Title: Composite Higgs, Dark Matter and Inflaton

Date: Jan 27, 2012 01:00 PM

URL: http://pirsa.org/12010165

Abstract: I will introduce models of dynamical electroweak symmetry breaking and their present and future impact on LHC physics. I will start by reviewing what LHC has seen and not seen and the main challenges of models of dynamical electroweak symmetry breaking. To overcome some of these problems we need a better understanding of strong dynamics. I will therefore review the state-of-the-art of the phase diagram of strongly coupled theories as function of the number of flavors, colors and matter representation. I will then show how these models can also lead to natural dark matter candidates able to provide a simple resolution to current experimental observations. If times allows, I will introduce new successful models of inflation in which the inflaton emerges as a composite state from a natural four-dimensional strongly coupled theory coupled to gravity.

DIAS
Danish Institute for Advanced Study

University of Southern Denmark

Composite Dynamics

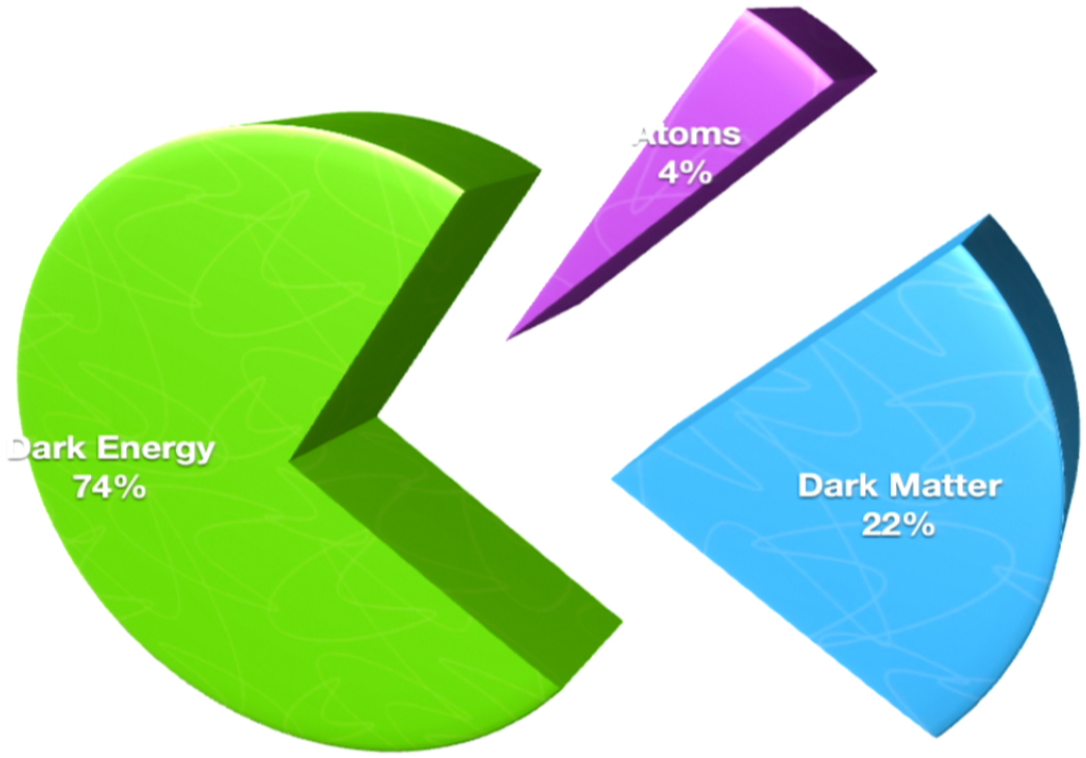
Francesco Sannino

CP^3 - Origins

Particle Physics & Origin of Mass

Canada - January - 2012

Riddles



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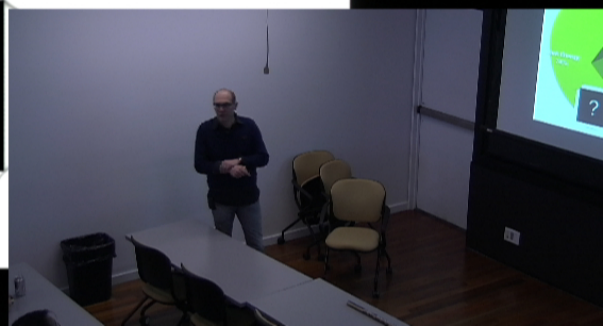
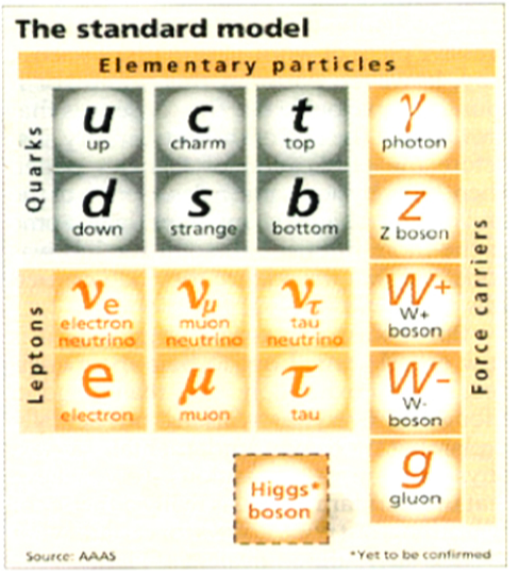
Riddles


Electro
Magnetic
Strong
Weak
Atoms
4%
Gravity
Dark Energy
74%
Dark Matter
22%
?
?



Standard Model

SM



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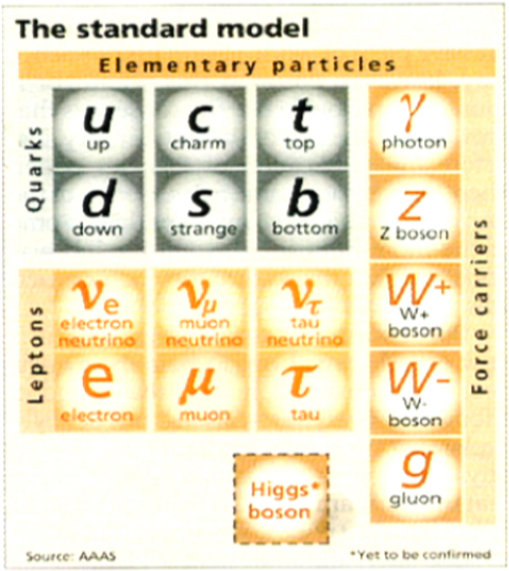
Standard Model

SM



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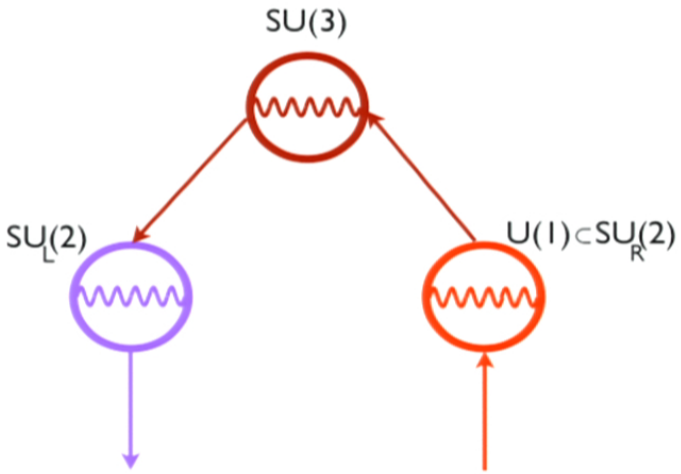
SM - Geometry



R-Quarks
L-Quarks
R-Leptons
L-Leptons
Weak GB
Gluons
Hyper - GB

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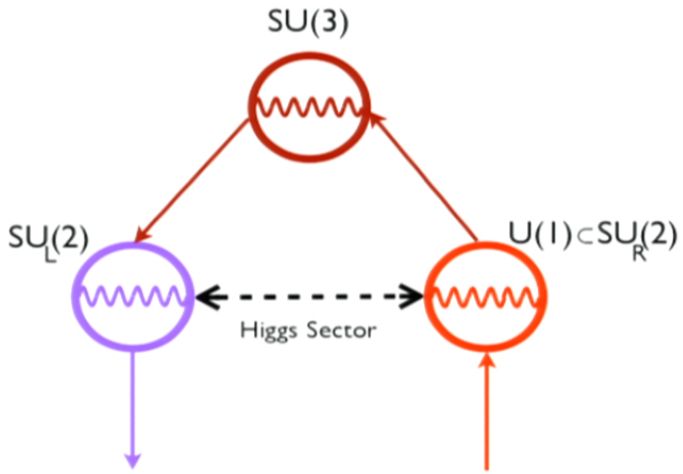
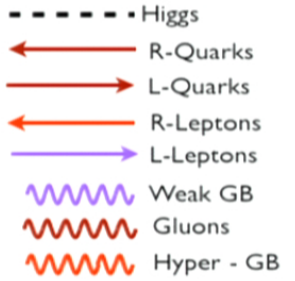
SM - Geometry





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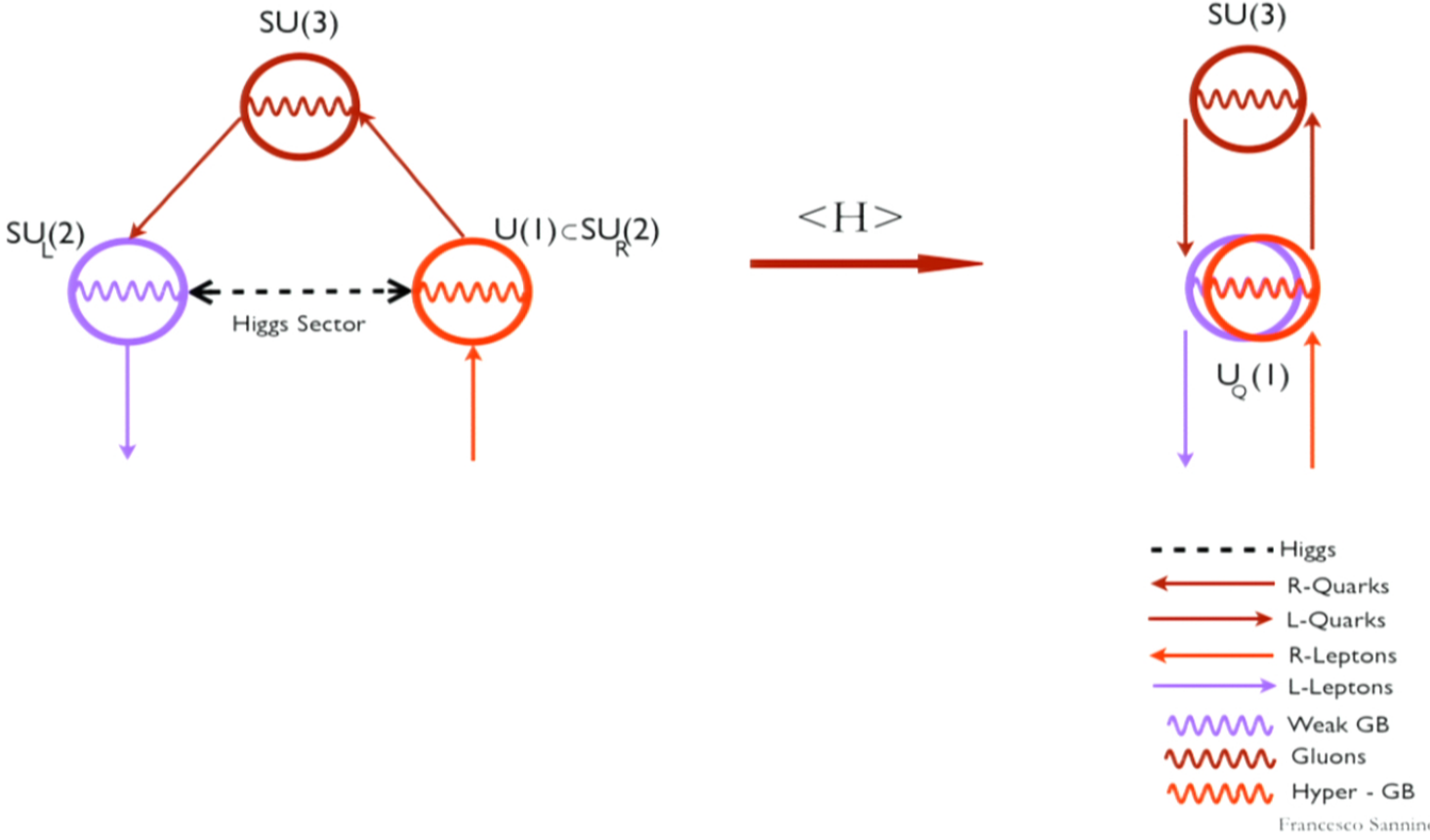
SM - Geometry



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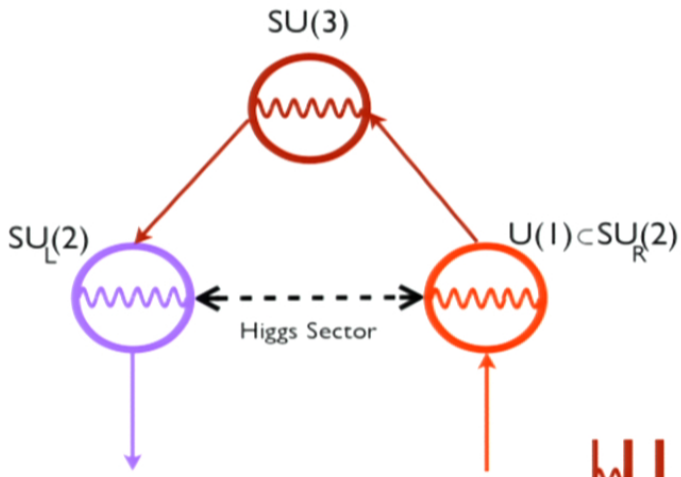
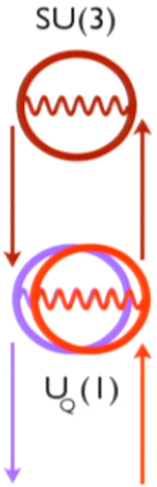
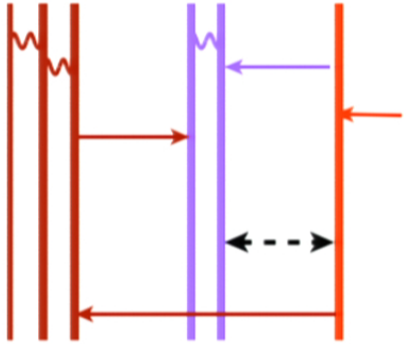
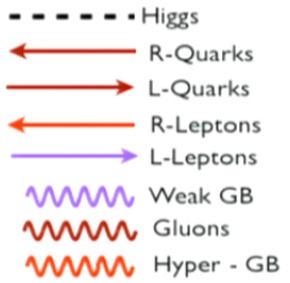
SM - Geometry





Branish





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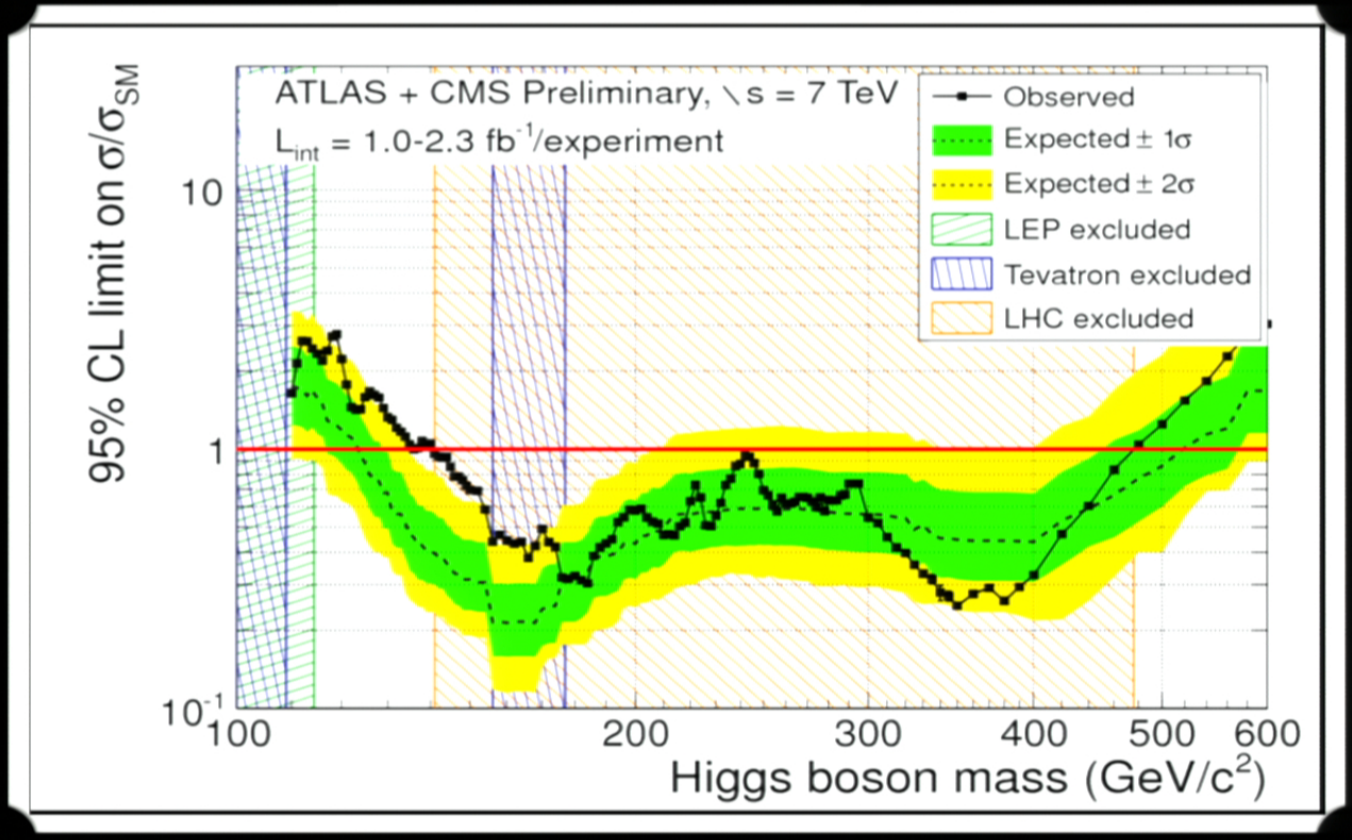
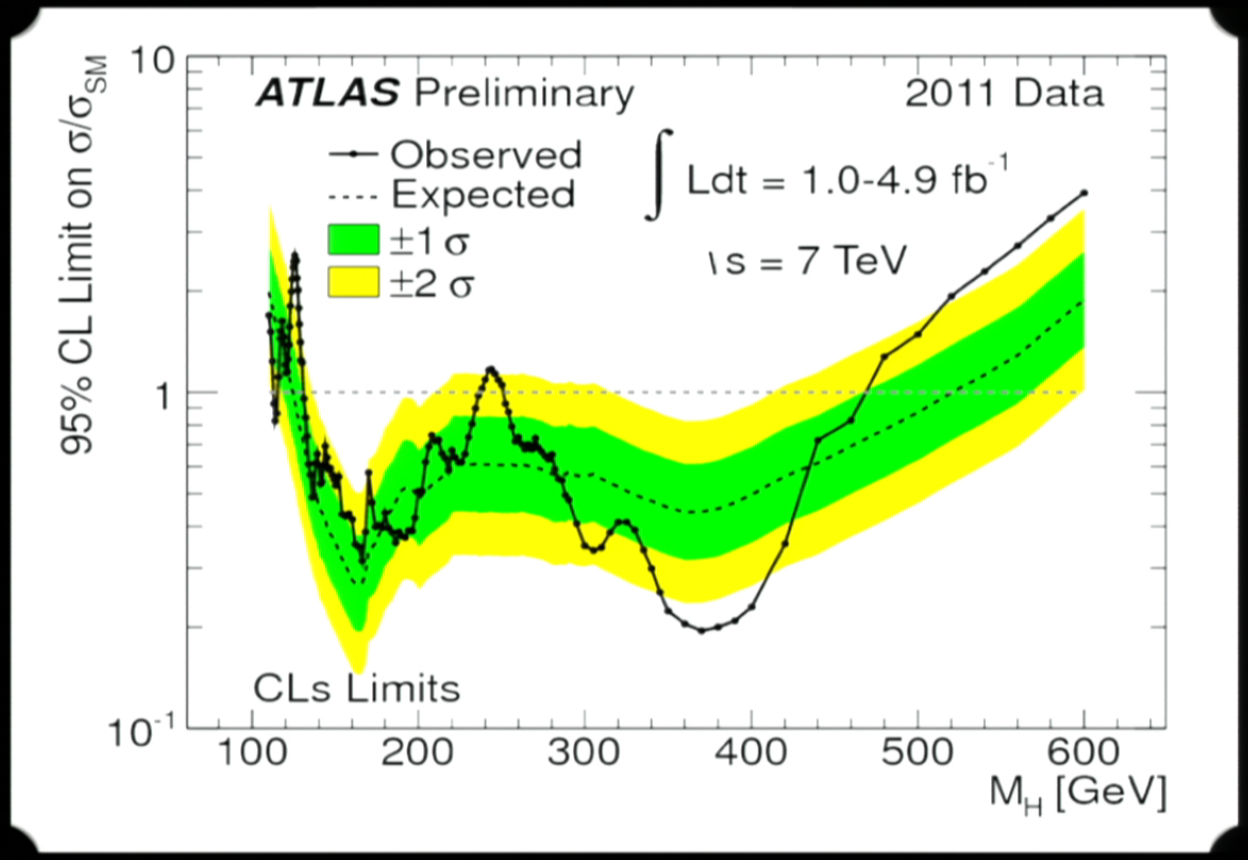
O' Higgs, where art thou!

