%

String theory $\leftrightarrow$ Field theory

String theory $\leftrightarrow$ Field theory
 $\leftarrow$ Large N

String theory $\leftrightarrow$ Field theory

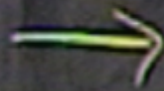
$\leftarrow$ Large N $su(N)$
fixed $\lambda = g_{\text{YM}}^2 N$

String theory $\leftrightarrow$ Field theory

$$g_s \sim \frac{1}{N}$$

$\leftarrow$ Large N $su(N)$

$$\text{fixed } \lambda = g_{\text{YM}} N$$



String theory $\leftrightarrow$ Field theory

$$g_s \sim \frac{1}{N}$$

$\leftarrow$ Large N $su(N)$
fixed $\lambda = g_{YM}^2 N$

quantum gravity $\rightarrow$

AdS/CFT

AdS/CFT
IIB on $AdS_5 \times S^5 \longleftrightarrow \mathcal{N}=4$ -SYM (SU(N))

AdS/CFT

$$\text{IIB on } \text{AdS}_5 \times S^5 \longleftrightarrow \mathcal{N}=4 \text{ SYM (SU(N))}$$

$$\lambda = g_{\text{YM}}^2 N$$

AdS/CFT

$$\text{IIB on } \text{AdS}_5 \times S^5 \longleftrightarrow \mathcal{N}=4\text{-SYM (SU(N))}$$
$$\lambda = g_{\text{YM}}^2 N$$

AdS/CFT

IIB on $AdS_5 \times S^5 \longleftrightarrow \mathcal{N}=4$ -SYM (SU(N))

$$\lambda = 4\pi g_s N \longleftrightarrow \lambda = g_{\text{YM}}^2 N$$

AdS/CFT

IIB on $AdS_5 \times S^5 \longleftrightarrow \mathcal{N}=4$ -SYM (SU(N))

$$\frac{R_{AdS}^4}{\alpha'^2} = \lambda = 4\pi g_s N \longleftrightarrow \lambda = \frac{g_{YM}^2}{N} N$$

$\lambda \rightarrow 0$ strongly curved $\longleftrightarrow$ weakly coupled

AdS/CFT

IIB on $AdS_5 \times S^5 \longleftrightarrow \mathcal{N}=4$ -SYM (SU(N))

$$\frac{R_{AdS}^4}{\alpha'^2} = \lambda = 4\pi g_s N \longleftrightarrow \lambda = g_{YM}^2 N$$

$\lambda \rightarrow 0$ strongly curved $\longleftrightarrow$ weakly coupled

$\lambda \rightarrow \infty$ weakly curved $\longleftrightarrow$ strongly coupled

AdS/CFT

$$\text{IIB on } \text{AdS}_5 \times S^5 \longleftrightarrow \mathcal{N}=4 \text{ SYM (SU(N))}$$

$$\frac{R_{\text{AdS}}^4}{\alpha'^2} = \lambda = 4\pi g_s N \longleftrightarrow \lambda = \frac{g_{\text{YM}}^2}{N} N$$

$\lambda \rightarrow 0$ strongly curved $\rightarrow$ weakly coupled

$\lambda \rightarrow \infty$ weakly curved $\rightarrow$ strongly coupled

(SUGRA)

AdS/CFT

IIB on $AdS_5 \times S^5 \longleftrightarrow \mathcal{N}=4$ -SYM (SU(N))

$$\frac{R_{AdS}^4}{\alpha'^2} = \lambda = 4\pi g_s N \longleftrightarrow \lambda = \frac{g_{YM}^2}{N} N$$

$\lambda \rightarrow 0$ strongly curved $\longleftrightarrow$ weakly coupled

$\lambda \rightarrow \infty$ weakly curved $\longleftrightarrow$ strongly coupled
(SUGRA)

AdS/CFT

$$\text{IIB on } \text{AdS}_5 \times S^5 \longleftrightarrow \mathcal{N}=4 \text{ SYM (SU(N))}$$

$$\frac{R_{\text{AdS}}^4}{\alpha'^2} = \lambda = 4\pi g_s N \longleftrightarrow \lambda = g_{\text{YM}}^2 N$$

g_s $1/N$

$$\lambda \rightarrow 0 \text{ strongly curved} \longleftrightarrow \text{weakly coupled}$$

$$\lambda \rightarrow \infty \text{ weakly curved} \longleftrightarrow \text{strongly coupled}$$

(SUGRA)

AdS/CFT

$$\text{IIB on } \text{AdS}_5 \times S^5 \longleftrightarrow \mathcal{N}=4 \text{ SYM (SU(N))}$$

$$\frac{R_{\text{AdS}}^4}{\alpha'^2} = \lambda = 4\pi g_s N \longleftrightarrow \lambda = g_{\text{YM}}^2 N$$

g_s $1/N$

$$\lambda \rightarrow 0 \quad \text{strongly curved} \longleftrightarrow \text{weakly coupled}$$

$$\lambda \rightarrow \infty \quad \text{weakly curved} \longleftrightarrow \underline{\text{strongly coupled}}$$

(SUGRA)

$$U(1) \times SU(2) \times SU(3)$$

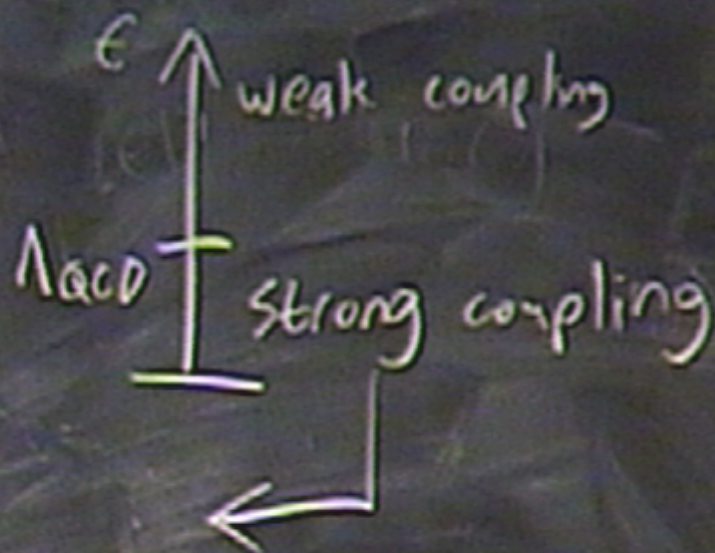
$U(1) \times SU(2) \times SU(3)$
pert. QCD

$U(1) \times SU(2) \times SU(3)$
pert. QCD

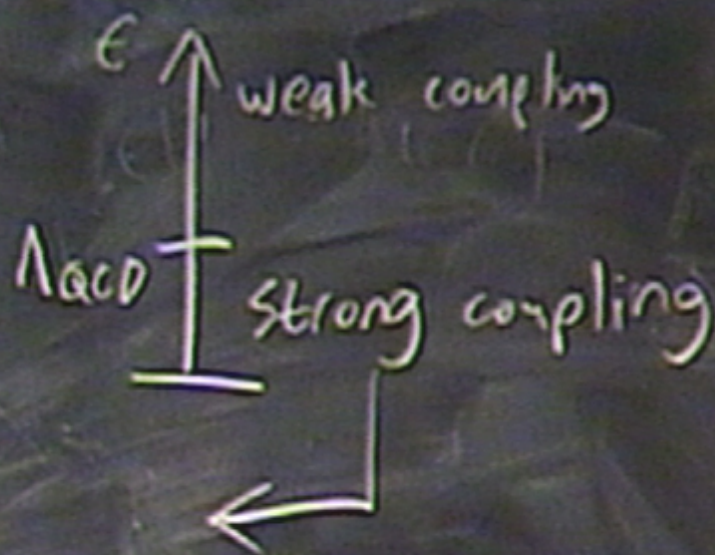
ϵ ↑ weak coupling
 Λ_{QCD} + strong coupling

$U(1) \times SU(2) \times SU(3)$
 pert. QCD

conf. ent
 mass g



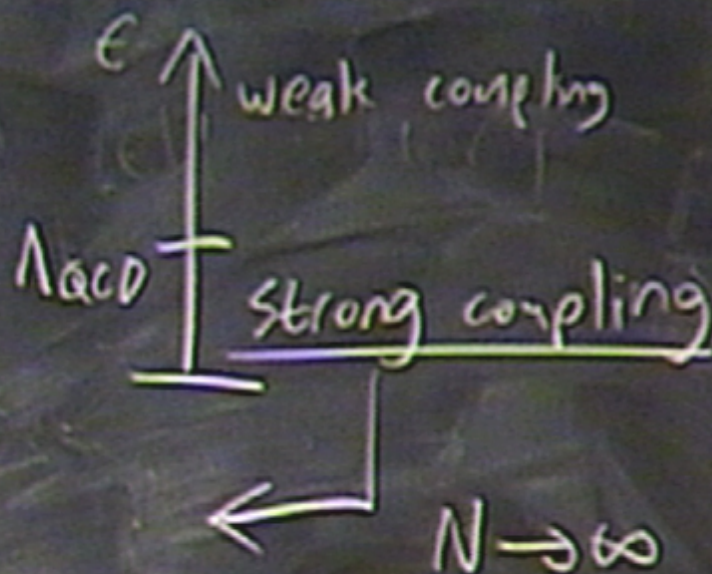
$U(1) \times SU(2) \times SU(3)$
pert. QCD



confinement
mass gap
chiral symmetry breaking
spectrum

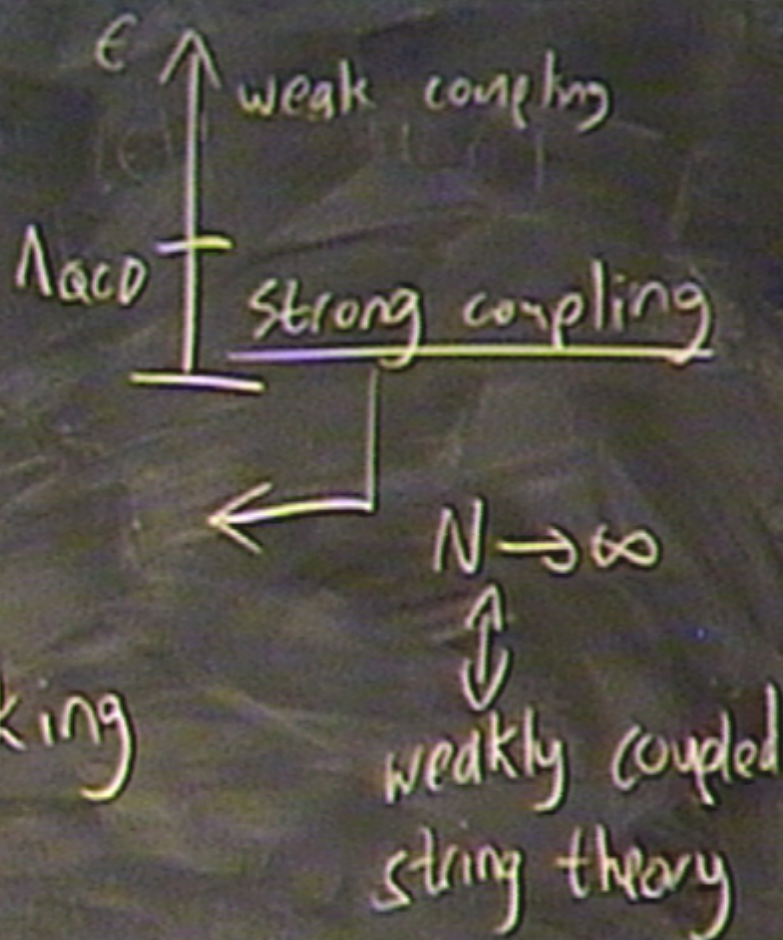
$U(1) \times SU(2) \times SU(3)$
 pert. QCD

confinement
 mass gap
 chiral symmetry breaking
 spectrum



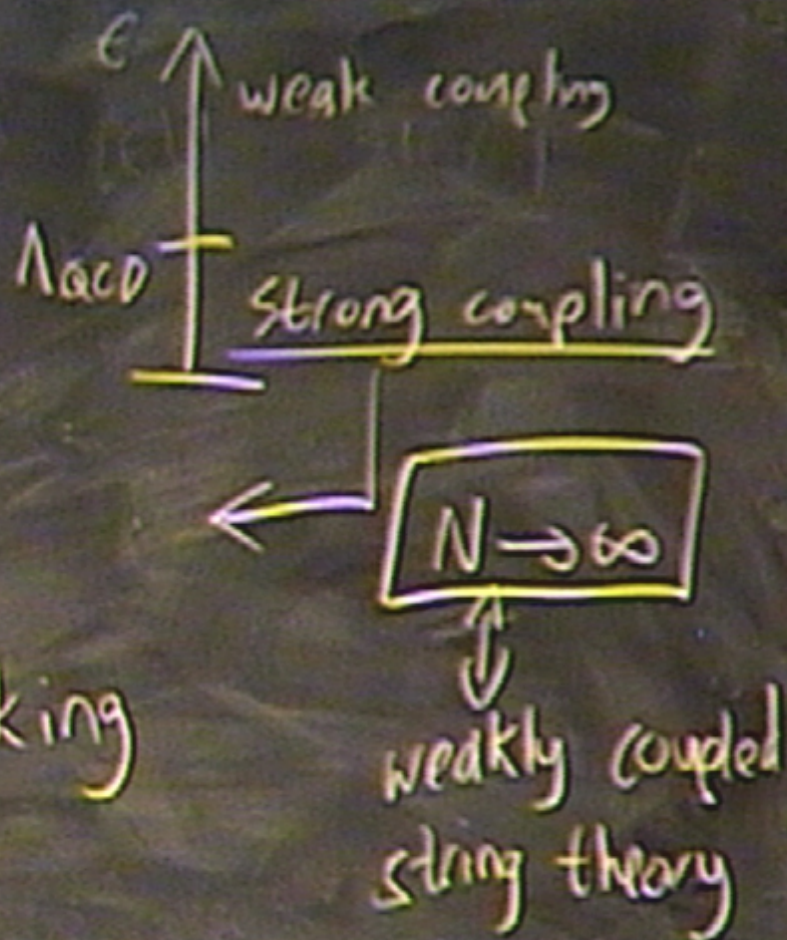
$$\underbrace{U(1) \times SU(2) \times SU(3)}_{\text{pert.}} \quad \text{QCD}$$

{ confinement
 mass gap
 chiral symmetry breaking
 spectrum



$U(1) \times SU(2) \times SU(3)$
 pert. QCD

{ confinement
 mass gap
 chiral symmetry breaking
 spectrum



$U(1) \times SU(2) \times SU(3)$
 pert. QCD

E
 weak coupling
 Λ_{QCD}
 strong coupling

Pure $SU(N)$ YM

$N \rightarrow \infty$

weakly coupled
 string theory

confinement
 mass gap
 chiral symmetry breaking
 spectrum

$U(1) \times SU(2) \times SU(3)$
 pert. QCD

E ↑ weak coupling
 Λ_{QCD} — strong coupling

{ confinement
 mass gap
 chiral symmetry breaking
 spectrum

* Pure $SU(N)$ YM
 * $n=1$ SYM

$N \rightarrow \infty$
 ↓
 weakly coupled string theory

$U(1) \times SU(2) \times SU(3)$
 pert. QCD

E
 weak coupling
 Λ_{QCD}
 strong coupling

{ confinement
 mass gap
 chiral symmetry breaking
 spectrum

* Pure $SU(N)$ YM
 * $n=1$ SYM

$N \rightarrow \infty$

weakly coupled
 string theory

$U(1) \times SU(2) \times SU(3)$
 pert. QCD

E
 weak coupling
 Λ_{QCD}
 strong coupling

{ confinement
 mass gap
 chiral symmetry breaking
 spectrum

* Pure $SU(N)$ YM
 * $n=1$ SYM

$N \rightarrow \infty$

weakly coupled
 string theory

Large N QCD $\xrightarrow{?}$ SUGRA

$\lambda \rightarrow 0$ strongly curved $\longleftrightarrow$ weakly coupled

$\lambda \rightarrow \infty$ weakly curved $\longleftrightarrow$ strongly coupled
(SUGRA)

Large N QCD $\xrightarrow{?}$ SUGRA

Λ SUGRA modes

String excitations

$\lambda \rightarrow 0$ strongly curved $\longleftrightarrow$ weakly coupled

$\lambda \rightarrow \infty$ weakly curved $\longleftrightarrow$ strongly coupled
(SUGRA)

Large N QCD $\xrightarrow{?}$ SUGRA

Λ SUGRA modes

M_s String excitations

$\Lambda \ll$

$\lambda \rightarrow 0$ strongly curved $\longleftrightarrow$ weakly curved

$\lambda \rightarrow \infty$ weakly curved (SUGRA) $\longleftrightarrow$ strongly

Large N QCD $\xrightarrow{?}$ SUGRA

Λ SUGRA modes

M_s String excitations

$\Lambda \ll M_s$

$\Lambda \rightarrow 0$ strongly curved $\longleftrightarrow$ weakly coupled

$\Lambda \rightarrow \infty$ weakly curved $\longleftrightarrow$ strongly coupled
(SUGRA)

Large N QCD $\xrightarrow{?}$ SUGRA

Λ SUGRA modes

M_s String excitations

$\Lambda \ll$

$\underline{\lambda} \rightarrow 0$ strongly curved $\longleftrightarrow$ weakly curved

$\lambda \rightarrow \infty$ weakly curved
(SUGRA)

Large N QCD $\xrightarrow{?}$ SUGRA

Λ SUGRA modes

M_s string excitations

$$\Lambda \ll M_s$$

$\Lambda \rightarrow 0$ strongly coupled

$\Lambda \rightarrow \infty$ weakly curved
(SUGRA)

weakly coupled

strongly coupled

Large N QCD $\xrightarrow{?}$ SUGRA

Λ SUGRA modes

M_s String excitations

$$\underline{\Lambda} \ll M_s$$

$\underline{\Lambda} \rightarrow 0$ strongly curved $\longleftrightarrow$ weakly coupled

$\Lambda \rightarrow \infty$ weakly curved $\longleftrightarrow$ strongly coupled
(SUGRA)

Large N QCD $\xrightarrow{?}$ SUGRA

Λ SUGRA modes

M_s string excitations

$$\frac{\Lambda}{\sqrt{T_s}} \ll \frac{M_s}{\sqrt{T_s}}$$

$\underline{\Lambda} \rightarrow 0$ strongly curved $\longleftrightarrow$ weakly coupled

$\underline{\Lambda} \rightarrow \infty$ weakly curved $\longleftrightarrow$ strongly coupled
(SUGRA)

Large N QCD $\xrightarrow{?}$ SUGRA

$$\Lambda_{\text{QCD}} \approx \sqrt{T_s}$$

Λ SUGRA modes

M_s string excitations

$$\frac{\Lambda}{\sqrt{T_s}}$$

$$\underline{\Lambda} \ll \underline{M_s}$$

$\underline{\Lambda} \rightarrow 0$ strongly curved $\longleftrightarrow$ weakly coupled

$\lambda \rightarrow \infty$ weakly curved $\longleftrightarrow$ strongly coupled
(SUGRA)

Large N QCD $\xrightarrow{?}$ SUGRA

$\Lambda_{\text{QCD}} \approx \sqrt{T_s}$
no SUGRA approximation

Λ SUGRA modes
 M_s string excitations
 $\frac{\Lambda}{\sqrt{T_s}} \ll \frac{M_s}{\sqrt{T_s}}$

$\underline{\lambda} \rightarrow 0$ strongly curved $\longleftrightarrow$ weakly coupled

$\lambda \rightarrow \infty$ weakly curved (SUGRA) $\longleftrightarrow$ strongly coupled

Large N QCD $\xrightarrow{?}$ SUGRA

$\Lambda_{\text{QCD}} \approx \sqrt{T_s}$
no SUGRA approximation

Λ SUGRA modes
 M_s string excitations
 $\underline{\Lambda} \ll \underline{M_s}$

$\underline{\lambda} \rightarrow 0$ strongly curved $\longleftrightarrow$ weakly coupled

$\lambda \rightarrow \infty$ weakly curved (SUGRA) $\longleftrightarrow$ strongly coupled

Large N QCD $\xrightarrow{?}$ SUGRA

$\Lambda_{\text{QCD}} \approx \sqrt{T_s}$
no SUGRA approximation

Λ SUGRA modes (spin ≤ 2)
 M_s string excitations
 $\frac{\Lambda}{\sqrt{T_s}} \ll \frac{M_s}{\sqrt{T_s}}$

$\underline{\lambda} \rightarrow 0$ strongly curved $\longleftrightarrow$ weakly coupled

$\lambda \rightarrow \infty$ weakly curved $\longleftrightarrow$ strongly coupled
(SUGRA)

Large N QCD $\xrightarrow{?}$ SUGRA

$\Lambda_{\text{QCD}} \approx \sqrt{T_s}$
 $\hookrightarrow$ no SUGRA approximation

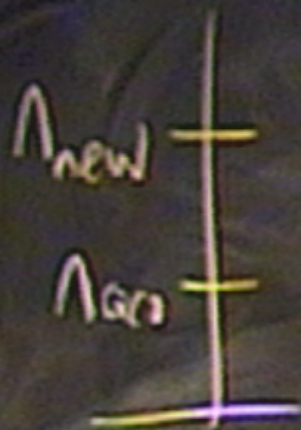
Λ SUGRA modes (spin ≤ 2)

M_s String excitations (All spin > 2)
 $\underline{\Lambda} \ll \underline{M_s}$

$\sqrt{T_s}$

$\lambda \rightarrow 0$ strongly curved $\longleftrightarrow$ weakly coupled

$\lambda \rightarrow \infty$ weakly curved (SUGRA) $\longleftrightarrow$ strongly coupled