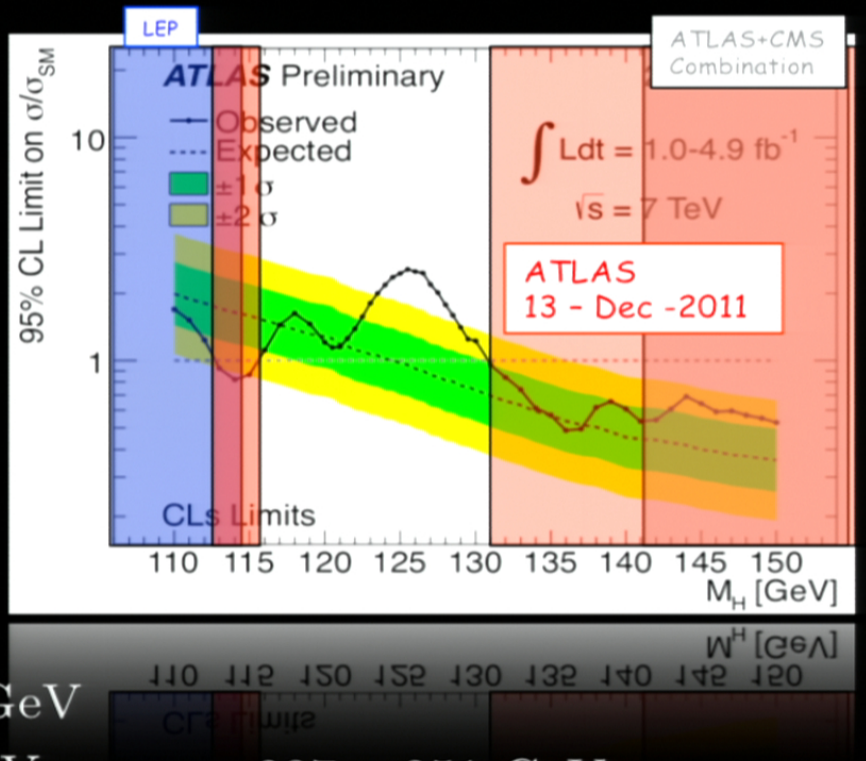
Status before December 2011



Status after December



Higgs Status Now

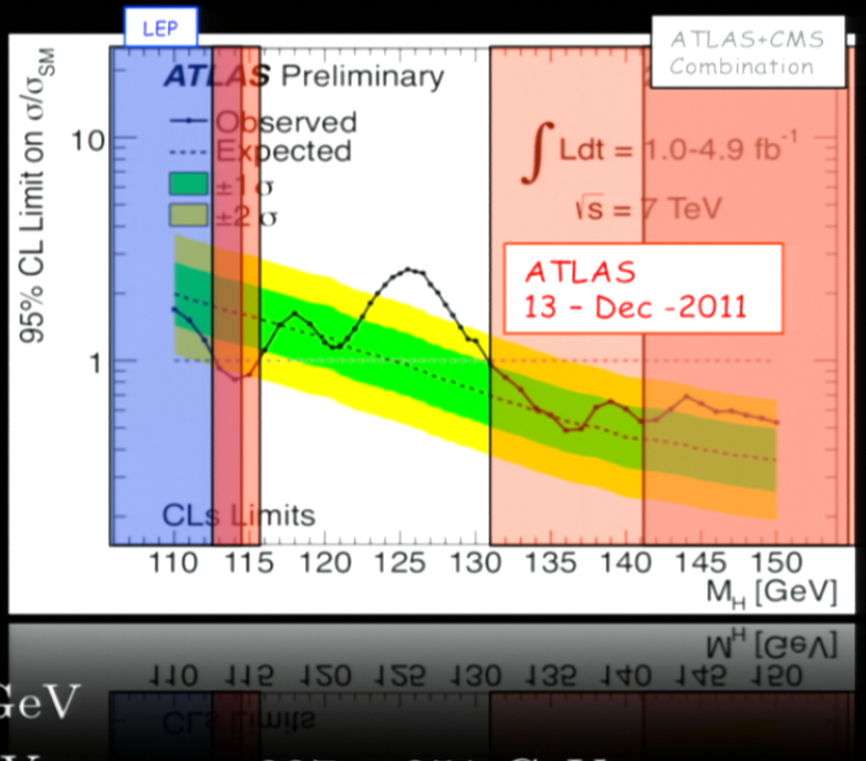


Excluded @ 95% CL

$112.7 < M_H < 115.5$ GeV

$131 < M_H < 453$ GeV except $237 - 251$ GeV

Higgs Status Now



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Discovery strategy

$$\#\,\text{Events} = \sigma \cdot \mathcal{L} \cdot \Delta t$$

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- σ is the cross section characterizing the underlying physics
- $\mathcal{L}$ is the luminosity, i.e. the particles present in the beam/time
- "Backgrounds" are events with the same final state of the signal event

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Discovery strategy

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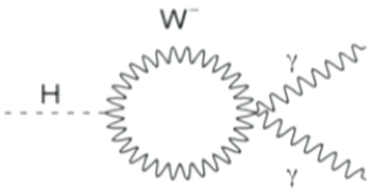
- σ is the cross section characterizing the underlying physics
- $\mathcal{L}$ is the luminosity, i.e. the particles present in the beam/time
- "Backgrounds" are events with the same final state of the signal event
- For the Higgs searches we can look at processes of the type:

$$p\,p \rightarrow H \rightarrow \gamma\gamma$$



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13th of December

$H \to \gamma\gamma$ 2.8 σ at 126 GeV

$H \to ZZ^* \to 4\ell$ 2.1 σ (3 events at 125 GeV)

$H \to W^+W^- \to (\ell^+\nu)(\ell^-\nu)$ 1.4 σ at 126 GeV

3.6σ excess at 126 GeV

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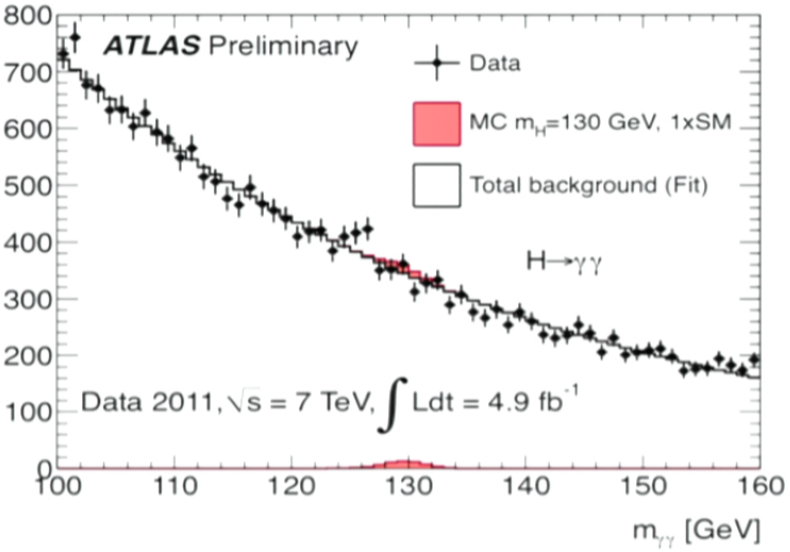

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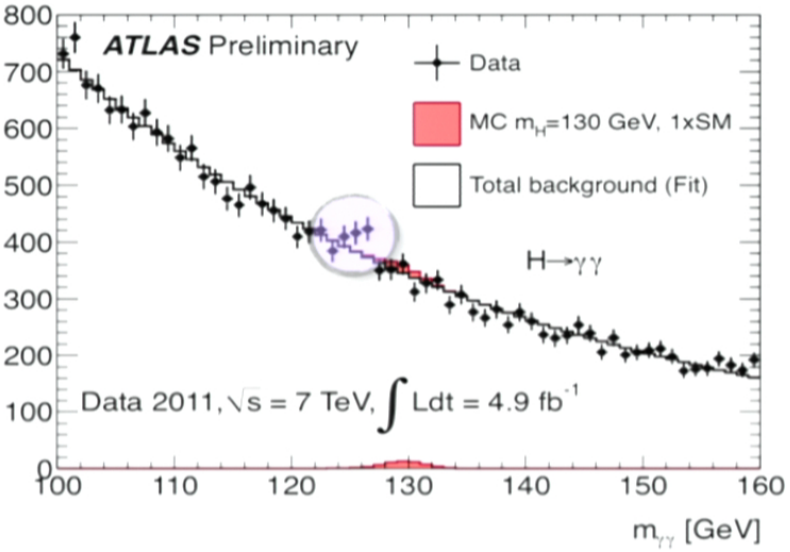

$H \to \gamma\gamma$ 2.34 σ at 123.5 GeV

$H \to ZZ^* \to 4\ell$ (2 events at 126 GeV)

2.4σ excess at 126 GeV

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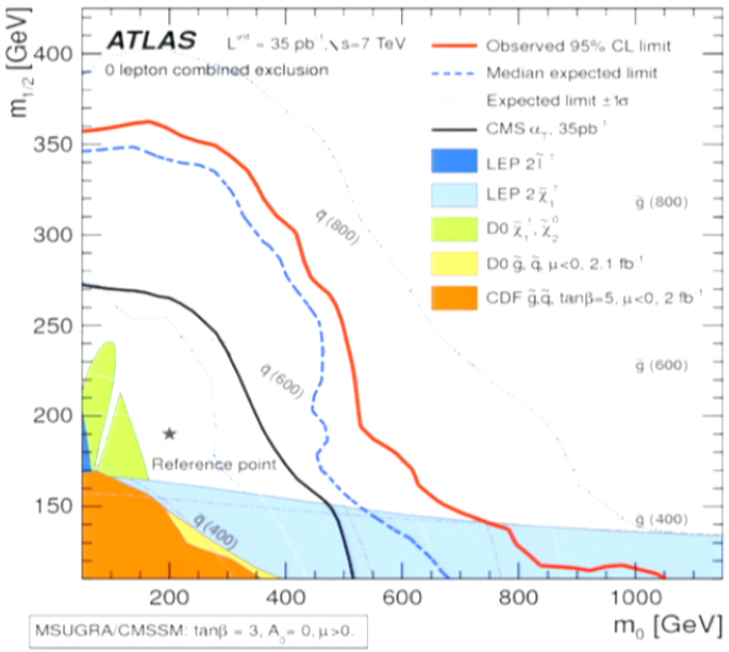
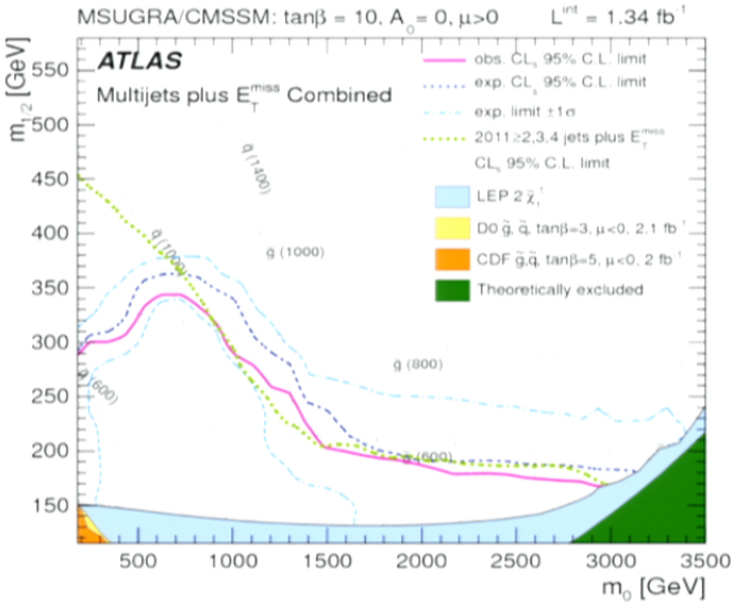
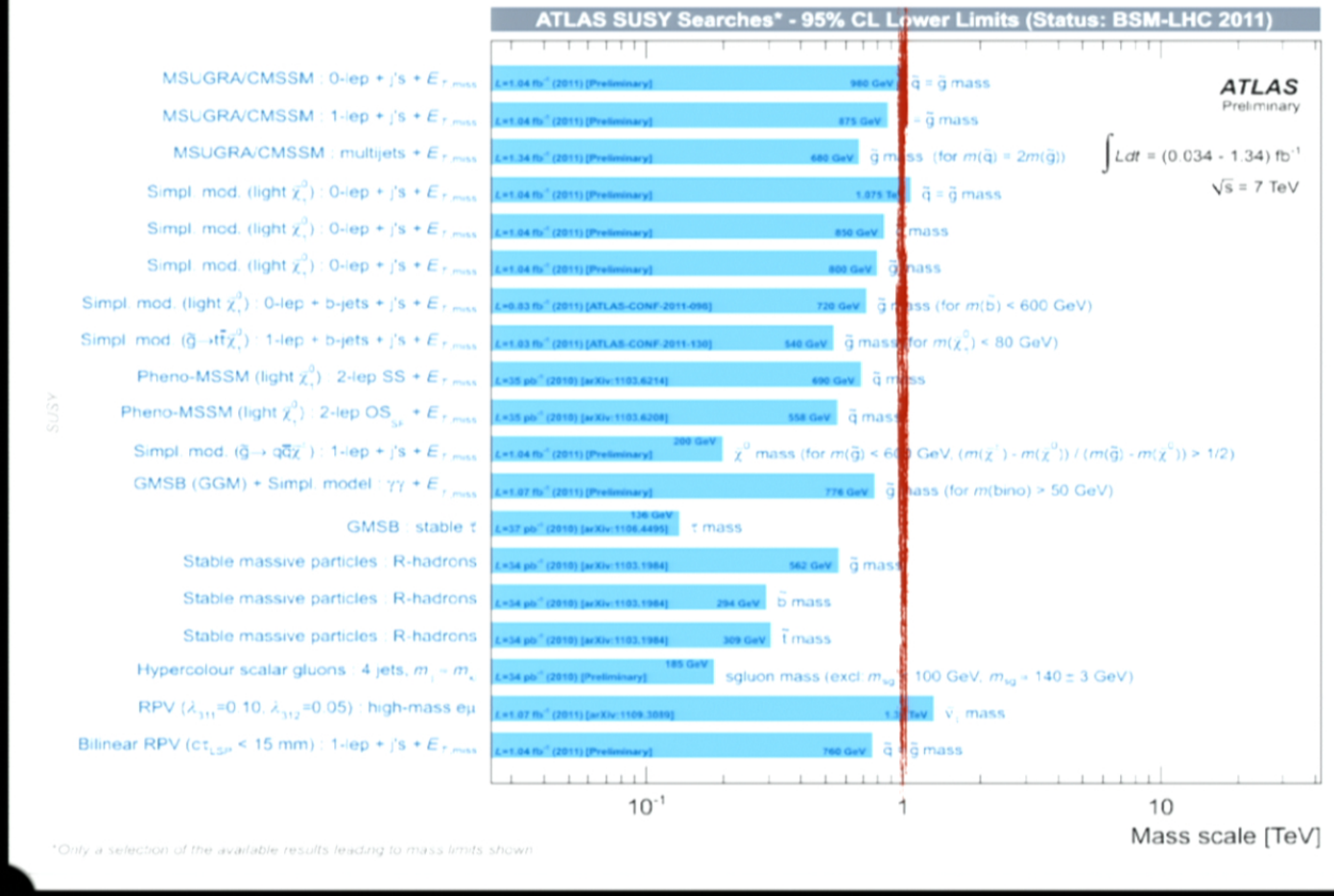
MSSM Status

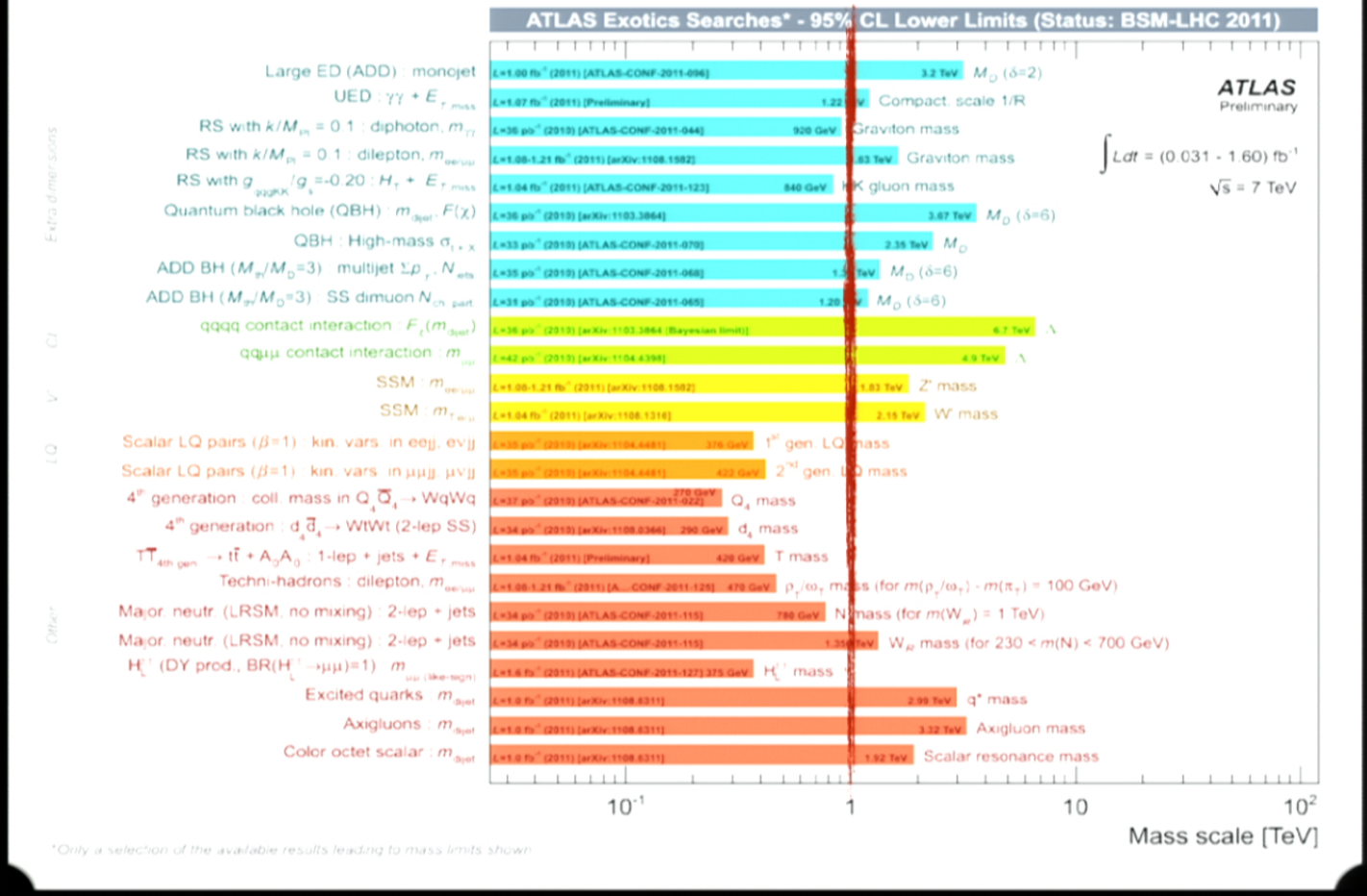


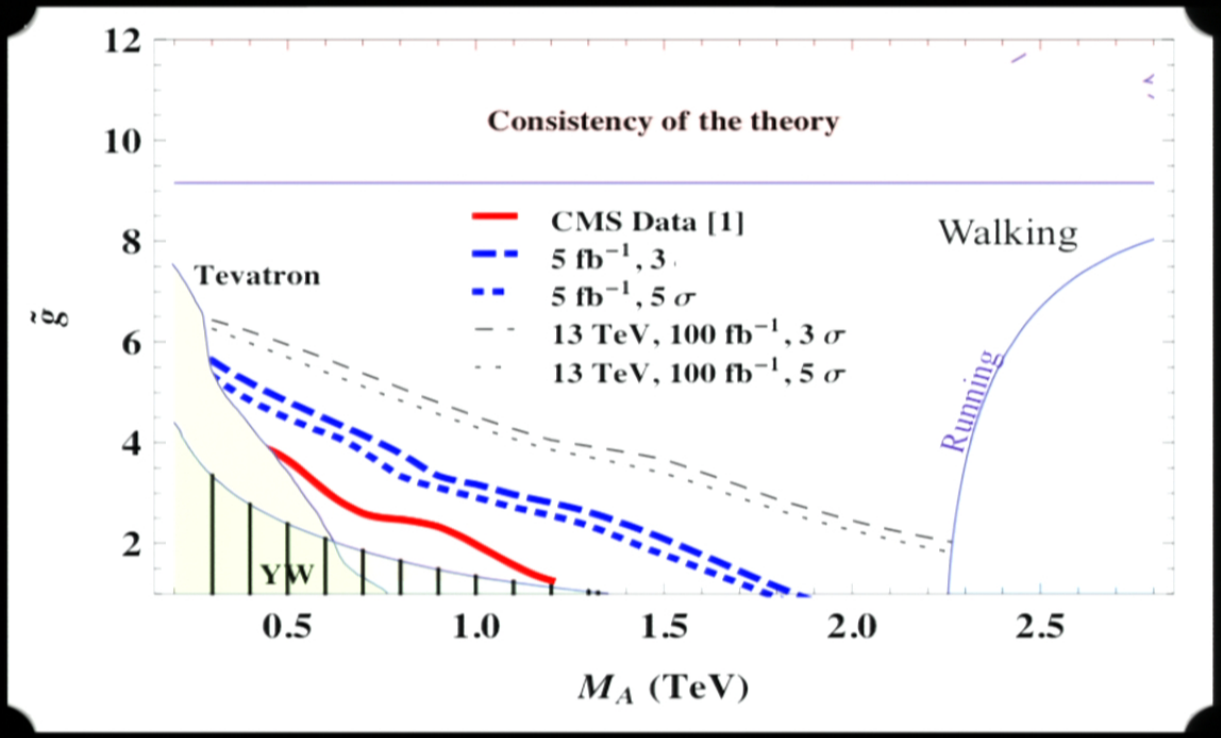
ATLAS Experiment © 2011 CERN



MSUGRA/CMSSM = five parameters:
the universal scalar mass m_0, gaugino mass $m_{1/2}$,
the trilinear scalar coupling A_0,
tan β: the ratio of the VEV of the two Higgses
the sign of the higgsino mass parameter μ.


ATLAS SUSY Searches* - 95% CL Lower Limits (Status: BSM-LHC 2011)
ATLAS
Preliminary
∫Ldt = (0.034 - 1.34) fb⁻¹
√s = 7 TeV
MSUGRA/CMSSM : 0-lep + j's + E_T,miss
MSUGRA/CMSSM : 1-lep + j's + E_T,miss
MSUGRA/CMSSM : multijets + E_T,miss
Simpl. mod. (light χ̃₁⁰) : 0-lep + j's + E_T,miss
Simpl. mod. (light χ̃₁⁰) : 0-lep + j's + E_T,miss
Simpl. mod. (light χ̃₁⁰) : 0-lep + j's + E_T,miss
Simpl. mod. (light χ̃₁⁰) : 0-lep + b-jets + j's + E_T,miss
Simpl. mod. (g̃→tt̄χ̃₁⁰) : 1-lep + b-jets + j's + E_T,miss
Pheno-MSSM (light χ̃₁⁰) : 2-lep SS + E_T,miss
Pheno-MSSM (light χ̃₁⁰) : 2-lep OS_SF + E_T,miss
Simpl. mod. (g̃→ qq̄χ̃₁⁰) : 1-lep + j's + E_T,miss
GMSB (GGM) + Simpl. model : γγ + E_T,miss
GMSB : stable τ̃
Stable massive particles : R-hadrons
Stable massive particles : R-hadrons
Stable massive particles : R-hadrons
Hypercolour scalar gluons : 4 jets, m_j = m_g
RPV (λ_311=0.10, λ_312=0.05) : high-mass eμ
Bilinear RPV (cτ_LSP < 15 mm) : 1-lep + j's + E_T,miss
980 GeV
875 GeV
680 GeV
850 GeV
800 GeV
720 GeV
540 GeV
690 GeV
558 GeV
200 GeV
776 GeV
136 GeV
562 GeV
294 GeV
309 GeV
185 GeV
1.3 TeV
760 GeV
q̃ = g̃ mass
g̃ mass (for m(q̃) = 2m(g̃))
g̃ mass (for m(b̃) < 600 GeV)
g̃ mass (for m(χ̃₁⁰) < 80 GeV)
χ̃₁⁰ mass (for m(g̃) < 6
ass (for m(bino) > 50 GeV)
τ̃ mass
b̃ mass
t̃ mass
sgluon mass (excl. m_sg
100 GeV, m_sg = 140 ± 3 GeV)
ν̃_τ mass
10⁻¹
1
10
Mass scale [TeV]
SUSY
*Only a selection of the available results leading to mass limits shown

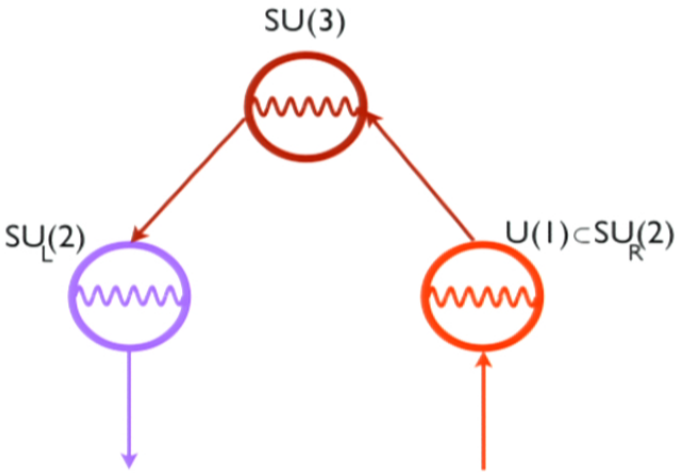

ATLAS Exotics Searches* - 95% CL Lower Limits (Status: BSM-LHC 2011)
ATLAS
Preliminary
∫Ldt = (0.031 - 1.60) fb⁻¹
√s = 7 TeV
Large ED (ADD) : monojet
UED : γγ + E_T,miss
RS with k/M_Pl = 0.1 : diphoton, m_γγ
RS with k/M_Pl = 0.1 : dilepton, m_ee/μμ
RS with g_ggKK/g_s=-0.20 : H_T + E_T,miss
Quantum black hole (QBH) : m_dijet, F(χ)
QBH : High-mass σ_1 + x
ADD BH (M_th/M_D=3) : multijet Σp_T, N_jets
ADD BH (M_th/M_D=3) : SS dimuon N_ch. part.
qqqq contact interaction : F_χ(m_dijet)
qqμμ contact interaction : m_μμ
SSM : m_ee/μμ
SSM : m_Tev,μ
Scalar LQ pairs (β=1) : kin. vars. in eejj, evjj
Scalar LQ pairs (β=1) : kin. vars. in μμjj, μνjj
4th generation : coll. mass in Q4Q4 → WqWq
4th generation : d4d4 → WtWt (2-lep SS)
TT 4th gen. → tt + A0A0 : 1-lep + jets + E_T,miss
Techni-hadrons : dilepton, m_ee/μμ
Major. neutr. (LRSM, no mixing) : 2-lep + jets
Major. neutr. (LRSM, no mixing) : 2-lep + jets
H_L^±± (DY prod., BR(H_L^±± → μμ)=1) : m_μμ (like-sign)
Excited quarks : m_dijet
Axigluons : m_dijet
Color octet scalar : m_dijet
3.2 TeV M_D (δ=2)
Compact. scale 1/R
920 GeV Graviton mass
.83 TeV Graviton mass
840 GeV KK gluon mass
3.87 TeV M_D (δ=6)
2.35 TeV M_D
1.5 TeV M_D (δ=6)
1.20 TeV M_D (δ=6)
6.7 TeV Λ
4.9 TeV Λ
1.83 TeV Z' mass
2.15 TeV W' mass
376 GeV 1st gen. LQ mass
422 GeV 2nd gen. LQ mass
270 GeV Q4 mass
290 GeV d4 mass
420 GeV T mass
ρT/ωT mass (for m(ρT/ωT) - m(πT) = 100 GeV)
780 GeV N mass (for m(WR) = 1 TeV)
1.35 TeV WR mass (for 230 < m(N) < 700 GeV)
375 GeV H_L^±± mass
2.99 TeV q* mass
3.32 TeV Axigluon mass
1.92 TeV Scalar resonance mass
Extra dimensions
LQ
CI
Other
10⁻¹
1
10
10²
Mass scale [TeV]
*Only a selection of the available results leading to mass limits shown



Andersen, Hapola, Sannino 11

Belyaev, Foad, Frandsen, Jarvinen, Pukhov, Sannino 08

Technicolor - Geometry



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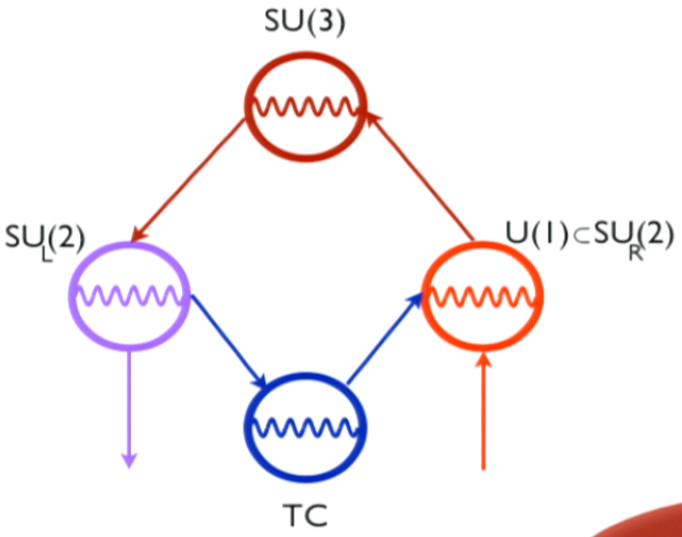
Technicolor - Geometry



Technicolor

R-TQuarks
L-TQuarks

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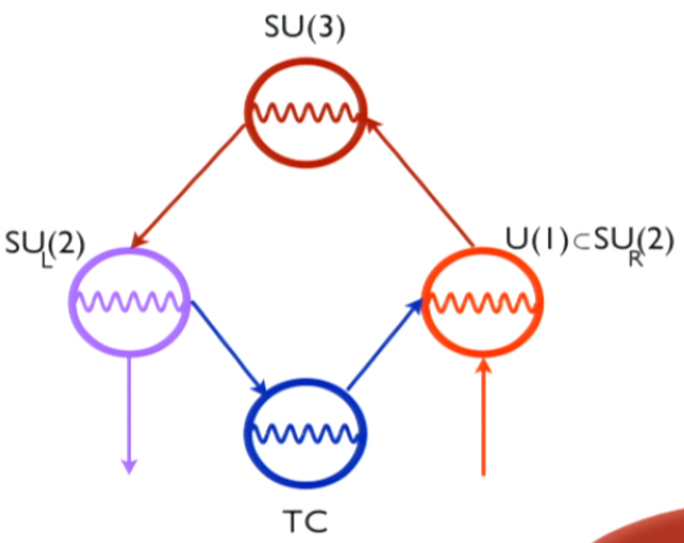
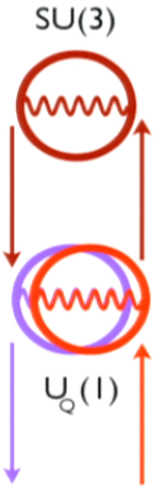
Technicolor - Geometry



$< \bar{Q}\, Q >$



Technicolor

R-TQuarks
L-TQuarks

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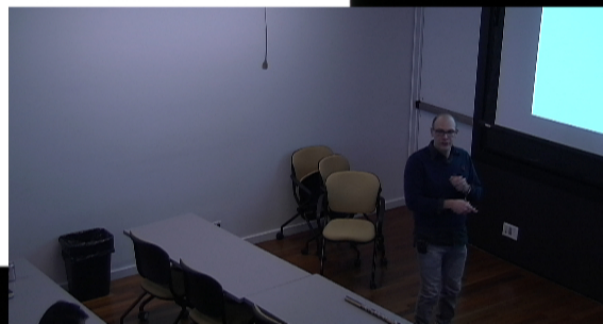
Dynamical EW Breaking

$$L(H) \rightarrow -\frac{1}{4} F^{a\mu\nu} F^{a}_{\mu\nu} + i\,\bar{Q}\gamma^{\mu} D_{\mu} Q + \cdots$$



Dynamical EW Breaking

$$L(H) \rightarrow -\frac{1}{4} F^{a\mu\nu} F^{a}_{\mu\nu} + i\,\bar{Q}\gamma^{\mu} D_{\mu} Q + \cdots$$

Dots are partially fixed by Anomalies as well as other principles

$$\cdots \qquad \rightarrow \qquad L(\text{New SM Fermions})$$

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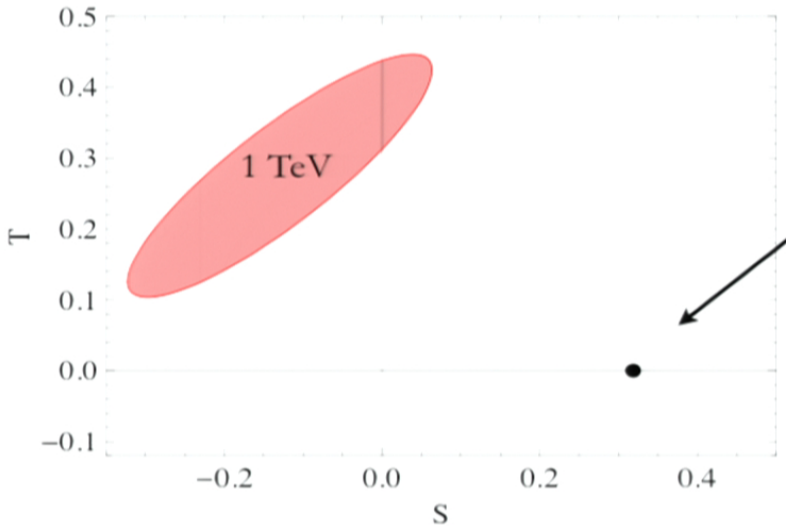
Need novel dynamics

Large & Positive S from QCD-like Technicolor

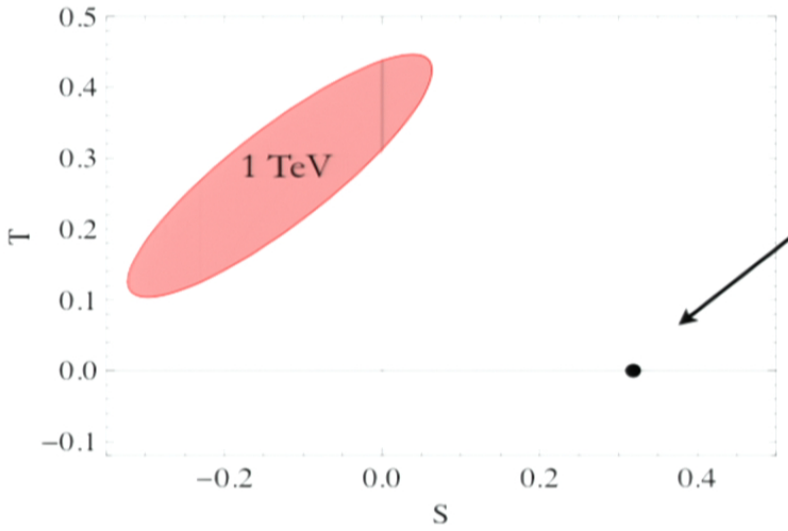


SU(3) + 1 Fund. Doublet

Weinberg, Susskind

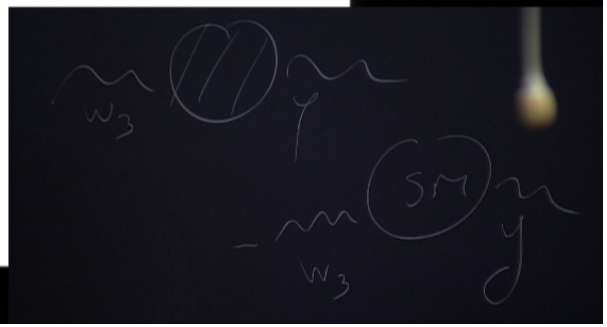
Need novel dynamics

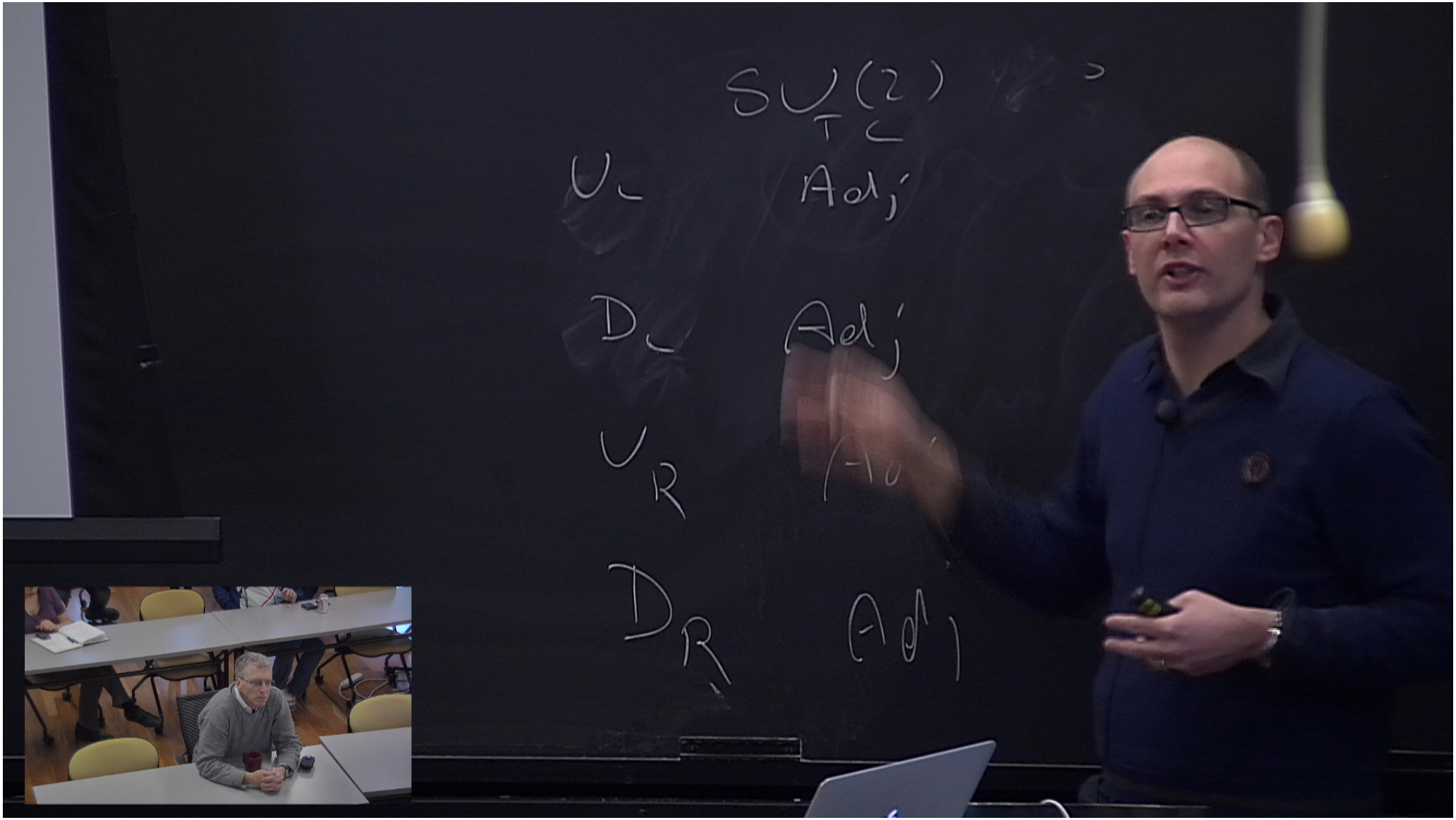
Large & Positive S from QCD-like Technicolor