ϵ ↑ weak coupling

strong coupling

$N \rightarrow \infty$

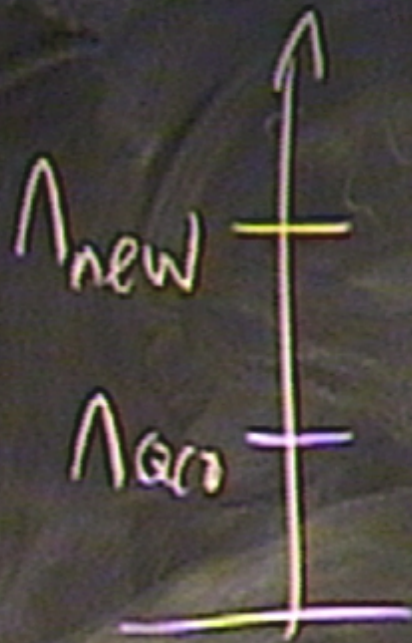
↓
weakly coupled
string theory

Λ_{new}

Λ_{QCD}

Λ_{new}

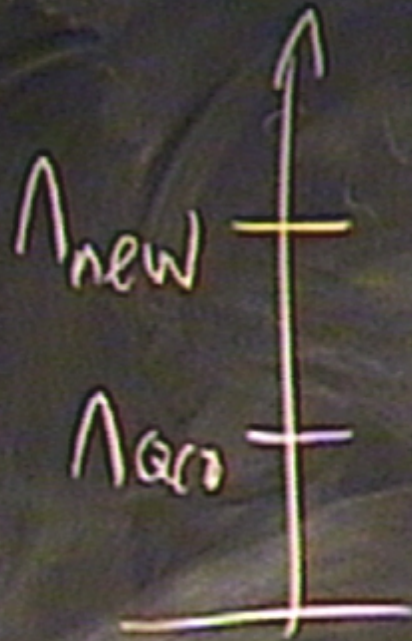
Λ_{QCD}



$$\lambda(\Lambda_{new})$$

$$\Lambda_{new} \gg \Lambda_{QCD}$$

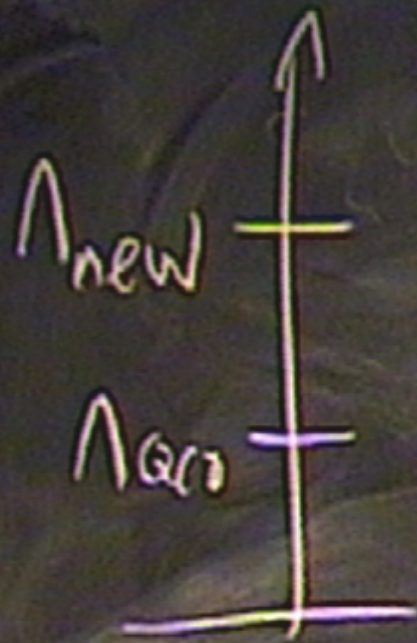
$$\lambda \ll 1$$



$$\lambda(\Lambda_{new})$$

$$\Lambda_{new} \gg \Lambda_{QCD}$$

$$\lambda \ll 1$$

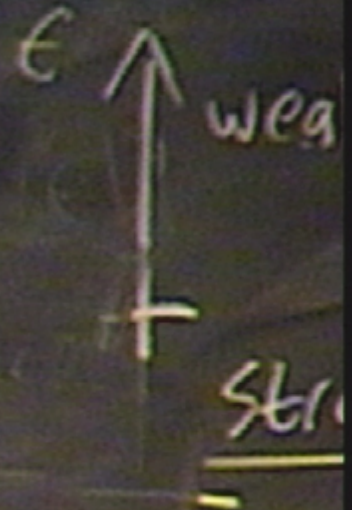


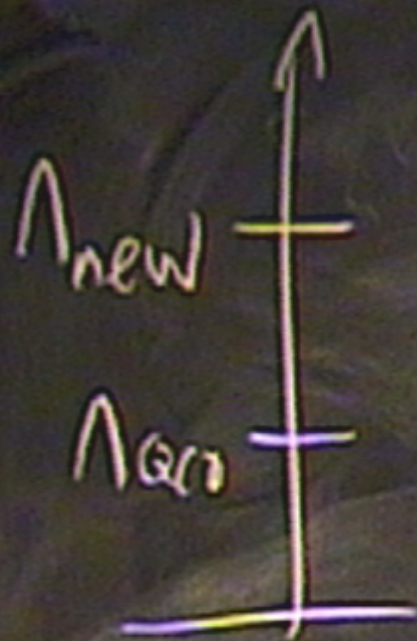
$$\lambda(\Lambda_{new})$$

$$\Lambda_{new} \gg \Lambda_{QCD}$$

$$\lambda \ll 1$$

low energies $\rightarrow$ QCD





$$\lambda(\Lambda_{new})$$

$$\Lambda_{new} \gg \Lambda_{QCD}$$

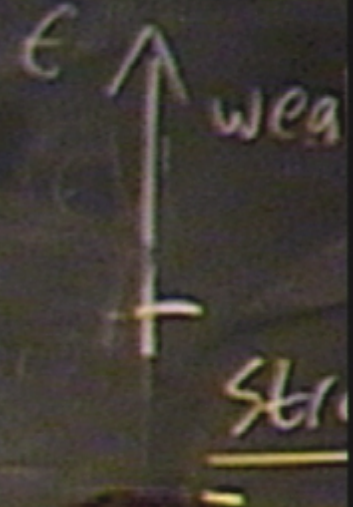
$$\lambda \ll 1$$

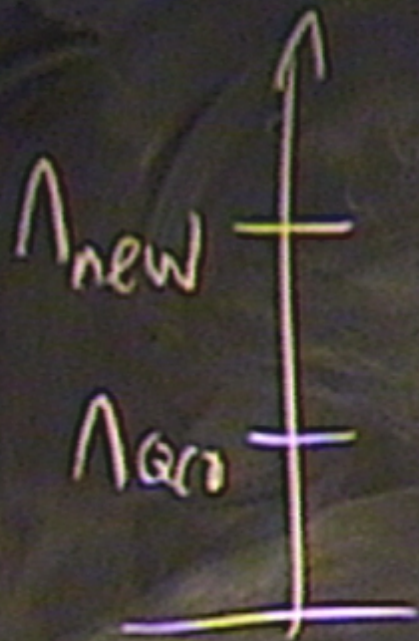
low energies $\rightarrow$

$$\Lambda_{new} \sim \Lambda_{QCD}$$

$$\lambda \sim 1$$

$\hookrightarrow$ SUSY





$$\lambda(\Lambda_{new})$$

$$\Lambda_{new} \gg \Lambda_{QCD}$$

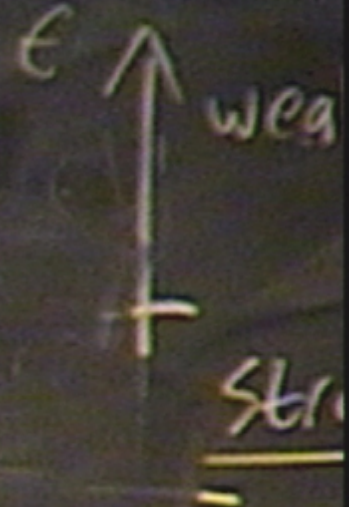
$$\lambda \ll 1$$

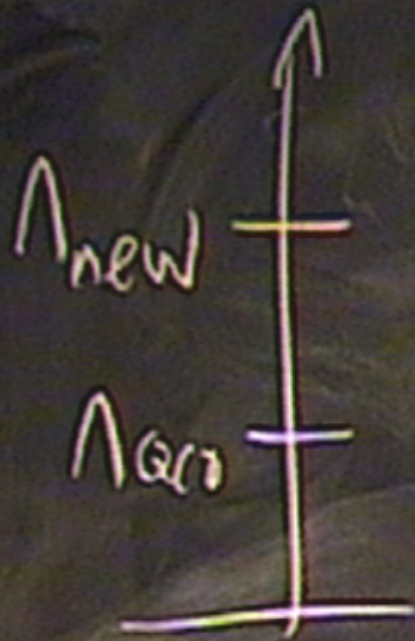
low energies $\rightarrow$ QCD

$$\Lambda_{new} \sim \Lambda_{QCD}$$

$$\lambda \sim 1$$

$\rightarrow$ SUSY





$$\lambda(\Lambda_{new})$$

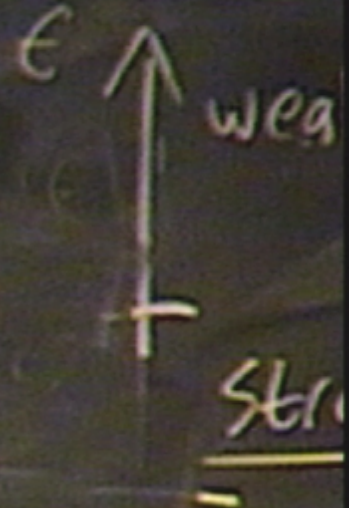
$$\Lambda_{new} \gg \Lambda_{QCD}$$

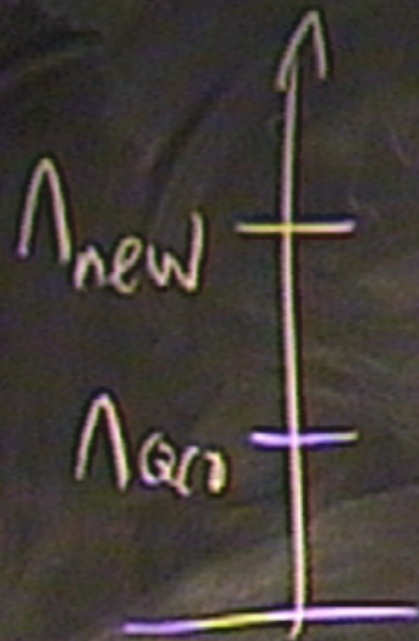
$$\lambda \ll 1$$

low energies $\rightarrow$ QCD

$$\Lambda_{new} \sim \Lambda_{QCD} \quad \underline{\lambda \sim 1}$$

$\rightarrow$ SUSY





$$\lambda(\Lambda_{new})$$

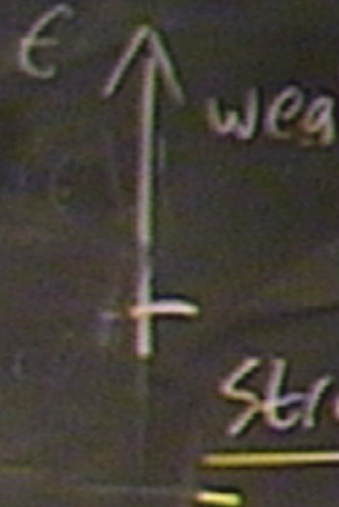
$$\Lambda_{new} \gg \Lambda_{QCD}$$

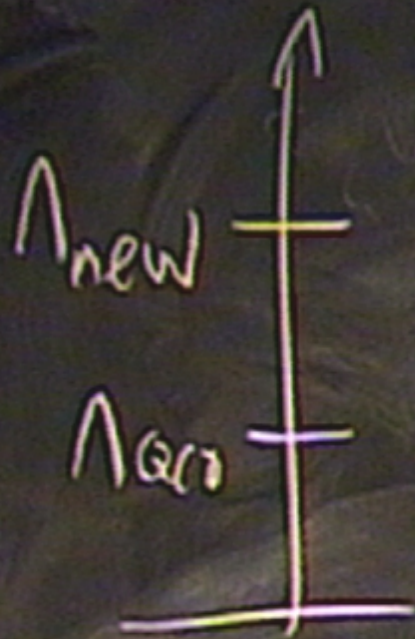
$$\lambda \ll 1$$

$\rightarrow$ low energies $\rightarrow$ QCD

$$\Lambda_{new} \sim \Lambda_{QCD} \quad \underline{\lambda \sim 1}$$

$\rightarrow$ SUGRA





$$\lambda(\Lambda_{new})$$

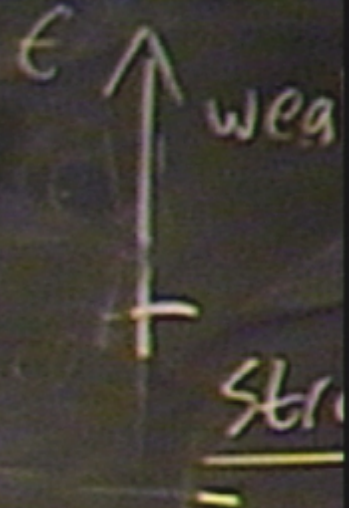
$$\Lambda_{new} \gg \Lambda_{QCD}$$

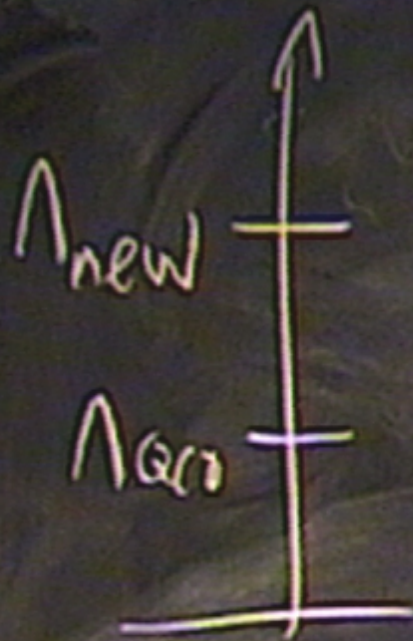
$$\lambda \ll 1$$

$\rightarrow$ low energies $\rightarrow$ QCD

$$\Lambda_{new} \sim \Lambda_{QCD} \quad \underline{\lambda \sim 1}$$

$\rightarrow$ SUGRA



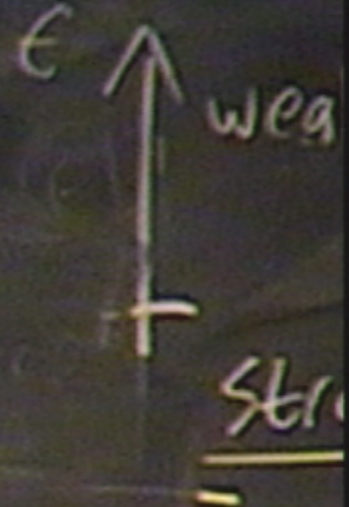


$$\lambda(\Lambda_{new})$$

$$\Lambda_{new} \gg \Lambda_{QCD}$$

$$\lambda \ll 1$$

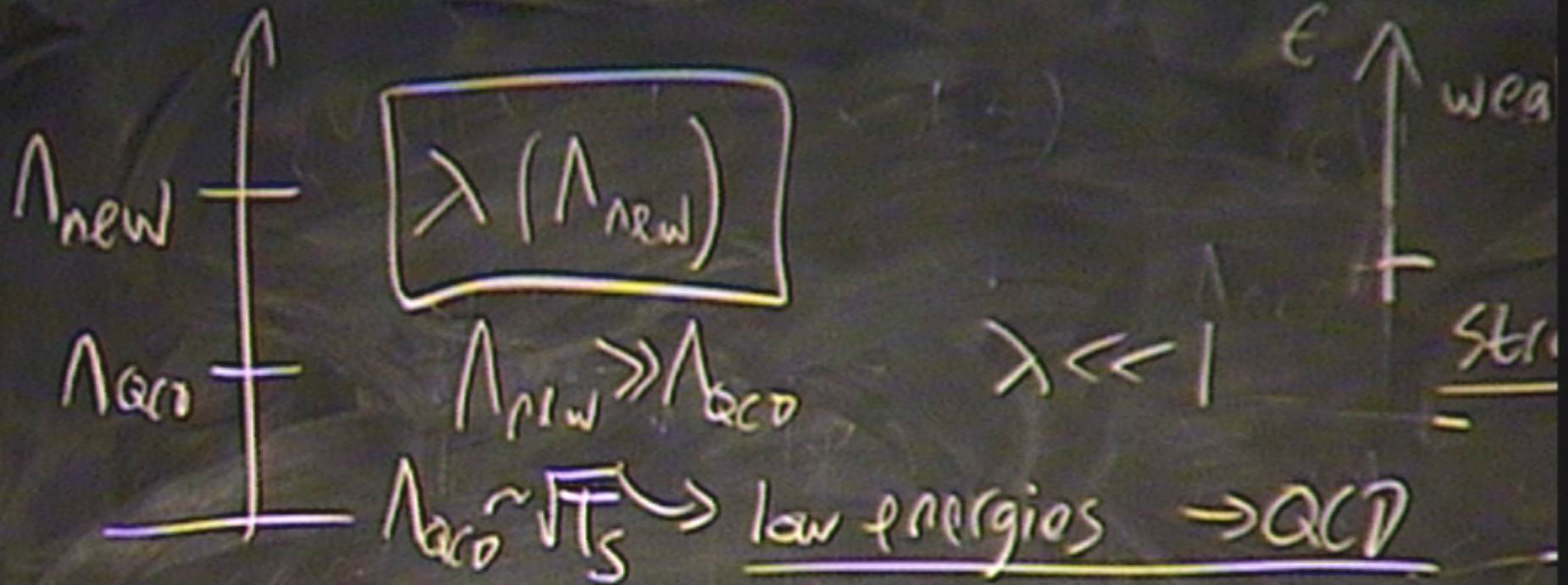
low energies $\rightarrow$ QCD



$$\Lambda_{new} \sim \Lambda_{QCD}$$

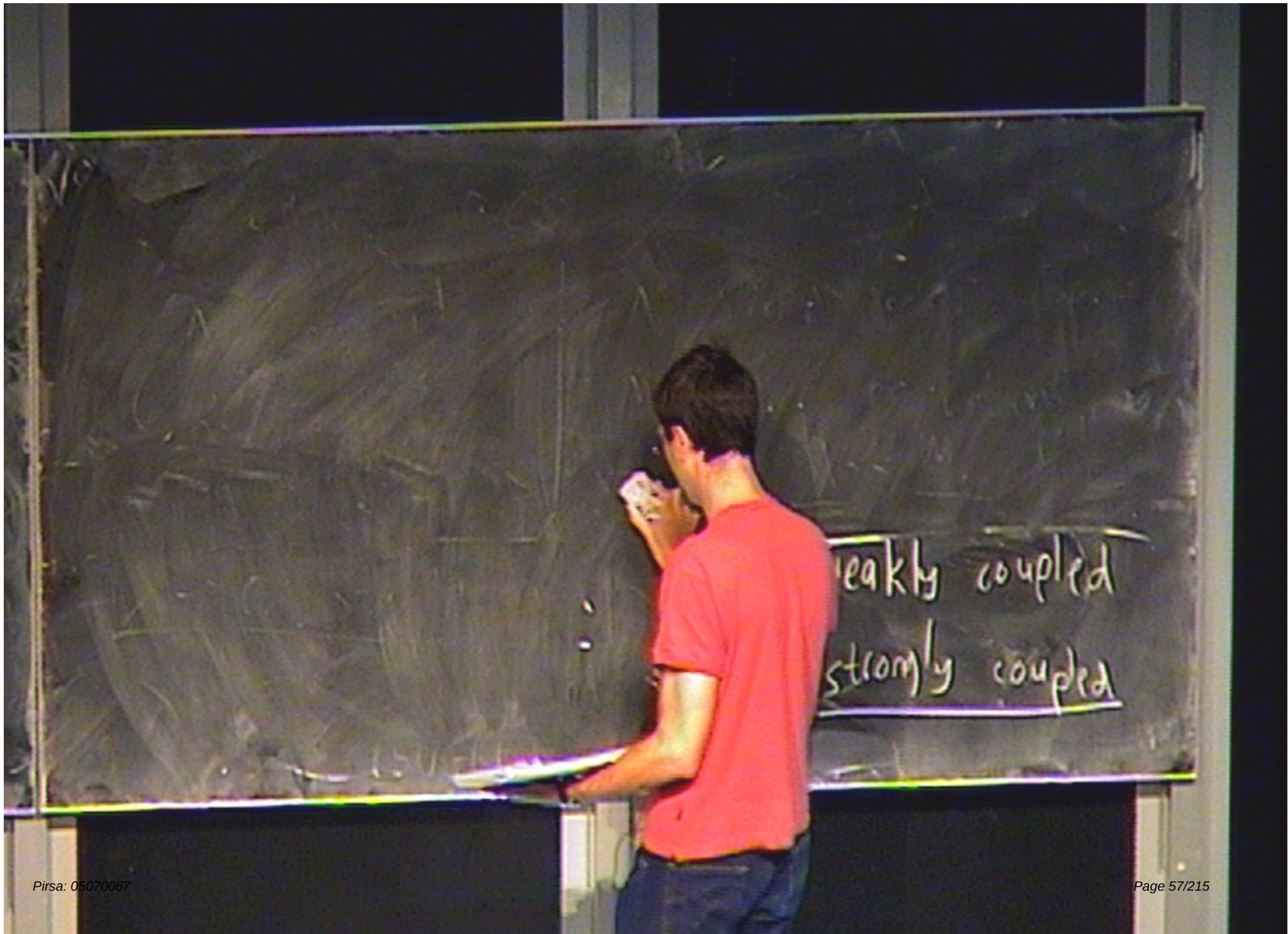
$$\lambda \sim 1$$

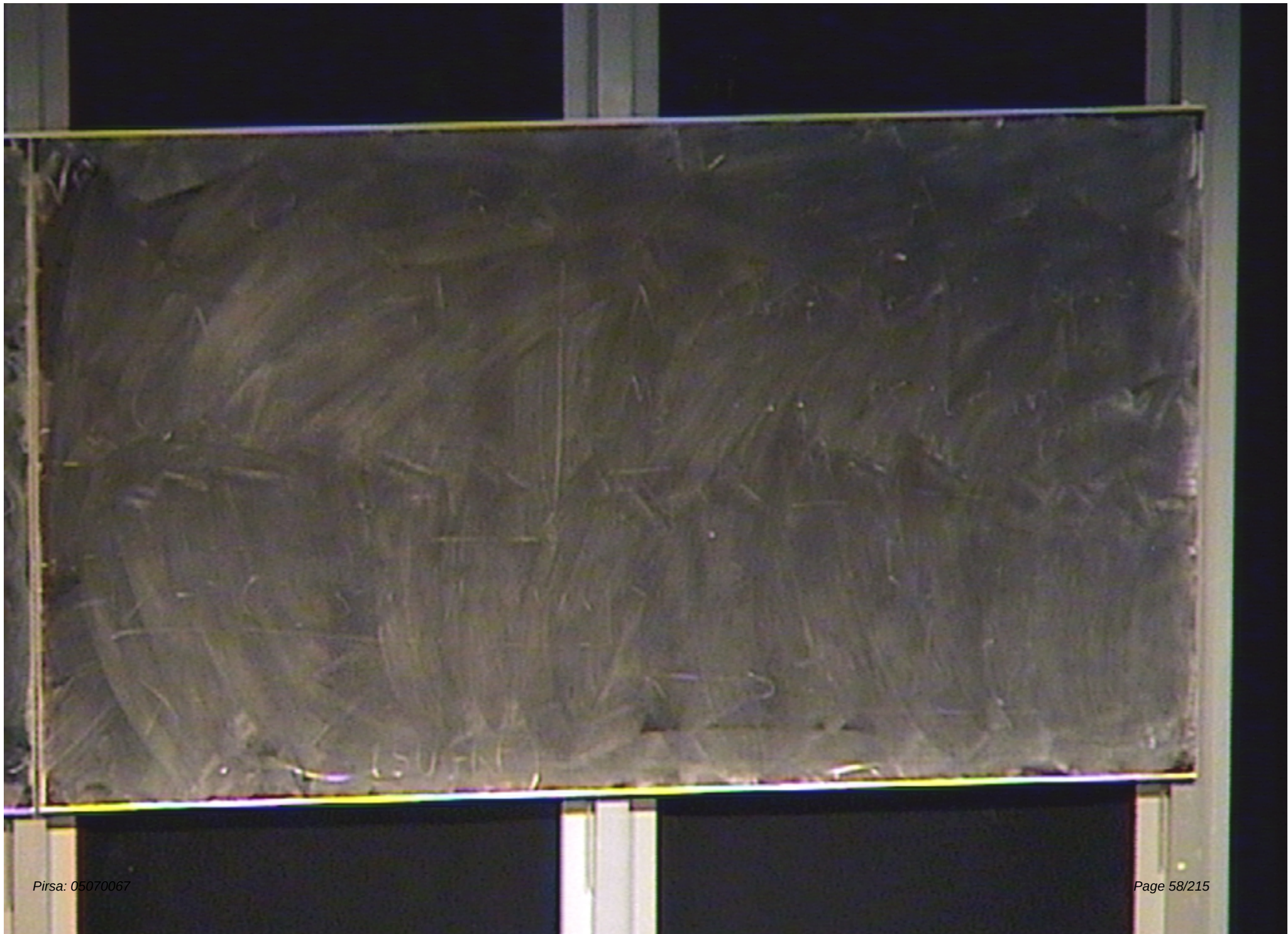
SUGRA



$$\Lambda_{new} \sim \Lambda_{QCD} \quad \lambda \sim 1$$

$$\sqrt{T_S} \gg \Lambda_{QCD} \rightarrow \text{SUGRA}$$





The non-AdS/non-CFT correspondence

1) Introduction

2) Deformations $\leftarrow$ Polchinski-Strassler

3) Compactifications $\leftarrow$ Maldacena-Nuñez

4) Cascades

hep-th/0212193 $\leftarrow$ References + ~70%

The non-AdS/non-CFT correspondence

1) Introduction

2) Deformations ← Polchinski-Strassler

3) Compactifications ← Maldacena-Núñez

4) Cascades ← Klebanov-Strassler

hep-th/0212193 ← References + ~70%

The non-AdS/non-CFT correspondence

- 1) Introduction
- 2) Deformations $\leftarrow$ Polchinski-Strassler
- 3) Compactifications $\leftarrow$ Maldacena-Nuñez
- 4) Cascades $\leftarrow$ Klebanov-Strassler
- hep-th/0212193 $\leftarrow$ References + ~70%

* $n=4$ SYM $d=4 \iff \text{IIB on } \text{AdS}_5 \times S^5$

* $n=4$ SYM $d=4 \iff \text{IIB on } \text{AdS}_5 \times S^5$

A_μ, λ^a, ϕ^i
 $a=1, \dots, 4 \quad i=1, \dots, 6$

* $n=4$ SYM $d=4 \iff \text{IIB on } \text{AdS}_5 \times S^5$

A_μ, λ^a, ϕ^i
 $a=1, \dots, 4 \quad i=1, \dots, 6$

* $n=4$ SYM $d=4 \iff \text{IIB on } \text{AdS}_5 \times S^5$

A_μ, λ^a, ϕ^i
 $a=1, \dots, 4 \quad i=1, \dots, 6$

$\mathcal{L} + m^2 \text{tr}(\phi^i \phi^i) + m \text{tr}(\lambda$

* $n=4$ SYM $d=4 \iff \text{IB on } \text{AdS}_5 \times S^5$

$$\left[\begin{array}{l} A_\mu, \lambda^a, \varphi^i \\ a=1, \dots, 4 \quad i=1, \dots, 6 \end{array} \right.$$

$$\rightarrow \mathcal{L} + m^2 \text{tr}(\varphi^i \varphi^i) + (m \text{tr}(\lambda^a \lambda^a) + \text{c.c.})$$

* $n=4$ SYM $d=4 \iff \text{IIB on } \text{AdS}_5 \times S^5$

$\left[\begin{array}{l} \underline{A}_\mu, \lambda^a, \varphi^i \\ a=1, \dots, 4 \quad i=1, \dots, 6 \end{array} \right.$

$$\rightarrow \mathcal{L} + m^2 \text{tr}(\varphi^i \varphi^i) + (m \text{tr}(\lambda^a \lambda^a) + \text{c.c.})$$

* $n=4$ SYM $d=4 \iff \text{IIB on } \text{AdS}_5 \times S^5$

$$\left[\begin{array}{l} \underline{A}_\mu, \lambda^a, \varphi^i \\ a=1, \dots, 4 \quad i=1, \dots, 6 \end{array} \right.$$

$$\rightarrow \mathcal{L} + m^2 \text{tr}(\varphi^i \varphi^i) + \left(m \text{tr}(\lambda^a \lambda^a) + \text{c.c.} \right)$$

$$\lambda \rightarrow 0 \quad \Delta=2$$

$$\Delta=3$$

* $n=4$ SYM $d=4 \iff \text{IIB on } \text{AdS}_5 \times S^5$

$$\left[\begin{array}{l} \underline{A}_\mu, \lambda^a, \phi^i \\ a=1, \dots, 4 \quad i=1, \dots, 6 \end{array} \right.$$

$$\rightarrow \mathcal{L} + m^2 \text{tr}(\phi^i \phi^i) + (m \text{tr}(\lambda^a \lambda^a) + \text{c.c.})$$

$\lambda \rightarrow 0 \quad \Delta=2 \qquad \qquad \Delta=3$

$$* \quad \lambda = g_{YM}^2 N$$

$$n=4 \text{ SYM } d=4 \iff \text{IB on } AdS_5 \times S^5$$

$$\left[\begin{array}{l} \underline{A}_\mu, \lambda^a, \varphi^i \\ a=1, \dots, 4 \quad i=1, \dots, 6 \end{array} \right.$$

$$\rightarrow \mathcal{L} + m^2 \text{tr}(\varphi^i \varphi^i) + (m \text{tr}(\lambda^a \lambda^a) + \text{c.c.})$$

$$\lambda \rightarrow 0 \quad \Delta=2$$

$$\Delta=3$$

$$\underline{\lambda \rightarrow \infty}$$

* $\lambda = g_{YM}^2 N$
 $n=4$ SYM $d=4 \iff \Pi B$ on $AdS_5 \times S^5$

$$\left[\begin{array}{l} \underline{A}_\mu, \lambda^a, \varphi^i \\ a=1, \dots, 4 \quad i=1, \dots, 6 \end{array} \right. \rightarrow \mathcal{L} + m^2 \text{tr}(\varphi^i \varphi^i) + (m \text{tr}(\lambda^a \lambda^a) + \text{c.c.})$$

$$\lambda \rightarrow 0 \quad \Delta=2$$

$$\Delta=3$$

$$\underline{\lambda \rightarrow \infty}$$

* $\lambda = g_{YM}^2 N$
 $n=4$ SYM $d=4 \iff \text{IB on } AdS_5 \times S^5$

$\left[\begin{array}{l} \underline{A}_\mu, \lambda^a, \varphi^i \\ a=1, \dots, 4 \quad i=1, \dots, 6 \end{array} \right.$

$$\mathcal{L} + m^2 \text{tr}(\varphi^i \varphi^i) + (m \text{tr}(\lambda^a \lambda^a) + \text{c.c.})$$

$\lambda \rightarrow 0 \quad \Delta=2 \qquad \Delta=3$

$\lambda \rightarrow \infty$

Chiral primary

$$\text{tr}(\phi^{i_1} \phi^{i_2} \dots \phi^{i_n})$$

Symmetric
Traceless
 $SO(6)$

Chiral primary

$$\text{tr}(\phi^{i_1} \phi^{i_2} \dots \phi^{i_k})$$

Symmetric
Traceless
 $SO(6)$

Chiral primary

$$\text{tr}(\phi^1 \phi^2 \dots \phi^k)$$

Symmetric
Traceless
 $SO(b)$

$$\Delta = k$$

$$Q \dots Q \text{tr}(\dots)$$

Not chiral

Chiral primary

$$\text{tr}(\phi^{i_1} \phi^{i_2} \dots \phi^{i_k})$$

✓ Symmetric
Traceless
 $SO(b)$

$$\Delta = k$$

$$Q \dots Q \text{tr}(\dots)$$

Not chiral

$$\text{tr}(\psi^i \psi^i)$$

$$\Delta = 2 + (\dots)\lambda + (\dots)\lambda^2 + \dots$$

* $\lambda = g_{YM}^2 N$
 $n=4$ SYM $d=4 \iff \text{IIB on } \text{AdS}_5 \times S^5$

$$\left[\begin{array}{l} \underline{A}_\mu, \lambda^a, \varphi^i \\ a=1, \dots, 4 \quad i=1, \dots, 6 \end{array} \right. \quad Q^2 \text{tr}(\varphi\varphi) \quad \downarrow$$

$$\rightarrow \mathcal{L} + m^2 \text{tr}(\varphi^i \varphi^i) + (m \text{tr}(\lambda^a \lambda^a) + \text{c.c.})$$

$$\lambda \rightarrow 0 \quad \Delta=2 \quad \Delta=3$$

$$\underline{\lambda \rightarrow \infty}$$

* $\lambda = g_{YM}^2 N$
 $n=4$ SYM $d=4 \iff \text{IB on } AdS_5 \times S^5$

$$\left[\begin{array}{l} \underline{A}_\mu, \lambda^a, \varphi^i \\ a=1, \dots, 4 \quad i=1, \dots, 6 \end{array} \right. \quad \vec{Q}^2 \text{tr}(\varphi\varphi) \quad \downarrow$$

$$\rightarrow \mathcal{L} + m^2 \text{tr}(\varphi^i \varphi^i) + (m \text{tr}(\lambda^a \lambda^a) + \text{c.c.})$$

$$\lambda \rightarrow 0 \quad \Delta=2$$

$$\Delta=3$$

$$\underline{\lambda \rightarrow \infty}$$

* $\lambda = g_{YM}^2 N$
 $n=4$ SYM $d=4 \iff \text{IIB on } AdS_5 \times S^5$

$\left[\begin{array}{l} \underline{A}_\mu, \lambda^a, \varphi^i \\ a=1, \dots, 4 \quad i=1, \dots, 6 \end{array} \right. \quad \vec{Q}^2 \text{tr}(\varphi\varphi) \quad \downarrow$
 $\rightarrow \mathcal{L} + m^2 \text{tr}(\varphi^i \varphi^i) + (m \text{tr}(\lambda^a \lambda^a) + \text{c.c.})$

$\lambda \rightarrow 0 \quad \Delta=2$

$\Delta=3$

$\lambda \rightarrow \infty$

$\Delta=3$

* $\lambda = g_{YM}^2 N$
 $n=4$ SYM $d=4 \iff \text{IIB on } AdS_5 \times S^5$

$\left[\begin{array}{l} \underline{A}_\mu, \lambda^a, \varphi^i \\ a=1, \dots, 4 \quad i=1, \dots, 6 \end{array} \right. \quad Q^2 \text{tr}(\varphi\varphi) \quad \downarrow$
 $\rightarrow \mathcal{L} + m^2 \text{tr}(\varphi^i \varphi^i) + (m \text{tr}(\lambda^a \lambda^a) + \text{c.c.})$

$\lambda \rightarrow 0 \quad \Delta=2$

$\Delta=3$

$\lambda \rightarrow \infty$

$\Delta=3$

* $\lambda = g_{YM}^2 N$
 $n=4$ SYM $d=4 \iff$ IIB on $AdS_5 \times S^5$

$\left[\begin{array}{l} \underline{A}_\mu, \lambda^a, \varphi^i \\ a=1, \dots, 4 \quad i=1, \dots, 6 \end{array} \right. \quad \vec{Q}^2 \text{tr}(\varphi\varphi) \quad \downarrow$

$$\rightarrow \mathcal{L} + m^2 \text{tr}(\varphi^i \varphi^i) + (m \text{tr}(\lambda^a \lambda^a) + \text{c.c.})$$