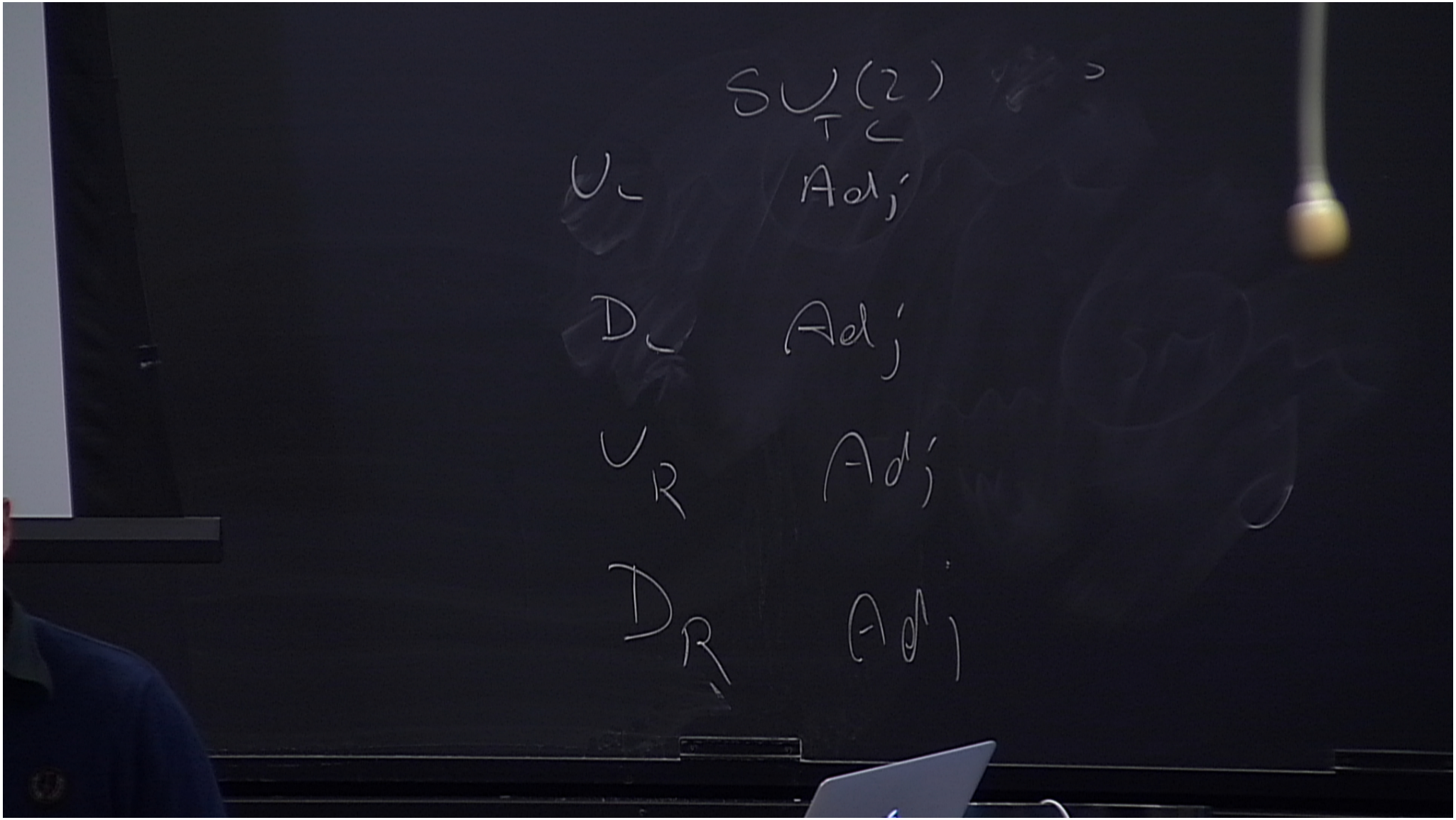


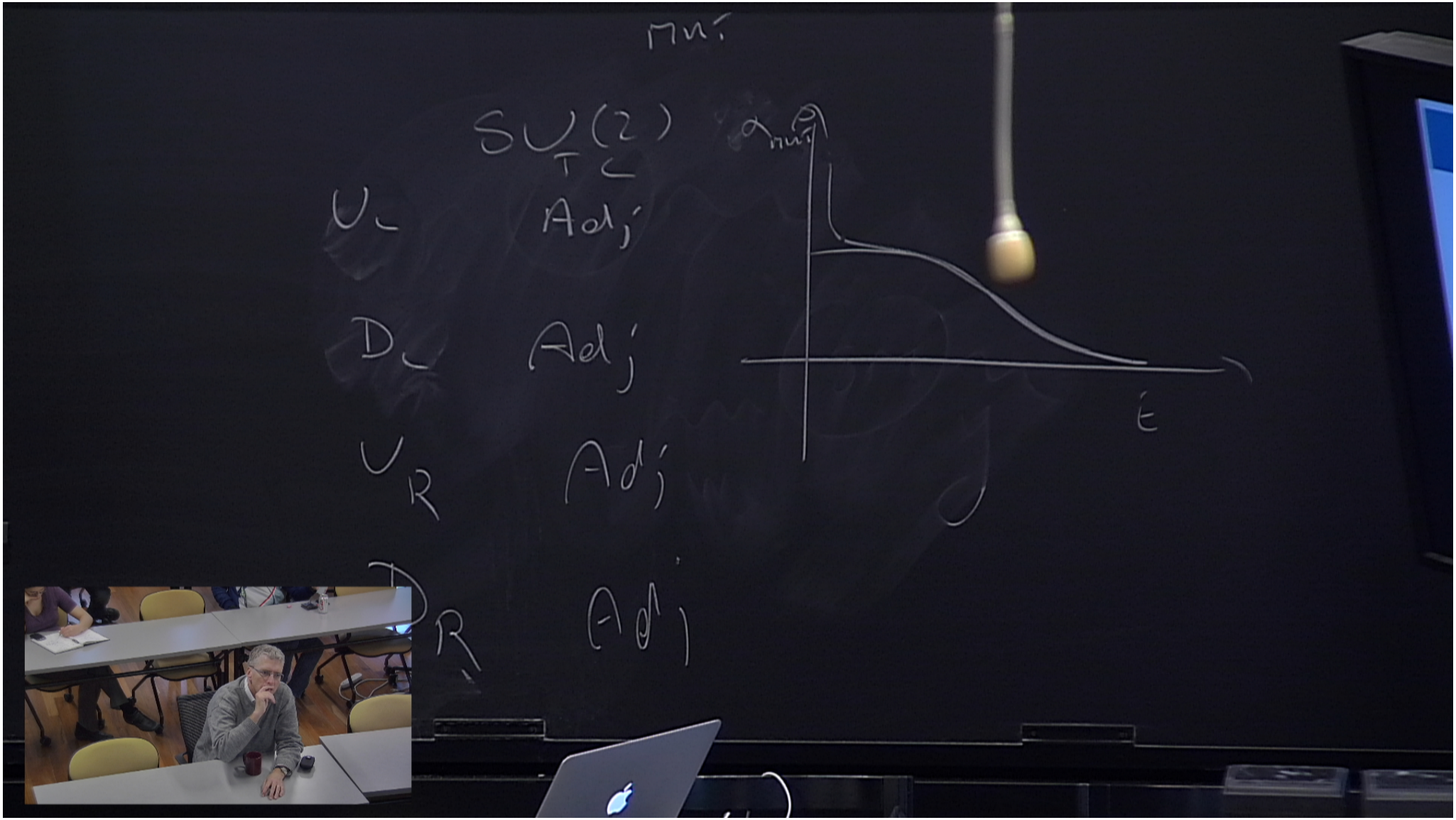
SU(3) + 1 Fund. Doublet

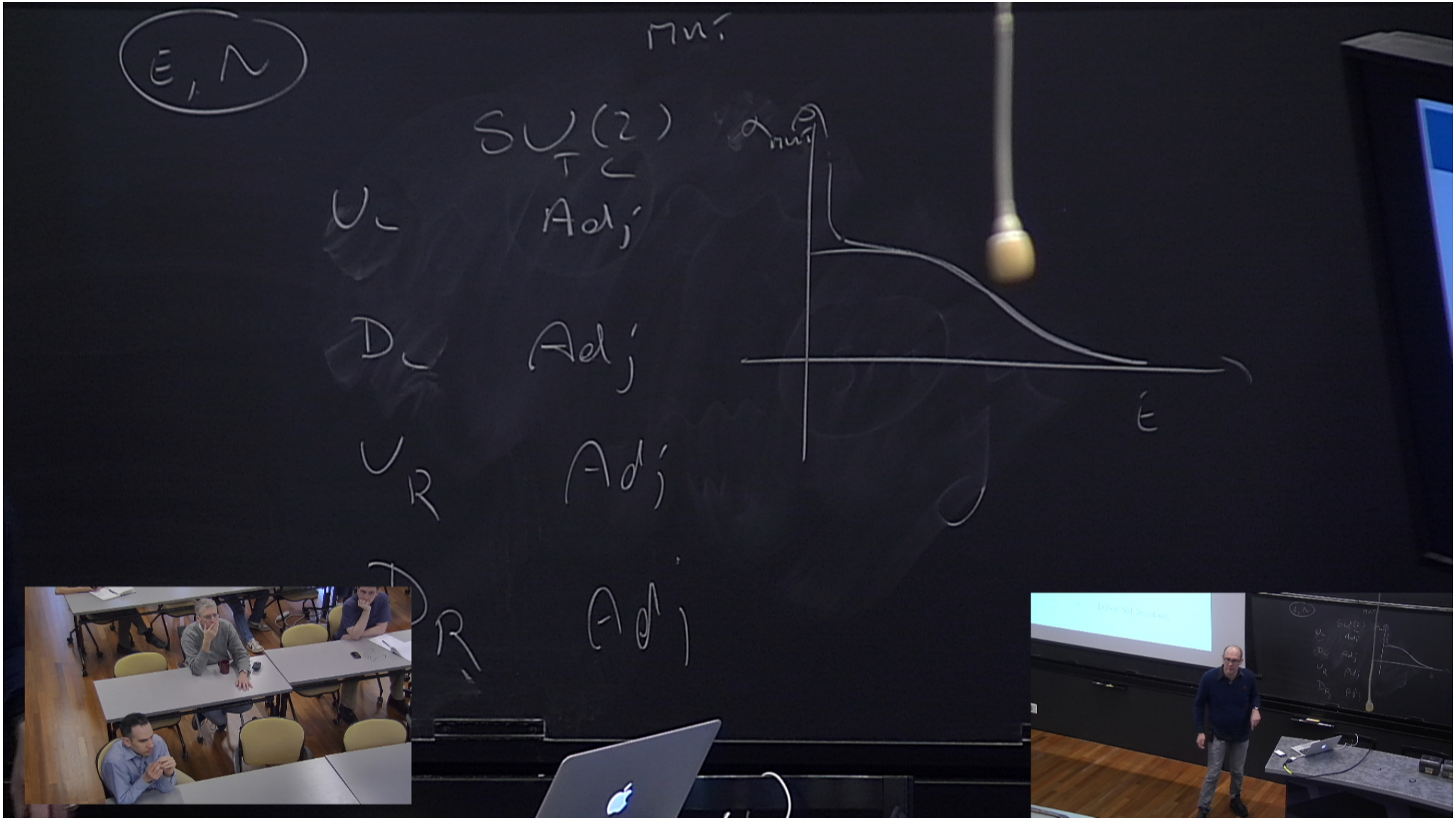
Weinberg, Susskind

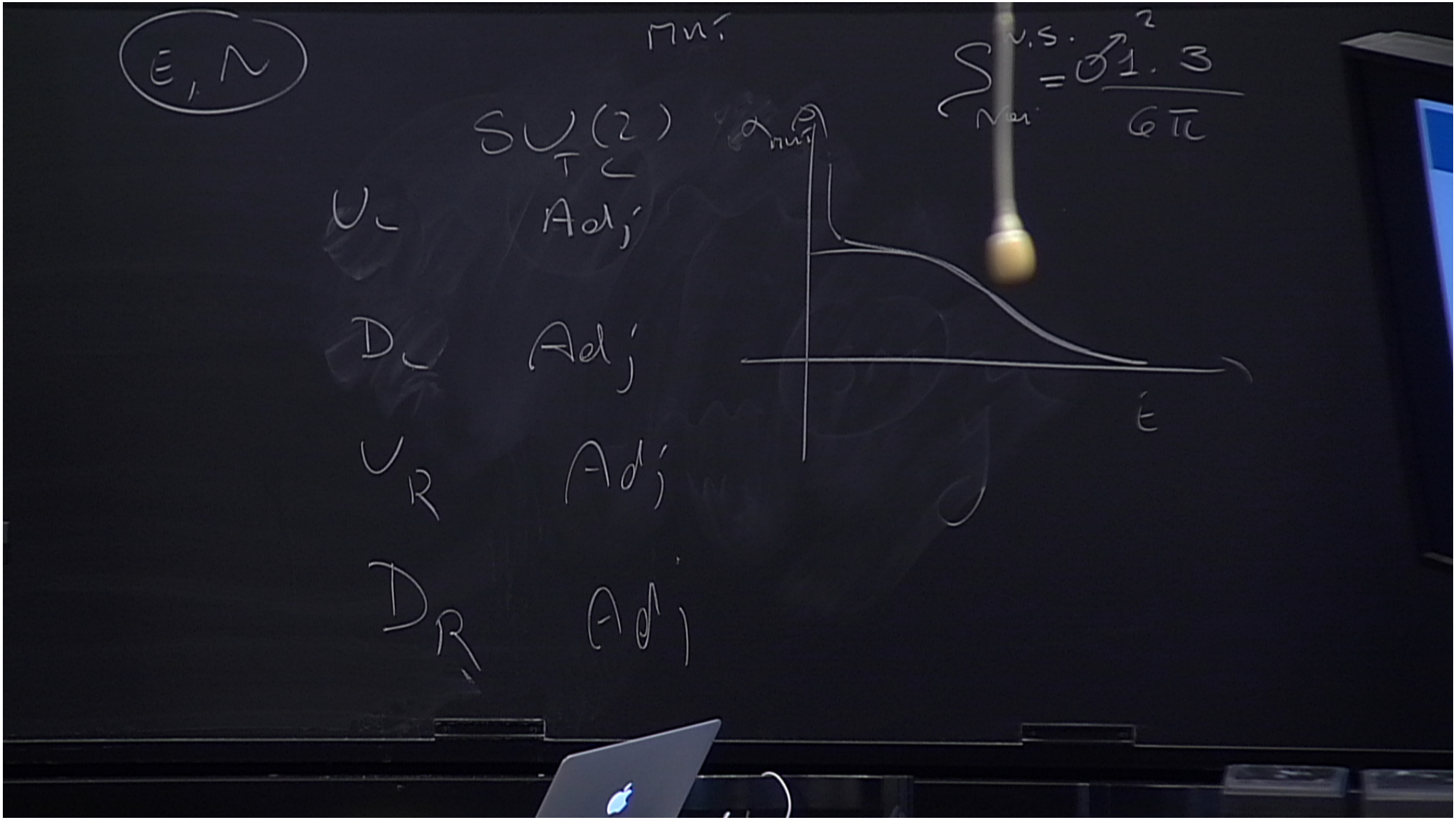


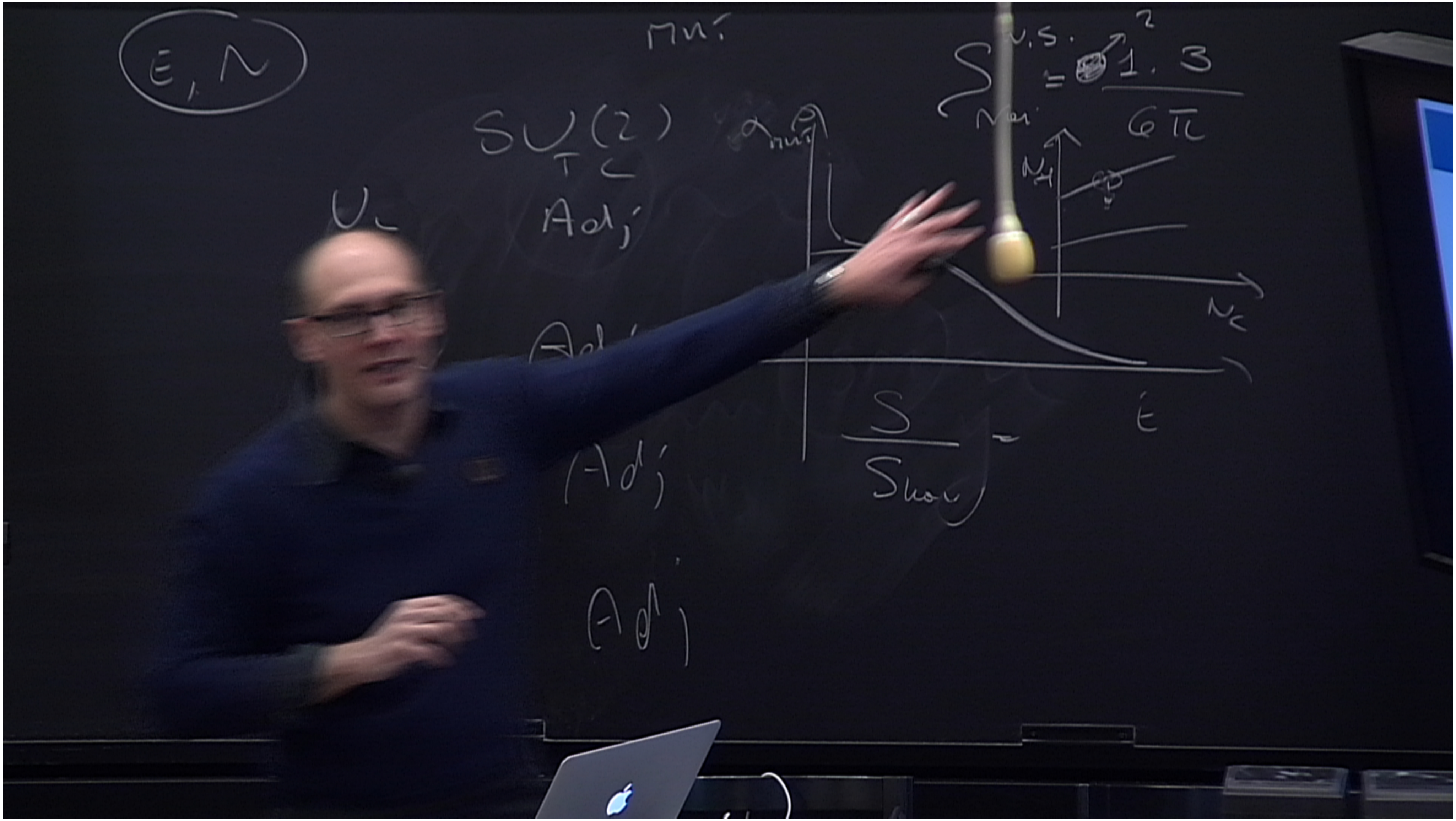

SU(2)
T
U_
Adj
D_
Adj
U_R
D_R

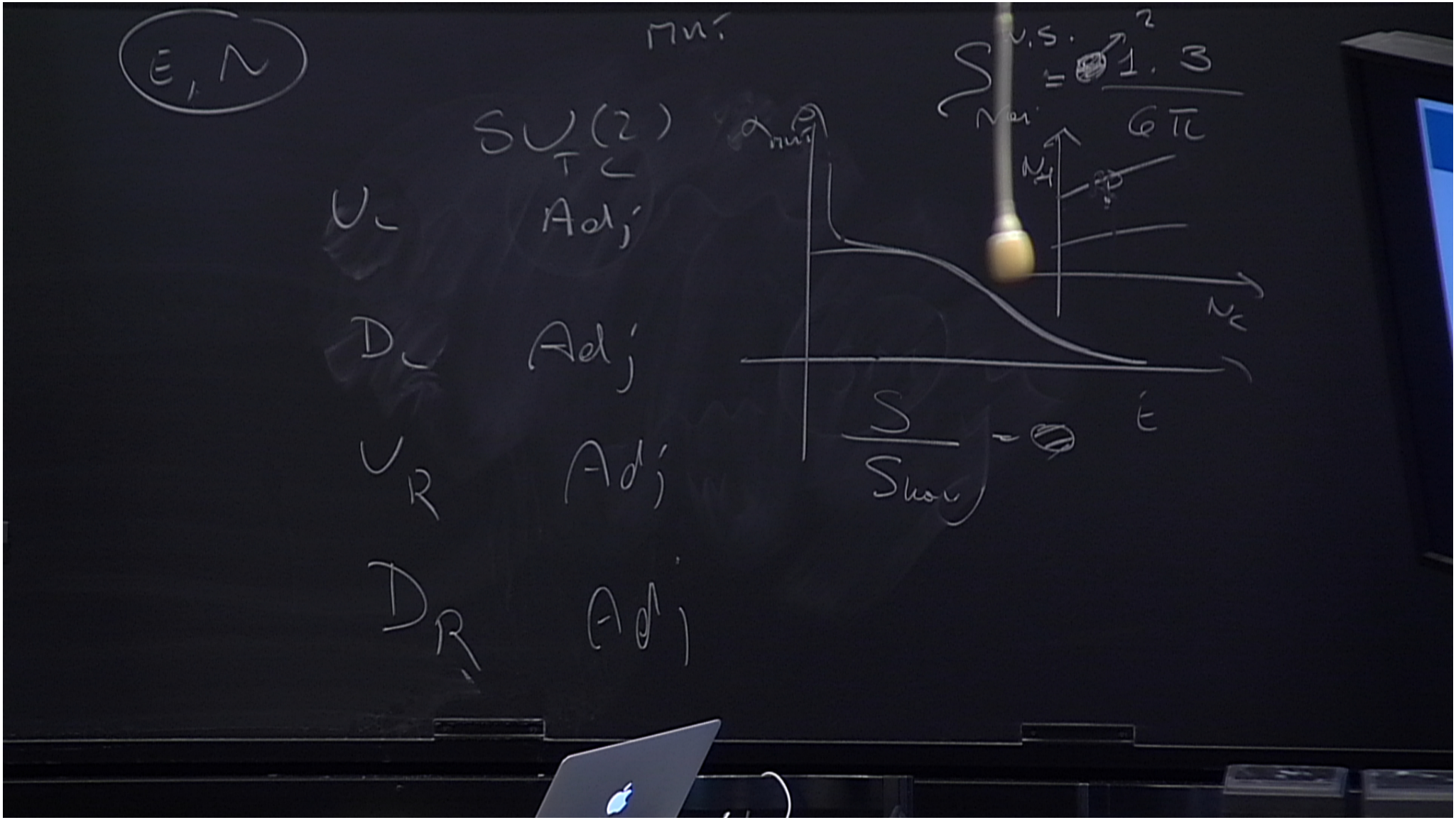

$SU_T(2)$
U_L Adj
D_L Adj
U_R Adj
D_R Adj


$SU_T(2)$
U_L Adj
D_L Adj
U_R Adj
D_R Adj
ϵ


E, N
SU(2)
T
U_ Adj
D_ Adj
U_R Adj
D_R Adj
E

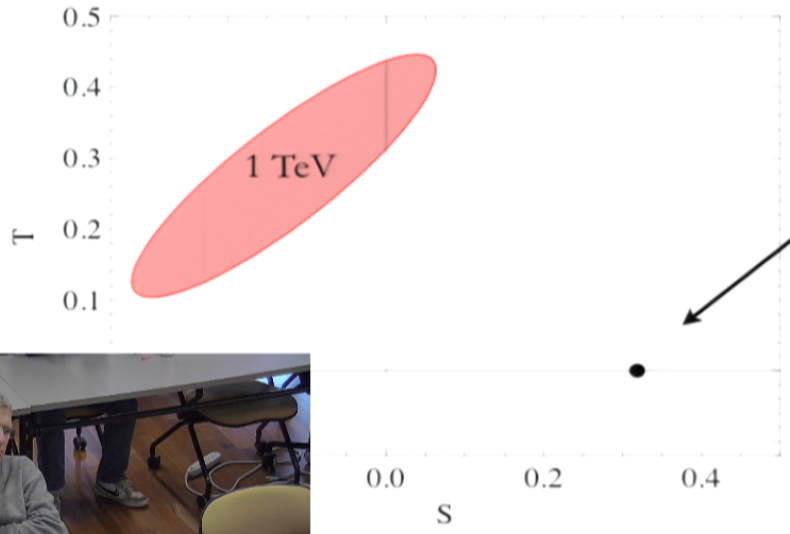

E, N
SU(2)
T <
U_ Adj
D_ Adj
U_R Adj
D_R Adj
E




E, N
SU(2)
Adj
Adj
Adj
Adj
1.3
GTL
S
Shot

Need novel dynamics

Large & Positive S from QCD-like Technicolor



SU(3) + 1 Fund. Doublet

Weinberg, Susskind

SM Fermion Masses

Francesco Sannino

Extending Technicolor

$$\bar{L} \cdot H e_R \quad \rightarrow \quad \bar{L} \frac{\bar{Q} Q}{\Lambda^2_{ETC}} e_R$$

Francesco Sannino

Different Approaches

Scalar-less New Gauge Interactions (Extended TC)

Marry SUSY and Technicolor

Francesco Sannino

Different Approaches

Scalar-less New Gauge Interactions (Extended TC)

Marry SUSY and Technicolor

Add New Scalars in the Flavor Sector

.....