$\lambda \rightarrow 0 \quad \Delta=2 \quad \Delta=3$

$\lambda \rightarrow \infty$ $\Delta=3$

Chiral primary

$$\text{tr}(\phi^{i_1} \phi^{i_2} \dots \phi^{i_k})$$

Symmetric
traceless
 $SO(b)$

$$\Delta = k$$

$$Q \dots Q \text{tr}(\dots)$$

$$\text{tr}(\phi^i \phi^i) \quad \Delta = 2 + ()\lambda + ()\lambda^2 + \dots$$

Chiral primary

$$\text{tr}(\phi^{i_1} \phi^{i_2} \dots \phi^{i_k})$$

Symmetric
Traceless
 $SO(6)$

$$\Delta = k$$

IIB SUGRA
on $AdS_5 \times S^5$

$$Q \dots Q \text{tr}(\dots)$$

Not chiral

$$\text{tr}(\psi^i \psi_i) \quad \Delta = 2 + (1)\lambda + (1)$$

Chiral primary

$$\text{tr}(\phi^{i_1} \phi^{i_2} \dots \phi^{i_k})$$

Symmetric
traceless
 $SO(6)$

II B SUGRA
on $AdS_5 \times S^5$

$$\frac{\Delta = k}{Q \dots Q \text{tr}(\dots)}$$

Not chiral

$$\text{tr}(\psi^i \psi_i)$$

$$\Delta = 2 + ()\lambda + ()\lambda^2 + \dots$$

~~SUGRA~~

Chiral primary

$$\text{tr}(\phi^{i_1} \phi^{i_2} \dots \phi^{i_k})$$

✓ Symmetric
Traceless
 $SO(b)$

II B SUGRA
on $AdS_5 \times S^5$

$$\frac{\Delta = k}{Q \dots Q \text{tr}(\dots)}$$

Not chiral

$$\text{tr}(\psi^i \psi_i) \quad \Delta = 2 + (1)\lambda$$

~~SUGRA~~

$$M \sim \frac{1}{\alpha'} \rightarrow \frac{1}{\alpha'}$$

Chiral primary

$$\text{tr}(\phi^{i_1} \phi^{i_2} \dots \phi^{i_k})$$

Symmetric
Traceless
 $SO(b)$

II B SUGRA
on $AdS_5 \times S^5$

$$\frac{\Delta = k}{Q \dots Q \text{tr}(\dots)}$$

Not chiral

$$\text{tr}(\psi^i \psi_i) \quad \Delta = 2 + ()\lambda + ()\lambda^2 + \dots$$

~~SUGRA~~

$$m \sim \frac{1}{\lambda^2}$$

$$\Delta \sim \lambda^{\frac{1}{4}}$$

Chiral primary

$$\text{tr}(\phi^{i_1} \phi^{i_2} \dots \phi^{i_k})$$

✓ Symmetric
traceless
SO(6)

IB SUGRA
on $AdS_5 \times S^5$

$$\frac{\Delta = k}{Q \dots Q + \text{tr}(\dots)}$$

Not chiral

$$\text{tr}(\phi^i \phi^i) \quad \Delta = 2 + ()\lambda + ()\lambda^2 + \dots$$

~~SUGRA~~

$$M \sim \frac{1}{\alpha'} \rightarrow$$

$$\Delta \geq \frac{1}{4}$$

$$\mathcal{L}_{\text{CFT}} + (m_1 \overline{\text{tr}(\lambda \lambda')} + m_2 \text{tr}(\lambda^2 \lambda'^2))$$

Not chiral

~~SUSY~~RA

$$m \sim \frac{1}{\Lambda^2}$$

$$\text{tr}(\psi' \psi)$$

$$-()\lambda + ()\lambda^2 -$$

$$\mathcal{L}_{\text{CFT}} + (M_1 \text{tr}(\lambda \lambda^\dagger) + M_2 \text{tr}(\lambda^2 \lambda^2) + M_3 \text{tr}(\lambda^3 \lambda^3) + M_4 \text{tr}(\lambda^\dagger \lambda^\dagger)) / \Lambda^4$$

Not chiral $\text{tr}(\psi^\dagger \psi)$ $\Delta = 2 + ()\lambda + ()\lambda^2$

~~SUSY~~ $\leftrightarrow$ $\Delta \geq \frac{1}{4}$

$$\mathcal{L}_{\text{CFT}} + (M_1 \text{tr}(\lambda \lambda') + M_2 \text{tr}(\lambda^2 \lambda^2) + M_3 \text{tr}(\lambda^3 \lambda^3) + M_4 \text{tr}(\lambda^4 \lambda^4)) + \text{cr.}$$

↓
induced scalar masses

Not chiral

$$\text{tr}(\psi' \psi) \quad \Delta = 2 + ()\lambda + ()\lambda^2 + \dots$$

~~SUSY~~ $\rightarrow$ $\Delta \approx \sqrt{\lambda}$

$m \approx \frac{1}{\sqrt{\lambda}}$ $\rightarrow$ $\Delta \approx \sqrt{\lambda}$

$$\mathcal{L}_{\text{CFT}} + (\overline{m_1} \text{tr}(\lambda' \lambda') + m_2 \text{tr}(\lambda^2 \lambda^2) + m_3 \text{tr}(\lambda^3 \lambda^3) + m_4 \text{tr}(\lambda^\dagger \lambda^\dagger)) / \Lambda^2$$

$\downarrow$
 induced scalar masses
 mixing $m \phi \phi \leftrightarrow \lambda \lambda$

* $\lambda = g_{YM}^2 N$
 $n=4$ SYM $d=4 \iff$ $\mathcal{N}=4$ on $AdS_5 \times S^5$

$\left[\begin{array}{l} \underline{A}_\mu, \lambda^a, \phi^i \\ i=1, \dots, 6 \end{array} \right] \quad \vec{Q}^2 \text{tr}(\phi^2)$

$\rightarrow \mathcal{L} + \cancel{\frac{1}{2} \text{tr}(\phi^i \phi^i)} + (m \text{tr}(\lambda^a \lambda^a) + \text{c.c.})$

$\Delta=2 \quad \Delta=3$
 $\Delta \sim \lambda^{1/4} \quad \Delta=3$

* $\lambda = g_{YM}^2 N$
 $n=4$ SYM $d=4 \iff \text{IIB on } AdS_5 \times S^5$

$\left[\begin{array}{l} \underline{A}_m, \lambda^a, \varphi^i \\ a=1, \dots, 4 \quad i=1, \dots, 6 \end{array} \right. \quad Q^2 \text{tr}(\varphi\varphi) \quad \downarrow$
 $\rightarrow \mathcal{L} + \cancel{m^2 \text{tr}(\varphi^i \varphi^i)} + (m \text{tr}(\lambda^a \lambda^a) + \text{c.c.})$
 $\text{tr}(\varphi^i \varphi^i) \quad \begin{array}{ll} \lambda \rightarrow 0 & \Delta = 2 \\ \lambda \rightarrow \infty & \Delta \sim \lambda^{1/4} \end{array} \quad \begin{array}{l} \Delta = 3 \\ \Delta = 3 \end{array}$

$$\lambda = g_{\text{YM}}^2 N$$

$$* \quad n=4 \text{ SYM } d=4 \iff \text{IIB on } \text{AdS}_5 \times S^5$$

$$\underline{A}_\mu, \lambda^a, \phi^i$$

$$a=1, \dots, 4 \quad i=1, \dots, 6$$

$$Q^2 \text{tr}(\phi\phi)$$

$$- \cancel{m^2 \text{tr}(\phi^i \phi^i)} + (m \text{tr}(\lambda^a \lambda^a) + \text{c.c.})$$

$$\Delta=2$$

$$\Delta=3$$

$$\Delta \sim \lambda^{1/4}$$

$$\Delta=3$$

$$m_{ij}^2 \text{tr}(\phi^i \phi^j)$$

* $\lambda = g_{YM}^2 N$
 $n=4$ SYM $d=4 \iff \text{IIB on } \text{AdS}_5 \times S^5$

A_μ, λ^a, ϕ^i
 $a=1, \dots, 4 \quad i=1, \dots, 6$

$Q^2 \text{tr}(\phi\phi)$

$$\mathcal{L} + \cancel{m^2 \text{tr}(\phi^i \phi^i)} + (m \text{tr}(\lambda^a \lambda^a) + \dots)$$

$\lambda \rightarrow 0 \quad \Delta = 2$

$\Delta = 3$

$\lambda \rightarrow \infty \quad \Delta \sim \lambda^{1/4}$

$\Delta = 3$

$m_{ij}^2 \text{tr}(\phi^i \phi^j)$
 $\hookrightarrow$ tachyons

* $\lambda = g_{YM}^2 N$
 $n=4$ SYM $d=4 \iff \text{IB on } AdS_5 \times S^5$

$\underline{A}_m, \lambda^a, \phi^i$ $Q^2 \text{tr}(\phi\phi)$
 $a=1, \dots, 4 \quad i=1, \dots, 6$

$\mathcal{L} + \cancel{m^2 \text{tr}(\phi^i \phi^i)} + (m \text{tr}(\lambda^a \lambda^a) + \text{c.c.})$

$\lambda \rightarrow 0 \quad \Delta=2$ $\Delta=3$

$m^2 \text{tr}(\phi^i \phi^i)$ $\lambda \rightarrow \infty \quad \Delta \sim \lambda^{1/4}$ $\Delta=3$

$\downarrow$ tachyons

$$\mathcal{L}_{\text{CFT}} + (\overline{M_1} \text{tr}(\dot{\lambda} \lambda') + M_2 \text{tr}(\lambda^2 \lambda^2) + M_3 \text{tr}(\lambda^3 \lambda^3) + M_4 \text{tr}(\lambda^4 \lambda^4)) / \text{tr}$$

$\downarrow$
 induced scalar masses
 mixing $m \phi \phi \leftrightarrow \lambda \lambda$ (? tachyonic)

$$\mathcal{L}_{\text{CFT}} + (M_1 \text{tr}(\lambda \lambda) + M_2 \text{tr}(\lambda^2 \lambda^2) + M_3 \text{tr}(\lambda^3 \lambda^3) + M_4 \text{tr}(\lambda^\dagger \lambda^\dagger)) + \text{cc}$$

$\downarrow$
 induced scalar masses
 mixing $m \phi \phi \leftrightarrow \lambda \lambda$

(? tachyonic)

Simplest: $n=1$ SUSY

$$\mathcal{L}_{\text{CFT}} + (m_1 \overline{\text{tr}(\dot{\lambda} \lambda')} + m_2 \text{tr}(\dot{\lambda}^2 \dot{\lambda}^2) + m_3 \text{tr}(\dot{\lambda}^3 \dot{\lambda}^3) + m_4 \text{tr}(\dot{\lambda}^4 \dot{\lambda}^4)) + \text{cc}$$

$\downarrow$
 induced scalar masses
 mixing $m \phi \phi \leftrightarrow \lambda \lambda$

(? tachyonic)

Simplest: $n=1$ SUSY $m_4 = 0$

$$\mathcal{L}_{\text{CFT}} + (M_1 \text{tr}(\lambda \lambda') + M_2 \text{tr}(\lambda^2 \lambda^2) + M_3 \text{tr}(\lambda^3 \lambda^3) + M_4 \text{tr}(\lambda^4 \lambda^4)) / \Lambda^4$$

$\downarrow$
 induced scalar masses
 mixing $m \phi \phi \leftrightarrow \lambda \lambda$

(? tachyonic)

Simplest: $N=1$ SUSY $M_4 = 0$

$$\mathcal{L}_{\text{CFT}} + (M_1 \text{tr}(\lambda \lambda^\dagger) + M_2 \text{tr}(\lambda^2 \lambda^2) + M_3 \text{tr}(\lambda^3 \lambda^3) + M_4 \text{tr}(\lambda^\dagger \lambda^\dagger)) + \text{cc.}$$

$\downarrow$
 induced scalar masses
 mixing $m \phi \phi \leftrightarrow \lambda \lambda$

(? tachyonic)

Simplest: $N=1$ SUSY $M_4 = 0$

$$W = \frac{2\sqrt{2}}{g_{\text{YM}}^2}$$

* $\lambda = g_{YM}^2 N$
 $n=4$ SYM $d=4 \longleftrightarrow \text{IIB on } \text{AdS}_5 \times S^5$

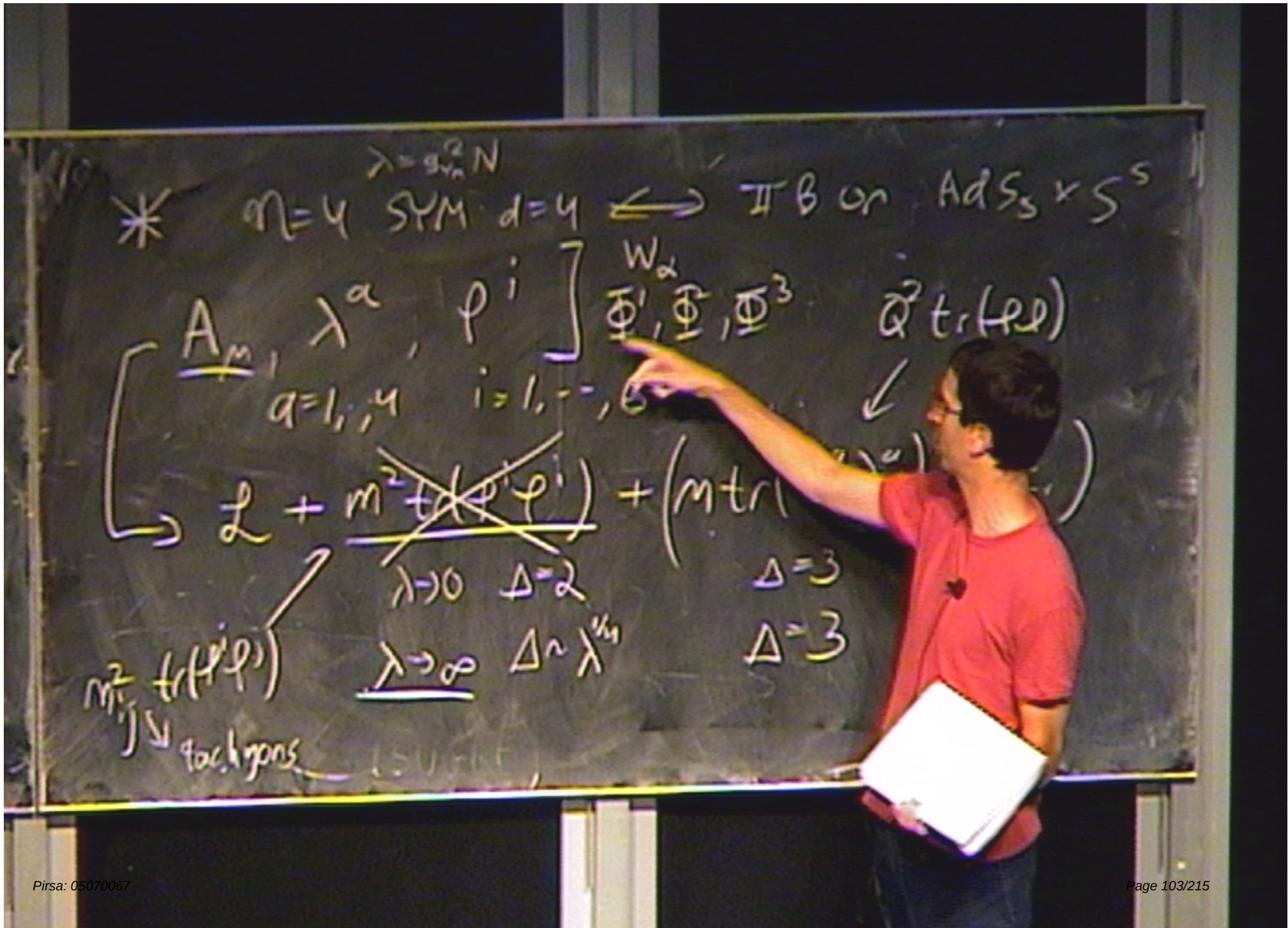
$$\left[\underline{A}_\mu, \lambda^a, \phi^i \right] \xrightarrow{W_\alpha} \Phi^1, \Phi^2, \Phi^3 \quad Q^2 \text{tr}(\phi\phi)$$

$i=1, \dots, 6$

$$\mathcal{L} + \cancel{m^2 \text{tr}(\phi^i \phi^i)} + m \text{tr}(\lambda^a \lambda^a) + \text{c.c.}$$

$\lambda \rightarrow 0 \quad \Delta = 2$ $\Delta = 3$
 $\lambda \rightarrow \infty \quad \Delta \sim \lambda^{1/4}$ $\Delta = 3$

$m^2 \text{tr}(\phi^i \phi^i)$
 $\downarrow$ tachyons



$$\lambda = g_{YM}^2 N$$

* $n=4$ SYM $d=4 \iff \text{IIB on } AdS_5 \times S^5$

$$\left[\begin{array}{c} \underline{A}_\mu, \lambda^a, \phi^i \\ a=1, \dots, 4 \quad i=1, \dots, 6 \end{array} \right] \xrightarrow{W_\alpha} \left[\begin{array}{c} \Phi^1, \Phi^2, \Phi^3 \\ \downarrow \end{array} \right] \quad Q^2 \text{tr}(\phi^2)$$

$$\mathcal{L} + \cancel{m^2 \text{tr}(\phi^i \phi^i)} + (m \text{tr}(\dots))$$

$\lambda \rightarrow 0 \quad \Delta = 2$
 $\lambda \rightarrow \infty \quad \Delta \sim \lambda^{1/4}$

$\Delta = 3$
 $\Delta = 3$

$m^2 \text{tr}(\phi^i \phi^i)$
 $\downarrow$
 tachyons

* $\lambda = g_{YM}^2 N$
 $n=4$ SYM $d=4 \longleftrightarrow \text{IIB on } \text{AdS}_5 \times S^5$

$$\left[\begin{array}{c} \underline{A}_\mu, \lambda^a, \phi^i \\ a=1, \dots, 4 \quad i=1, \dots, 6 \end{array} \right] \xrightarrow{W_\alpha} \Phi^1, \Phi^2, \Phi^3 \quad Q^2 \text{tr}(\phi\phi)$$

$$\mathcal{L} + \cancel{m^2 \text{tr}(\phi^i \phi^i)} + (m \text{tr}(\lambda^a \lambda^a)) +$$

$$\lambda \rightarrow 0 \quad \Delta = 2 \quad \Delta = 3$$

$$\lambda \rightarrow \infty \quad \Delta \sim \lambda^{1/4} \quad \Delta = 3$$

$$m^2 \text{tr}(\phi^i \phi^i) \rightarrow \text{tachyons}$$

* $\lambda = g_{YM}^2 N$
 $n=4$ SYM $d=4 \longleftrightarrow$ $\mathcal{N}=8$ on $AdS_5 \times S^5$

$$\left[\underline{A}_m, \lambda^a, \phi^i \right] \xrightarrow{W_\alpha} \Phi^1, \Phi^2, \Phi^3 \quad \bar{Q}^2 \text{tr}(\psi\psi)$$

$a=1, \dots, 4 \quad i=1, \dots, 6$

$$\mathcal{L} + \cancel{m^2 \text{tr}(\phi^i \phi^i)} + (m \text{tr}(\lambda^a \lambda^a) + \text{c.c.})$$

$m^2 \text{tr}(\phi^i \phi^i) \xrightarrow{\lambda \rightarrow 0} \Delta=2$
 $\xrightarrow{\lambda \rightarrow \infty} \Delta \sim \lambda^{1/4} \quad \Delta=3$

$\downarrow$ tachyons $(SU(4) \times U(1))$

* $\lambda = g_{YM}^2 N$
 $n=4$ SYM $d=4 \longleftrightarrow$ ΠB on $AdS_5 \times S^5$

$$\left[\underline{A}_m, \lambda^a, \phi^i \right] \xrightarrow{W_\alpha} \Phi^1, \Phi^2, \Phi^3 \quad \partial^2 \text{tr}(\phi\phi)$$

$a=1, \dots, 4 \quad i=1, \dots, 6$

$$\mathcal{L} + \cancel{m^2 \text{tr}(\phi^i \phi^i)} + (m \text{tr}(\lambda^a \lambda^a) + \text{c.c.})$$