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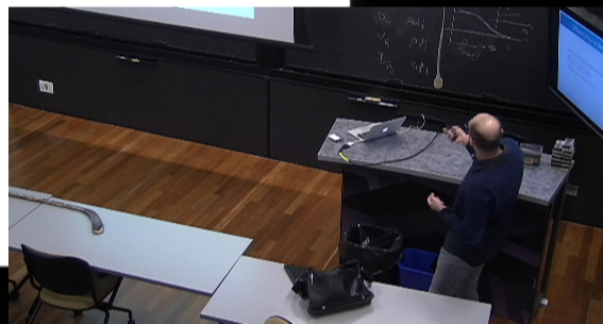
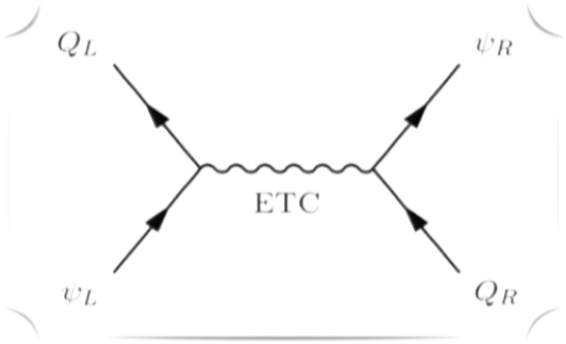
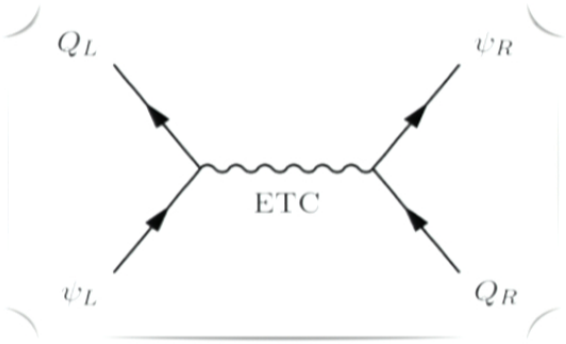


Naive Extended Technicolor



Eichten & Lane 80

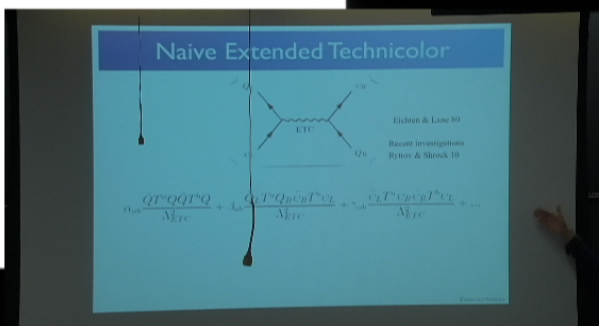
Naive Extended Technicolor



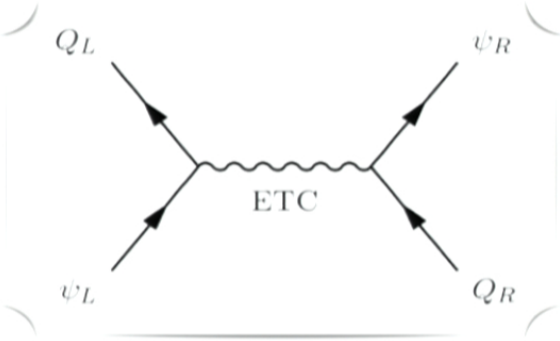
Eichten & Lane 80

Recent investigations
Ryttov & Shrock 10

$$\alpha_{ab}\frac{\bar{Q}T^aQ\bar{Q}T^bQ}{\Lambda^2_{ETC}}+\beta_{ab}\frac{\bar{Q}_LT^aQ_R\bar{\psi}_RT^b\psi_L}{\Lambda^2_{ETC}}+\gamma_{ab}\frac{\bar{\psi}_LT^a\psi_R\bar{\psi}_RT^b\psi_L}{\Lambda^2_{ETC}}+\ldots$$



Naive Extended Technicolor



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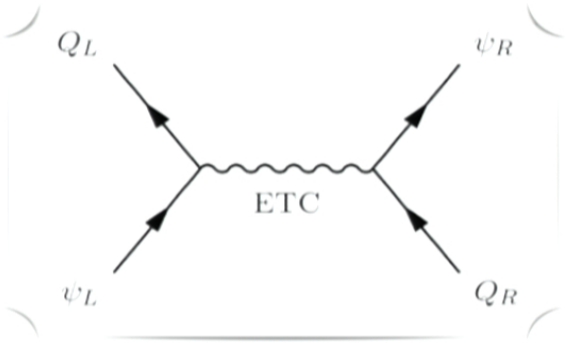
PNG Masses

SM-Fermion Masses

FCNC Operators

Francesco Sannino

Naive Extended Technicolor



Fukano, Sannino 10

Eichten & Lane 80

Recent investigations
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Modifies TC dynamics

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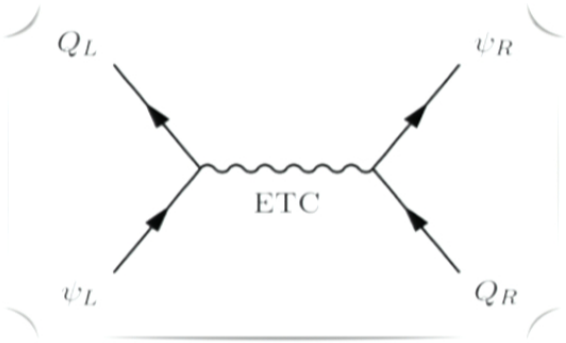

Fukano, Sannino 10

Eichten & Lane 80

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PNG Masses

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FCNC Operators

Antola, Di Chira, Sannino, Tuominen 10,11

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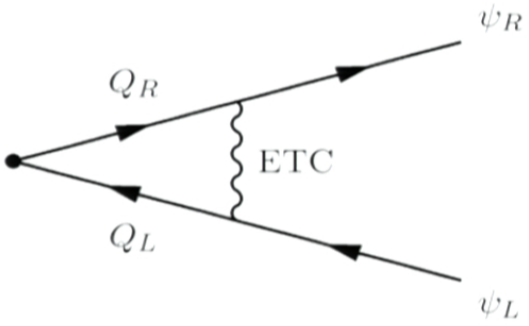
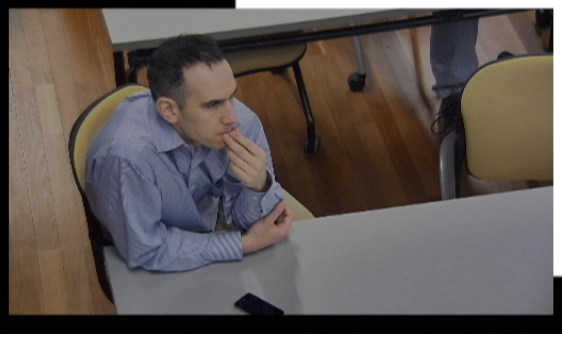
Beta - Terms



$$m_{\mathrm{f}} \approx \frac{g^2_{ETC}}{\Lambda^2_{ETC}} < \bar{Q}Q >_{ETC}$$



Gamma - Terms

$$\frac{1}{\Lambda^2_{ETC}}(\bar{s}\gamma^5 d)(\bar{s}\gamma^5 d) + \frac{1}{\Lambda^2_{ETC}}(\bar{\mu}\gamma^5 e)(\bar{e}\gamma^5 e) + \ldots$$

Gamma - Terms

$$\frac{1}{\Lambda^2_{ETC}}(\bar{s}\gamma^5 d)(\bar{s}\gamma^5 d) + \frac{1}{\Lambda^2_{ETC}}(\bar{\mu}\gamma^5 e)(\bar{e}\gamma^5 e) + \ldots$$

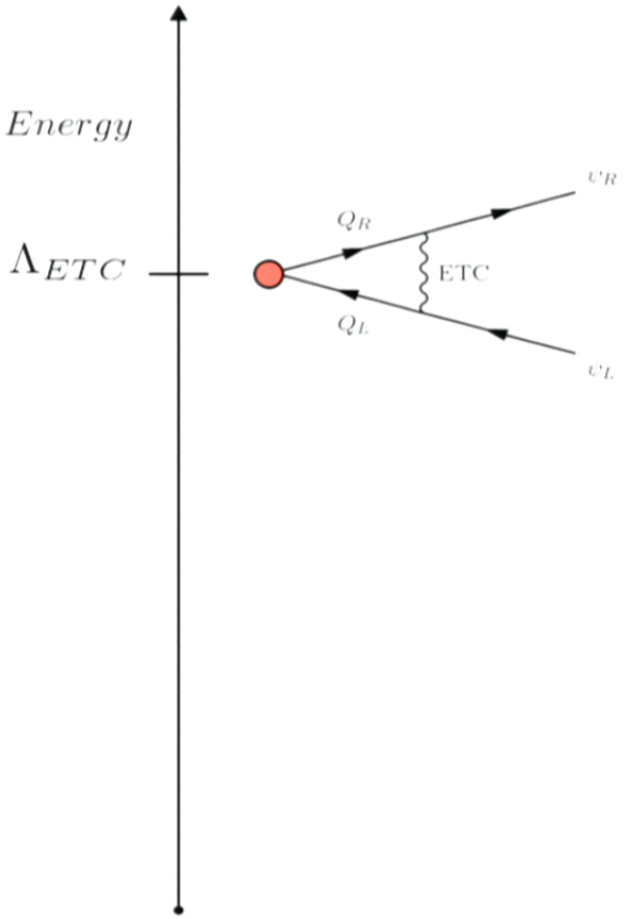
$$\downarrow$$

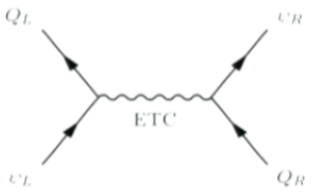
$$\Lambda_{ETC} \geq 10^3 \Lambda_{TC}$$

Too small Top mass if

$$< \bar{Q}Q >_{ETC} \approx < \bar{Q}Q >_{TC} \sim \Lambda_{TC}^3$$

$$m_{\rm f} \approx \frac{g_{ETC}^2}{\Lambda_{ETC}^2} < \bar{Q}Q >_{ETC} \quad \ll \quad m_{\rm Top}$$





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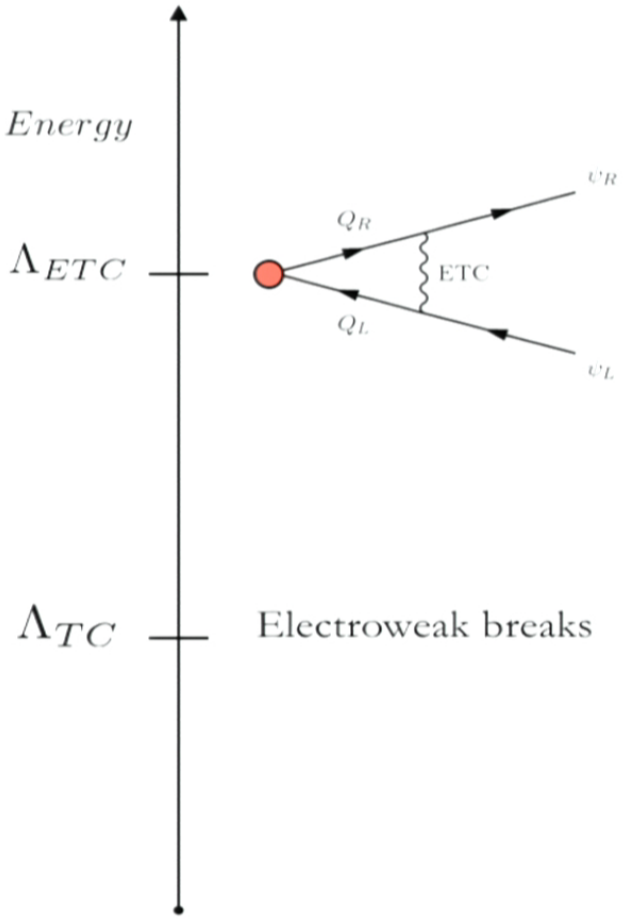
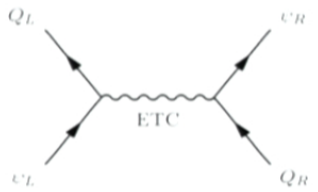
Francesco Sannino





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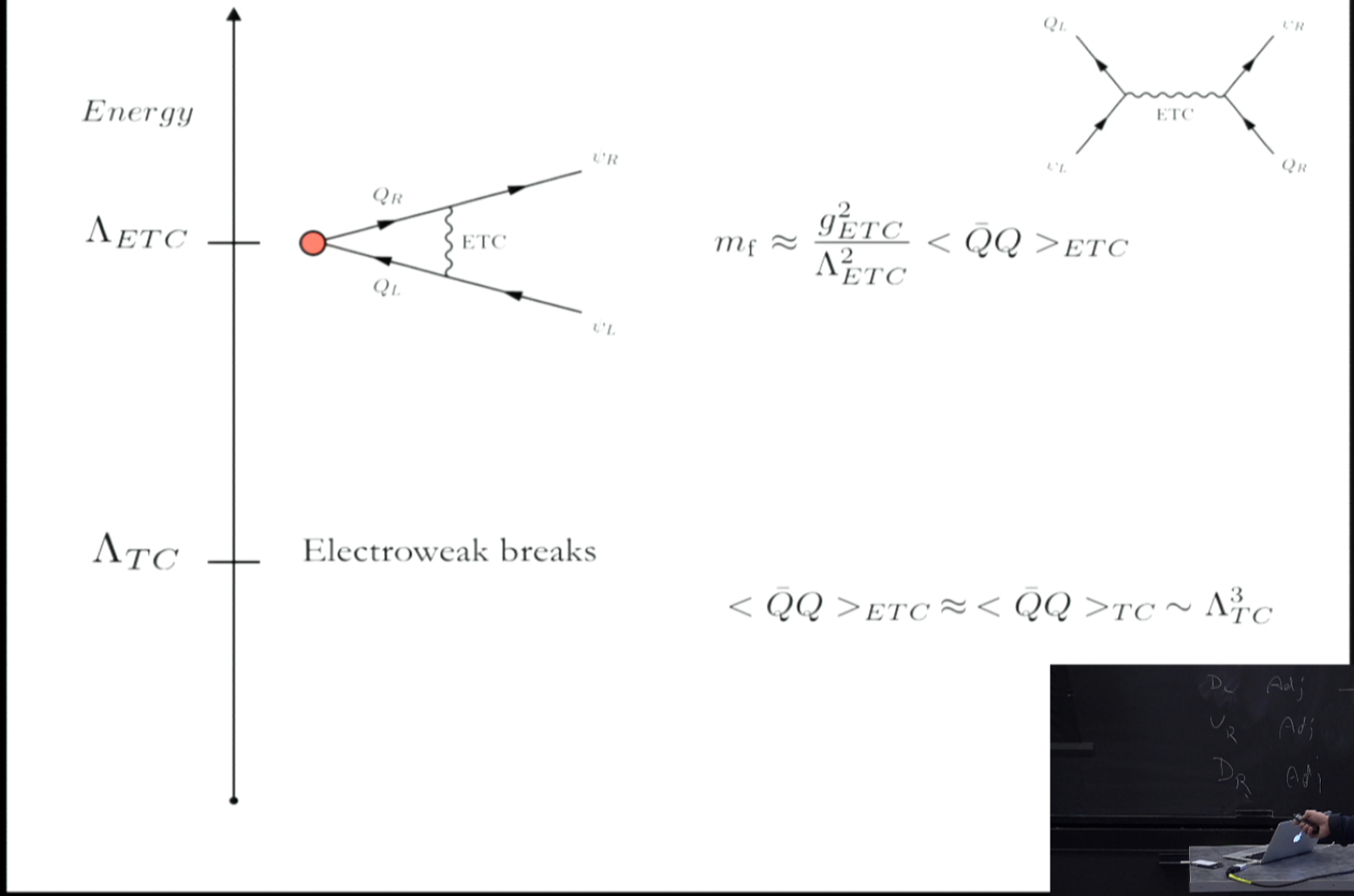
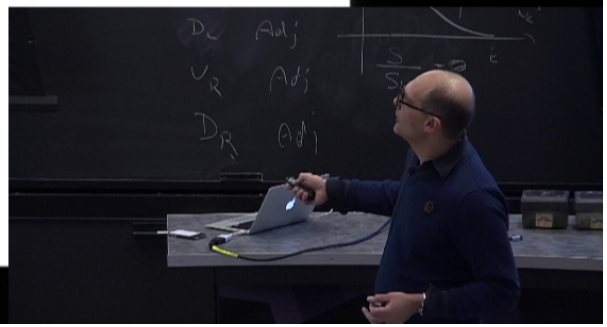
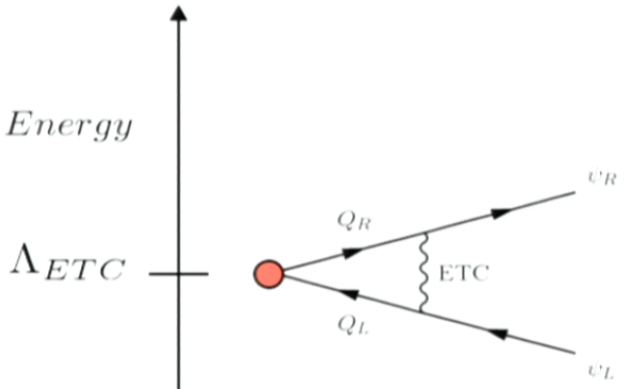
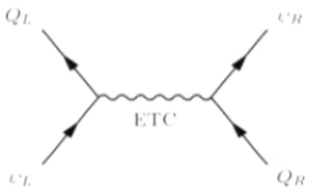

Energy
Λ_{ETC}
Λ_{TC}
Electroweak breaks
Q_R
Q_L
ETC
u_R
u_L
Q_L
u_R
ETC
u_L
Q_R
$m_f \approx \frac{g^2_{ETC}}{\Lambda^2_{ETC}} < \bar{Q}Q >_{ETC}$
$< \bar{Q}Q >_{ETC} \approx < \bar{Q}Q >_{TC} \sim \Lambda^3_{TC}$







$$m_{\mathrm{f}} \approx \frac{g_{ETC}^2}{\Lambda_{ETC}^2} < \bar{Q}Q >_{ETC}$$

Λ_{TC} Electroweak breaks

$$< \bar{Q}Q >_{ETC} \approx < \bar{Q}Q >_{TC} \sim \Lambda_{TC}^3$$

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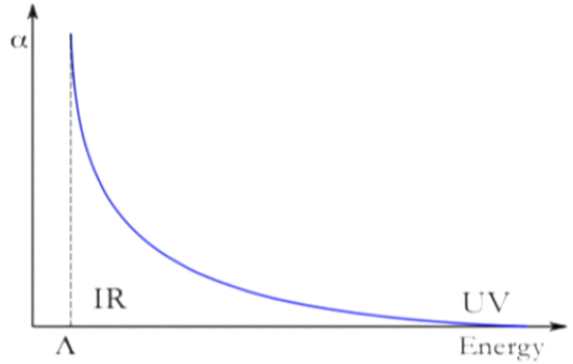
Francesco Sannino

Near Conformal



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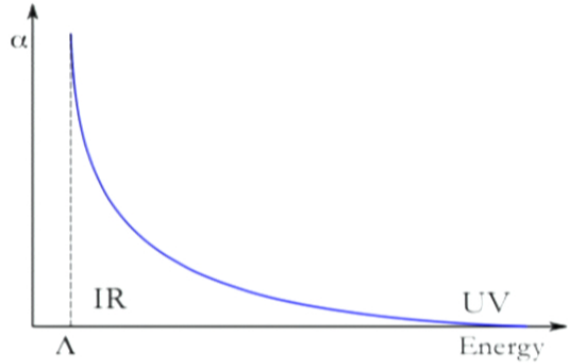
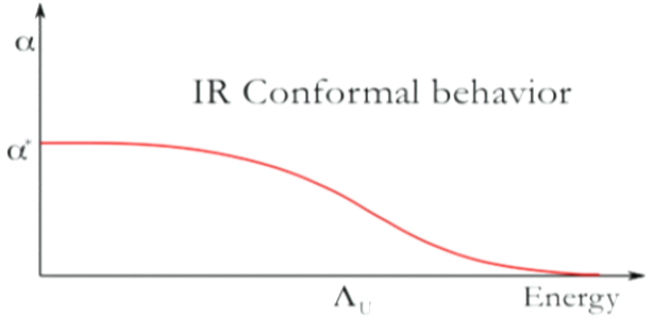
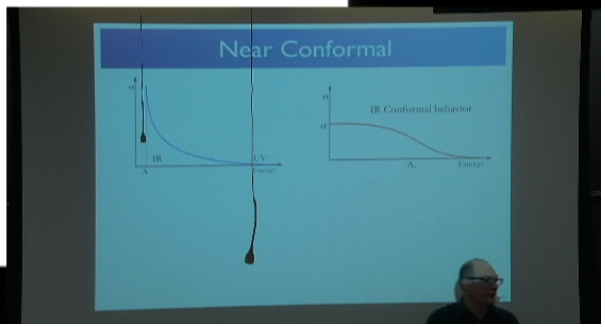
Near Conformal

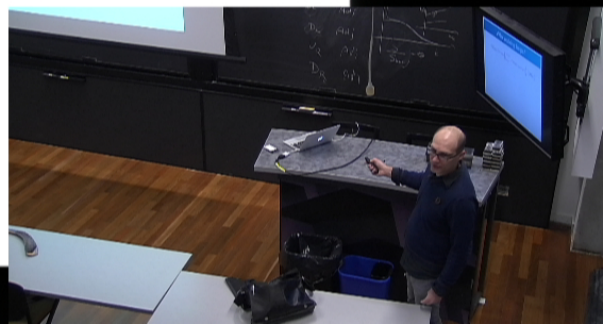






Why walking helps?

$$\left\langle \bar{Q}Q_{ETC} \right\rangle = \exp\left(\int_{\Lambda_{TC}}^{\Lambda_{ETC}} d\ln(\mu)\ \gamma_m(\alpha(\mu)) \right) \left\langle \bar{Q}Q_{TC} \right\rangle$$



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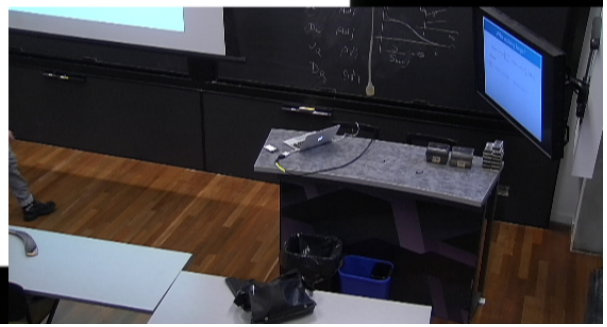
QCD-Like

$$\exp\left(\int_{\Lambda_{TC}}^{\Lambda_{ETC}} d\ln(\mu)\ \gamma_m(\alpha(\mu)) \right) \quad \sim \quad (\ln(\Lambda_{ETC}/\Lambda_{TC}))^{\gamma_m}$$



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QCD-Like

$$\exp\left(\int_{\Lambda_{TC}}^{\Lambda_{ETC}} d\ln(\mu)\ \gamma_m(\alpha(\mu)) \right) \quad \sim \quad (\ln(\Lambda_{ETC}/\Lambda_{TC}))^{\gamma_m}$$

Near the conformal window

$$\exp\left(\int_{\Lambda_{TC}}^{\Lambda_{ETC}} d\ln(\mu)\ \gamma_m(\alpha(\mu)) \right) \quad \sim \quad (\Lambda_{ETC}/\Lambda_{TC})^{\gamma_m(\alpha^\star)}$$

Francesco Sannino

$$m_{\rm f} \approx \frac{g^2_{ETC}}{\Lambda^2_{ETC}} < \bar{Q}Q >_{ETC} = \frac{g^2_{ETC}}{\Lambda^2_{ETC}} \left(\frac{\Lambda_{ETC}}{\Lambda_{TC}} \right)^{\gamma_m(\alpha^*)} < \bar{Q}Q >_{TC}$$

If large anomalous dimension, around $\gamma_m(\alpha^*) \sim 1.7$

Francesco Sannino

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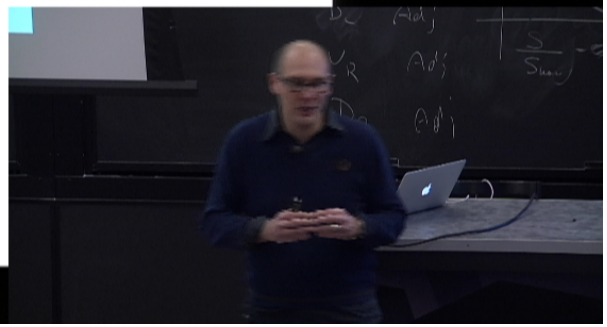
Fermion Mass Enhancement & FCNC decoupling

Francesco Sannino

- Understand Phase Diagram of gauge theories

- Understand Phase Diagram of gauge theories
- Ideal Walking is needed



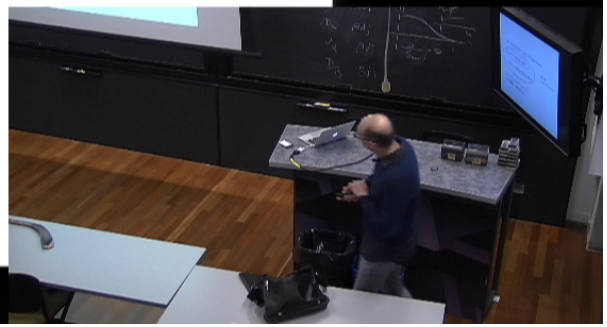
- Understand Phase Diagram of gauge theories
- Ideal Walking is needed
- Need a working example of ETC

iWalk

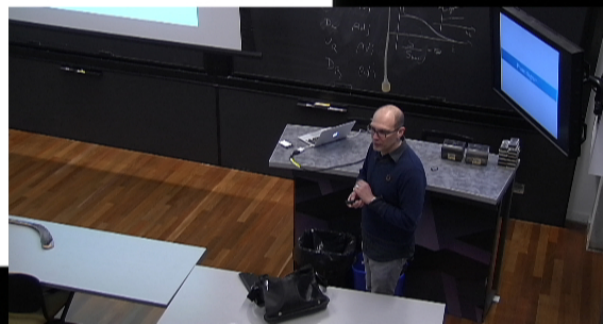
Fukano & Sannino 10

Antola, Di Chira, Sannino, Tuominen 10,11

SUSY ETC + Technicolor



Phase diagram



Knobs

Gauge Group, i.e. SU, SO, SP

Knobs

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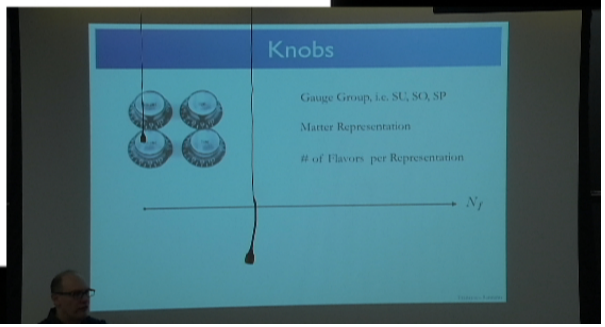
Matter Representation

# of Flavors per Representation

N_f



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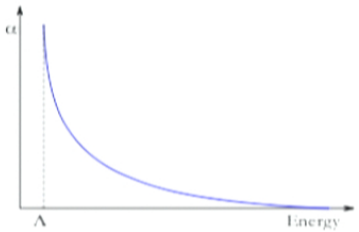
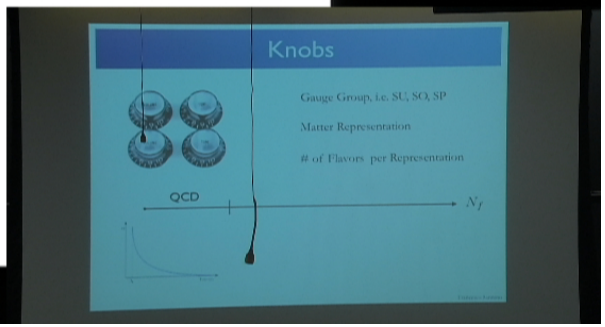
QCD

N_f





Knobs

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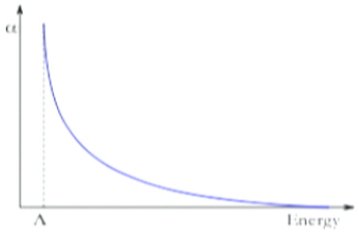
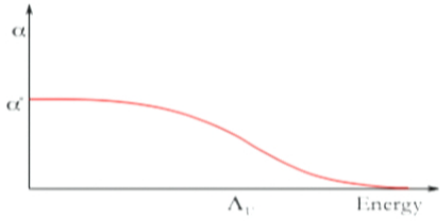
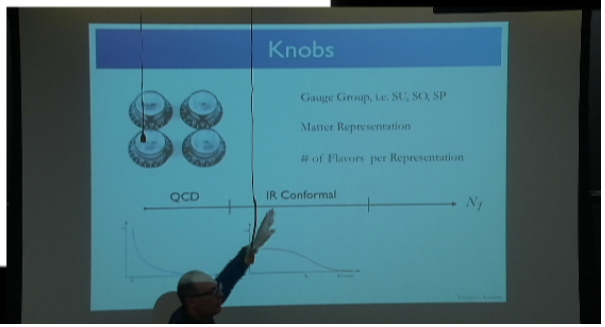






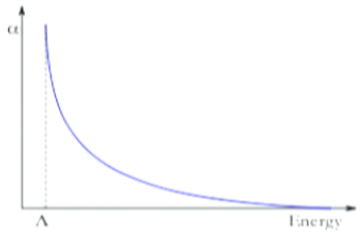
Knobs

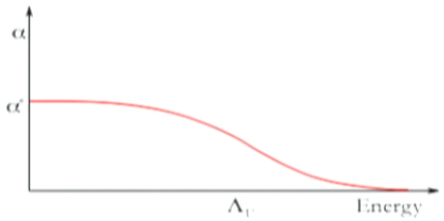
Gauge Group, i.e. SU, SO, SP

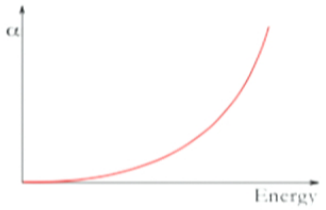
Matter Representation

# of Flavors per Representation

QCD | IR Conformal | Infrared free → N_f



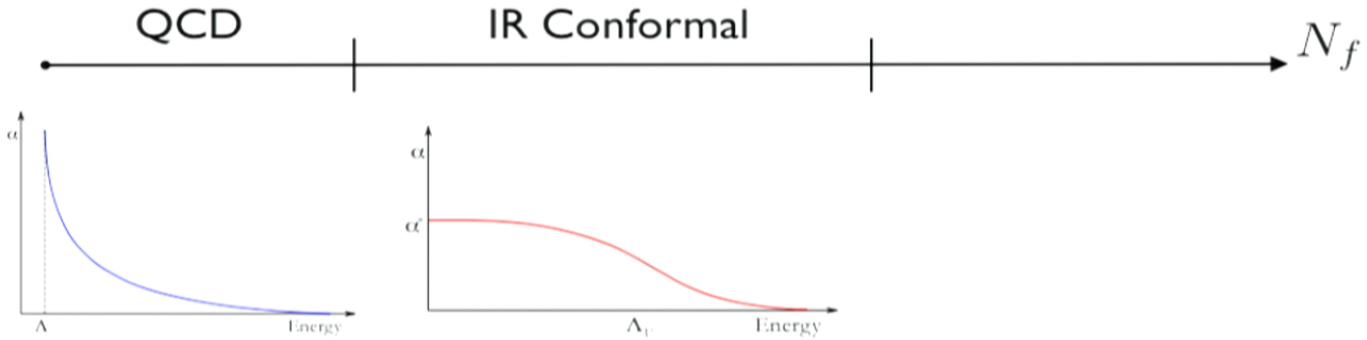




Francesco Sannino

A novel phase @ large Nf

Pica & Sannino 10



Francesco Sannino

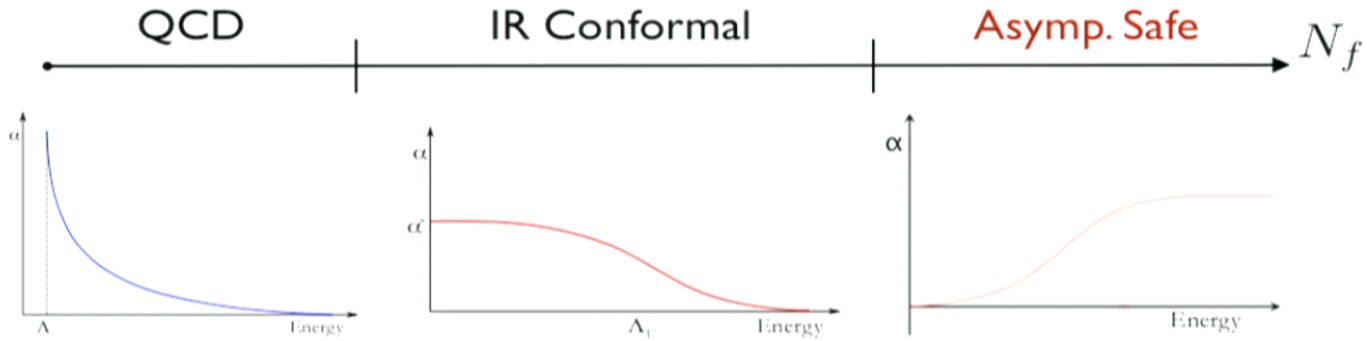
A novel phase @ large Nf

Interesting structure at large Nf

Pica & Sannino 10

First coefficients at large Nf are known

Ciuchini, Derkachov, Gracey, Manashov '99



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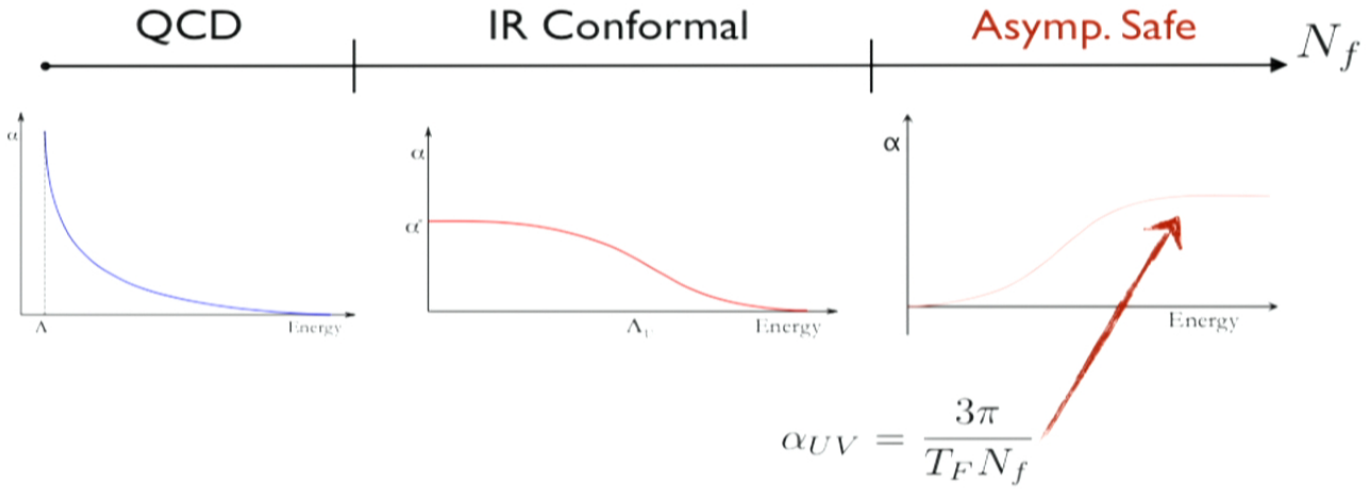
A novel phase @ large Nf

Interesting structure at large Nf

Pica & Sannino 10

First coefficients at large Nf are known

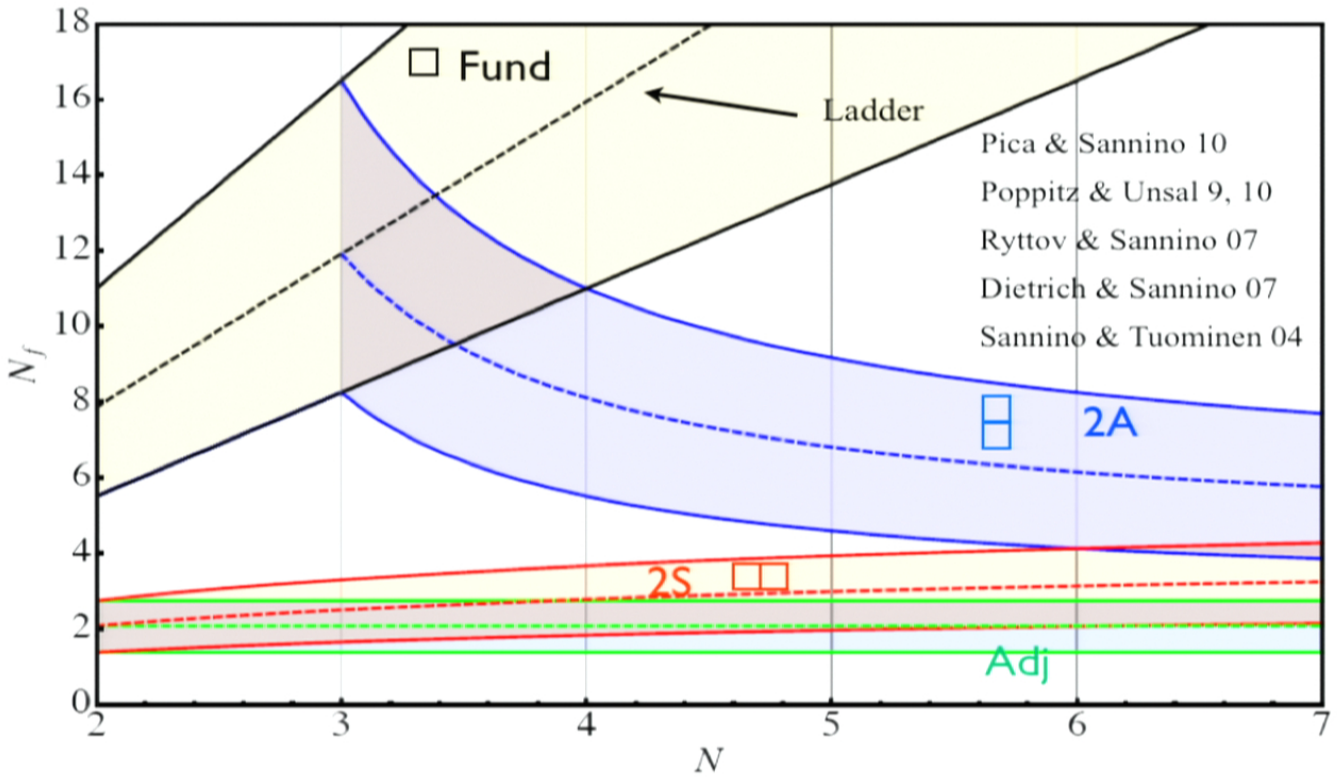
Ciuchini, Derkachov, Gracey, Manashov '99