$m^2 \text{tr}(\phi^i \phi^i)$ $\xrightarrow{\lambda \rightarrow 0} \Delta=2$ $\Delta=3$
 $\xrightarrow{\lambda \rightarrow \infty} \Delta \sim \lambda^{1/4}$ $\Delta=3$
 $\downarrow$ tachyons

$$\mathcal{L}_{\text{CFT}} + (M_1 \text{tr}(\dot{\lambda} \dot{\lambda}') + M_2 \text{tr}(\lambda^2 \lambda'^2) + M_3 \text{tr}(\lambda^3 \lambda'^3) + M_4 \text{tr}(\lambda^4 \lambda'^4)) / \text{tr}$$

$\downarrow$
 induced scalar masses
 mixing $m\phi\phi \leftrightarrow \lambda\lambda$ (? tachyonic)

Simplest: $N=1$ SUSY $M_4 = 0$

$$W = \frac{2\sqrt{2}}{g_{\text{YM}}^2} \text{tr}(\Phi^2 \Gamma \Phi)$$

$$\mathcal{L}_{\text{CFT}} + \left(m_1 \text{tr}(\lambda \lambda^\dagger) + m_2 \text{tr}(\lambda^2 \lambda^2) + m_3 \text{tr}(\lambda^3 \lambda^3) + m_4 \text{tr}(\lambda^\dagger \lambda^\dagger) \right) + \text{tr}(\dots)$$

$\downarrow$
 induced scalar masses
 mixing $m\phi\phi \leftrightarrow \lambda\lambda$

(? tachyonic)

Simplest: $\mathcal{N}=1$ SUSY $m_4 = 0$

$$W = \frac{2\sqrt{2}}{g_{\text{YM}}^2} \text{tr}(\Phi_1 [\Phi_2, \Phi_3])$$

$$\mathcal{L}_{\text{CFT}} + (m_1 \text{tr}(\lambda \lambda^\dagger) + m_2 \text{tr}(\lambda^2 \lambda^2) + m_3 \text{tr}(\lambda^3 \lambda^3) + m_4 \text{tr}(\lambda^\dagger \lambda^\dagger)) + \text{cc}$$

$\downarrow$
 induced scalar masses
 mixing $m\phi\phi \leftrightarrow \lambda\lambda$ (? tachyonic)

Simplest: $N=1$ SUSY $m_4 = 0$

$$W = \frac{2\sqrt{2}}{g_{\text{YM}}^2} \text{tr}(\Phi_1 [\Phi_2, \Phi_3]) + \frac{1}{g_{\text{YM}}^2} (m_1 \text{tr}(\Phi_1^2) + m_2 \text{tr}(\Phi_2^2) + m_3 \text{tr}(\Phi_3^2))$$

$$\mathcal{L}_{\text{CFT}} + \left(m_1 \text{tr}(\lambda \lambda^\dagger) + m_2 \text{tr}(\lambda^2 \lambda^2) + m_3 \text{tr}(\lambda^3 \lambda^3) + m_4 \text{tr}(\lambda^\dagger \lambda^\dagger) \right) + \text{cor.}$$

$\downarrow$
 induced scalar masses
 mixing $m\phi\phi \leftrightarrow \lambda\lambda$ (? tachyonic)

Simplest: $N=1$ SUSY $m_4 = 0$

$$W = \frac{2\sqrt{2}}{g_{\text{YM}}^2} \text{tr}(\Phi_1 [\Phi_2, \Phi_3]) + \frac{1}{g_{\text{YM}}^2} \left(m_1 \text{tr}(\Phi_1^2) + m_2 \text{tr}(\Phi_2^2) + m_3 \text{tr}(\Phi_3^2) \right)$$

$$\mathcal{L}_{\text{CFT}} + \left(m_1 \text{tr}(\lambda \lambda') + m_2 \text{tr}(\lambda^2 \lambda^2) + m_3 \text{tr}(\lambda^3 \lambda^3) + m_4 \text{tr}(\lambda^4 \lambda^4) \right) + \text{cc}$$

$\downarrow$
 induced scalar masses
 mixing $m \phi \phi \leftrightarrow \lambda \lambda$ (? tachyonic)

Simplest: $N=1$ SUSY $m_4 = 0$

$$W = \frac{2\sqrt{2}}{g_{\text{YM}}^2} \text{tr}(\Phi_1 [\Phi_2, \Phi_3]) + \frac{1}{g_{\text{YM}}^2} \left(m_1 \text{tr}(\Phi_1^2) + m_2 \text{tr}(\Phi_2^2) + m_3 \text{tr}(\Phi_3^2) \right)$$

$m_1, m_2, m_3 \neq 0$

$$\mathcal{L}_{\text{CFT}} + \left(m_1 \text{tr}(\lambda \lambda') + m_2 \text{tr}(\lambda^2 \lambda^2) + m_3 \text{tr}(\lambda^3 \lambda^3) + m_4 \text{tr}(\lambda^\dagger \lambda^\dagger) \right) + \text{cc}$$

$\downarrow$
 induced scalar masses
 mixing $m \phi \phi \leftrightarrow \lambda \lambda$ (? tachyon)

Simplest: $\mathcal{N}=1$ SUSY $m_4 = 0$

$$W = \frac{2\sqrt{2}}{g_{\text{YM}}^2} \text{tr}(\Phi_1 [\Phi_2, \Phi_3]) + \frac{1}{g_{\text{YM}}^2} \left(m_1 \text{tr}(\Phi_1^2) + m_2 \text{tr}(\Phi_2^2) + m_3 \text{tr}(\Phi_3^2) \right)$$

$m_1, m_2, m_3 \neq 0$

$$\mathcal{L}_{\text{CFT}} + (M_1 \text{tr}(\dot{\lambda} \dot{\lambda}') + M_2 \text{tr}(\lambda^2 \lambda'^2) + M_3 \text{tr}(\lambda^3 \lambda'^3) + M_4 \text{tr}(\lambda^4 \lambda'^4)) + \text{cc}$$

$\downarrow$
 induced scalar masses
 mixing $m_{\Phi\Phi} \leftrightarrow \lambda\lambda$ (? tachyonic)

Simplest: $N=1$ SUSY $M_4 = 0$

$$W = \frac{2\sqrt{2}}{g_{\text{YM}}^2} \text{tr}(\Phi_1 [\Phi_2, \Phi_3]) + \frac{1}{g_{\text{YM}}^2} (M_1 \text{tr}(\Phi_1^2) + M_2 \text{tr}(\Phi_2^2) + M_3 \text{tr}(\Phi_3^2))$$

$M_1, M_2, M_3 \neq 0$

Naive

Naive :

Naive :

$$\epsilon \ll m;$$

$$n = 1 \text{ SYM}$$

Naive :

$\epsilon \ll m;$

$n=1$ SYM

Naive :

$$E \ll m;$$

$$n = 1 \text{ SYM}$$

$$\Lambda_{\text{SYM}}$$

Naive :

$$E \ll m;$$

$$n = 1 \text{ SYM}$$

$$\Lambda_{\text{SYM}}$$

Naive :

$$\epsilon \ll \underline{m_i}$$

$$n = 1 \text{ SYM}$$

$$\underline{\Lambda_{\text{SYM}}}$$

$$\epsilon \uparrow g_m^2$$

Naive :

$$\epsilon \ll \underline{m_i}$$

$$n = 1 \text{ SYM}$$

$$\underline{\Lambda_{\text{SYM}}}$$

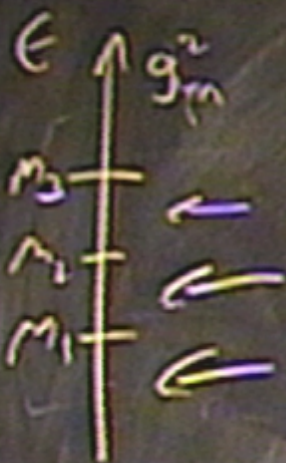
$$\begin{array}{c} \epsilon \uparrow g_m^2 \\ m_3 \\ m_2 \\ m_1 \end{array}$$

Naive :

$$\epsilon \ll \underline{m_i}$$

$$n = 1 \text{ SYM}$$

$$\underline{\Lambda_{\text{SYM}}}$$



Naive

$$\epsilon \ll \underline{m_1}$$

$$n = 1 \text{ SYM}$$

$$\underline{\Lambda_{\text{SYM}}}$$

$$\epsilon \uparrow g_m^2$$

$$m_3$$

$$m_2$$

$$m_1$$

$$\leftarrow \Lambda_{\text{SYM}}$$

Naive :

$$\epsilon \ll \underline{m_i}$$

$$n = 1 \text{ SYM}$$

$$\underline{\Lambda_{\text{SYM}}}$$

$\epsilon \uparrow g_m^2$

m_3

m_2

m_1

←

←

←

Λ_{SYM}

Naive :

$$E \ll \underline{m_i}$$

$$n = 1 \text{ SYM}$$

$$\underline{\Lambda_{\text{SYM}}}$$

$$E \uparrow g_m^2$$

$$m_3$$

$$m_2$$

$$m_1$$



$$\Lambda_{\text{SYM}}^3 =$$

Naive :

$$\epsilon \ll \underline{m_i}$$

$$n = 1 \text{ SYM}$$

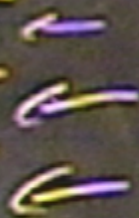
$$\underline{\Lambda_{\text{SYM}}}$$

$$\epsilon \uparrow g_m^2$$

$$m_3$$

$$m_2$$

$$m_1$$

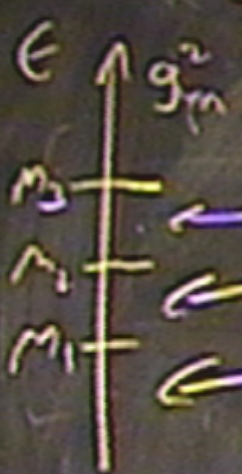


$$\Lambda_{\text{SYM}}^3 = m_1 m_2 m_3 e^{-\frac{8\pi^2}{g_m^2 N}}$$

Naive :

$$\epsilon \ll m_i$$

$$n = 1 \text{ SYM}$$



$$\left(\frac{\Lambda}{\mu}\right)^b = e^{-\frac{8\pi^2}{g_m^2 N}}$$

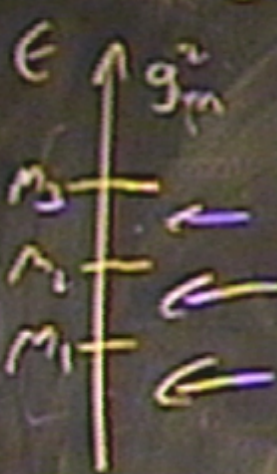
$$\Lambda_{\text{SYM}}$$

$$\Lambda_{\text{SYM}}^3 = m_1 m_2 m_3 e^{-\frac{8\pi^2}{g_m^2 N}}$$

Naive :

$$\epsilon \ll m_i$$

$$n = 1 \text{ SYM}$$



$$\left(\frac{\Lambda}{\mu}\right)^b = e^{-\frac{8\pi^2}{g_m^2 N}}$$

$$\Lambda_{\text{SYM}}$$

$$\Lambda_{\text{SYM}}^3 = m_1 m_2 m_3 e^{-\frac{8\pi^2}{g_m^2 N}}$$

Naive :

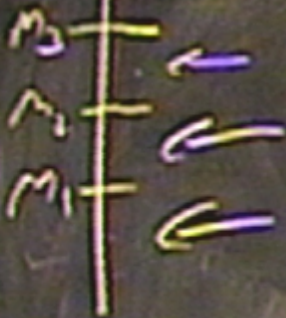
$$E \ll m_i$$

$$n = 1 \text{ SYM}$$

$$E \uparrow g_m^2$$

$$\left(\frac{\Lambda}{\mu}\right)^6 = e^{-\frac{8\pi^2}{g_m^2 N}}$$

$$\Lambda_{\text{SYM}}$$



$$\Lambda_{\text{SYM}}^3 = m_1 m_2 m_3 e^{-\frac{8\pi^2}{g_m^2 N}}$$

Naive :

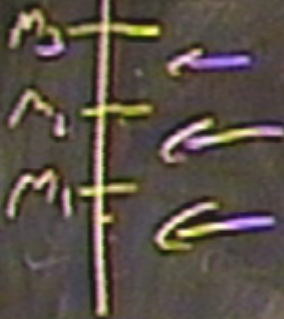
$$E \ll m_i$$

$$n = 1 \text{ SYM}$$

$$E \uparrow g_m^2$$

$$\left(\frac{\Lambda}{m}\right)^6 = e^{-\frac{8\pi^2}{g_m^2 N}}$$

$$\Lambda_{\text{SYM}}$$



$$\Lambda_{\text{SYM}}^3 = m_1 m_2 m_3 e^{-\frac{8\pi^2}{g_m^2 N}}$$

Naive :

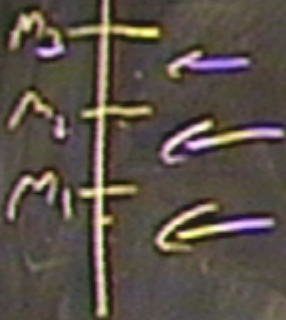
$$\epsilon \ll m_i$$

$$n = 1 \text{ SYM}$$

$$\epsilon \uparrow g_m^2$$

$$\left(\frac{\Lambda}{m}\right)^6 = e^{-\frac{8\pi^2}{g_m^2 N}}$$

$$\Lambda_{\text{SYM}}$$

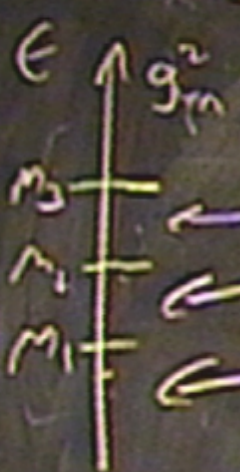


$$\Lambda_{\text{SYM}}^3 = m_1 m_2 m_3 e^{-\frac{8\pi^2}{g_m^2 N}}$$

Naive :

$$\epsilon \ll \underline{m_i}$$

$$n = 1 \text{ SYM}$$



$$\left(\frac{\Lambda}{\mu}\right)^6 = e^{-\frac{8\pi^2}{g_m^2 N}}$$

$$\underline{\Lambda_{\text{SYM}}}$$

$$\underline{\Lambda_{\text{SYM}}^3 = m_1 m_2 m_3 e^{-\frac{8\pi^2}{g_m^2 N}}}$$

$$\lambda = g_m^2 N \ll 1$$

Naive :

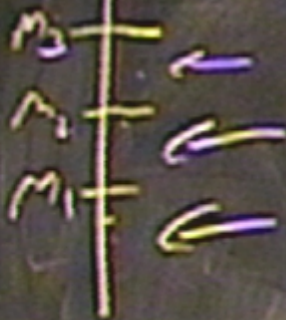
$$\epsilon \ll m_i$$

$$n = 1 \text{ SYM}$$

$$\epsilon \uparrow g_m^2$$

$$\left(\frac{\Lambda}{m}\right)^6 = e^{-\frac{8\pi^2}{g_m^2 N}}$$

$$\underline{\Lambda_{\text{SYM}}}$$



$$\Lambda_{\text{SYM}}^3 = m_1 m_2 m_3 \cdot e^{-\frac{8\pi^2}{g_m^2 N}}$$

$$\lambda = g_m^2 N \ll 1$$

$$\Lambda_{\text{SYM}} \ll m_i$$

Naive :

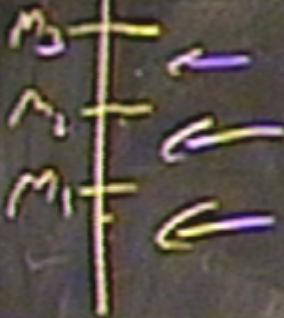
$$\epsilon \ll m_i$$

$$n = 1 \text{ SYM}$$

$$\epsilon \uparrow g_m^2$$

$$\left(\frac{\Lambda}{\mu}\right)^b = e^{-\frac{8\pi^2}{g_m^2 N}}$$

$$\Lambda_{\text{SYM}}$$



$$\Lambda_{\text{SYM}}^3 = m_1 m_2 m_3 e^{-\frac{8\pi^2}{g_m^2 N}}$$

$$\lambda = g_m^2 N \ll 1$$

$$\Lambda_{\text{SYM}} \ll m_i$$

Naive

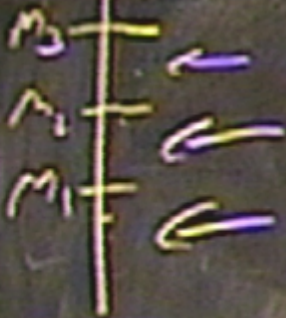
$$E \ll m_i$$

$$n = 1 \text{ SYM}$$

$$E \uparrow g_m^2$$

$$\left(\frac{\Lambda}{m}\right)^6 = e^{-\frac{8\pi^2}{g_m^2 N}}$$

$$\Lambda_{\text{SYM}}$$



$$\Lambda_{\text{SYM}}^3 = m_1 m_2 m_3 e^{-\frac{8\pi^2}{g_m^2 N}}$$

$$\lambda = g_m^2 N \ll 1$$

$$\Lambda_{\text{SYM}} \ll m_i$$

Naive V

Naive :

$$\epsilon \ll m_i$$

$$n = 1 \text{ SYM}$$

$$\epsilon \uparrow g_m^2$$

$$\left(\frac{\Lambda}{\mu}\right)^b = e^{-\frac{8\pi^2}{g_m^2 N}}$$

$$\Lambda_{\text{SYM}}$$

$$m_i \sim \Lambda_{\text{new}}$$

$$\begin{array}{c} m_3 \\ m_2 \\ m_1 \end{array} \leftarrow$$

$$\Lambda_{\text{SYM}}^3 = m_1 m_2 m_3 e^{-\frac{8\pi^2}{g_m^2 N}}$$

$$\lambda = g_m^2 N \ll 1$$

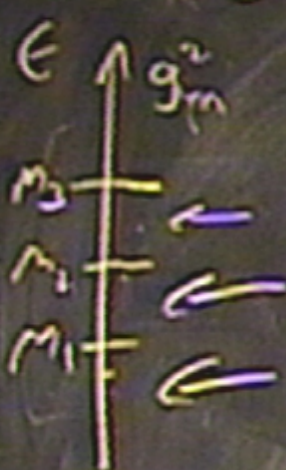
$$\Lambda_{\text{SYM}} \ll m_i$$

Naive V

Naive :

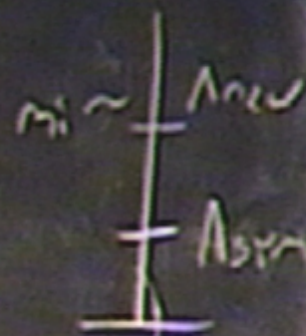
$$\epsilon \ll m_i$$

$$n = 1 \text{ SYM}$$



$$\left(\frac{\Lambda}{\mu}\right)^b = e^{-\frac{8\pi^2}{g_m^2 N}}$$

$$\Lambda_{\text{SYM}}$$



$$\Lambda_{\text{SYM}}^3 = m_1 m_2 m_3 e^{-\frac{8\pi^2}{g_m^2 N}}$$

$$\lambda = g_m^2 N \ll 1$$

$$\Lambda_{\text{SYM}} \ll m_i$$

Naive V

Naive :

$$\epsilon \ll m_i$$

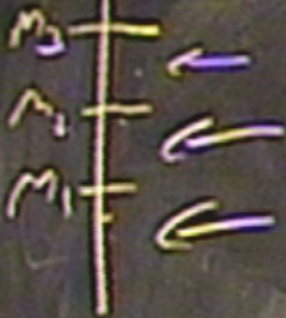
$$n = 1 \text{ SYM}$$

$$\epsilon \uparrow g_m^2$$

$$\left(\frac{\Lambda}{m}\right)^6 = e^{-\frac{8\pi^2}{g_m^2 N}}$$

$$\Lambda_{\text{SYM}}$$

$$m_i \sim \Lambda_{\text{new}}$$



$$\Lambda_{\text{SYM}}^3 = m_1 m_2 m_3 e^{-\frac{8\pi^2}{g_m^2 N}}$$



$$\lambda = g_m^2 N \ll 1$$

$$\Lambda_{\text{SYM}} \ll m_i$$

Naive V

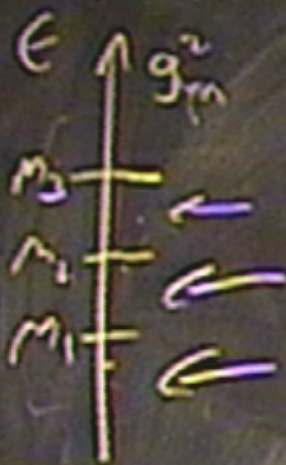
$$\lambda \gg 1$$

$$\Lambda_{\text{SYM}} \sim m_i$$

Naive

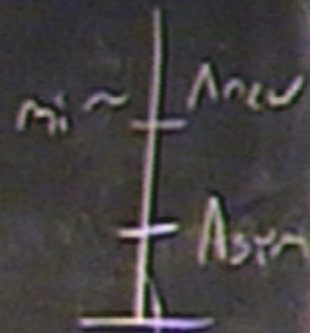
$$\epsilon \ll m_i$$

$$n = 1 \text{ SYM}$$



$$\left(\frac{\Lambda}{m}\right)^6 = e^{-\frac{8\pi^2}{g_m^2 N}}$$

$$\Lambda_{\text{SYM}}$$



$$\Lambda_{\text{SYM}}^3 = m_1 m_2 m_3 e^{-\frac{8\pi^2}{g_m^2 N}}$$

$$\lambda = g_m^2 N \ll 1$$

$$\Lambda_{\text{SYM}} \ll m_i$$

Naive $\checkmark$

$$\lambda \gg 1$$

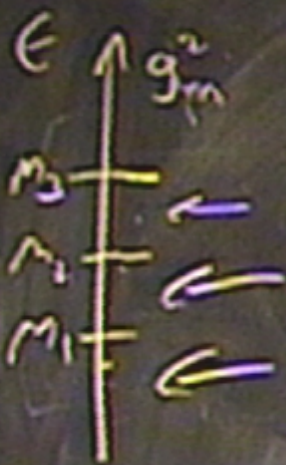
$$\Lambda_{\text{SYM}} \sim m_i$$

X

Naive :

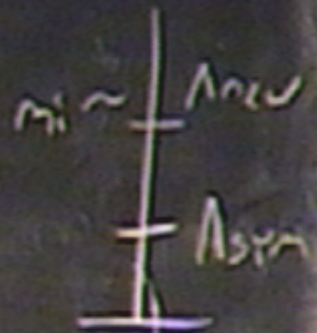
$$\epsilon \ll m_i$$

$$\eta = 1 \text{ SYM}$$



$$\left(\frac{\Lambda}{\mu}\right)^b = e^{-\frac{8\pi^2}{g_m^2 N}}$$

$$\Lambda_{\text{SYM}}$$



$$\Lambda_{\text{SYM}}^3 = m_1 m_2 m_3 e^{-\frac{8\pi^2}{g_m^2 N}}$$

$$\lambda = g_m^2 N \ll 1$$

$$\Lambda_{\text{SYM}} \ll m_i$$

Naive V

$$\lambda \gg 1$$

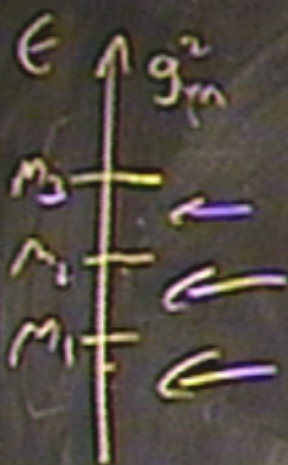
$$\Lambda_{\text{SYM}} \sim m_i$$

X

Naive :

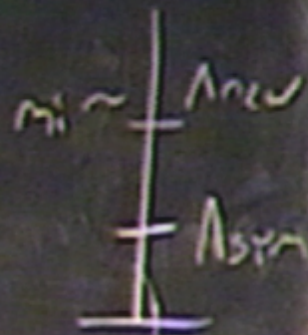
$$\epsilon \ll m_i$$

$$\eta = 1 \text{ SYM}$$



$$\left(\frac{\Lambda}{m}\right)^6 = e^{-\frac{8\pi^2}{g_m^2 N}}$$

$$\Lambda_{\text{SYM}}$$



$$\Lambda_{\text{SYM}}^3 = m_1 m_2 m_3 e^{-\frac{8\pi^2}{g_m^2 N}}$$

$$\lambda = g_m^2 N \ll 1$$

$$\Lambda_{\text{SYM}} \ll m_i$$

Naive V

$$\lambda \gg 1$$

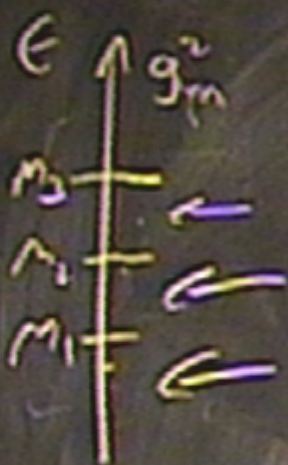
$$\Lambda_{\text{SYM}} \sim m_i$$

SUGRA? X

Naive :

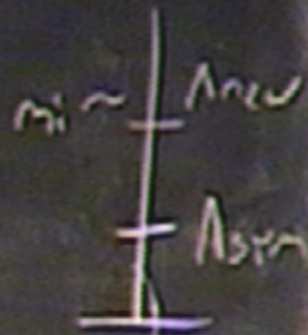
$$\epsilon \ll m_i$$

$$\eta = 1 \text{ SYM}$$



$$\left(\frac{\Lambda}{\mu}\right)^b = e^{-\frac{8\pi^2}{g_m^2(N)}} \quad A$$

$$\Lambda_{\text{SYM}}$$



$$\Lambda_{\text{SYM}}^3 = m_1 m_2 m_3 e^{-\frac{8\pi^2}{g_m^2 N}}$$

$$\lambda = g_m^2 N \ll 1$$

$$\Lambda_{\text{SYM}} \ll m_i$$

Naive V

$$\lambda \gg 1$$

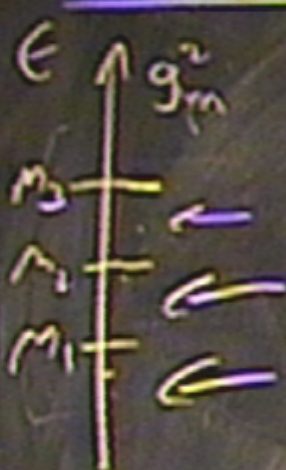
$$\Lambda_{\text{SYM}} \sim m_i$$

SUGRA? X

Naive :

$$\epsilon \ll m_i$$

$$n = 1 \text{ SYM}$$



$$\left(\frac{\Lambda}{m}\right)^6 = e^{-\frac{8\pi^2}{g_m^2 N}}$$

$$\Lambda_{\text{SYM}}$$

$$m_i \sim \Lambda_{\text{new}} + \Lambda_{\text{SYM}}$$

$$\Lambda_{\text{SYM}}^3 = m_1 m_2 m_3 e^{-\frac{8\pi^2}{g_m^2 N}}$$

$$\lambda = g_m^2 N \ll 1$$

$$\Lambda_{\text{SYM}} \ll m_i$$

Naive

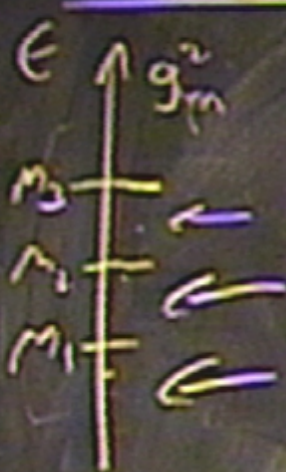
$$\lambda \gg 1$$

$$\Lambda_{\text{SYM}} \sim m_i \text{ SUGRA?}$$

Naive :

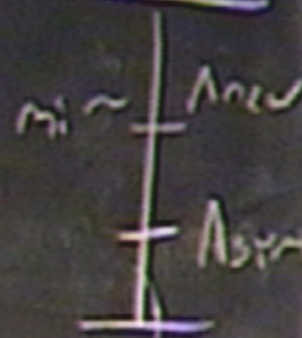
$$E \ll m_i$$

$$g = 1 \text{ SYM}$$



$$\left(\frac{\Lambda}{m}\right)^6 = e^{-\frac{8\pi^2}{g_m^2 N}}$$

$$\Lambda_{\text{SYM}}$$



$$\Lambda_{\text{SYM}}^3 = m_1 m_2 m_3 e^{-\frac{8\pi^2}{g_m^2 N}}$$

$$\lambda = g_m^2 N \ll 1$$

$$\Lambda_{\text{SYM}} \ll m_i$$

Naive V

$$\lambda \gg 1$$

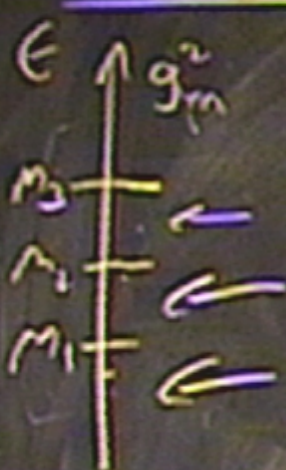
$$\Lambda_{\text{SYM}} \sim m_i$$

SUGRA? X

Naive :

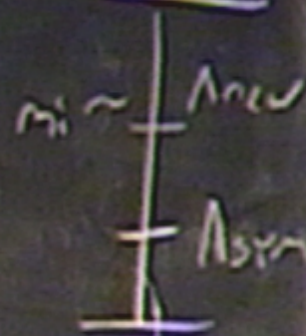
$$\epsilon \ll m_i$$

$$n = 1 \text{ SYM}$$



$$\left(\frac{\Lambda}{\mu}\right)^6 = e^{-\frac{8\pi^2}{g_m^2 N}}$$

$$\Lambda_{\text{SYM}}$$



$$\Lambda_{\text{SYM}}^3 = m_1 m_2 m_3 e^{-\frac{8\pi^2}{g_m^2 N}}$$

$$\lambda = g_m^2 N \ll 1$$

$$\Lambda_{\text{SYM}} \ll m_i$$

Naive V

$$\lambda \gg 1$$

$$\Lambda_{\text{SYM}} \sim m_i$$

SUGRA? X

Many discrete vacua:

$$W = \frac{2\sqrt{2}}{g_{YM}^2} \text{tr}(\Phi_1 [\Phi_2, \Phi_3]) + \frac{1}{g_{YM}^2} (m_1 \text{tr}(\Phi_1^2) + m_2 \text{tr}(\Phi_2^2) + m_3 \text{tr}(\Phi_3^2))$$

$m_1, m_2, m_3 \neq 0$

Many discrete ^{SUSY} vacua:

$$W = \frac{2\sqrt{2}}{g_{\text{YM}}^2} \text{tr}(\Phi_1 [\Phi_2, \Phi_3]) + \frac{1}{g_{\text{YM}}^2} (m_1 \text{tr}(\Phi_1^2) + m_2 \text{tr}(\Phi_2^2) + m_3 \text{tr}(\Phi_3^2))$$

$m_1, m_2, m_3 \neq 0$

Many discrete ^{SUSY} vacua: $\frac{\partial W}{\partial \Phi_i} = 0$ / complexified
gauge group
 $SL(N, \mathbb{C})$

$$W = \frac{2\sqrt{2}}{g_{YM}^2} \text{tr}(\Phi_1 [\Phi_2, \Phi_3]) + \frac{1}{g_{YM}^2} (m_1 \text{tr}(\Phi_1^2) + m_2 \text{tr}(\Phi_2^2) + m_3 \text{tr}(\Phi_3^2))$$

$m_1, m_2, m_3 \neq 0$

SUSY
 Many discrete vacua: $\frac{\partial W}{\partial \Phi_i} = 0$ / complexified gauge group $SL(N, \mathbb{C})$
 $[\Phi_i, \Phi_j] = -\frac{m}{\sqrt{2}} \epsilon_{ijk} \Phi_k$

$$W = \frac{2\sqrt{2}}{g_{YM}^2} \text{tr}(\Phi_1 [\Phi_2, \Phi_3]) + \frac{1}{g_{YM}^2} (m_1 \text{tr}(\Phi_1^2) + m_2 \text{tr}(\Phi_2^2) + m_3 \text{tr}(\Phi_3^2))$$

$m_1, m_2, m_3 \neq 0$

Many discrete ^{SUSY} vacua: $\frac{\partial W}{\partial \Phi_i} = 0$ / complexified
 gauge group $SL(N, \mathbb{C})$

$$[\Phi_i, \Phi_j] = -\frac{m}{\sqrt{2}} \varepsilon_{ijk} \Phi_k \leftarrow$$

$$W = \frac{2\sqrt{2}}{g_{YM}^2} \text{tr}(\Phi_1 [\Phi_2, \Phi_3]) + \frac{1}{g_{YM}^2} (m_1 \text{tr}(\Phi_1^2) + m_2 \text{tr}(\Phi_2^2) + m_3 \text{tr}(\Phi_3^2))$$

$m_1, m_2, m_3 \neq 0$

$\overbrace{\text{SUSY}}^{\text{SUSY}}$
 Many discrete vacua: $\frac{\partial W}{\partial \Phi_i} = 0$ / complexified gauge group $SL(N, \mathbb{C})$
 $[\Phi_i, \Phi_j] = -\frac{m}{\sqrt{2}} \epsilon_{ijk} \Phi_k$

$\rightarrow \frac{\sqrt{2} \Phi_i}{m}$

$W = \frac{2\pi}{g_m} ([\Phi_1, \Phi_2] + [\Phi_2, \Phi_3] + [\Phi_3, \Phi_1]) + \frac{1}{g_m^2} (m_1 \text{tr}(\Phi_1^2) + m_2 \text{tr}(\Phi_2^2) + m_3 \text{tr}(\Phi_3^2))$
 $m_1, m_2, m_3 \neq 0$

Many discrete vacua: $\frac{\partial W}{\partial \Phi_i} = 0$ / complexified gauge group $SL(N, \mathbb{C})$

$$[\Phi_i, \Phi_j] = -\frac{m}{\sqrt{2}} \varepsilon_{ijk} \Phi_k$$

$\rightarrow \frac{\sqrt{2}\Phi_i}{m}$ are a representation N -dimensional

$$W = \frac{2\sqrt{2}}{g_{YM}^2} \text{tr}(\Phi_1 [\Phi_2, \Phi_3]) + \frac{1}{g_{YM}^2} (m_1 \text{tr}(\Phi_1^2) + m_2 \text{tr}(\Phi_2^2) + m_3 \text{tr}(\Phi_3^2))$$

$m_1, m_2, m_3 \neq 0$

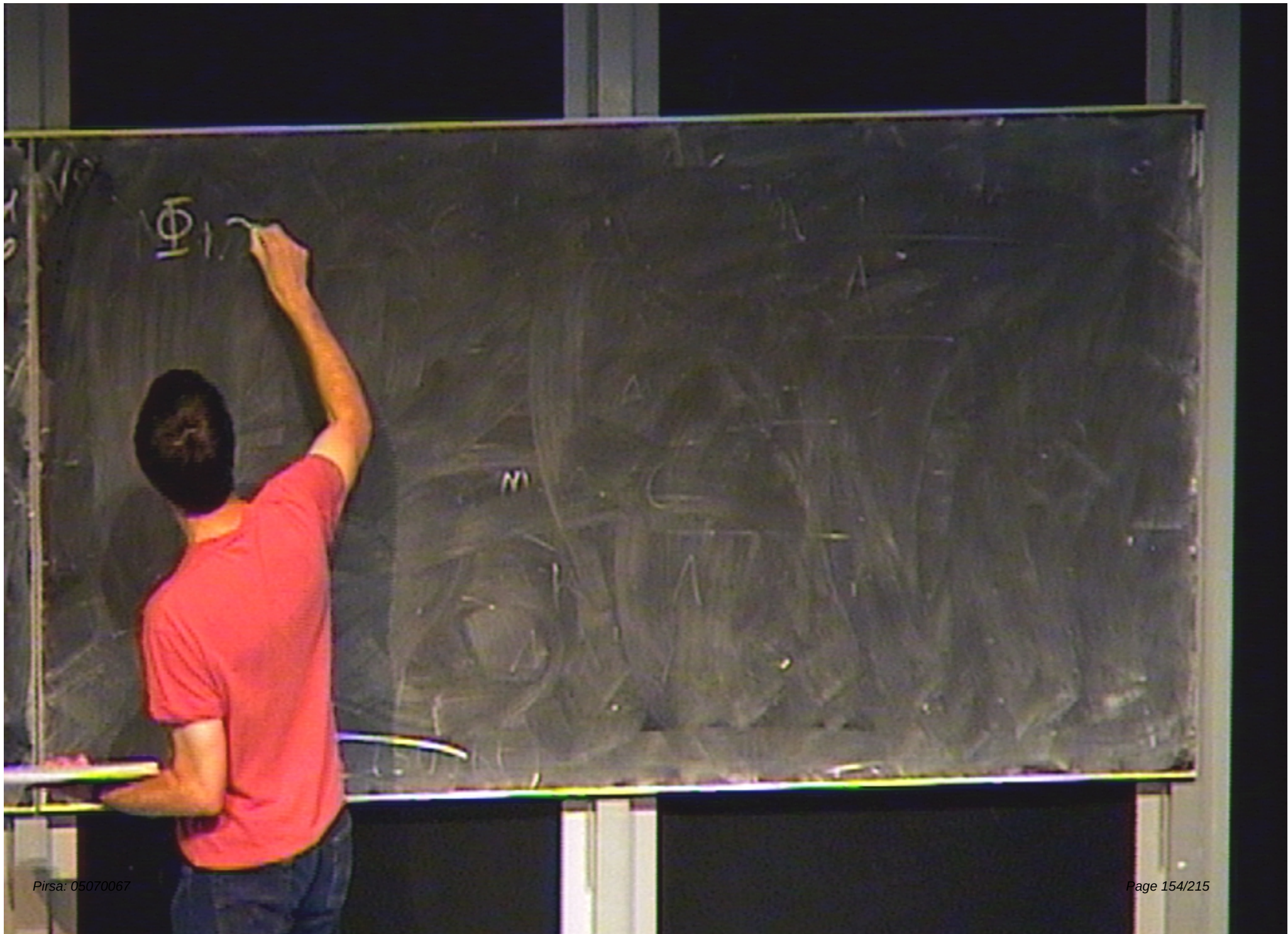
Many discrete vacua: $\frac{\partial W}{\partial \Phi_i} = 0$ SUSY Classical vacua
complexified gauge group $SL(N, \mathbb{C})$