$$\alpha_{UV} = \frac{3\pi}{T_F N_f}$$

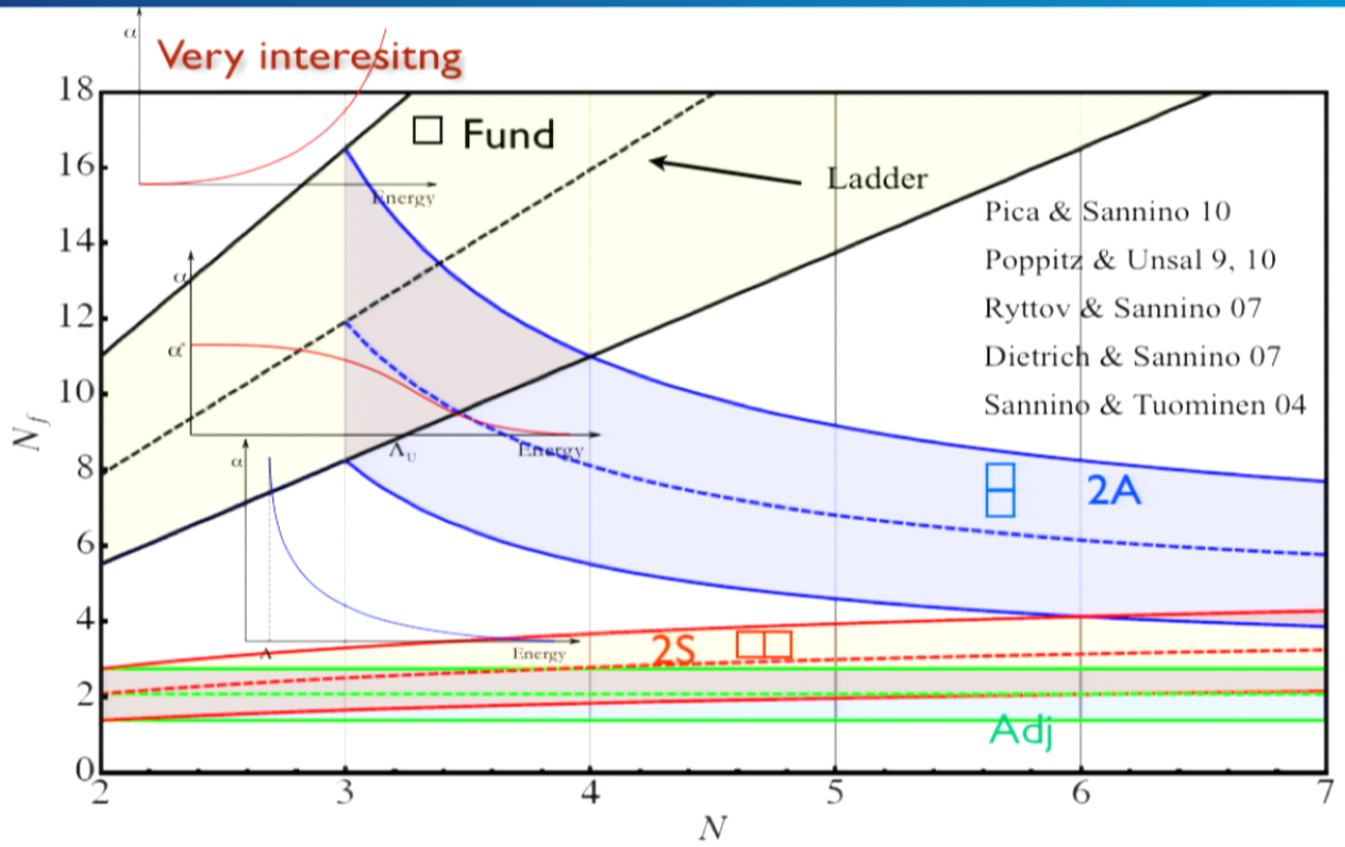
Francesco Sannino

SU(N) Phase Diagram

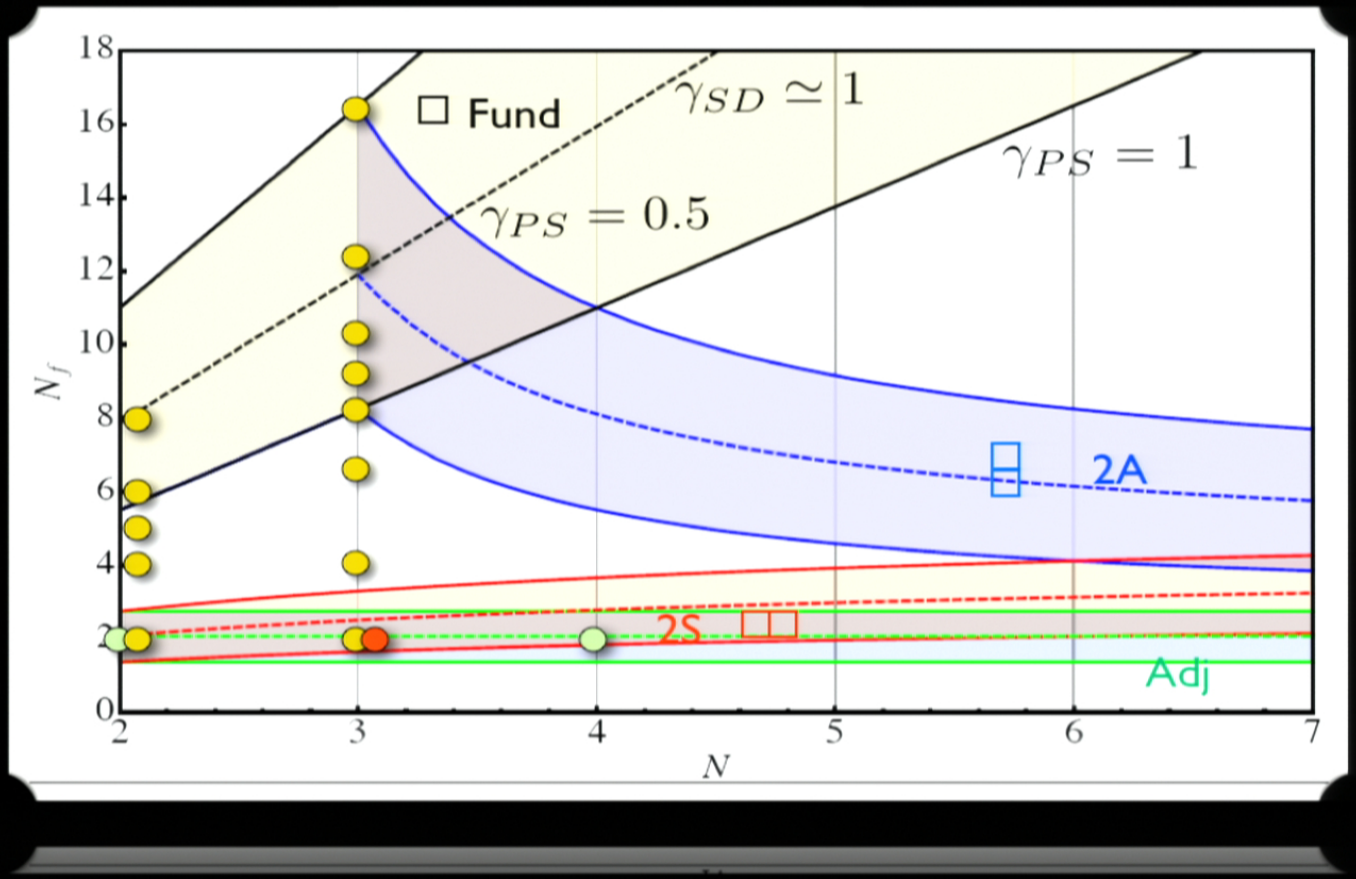


Francesco Sannino

SU(N) Phase Diagram



Lattice SU(N) Phase Diagram



Minimal Working TC

- Minimal WT

$SU(2)_{TC}$ $\square\square$ U N D E

Sannino & Tuominen 04

Dietrich, Sannino, Tuominen 05

Frandsen, Masina, Sannino 09

Minimal Working TC

- Minimal WT

$SU(2)_{TC}$  U D N E

Sannino & Tuominen 04
Dietrich, Sannino, Tuominen 05
Frandsen, Masina, Sannino 09

- Next to MWT

$SU(3)_{TC}$  U D

Sannino, Tuominen 04
Dietrich, Sannino, Tuominen 05

- Orthogonal

$SO(4)_{TC}$  U D

Frandsen, Sannino 09

Minimal Working TC

- Minimal WT

$SU(2)_{TC}$  U D N E

Sannino & Tuominen 04
Dietrich, Sannino, Tuominen 05
Frandsen, Masina, Sannino 09

- Next to MWT

$SU(3)_{TC}$  U D

Sannino, Tuominen 04
Dietrich, Sannino, Tuominen 05

- Orthogonal

$SO(4)_{TC}$ U D

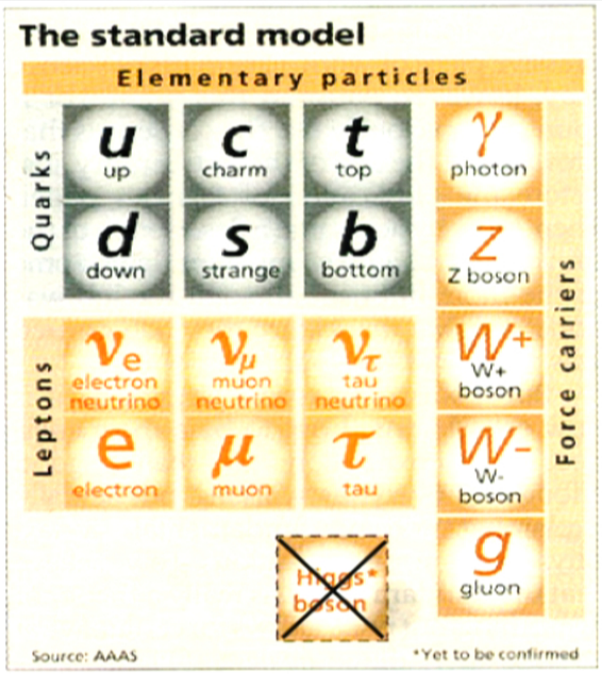
Frandsen, Sannino 09

Vanilla TC

- Ultra MT

$SU(2)_{TC}$  U D

Ryttov & Sannino 08



N
Extra Neutrino

ζ
Extra Electron

U(1)

SU(2)

SU(3)

U
t-up

G
t-glue

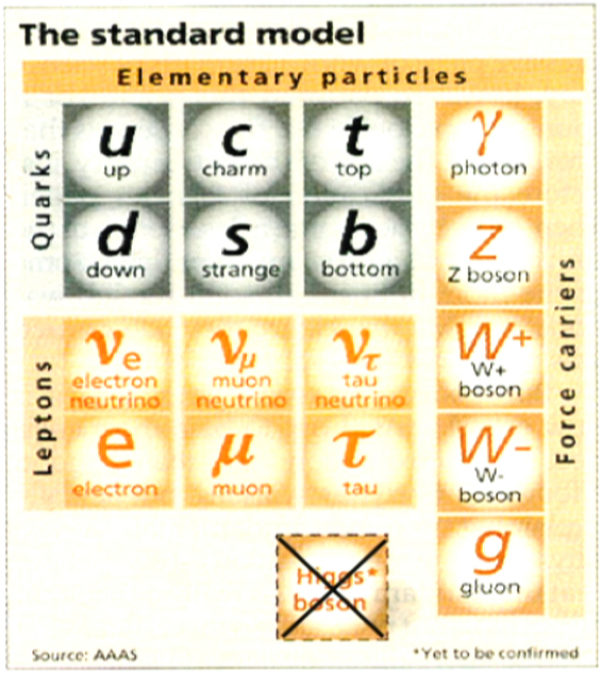
SU(2)

D
t-down

F.S. + Tuominen 04

Dietrich, F.S., Tuominen 05

U and D: Adj of SU(2)



N
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ζ
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U(1)

SU(2)

SU(3)

U
t-up

G
t-glue

SU(2)

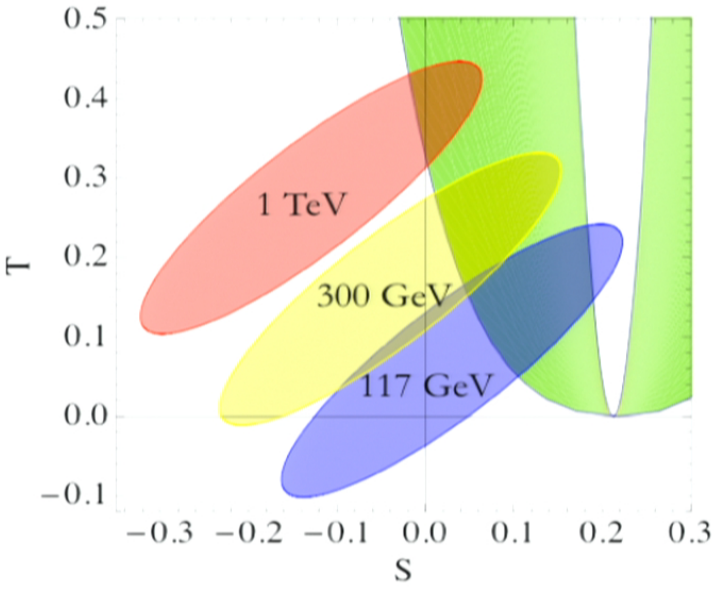
D
t-down

F.S. + Tuominen 04

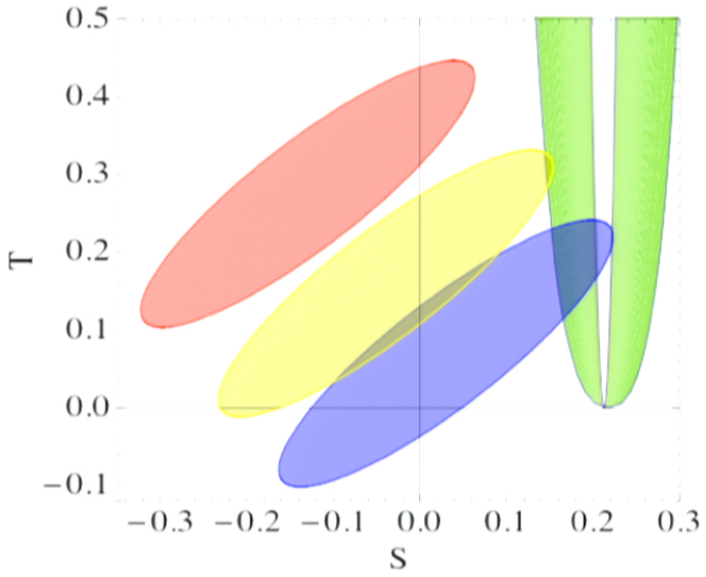
Dietrich, F.S., Tuominen 05

U and D: Adj of SU(2)

New Leptons & Precision Data



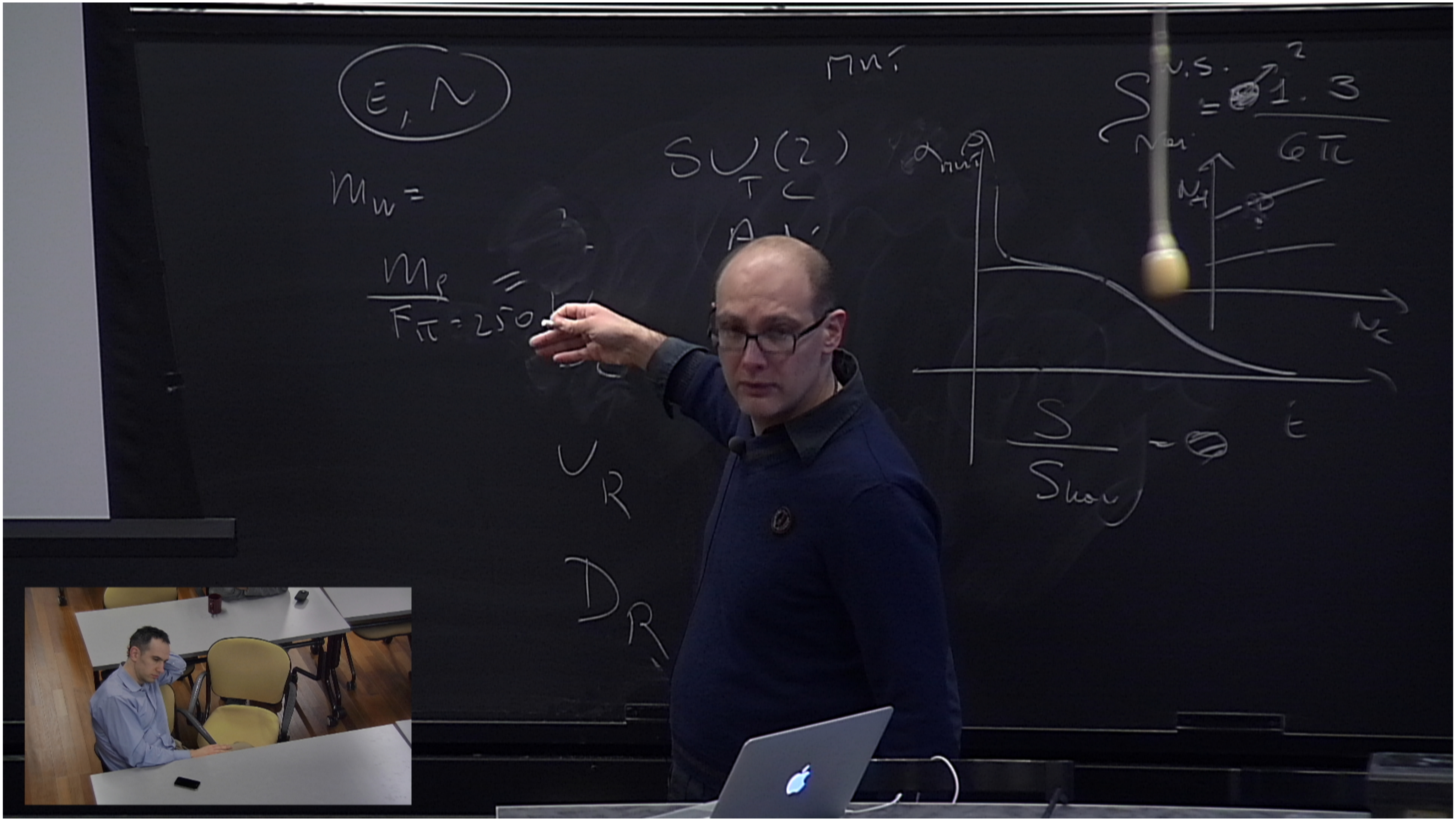
Exotic Leptonic hypercharge Y=-3/2

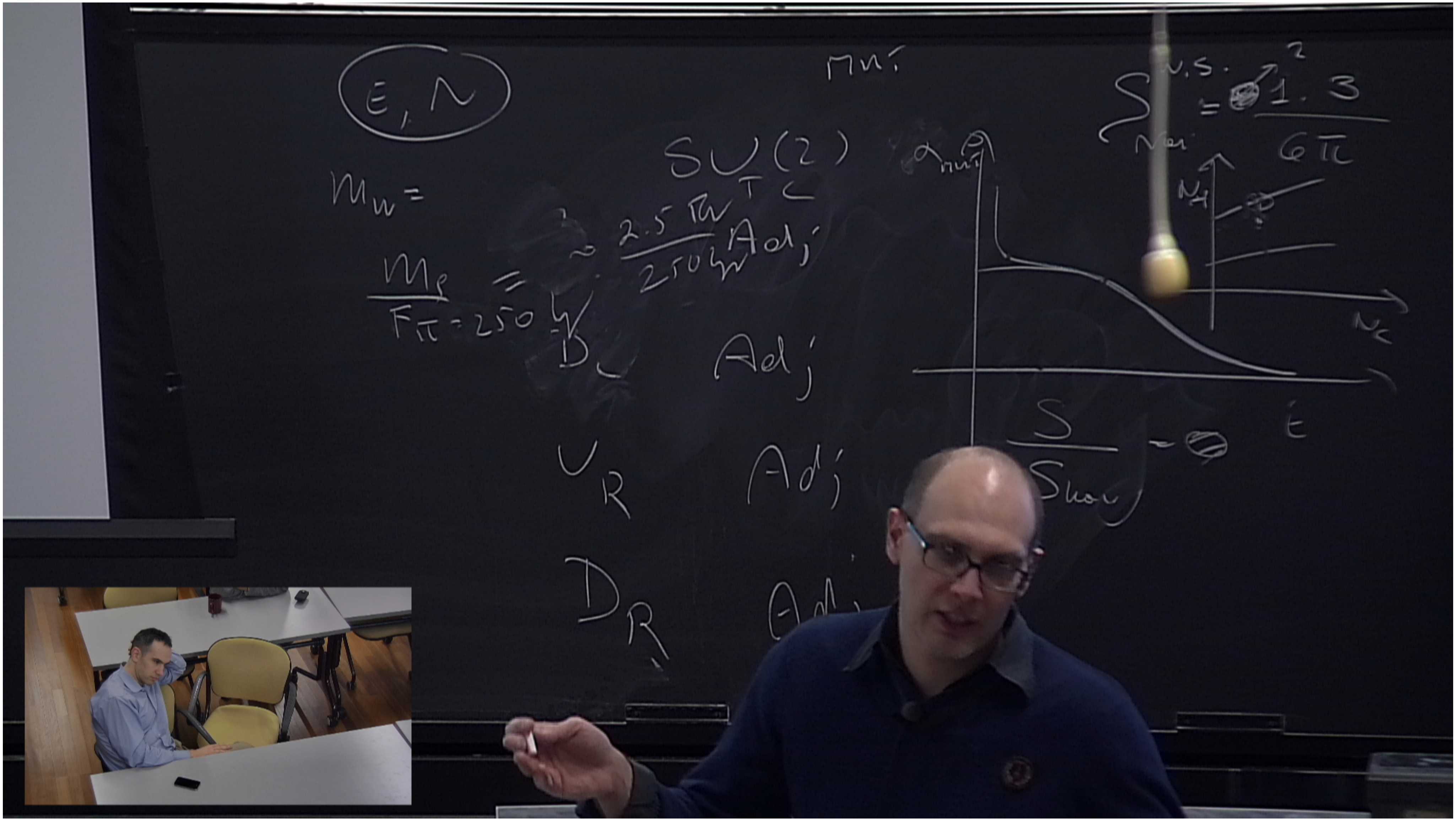


Standard Model Leptonic hypercharge

MWT Features

- The most economical WT theory
- Compatible with precision measurements
- Possible DM candidates
- Light Composite Higgs
- Under investigation on the Lattice


E, N
SU(2)
t
U_R
D_R


E, N
SU(2)
Adj
Adj
6π
1.3

MWT Features

- The most economical WT theory
- Compatible with precision measurements
- Possible DM candidates
- Light Composite Higgs
- Under investigation on the Lattice

MWT Effective Lagrangian

$$\mathcal{L}(\text{Composites}) + \mathcal{L}(\text{Mixing with SM}) + \mathcal{L}(\text{New Leptons}) + \mathcal{L}(\text{SM} - \text{Higgs})$$

Foadi, Frandsen, Ryttov & F.S. 07

MWT Effective Lagrangian

$$\mathcal{L}(\text{Composites}) + \mathcal{L}(\text{Mixing with SM}) + \mathcal{L}(\text{New Leptons}) + \mathcal{L}(\text{SM} - \text{Higgs})$$

Composite Higgs — H

Composite Axial - Vector States — $R_{1,2}$

Foadi, Frandsen, Ryttov & F.S. 07

MWT Effective Lagrangian

$$\mathcal{L}(\text{Composites}) + \mathcal{L}(\text{Mixing with SM}) + \mathcal{L}(\text{New Leptons}) + \mathcal{L}(\text{SM} - \text{Higgs})$$