$$[\Phi_i, \Phi_j] = -\frac{m}{\sqrt{2}} \varepsilon_{ijk} \Phi_k$$

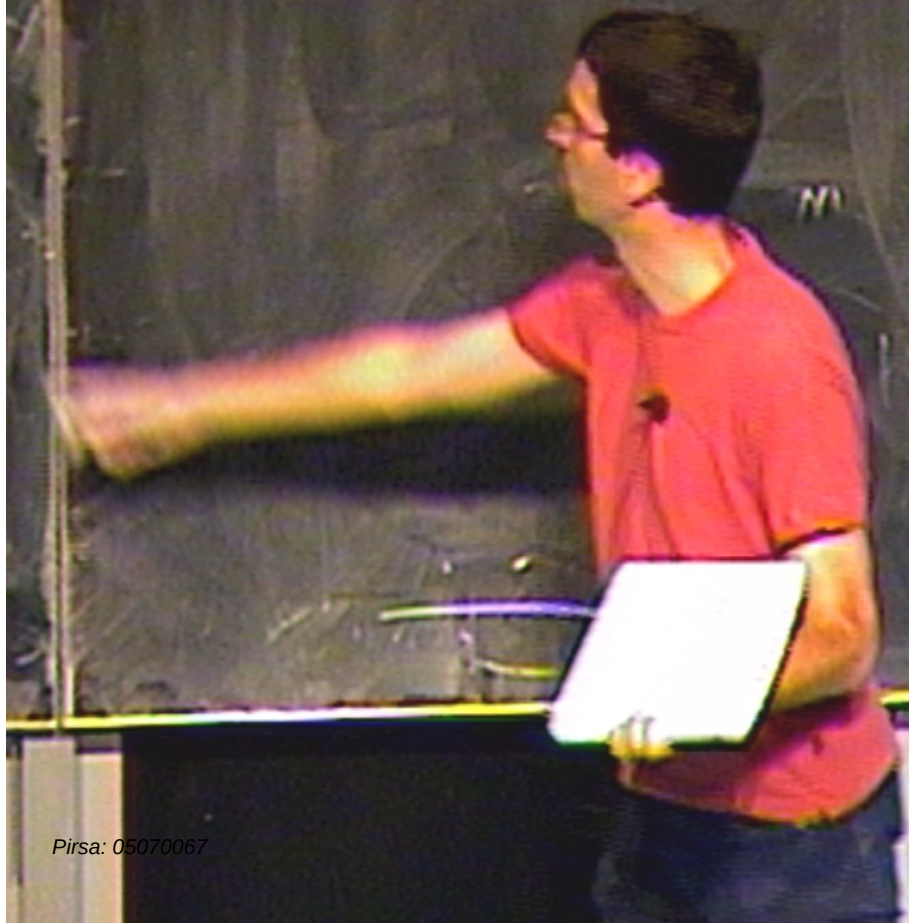
$\rightarrow \frac{\sqrt{2}\Phi_i}{m}$ are a representation
 N-dimensional

$$W = \frac{2\sqrt{2}}{g_{YM}^2} \text{tr}(\Phi_1 [\Phi_2, \Phi_3]) + \frac{1}{g_{YM}^2} (m_1 \text{tr}(\Phi_1^2) + m_2 \text{tr}(\Phi_2^2) + m_3 \text{tr}(\Phi_3^2))$$

$m_1, m_2, m_3 \neq 0$



$$\Phi_1 \sim \begin{pmatrix} \lambda_1 & 0 & 0 \\ 0 & \lambda_2 & 0 \\ 0 & 0 & \ddots \end{pmatrix}$$



$$\Phi_1 \sim \begin{pmatrix} n_1 & 0 & 0 \\ 0 & n_2 & 0 \\ 0 & 0 & \ddots \end{pmatrix}$$

$$\sum n_i = N$$

$$* n_1 = N$$

$$\Phi_1 \sim \begin{pmatrix} n_1 & 0 & 0 \\ 0 & n_2 & 0 \\ 0 & 0 & \ddots \end{pmatrix}$$

$$\sum n_i = N$$

$$* n_1 = N \quad \text{SU}(N)$$

$$\underline{\Phi}_1 \sim \begin{pmatrix} n_1 & 0 & 0 \\ 0 & n_2 & 0 \\ 0 & 0 & \ddots \end{pmatrix}$$

$$\sum n_i = N$$

* $n_1 = N$ ~~SU(N)~~ Higgs vacuum

* In all other vacua, some is preserved

$$\Phi \sim \begin{pmatrix} n_1 & 0 & 0 \\ 0 & n_2 & 0 \\ 0 & 0 & \ddots \end{pmatrix}$$

$$\sum n_i = N$$

* $n_i = N$ ~~$SU(N)$~~ Higgs vacuum

* In all other vacua, some is preserved

$n_i = 1 \rightarrow \Phi_i = 0$ classically $SU(N)$ is preserved

$$\Phi_1 \sim \begin{pmatrix} n_1 & 0 & 0 \\ 0 & n_2 & 0 \\ 0 & 0 & \ddots \end{pmatrix}$$

$$\sum n_i = N$$

$$* n_i = N \quad \text{SU}(N)$$

Higgs vacuum

* In all other vacua, some is preserved

$$n_i = 1 \rightarrow \Phi_i = 0 \quad \text{classically SU}(N) \text{ is preserved}$$

$\hookrightarrow N$ vacua

$$\Phi_1 \sim \begin{pmatrix} n_1 & 0 & 0 \\ 0 & n_2 & 0 \\ 0 & 0 & \ddots \end{pmatrix}$$

$$\sum n_i = N$$

$$* n_i = N \quad \text{SU}(N)$$

Higgs vacuum

* In all other vacua, some is preserved

$n_i = 1 \rightarrow \Phi_i = 0$ classically SU(N) is preserved

$\hookrightarrow N$ vacua

$$\Phi_i \sim \begin{pmatrix} n_i & 0 & 0 \\ 0 & n_i & 0 \\ 0 & 0 & \ddots \end{pmatrix}$$

$$\sum n_i = N$$

* $n_i = N$ ~~$SU(N)$~~ Higgs vacuum

* In all other vacua, some is preserved

$n_i = 1 \rightarrow \Phi_i = 0$ classically $SU(N)$ is preserved

$\hookrightarrow N$ vacua

$$\Phi \sim \begin{pmatrix} n_1 & 0 & 0 \\ 0 & n_2 & 0 \\ 0 & 0 & \ddots \end{pmatrix}$$

$$\sum n_i = N$$

$$* n_i = N \quad \text{SU(N)}$$

Higgs vacuum

* In all other vacua, some is preserved

$n_i = 1 \rightarrow \Phi_i = 0$ classically SU(N) is preserved

$\hookrightarrow N$ vacua, $\langle \text{tr}(\lambda\lambda) \rangle$

$$n=1 \text{ SU(N)} \quad U(1)_R \rightarrow Z_{2N} \rightarrow Z_2$$

$$\Phi_1 \sim \begin{pmatrix} n_1 & 0 & 0 \\ 0 & n_2 & 0 \\ 0 & 0 & \ddots \end{pmatrix}$$

$$\sum n_i = N$$

* $n_i = N$ ~~SU(N)~~ Higgs vacuum

* In all other vacua, some is preserved

$n_i = 1 \rightarrow \Phi_i = 0$ classically SU(N) is preserved

$\hookrightarrow N$ vacua, $\langle \text{tr}(\lambda\lambda) \rangle$

$\eta = 1$ SYM $\underline{U(1)_R} \rightarrow Z_{2N} \rightarrow Z_2$

$$\Phi_1 \sim \begin{pmatrix} n_1 & 0 & 0 \\ 0 & n_2 & 0 \\ 0 & 0 & \ddots \end{pmatrix}$$

$$\sum n_i = N$$

* $n_i = N$ ~~$SU(N)$~~ Higgs vacuum

* In all other vacua, some is preserved

$n_i = 1 \rightarrow \Phi_i = 0$ classically $SU(N)$ is preserved

$\hookrightarrow N$ vacua, $\langle \text{tr}(\lambda\lambda) \rangle$

$n=1$ $SU(N)$ $U(1)_R \rightarrow Z_{2N} \rightarrow Z_2$

$$\Phi \sim \begin{pmatrix} n_1 & 0 & 0 \\ 0 & n_2 & 0 \\ 0 & a & \ddots \end{pmatrix}$$

$$* n_i = q \quad N = pq$$

$$SU(N) \xrightarrow{\text{Higgs}} SU(p)$$

$$* n_i = N$$

Higgs vacuum

* In all other q , some is preserved.

$n_i = 1 \rightarrow \Phi_i$ classically $SU(N)$ is preserved

$\hookrightarrow N$ vacua, $\langle \text{tr}(\lambda\lambda) \rangle$

$$\text{sym } U(1)_R \rightarrow Z_{2N} \rightarrow Z_2$$

$$\Phi_i \sim \begin{pmatrix} n_i & 0 & 0 \\ 0 & n_i & 0 \\ 0 & 0 & \ddots \end{pmatrix}$$

$$* n_i = q \quad N = pq$$

$$SU(N) \xrightarrow{\text{Higgs}} SU(p)$$

$$* n_i = N \quad \cancel{SU(N)} \quad \text{Higgs vacuum}$$

* In all other vacua, some is preserved.

$n_i = 1 \rightarrow \Phi_i = 0$ classically $SU(N)$ is preserved.

$\hookrightarrow N$ vacua, $\langle \text{tr}(\lambda\lambda) \rangle$

$$n=1 \text{ Sym } U(1)_R \rightarrow Z_{2N} \rightarrow Z_2$$

$$\Phi_1 \sim \begin{pmatrix} n_1 & 0 & 0 \\ 0 & n_2 & 0 \\ 0 & 0 & \ddots \end{pmatrix}$$

$$* n_i = q \quad N = pq$$

$$SU(N) \xrightarrow{\text{Higgs}} SU(p)$$

p different vacua $\leftarrow$ am

$$* n_i = N \quad \cancel{SU(N)}$$

Higgs vacuum

* In all other vacua, some is preserved

$n_i = 1 \rightarrow \Phi_i = 0$ classically $SU(N)$ is preserved

confining vacua

$\hookrightarrow N$ vacua, $\langle \text{tr}(\lambda\lambda) \rangle$

$$n=1 \text{ Sym } U(1)_R \rightarrow Z_{2N} \rightarrow Z_2$$

$$\Phi_1 \sim \begin{pmatrix} n_1 & 0 & 0 \\ 0 & n_2 & 0 \\ 0 & 0 & 0 \end{pmatrix}$$

* $n_i = q$ $N = pq$
 $SU(N) \xrightarrow{\text{Higgs}} SU(p)$
 p different vacua $\leftarrow$ QM

* $n_i = N$ $SU(N)$ is vacuum

* In all other vacua, $SU(N)$ is preserved

$n_i = 1 \rightarrow \Phi_i = 0$ classical $SU(N)$ is preserved

confining vacua $\rightarrow$ $\langle \text{tr}(\lambda\lambda) \rangle$
 $\eta = 1$ sym $Z_{2N} \rightarrow Z_2$

$$\Phi_1 \sim \begin{pmatrix} n_1 & 0 & 0 \\ 0 & n_2 & 0 \\ 0 & 0 & \ddots \end{pmatrix}$$

$$* n_i = q \quad N = pq$$

$$SU(N) \xrightarrow{\text{Higgs}} SU(p) \times SU(q)$$

p different vacua $\leftarrow q$

$$* n_i = N \quad \cancel{SU(N)}$$

Higgs vacu

* In all other vacua, some is preserved

$n_i = 1 \rightarrow \Phi_i = 0$ classically $SU(N)$ is preserved

confining vacua

$\hookrightarrow N$ vacua

$n=1$ $SU(N)$

$U(1)_R$

$$\Phi_1 \sim \begin{pmatrix} n_1 & 0 & 0 \\ 0 & n_2 & 0 \\ 0 & 0 & \ddots \end{pmatrix}$$

$$* n_i = q \quad N = pq$$

$$SU(N) \xrightarrow{\text{Higgs}} SU(p)$$

p different vacua $\leftarrow$ q m

$$* n_i = N \quad \cancel{SU(N)}$$

Higgs vacuum

* In all other vacua, some is preserved

$$n_i = 1 \rightarrow \Phi_i = 0 \quad \text{classically } SU(N) \text{ is preserved}$$

confining vacua

$\hookrightarrow N$ vacua, $\langle \text{tr}(\lambda\lambda) \rangle$

$$n=1 \text{ Sym } U(1)_R \rightarrow Z_{2N} \rightarrow Z_2$$

$$\Phi_i \sim \begin{pmatrix} n_i & 0 & 0 \\ 0 & n_i & 0 \\ 0 & 0 & \ddots \end{pmatrix}$$

$$* n_i = q \quad N = pq$$

$$SU(N) \xrightarrow{\text{Higgs}} SU(p)$$

p different vacua

* Otherwise $\rightarrow U(1)$

* $n_i = N$ ~~$SU(N)$~~

Higgs vacuum

* In all other vacua, some is preserved.

$n_i = 1 \rightarrow \Phi_i = 0$ classically $SU(N)$ is preserved

confining vacua $\rightarrow$ $\hookrightarrow N$ vacua, $\langle \text{tr}(\lambda\lambda) \rangle$

$n=1$ sym $U(1)_R \rightarrow Z_{2N} \rightarrow Z_2$

$$\Phi_1 \sim \begin{pmatrix} n_1 & 0 & 0 \\ 0 & n_2 & 0 \\ 0 & 0 & \ddots \end{pmatrix}$$

$$* n_i = q \quad N = pq$$

$$SU(N) \xrightarrow{\text{Higgs}} SU(p)$$

* Otherwise $\rightarrow U(1) \rightarrow$ no mass gap } different vacua

* $n_i = N$ ~~$SU(N)$~~ } Higgs vacuum

* In all other vacua, some is preserved

$n_i = 1 \rightarrow \Phi_i = 0$ classically $SU(N)$ is preserved

confining vacua $\rightarrow$ $\hookrightarrow N$ vacua, $\langle \text{tr}(\lambda\lambda) \rangle$

$n=1$ sym $U(1)_R \rightarrow Z_{2N} \rightarrow Z_2$

$$\Phi_1 \sim \begin{pmatrix} n_1 & 0 & 0 \\ 0 & n_2 & 0 \\ 0 & 0 & \ddots \end{pmatrix}$$

$$* n_i = q \quad N = pq$$

$$SU(N) \xrightarrow{\text{Higgs}} SU(p)$$

* Otherwise $\rightarrow U(1) \rightarrow$ no mass gap } different vacua $\leftarrow$ a.m.
 * $n_i = N$ $SU(N)$ Higgs vacuum

* In all other vacua, some is preserved
 $n_i = 1 \rightarrow \Phi_i = 0$ classically $SU(N)$ is preserved

confining vacua $\rightarrow$ $\hookrightarrow N$ vacua, $\langle \text{tr}(\lambda\lambda) \rangle$
 $n=1$ sym $U(1)_R \rightarrow Z_{2N} \rightarrow Z_2$

$$\Phi_i \sim \begin{pmatrix} n_1 & 0 & 0 \\ 0 & n_2 & 0 \\ 0 & 0 & \ddots \end{pmatrix}$$

$$* n_i = q \quad N = pq$$

$$SU(N) \xrightarrow{\text{Higgs}} SU(p)$$

* Otherwise $\rightarrow U(1) \rightarrow$ no mass gap } p different vacua

* $n_i = N$ ~~$SU(N)$~~ } Higgs vacuum

* In all other vacua, some is preserved

$n_i = 1 \rightarrow \Phi_i = 0$ classically $SU(N)$ is preserved

confining vacua $\rightarrow$ $\hookrightarrow N$ vacua, $\langle \text{tr}(\lambda\lambda) \rangle$

$n=1$ sym $U(1)_R \rightarrow Z_{2N} \rightarrow Z_2$

$$\Phi_1 \sim \begin{pmatrix} n_1 & 0 & 0 \\ 0 & n_2 & 0 \\ 0 & 0 & \vdots \end{pmatrix}$$

$$* n_i = q \quad N = pq$$

$$SU(N) \xrightarrow{\text{Higgs}} SU(p)$$

* Otherwise $\rightarrow U(1) \rightarrow$ no mass gap } different vacua
 * $n_i = N$ ~~$SU(N)$~~ } Higgs vacuum

all other vacua, some is preserved
 $\eta=1 \rightarrow \Phi_i=0$ classically $SU(N)$ is preserved

conf vacua $\rightarrow$ $\hookrightarrow N$ vacua, $\langle \text{tr}(\lambda\lambda) \rangle$
 $\eta=1 \text{ sym } U(1)_R \rightarrow Z_{2N} \rightarrow Z_2$

SUSY Classical vacua
 Many discrete vacua: $\frac{\partial W}{\partial \Phi_i} = 0$ / complexified gauge group $SL(N, \mathbb{C})$

$$[\Phi_i, \Phi_j] = -\frac{m}{\sqrt{2}} \varepsilon_{ijk} \Phi_k$$

$\left(\frac{\sqrt{2} \Phi_i}{m} \right)$ are a representation
 N -dimensional

$m_i \neq 0$ vacuum

$$W = \frac{2\sqrt{2}}{g_{YM}^2} \text{tr}(\Phi_1 [\Phi_2, \Phi_3]) + \frac{1}{g_{YM}^2} (m_1 \Phi_1 + m_2 \Phi_2 + m_3 \Phi_3)$$

$m_1, m_2, m_3 \neq 0$

Many discrete vacua: $\frac{\partial W}{\partial \Phi_i} = 0$ SUSY Classical vacua complexified gauge group $SL(N, \mathbb{C})$

$$[\Phi_i, \Phi_j] = -\frac{m}{\sqrt{2}} \varepsilon_{ijk} \Phi_k$$

$\rightarrow \frac{\sqrt{2}\Phi_i}{m}$ are a representation N -dimensional

$m_i \neq 0$ one vacuum
(+ maybe metastable vacua)

$$W = \frac{2\sqrt{2}}{g_{YM}^2} \text{tr}(\Phi_1 [\Phi_2, \Phi_3]) + \frac{1}{g_{YM}^2} (m_1 \text{tr}(\Phi_1^2) + m_2 \text{tr}(\Phi_2^2) + m_3 \text{tr}(\Phi_3^2))$$

$m_1, m_2, m_3 \neq 0$

$m=4$ SYM $\leftrightarrow$ IIB on $AdS_3 \times S^5$

$m=4$ SYM $\leftrightarrow$ IIB on $AdS_5 \times S^5$

$$\langle e^{iS[\lambda_i(x), \theta_i(x)]} \rangle$$

$$m=4 \text{ SYM} \leftrightarrow \text{IIB on } \text{AdS}_5 \times S^5$$

$$\langle e^{i \int \lambda_i(x) \theta_i(x)} \rangle_{m=4 \text{ SYM}} \leftrightarrow Z_{\text{IIB}}$$

$$\theta_i(x) \leftrightarrow \chi_i(x, z)$$

$$ds_{\text{AdS}}^2 = \frac{dx_\mu dx^\mu + dz^2}{z^2}$$

$$m=4 \text{ SYM} \longleftrightarrow \text{IB on } \text{AdS}_5 \times S^5$$

$$\langle e^{i \int \lambda_i(x) \theta_i(x)} \rangle_{m=4 \text{ SYM}} \longleftrightarrow Z_{\text{IB}}$$

$$\theta_i(x) \longleftrightarrow \chi_i(x, z)$$

$$ds_{\text{AdS}}^2 = \frac{dx_\mu dx^\mu + dz^2}{z^2}$$

$$m=4 \text{ SYM} \longleftrightarrow \text{IIB on } \text{AdS}_5 \times S^5$$

$$\langle e^{i \int \lambda_i(x) \theta_i(x)} \rangle_{m=4 \text{ SYM}} \longleftrightarrow Z_{\text{IIB}}(\chi_i(x, z))$$

$$\theta_i(x) \longleftrightarrow \chi_i(x, z)$$

$$ds_{\text{AdS}}^2 = \frac{dx_\mu dx^\mu + dz^2}{z^2}$$

$$m=4 \text{ SYM} \longleftrightarrow \text{IIB on } \text{AdS}_5 \times S^5$$

$$\langle e^{i \int \lambda_i(x) \theta_i(x)} \rangle_{m=4 \text{ SYM}} \longleftrightarrow \int_{\text{IIB}} \left(\chi_i(x, z) \xrightarrow{z \rightarrow 0} \lambda_i(x) z^{4-0} \right)$$

$$\theta_i(x) \longleftrightarrow \frac{\chi_i(x, z)}{\Delta_i(\Delta_i - 4) = m^2 R^2}$$

$$ds_{\text{AdS}}^2 = \frac{dx^m + dz^2}{z^2}$$

$$m=4 \text{ SYM} \leftrightarrow \text{IIB on } \text{AdS}_5 \times S^5$$

$$\langle e^{i \int \lambda_i(x) \theta_i(x)} \rangle_{m=4 \text{ SYM}} \leftrightarrow \int_{\text{IIB}} \left(\chi_i(x, z) \xrightarrow{z \rightarrow 0} \lambda_i(x) z^{4-0} \right)$$

$$\theta_i(x) \leftrightarrow \frac{\chi_i(x, z)}{z}$$

$$\Delta_i(\Delta_i - 4) = \frac{m^2 R^2}{2} \quad \frac{dS_{\text{AdS}}}{z^2} = \frac{dx_n dx^n + dz^2}{z^2}$$

Many discrete vacua: $\frac{\partial W}{\partial \Phi_i} = 0$ / $\text{complexified gauge group } \text{SL}(N, \mathbb{C})$

$$[\Phi_i, \Phi_j] = -\frac{m}{\sqrt{2}} \epsilon_{ijk} \Phi_k$$

$\rightarrow \frac{\sqrt{2}\Phi_i}{m}$ are presentation dimensional

$m_i \neq 0$ one vacuum
(+ maybe metastable vacuum)

$$W = \frac{2\sqrt{2}}{g_{YM}^2} \text{tr}([\Phi_1, \Phi_2] \Phi_3) + \frac{1}{g_{YM}^2} (m_1 \text{tr}(\Phi_1^2) + m_2 \text{tr}(\Phi_2^2) + m_3 \text{tr}(\Phi_3^2))$$

$$m=4 \text{ SYM} \longleftrightarrow \text{IIB on } \text{AdS}_5 \times S^5$$

$$\langle e^{i \int \lambda_i(x) \theta_i(x)} \rangle_{m=4 \text{ SYM}} \longleftrightarrow Z_{\text{IIB}} \left(\begin{matrix} \chi_i(x, z) \xrightarrow{z \rightarrow 0} \\ \lambda_i(x) z^{4-D_i} \end{matrix} \right)$$

$$\theta_i(x) \longleftrightarrow \frac{\chi_i(x, z)}{z}$$

$$\Delta_i(D_i - 4) = \frac{m^2 R^2}{dS_{\text{AdS}}} = \frac{dx_\mu dx^\mu + dz^2}{z^2}$$

$$m=4 \text{ SYM} \longleftrightarrow \text{IIB on } \text{AdS}_5 \times S^5$$

$$\langle e^{i \int \lambda_i(x) \theta_i(x)} \rangle_{m=4 \text{ SYM}} \longleftrightarrow Z_{\text{IIB}} \left(\lambda_i(x, z) \xrightarrow{z \rightarrow 0} \lambda_i(x) z^{4-D_i} \right)$$

$$\theta_i(x) \longleftrightarrow \frac{\chi_i(x, z)}{z}$$

$$\Delta_i(D_i - 4) = \frac{m^2 R^2}{dS_{\text{AdS}}} = \frac{dx_n dx^n + dz^2}{z^2}$$

$$W = \frac{2\sqrt{2}}{g_{YM}^2} \text{tr}(\Phi_1 [\Phi_2, \Phi_3]) + \frac{1}{g_{YM}^2} (m_1 \text{tr}(\Phi_1^2) + m_2 \text{tr}(\Phi_2^2) + m_3 \text{tr}(\Phi_3^2))$$

$m_1, m_2, m_3 \neq 0$

$m_1 \neq 0$ one var
(+ maybe
nltq stable)

$$W = \frac{2\lambda}{g_{YM}^2} \text{tr} \left(\frac{1}{2} [\Phi^a, \Phi^b]^2 \right)$$

M_1, M_2, M_3

$$\frac{1}{2} \left(m_1 \text{tr}(\Phi_1^2) + m_2 \text{tr}(\Phi_2^2) + m_3 \text{tr}(\Phi_3^2) \right)$$



$$I + \underbrace{\text{tr}(\lambda^q \lambda^q)}_{0!}$$

$$\lambda + \underbrace{\text{mult}(\lambda^q \lambda^q)}_{\sigma_i} \leftrightarrow \chi_i$$

$$L + \underbrace{\text{matr}(\lambda^a \lambda^a)}_{\sigma_i}$$

$$\leftrightarrow \chi_i$$

B_{ab}

C_{ab}

$$L + \underbrace{\text{tr}(\lambda^a \lambda^a)}_{\sigma_i}$$

$$\longleftrightarrow \chi_i$$

$$B_{ab} \in S^3$$

$$C_{ab}$$

$$1 + \underbrace{\text{matr}(\lambda^a \lambda^a)}_{\sigma_i} \leftrightarrow \chi_i \quad \begin{matrix} \underline{B_{ab}} \in S^3 \\ \underline{C_{ab}} \end{matrix}$$

$$L + \underbrace{\text{matr}(\lambda^a \lambda^a)}_{\sigma_i} \leftrightarrow \chi_i \leftarrow \begin{cases} \underline{B_{ab}} \in S^3 \\ \underline{C_{ab}} \end{cases}$$

$$\begin{aligned}
 \mathcal{L} + \underbrace{m \text{tr}(\lambda^a \lambda^a)}_{\sigma_1} &\leftrightarrow \chi_i \leftarrow \begin{cases} \underline{B_{ab}{}^c} \in S^3 \\ \underline{C_{ab}} \end{cases} \\
 &\downarrow \\
 \chi_i(x, z) &\xrightarrow{z \rightarrow 0} m z
 \end{aligned}$$

$$\begin{aligned}
 \mathcal{L} + \underbrace{m \text{tr}(\lambda^a \lambda^a)}_{\sigma_1} &\leftrightarrow \chi_i \leftarrow \begin{cases} \underline{B_{ab}^k} \in S^3 \\ \underline{C_{ab}} \end{cases} \\
 &\downarrow \\
 \chi_i(x, z) &\xrightarrow{z \rightarrow 0} m z
 \end{aligned}$$

$$\mathcal{L} + \underbrace{m \text{tr}(\lambda^a \lambda^a)}_{0!}$$

$$\leftrightarrow \chi_i \leftarrow \begin{cases} \underline{B_{ab}} \in S^3 \\ \underline{C_{ab}} \end{cases}$$

↓

$$\begin{aligned} &\rightarrow \text{SUGRA solutions w/ } \chi_i(x, z) \xrightarrow{z \rightarrow 0} m z \\ &\rightarrow \mathcal{L} + m \text{tr}(\lambda \lambda) \end{aligned}$$

$$m=4 \text{ SYM} \longleftrightarrow \text{IB on } \text{AdS}_3 \times S^5$$

$$\langle e^{i \int \lambda_i(x) \theta_i(x)} \rangle_{m=4 \text{ SYM}} \longleftrightarrow Z_{\text{IB}} \left(\chi_i(x, z) \xrightarrow{z \rightarrow 0} \lambda_i(x) z^{4-0_i} \right)$$

$$\longleftrightarrow \theta_i(x) \longleftrightarrow \frac{\chi_i(x, z)}{z}$$

$$\Delta_i(\Delta_i - 4) = \frac{m^2 R^2}{2} \quad \frac{dS_{\text{AdS}}}{z^2} = \frac{dx_\mu dx^\mu + dz^2}{z^2}$$

$$m=4 \text{ SYM} \longleftrightarrow \text{IIB on } \text{AdS}_5 \times S^5$$

$$\langle e^{i \int \lambda_i(x) \theta_i(x)} \rangle_{m=4 \text{ SYM}} \longleftrightarrow \int_{\text{IIB}} \left(\chi_i(x, z) \xrightarrow{z \rightarrow 0} \lambda_i(x) z^{4-D_i} \right)$$

$$\int d^4 w V_i(x, w) \longleftrightarrow \theta_i(x) \longleftrightarrow \frac{\chi_i(x, z)}{\Delta_i(D_i - 4) = \frac{m^2 R^2}{dS_{\text{AdS}}}} = \frac{dx_\mu dx^\mu + dz^2}{z^2}$$

$$m=4 \text{ SYM} \longleftrightarrow \text{IIB on } \text{AdS}_5 \times S^5$$

$$\langle e^{i \int \lambda_i(x) \theta_i(x)} \rangle_{m=4 \text{ SYM}} \longleftrightarrow Z_{\text{IIB}} \left(\begin{matrix} x_i(x, z) \xrightarrow{z \rightarrow 0} \\ \lambda_i(x) z^{4-\Delta_i} \end{matrix} \right)$$

$$\int d^3w V_i(x, w) \longleftrightarrow \theta_i(x) \longleftrightarrow \frac{\chi_i(x, z)}{\Delta_i(\Delta_i - 4) = \frac{m^2 R^2}{2}} = \frac{dx_\mu dx^\mu + dz^2}{z^2}$$

$$Z_{\text{w.s.}} + m \int d^4x \int d^3w V_i(x, w)$$

$$m=4 \text{ SYM} \longleftrightarrow \text{IIB on } \text{AdS}_5 \times S^5$$

$$\langle e^{i \int \lambda_i(x) \theta_i(x)} \rangle_{m=4 \text{ SYM}} \longleftrightarrow Z_{\text{IIB}} \left(\chi_i(x, z) \xrightarrow{z \rightarrow 0} \lambda_i(x) z^{4-\Delta_i} \right)$$

$$\int d^4 \omega V_i(x, \omega) \longleftrightarrow \theta_i(x) \longleftrightarrow \frac{\chi_i(x, z)}{z^{\Delta_i(\Delta_i-4) = \frac{m^2 R^2}{2}}} = \frac{dx_\mu dx^\mu + dz^2}{z^2}$$

$$Z_{\text{w.s.}} + m \int d^4 x \int d^4 \omega V_i(x, \omega)$$

$$\mathcal{L} + m \underbrace{\text{tr}(\lambda^a \lambda^a)}_{\sigma_i}$$

$$\longleftrightarrow \chi_i \leftarrow \begin{cases} \underline{B_{ab}^k} \in S^3 \\ \underline{C_{ab}} \end{cases}$$

$\Rightarrow$ SUGRA solutions w/ $\chi_i(\lambda)$ $\xrightarrow{z \rightarrow 0} m z$
 $\Rightarrow \mathcal{L} + m \text{tr}(\lambda \lambda)$

$$\mathcal{L} + \underbrace{\text{tr}(\lambda^a \lambda^a)}_{\sigma_1} + \dots \leftrightarrow \chi_i \leftarrow \begin{cases} \underline{B_{ab}{}^k} \in S^3 \\ \underline{C_{ab}} \end{cases}$$

$$\begin{aligned} & \xrightarrow{\eta=1} \text{SUGRA} \text{ w/ } \chi_i(x, z) \xrightarrow{z \rightarrow 0} m z \\ & \Rightarrow \mathcal{L} + \text{tr}(\lambda^a \lambda^a) \end{aligned}$$

$$\mathcal{L} + \underbrace{m \text{tr}(\lambda^\dagger \lambda)}_{\sigma_1} \leftrightarrow \chi_i \leftarrow \begin{cases} \underline{B_{ab}^k} \in S^3 \\ \underline{C_{ab}} \end{cases}$$

$\downarrow$
 $\xrightarrow{n=1} \text{SUGRA solutions w/ } \chi_i(x, z) \xrightarrow{z \rightarrow 0} m z$
 $\Rightarrow \mathcal{L} + m \text{tr}(\lambda \lambda)$

$$\mathcal{L} + \underbrace{m \text{tr}(\lambda^a \lambda^a)}_{0!} \leftrightarrow \chi_i \leftarrow \begin{cases} B_{ab}{}^k \in S^3 \\ C_{ab} \end{cases}$$

$\xrightarrow{n=1}$ SUGRA solutions w/ $\chi_i(x, z)$ $m z$
 $\rightarrow \mathcal{L} + m \text{tr}(\lambda \lambda)$

$$m=4 \text{ SYM} \longleftrightarrow \text{IIB on } \text{AdS}_5 \times S^5 \quad \begin{matrix} -32 \\ n=4 \end{matrix}$$

$$\langle e^{i \int \lambda_i(x) \theta_i(x)} \rangle_{m=4 \text{ SYM}} \longleftrightarrow Z_{\text{IIB}} \left(\chi_i(x, z) \xrightarrow{z \rightarrow 0} \lambda_i(x) z^{\Delta_i} \right)$$

$$\int d^3 \omega V_i(x, \omega) \longleftrightarrow \theta_i(x) \longleftrightarrow \frac{\chi_i(x, z)}{z} \quad \Delta_i(\Delta_i - 4) = \frac{m^2 R^2}{2}$$

$$Z_{\text{W.S.}} + m \int d^4 x \int d^3 \omega V_i(x, \omega) \quad \frac{dS_{\text{AdS}}}{dS} = \frac{dx_n dx^n + dz^2}{z^2}$$

$$m=4 \text{ SYM} \longleftrightarrow \text{IIB on } \text{AdS}_5 \times S^5 \quad \begin{matrix} -32 \\ n=4 \end{matrix}$$

$$\langle e^{i \int \lambda_i(x) \theta_i(x)} \rangle_{\substack{n=4 \\ \text{SYM}}} \longleftrightarrow Z_{\text{IIB}} \left(\chi_i(x, z) \xrightarrow{z \rightarrow 0} \lambda_i(x) z^{4-D_i} \right)$$

$$\int d^3w V_i(x, w) \longleftrightarrow \theta_i(x) \longleftrightarrow \frac{\chi_i(x, z)}{\Delta_i(D_i - 4) = \frac{m^2 R^2}{2}} = \frac{dx_n dx^m + dz^2}{z^2}$$

$$Z_{\text{w.s.}} + m \int d^4x \int d^3w V_i(x, w)$$

$$\mathcal{L} + m \underbrace{\text{tr}(\lambda^a \lambda^a)}_{\sigma_i} \leftrightarrow \chi_i \leftarrow \begin{cases} \underline{B_{ab}{}^k} \in S^3 \\ \underline{C_{ab}} \end{cases}$$

$$\begin{aligned} & \xrightarrow{n=1} \text{SUGRA solutions w/ } \chi_i(x, z) \xrightarrow{z \rightarrow 0} m z \\ & \Rightarrow \mathcal{L} + m \text{tr}(\lambda \lambda) \end{aligned}$$

Singular solutions

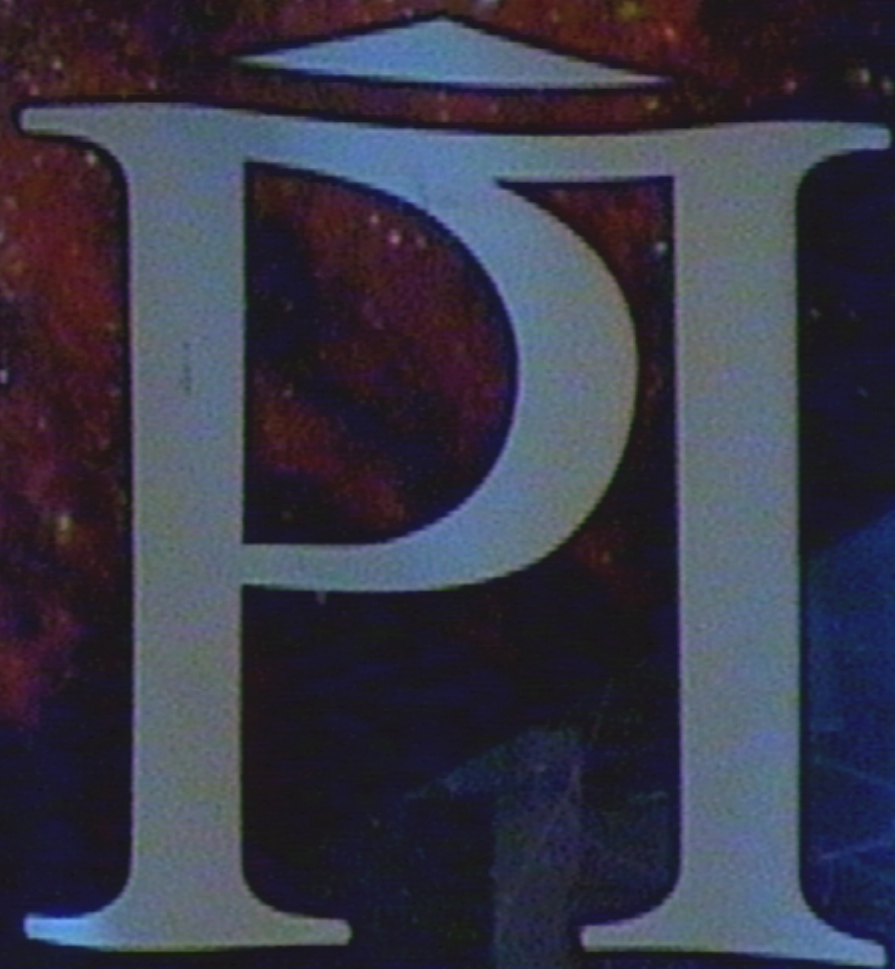
$$\mathcal{L} + m \underbrace{\text{tr}(\lambda^a \lambda^a)}_{\sigma_i} \leftrightarrow \chi_i \leftarrow \begin{cases} \underline{B_{ab}^k} \in S^3 \\ \underline{C_{ab}} \end{cases}$$

$$\begin{aligned} & \xrightarrow{n=1} \text{SUGRA solutions w/ } \chi_i(x, z) \xrightarrow{z \rightarrow 0} m z \\ & \rightarrow \mathcal{L} + m \text{tr}(\lambda \lambda) \end{aligned}$$

Singular solutions
SUGRA



Hints:

A large, stylized logo consisting of the letters 'P' and 'I' in a serif font. The 'P' and 'I' are joined together, with the 'P' having a distinctive shape where the top bar is a triangle. The logo is set against a dark, textured background that resembles a starry night sky or a nebula.

PERIMETER
INSTITUTE
FOR THEORETICAL PHYSICS