Composite Higgs — H

Composite Axial - Vector States — $R_{1,2}$

Heavy Electron — ζ

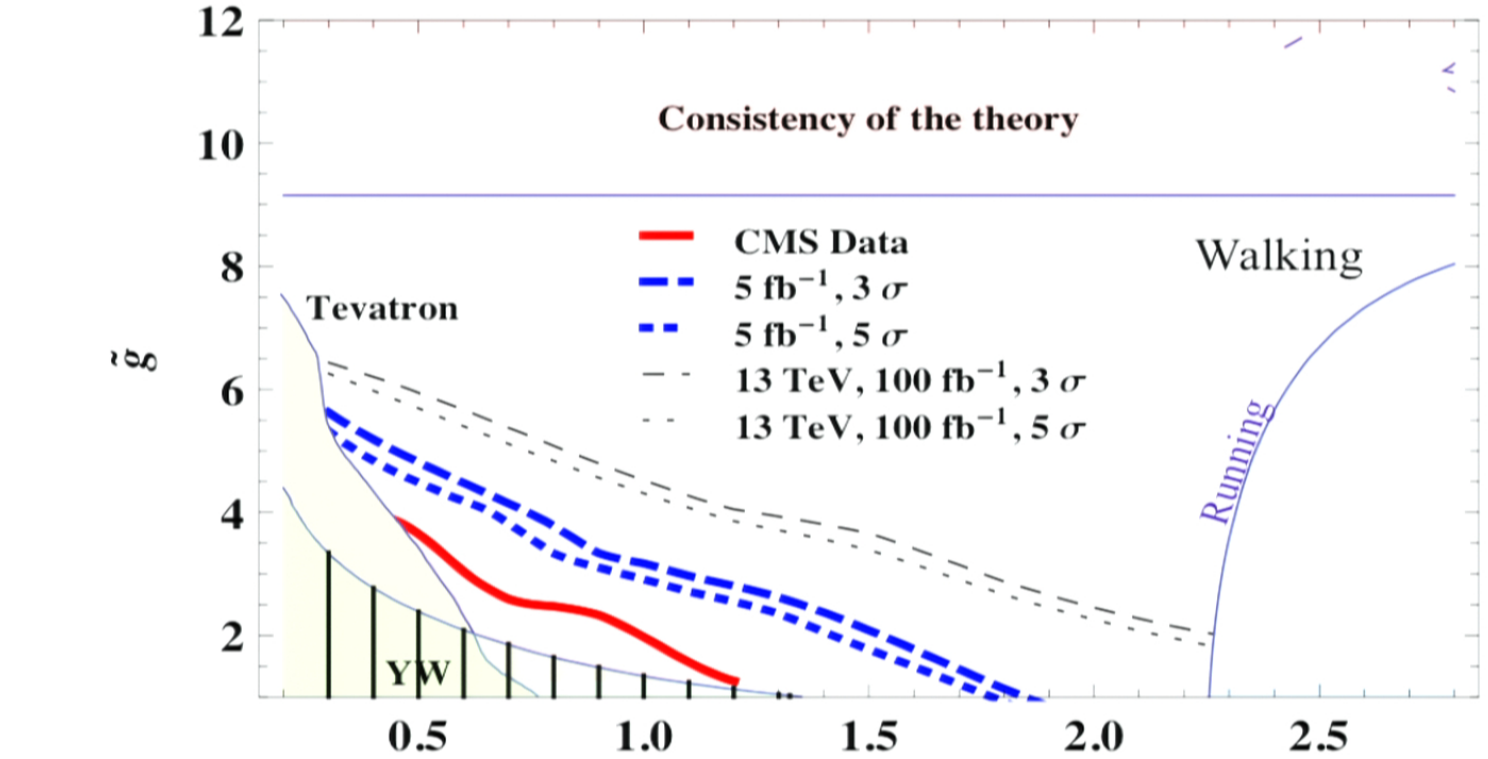
2 Heavy Majoranas — N_1 N_2

Frandsen, Masina, Sannino 09

Hapola, Masina, Sannino 11

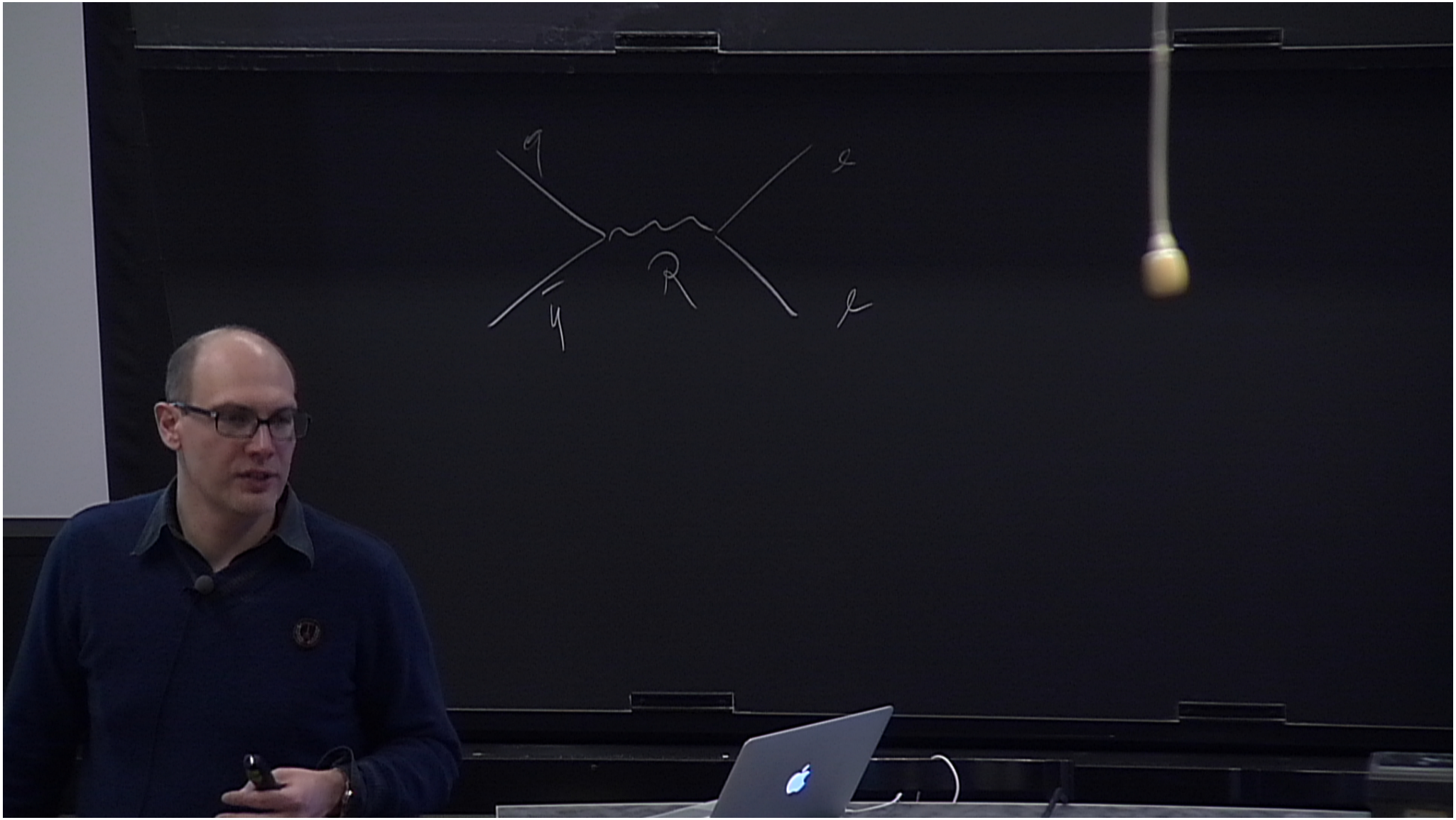
Foadi, Frandsen, Ryttov & F.S. 07

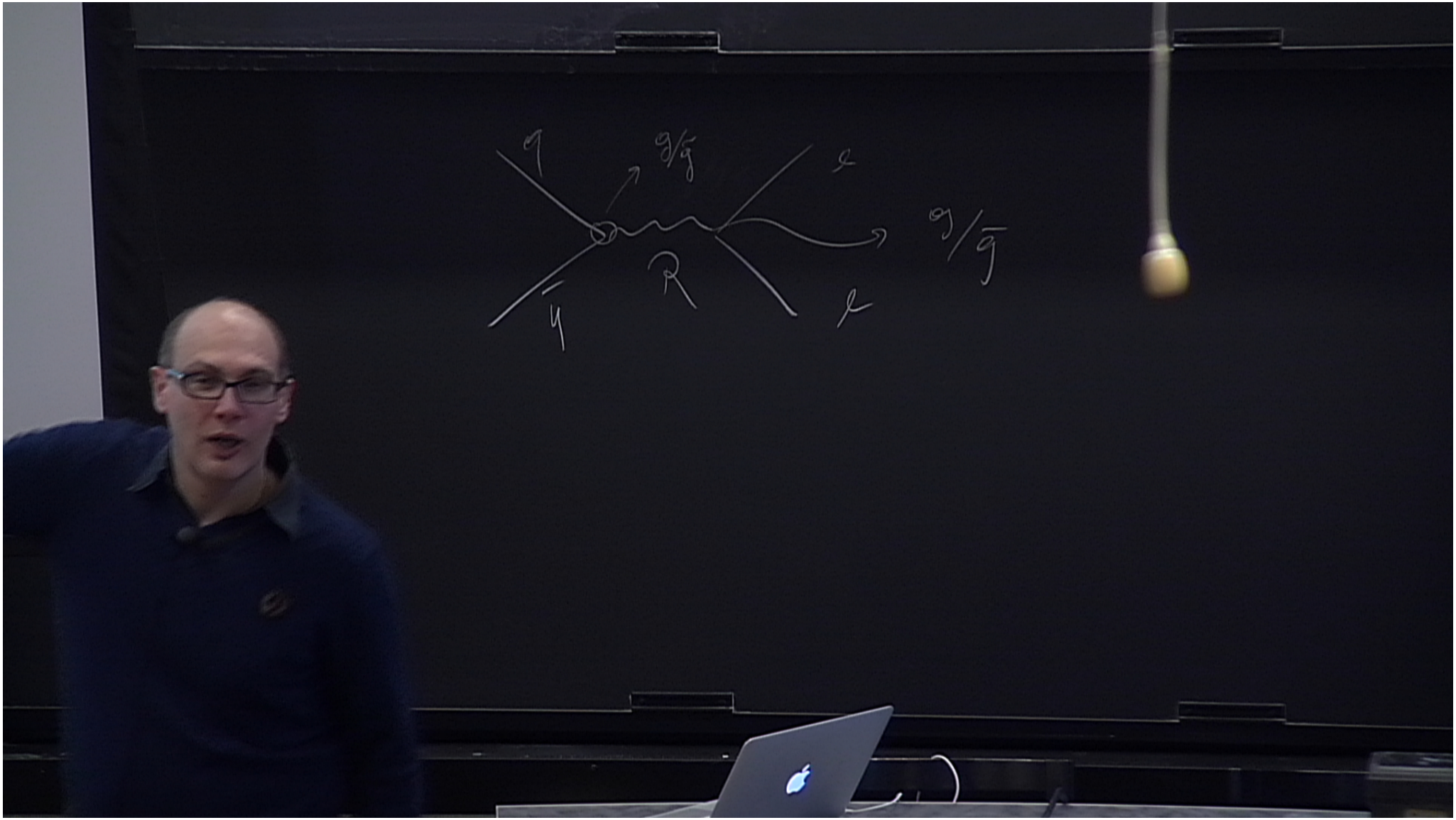
Constraining MWT



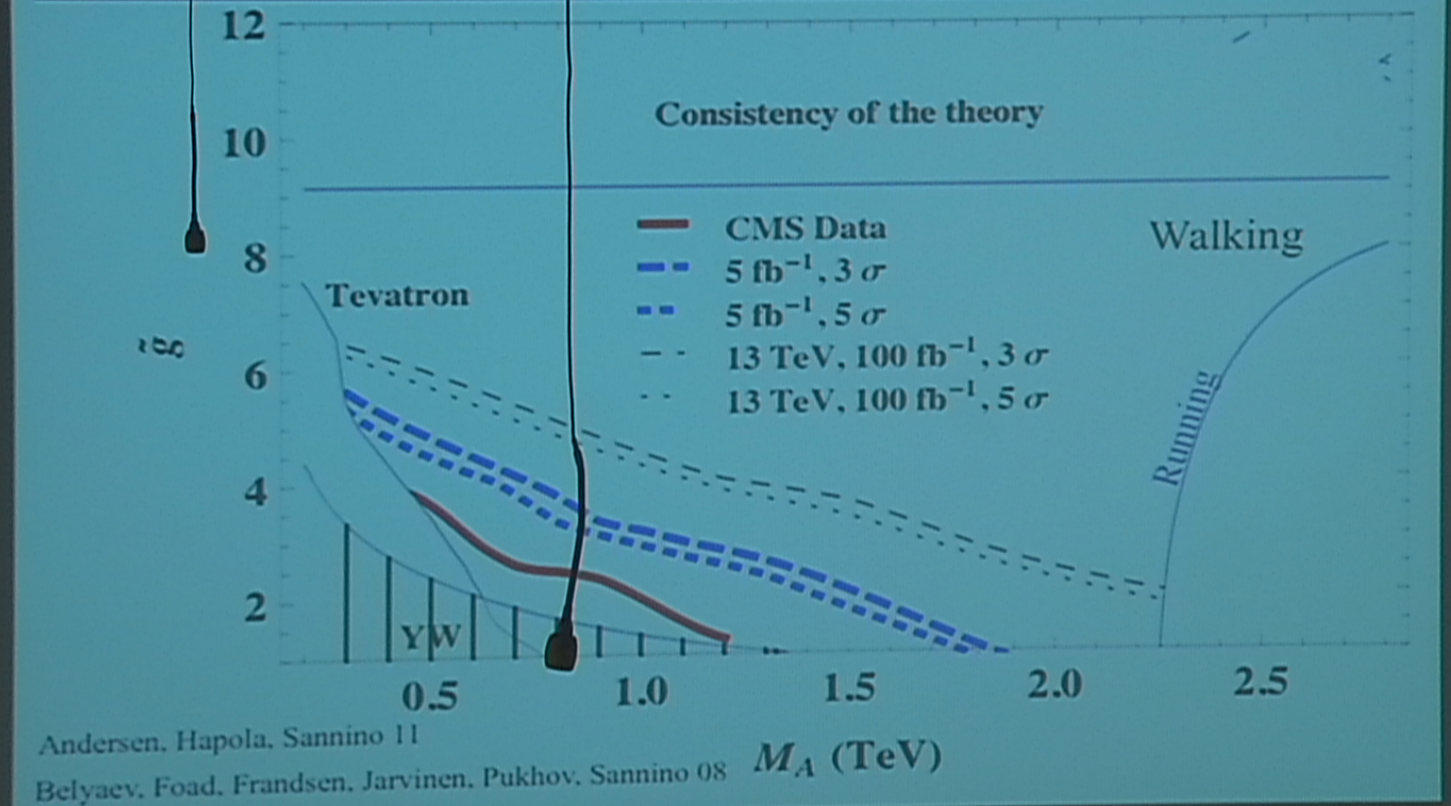
Andersen, Hapola, Sannino 11

Belyaev, Foad, Frandsen, Jarvinen, Pukhov, Sannino 08


q
ℓ
R
q̄
ℓ


q
g/q
q̄
g/q̄
R

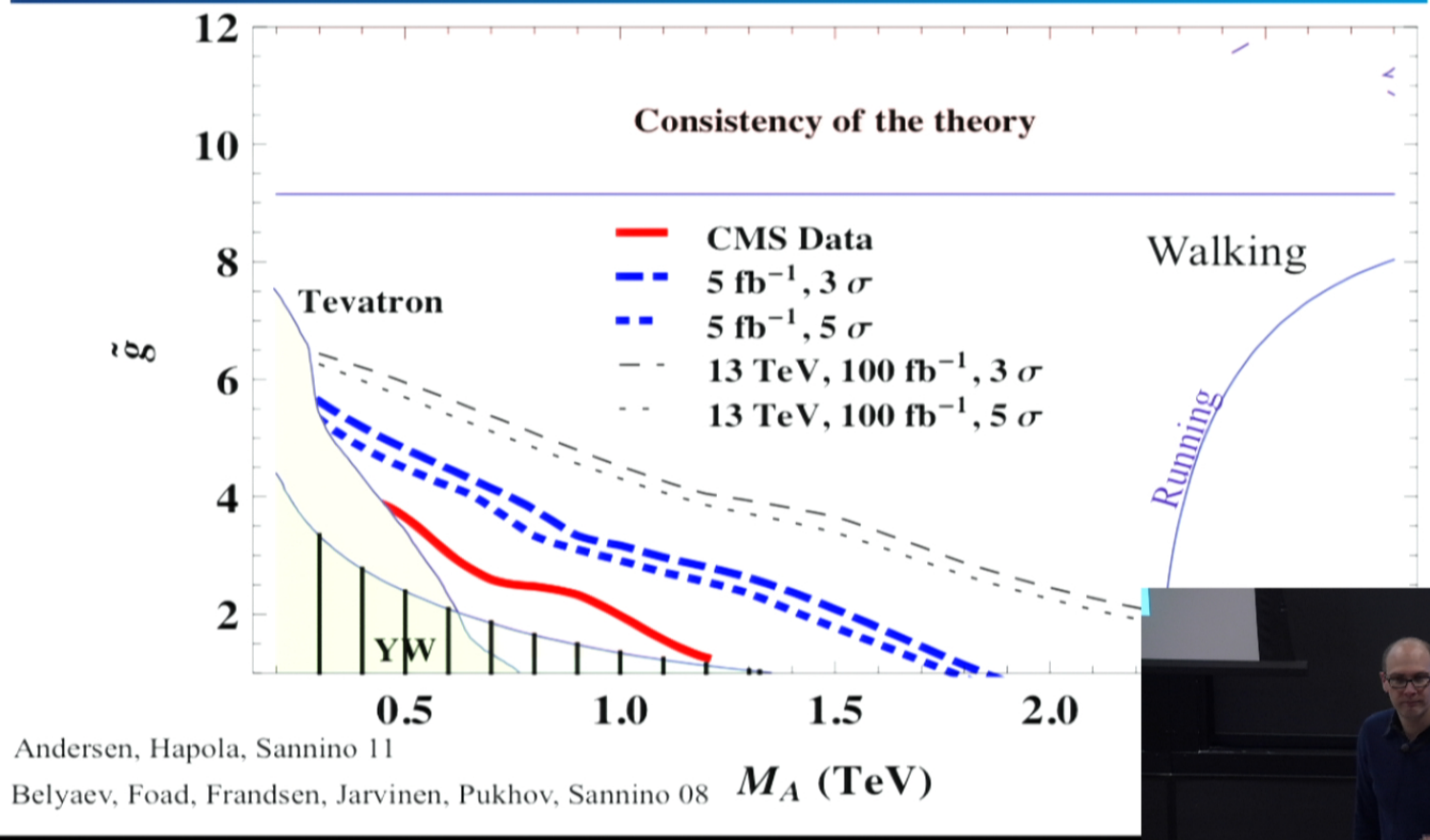
Constraining MWT



Andersen, Hapola, Sannino 11

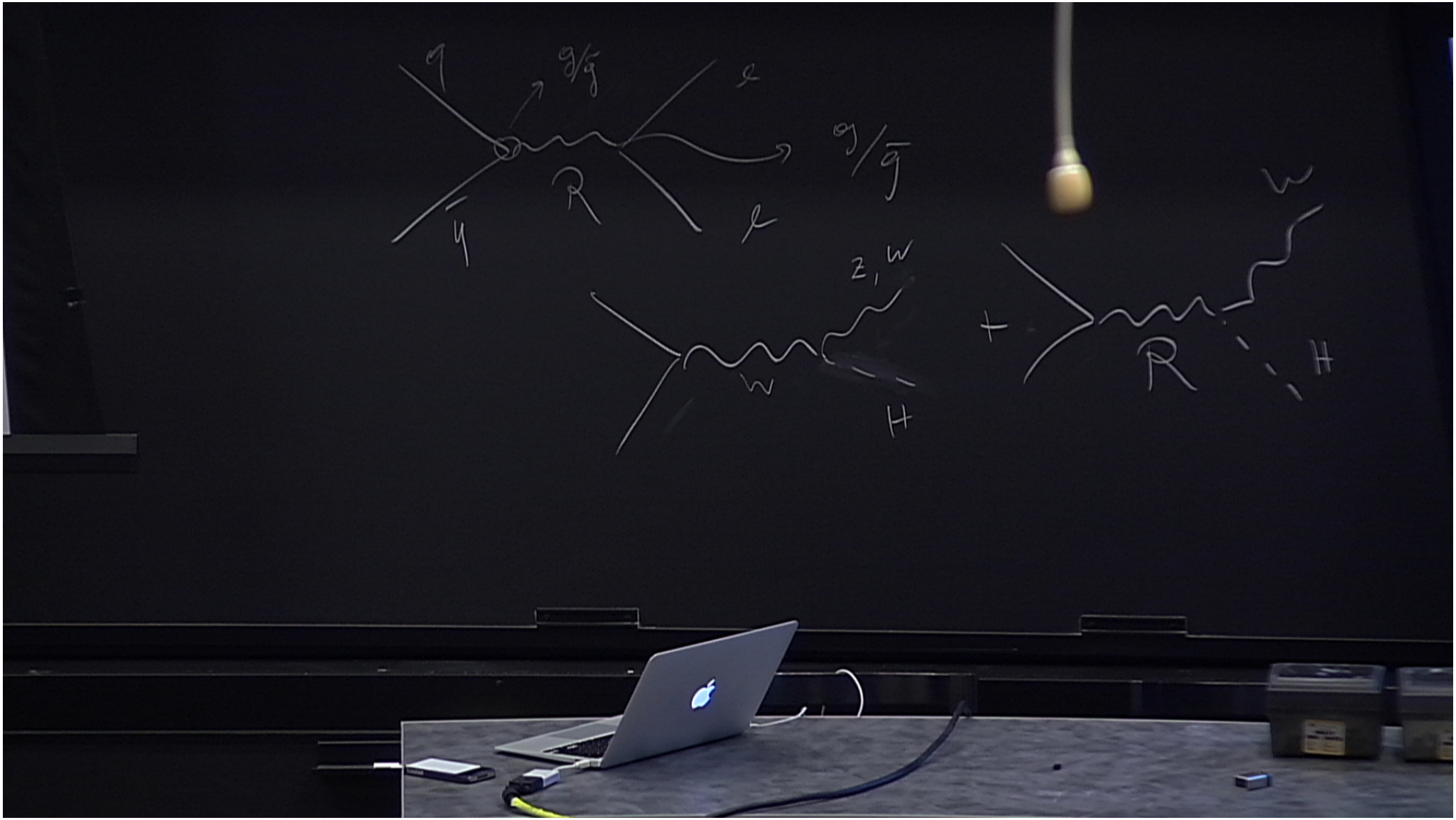
Belyaev, Foad, Frandsen, Jarvinen, Pukhov, Sannino 08

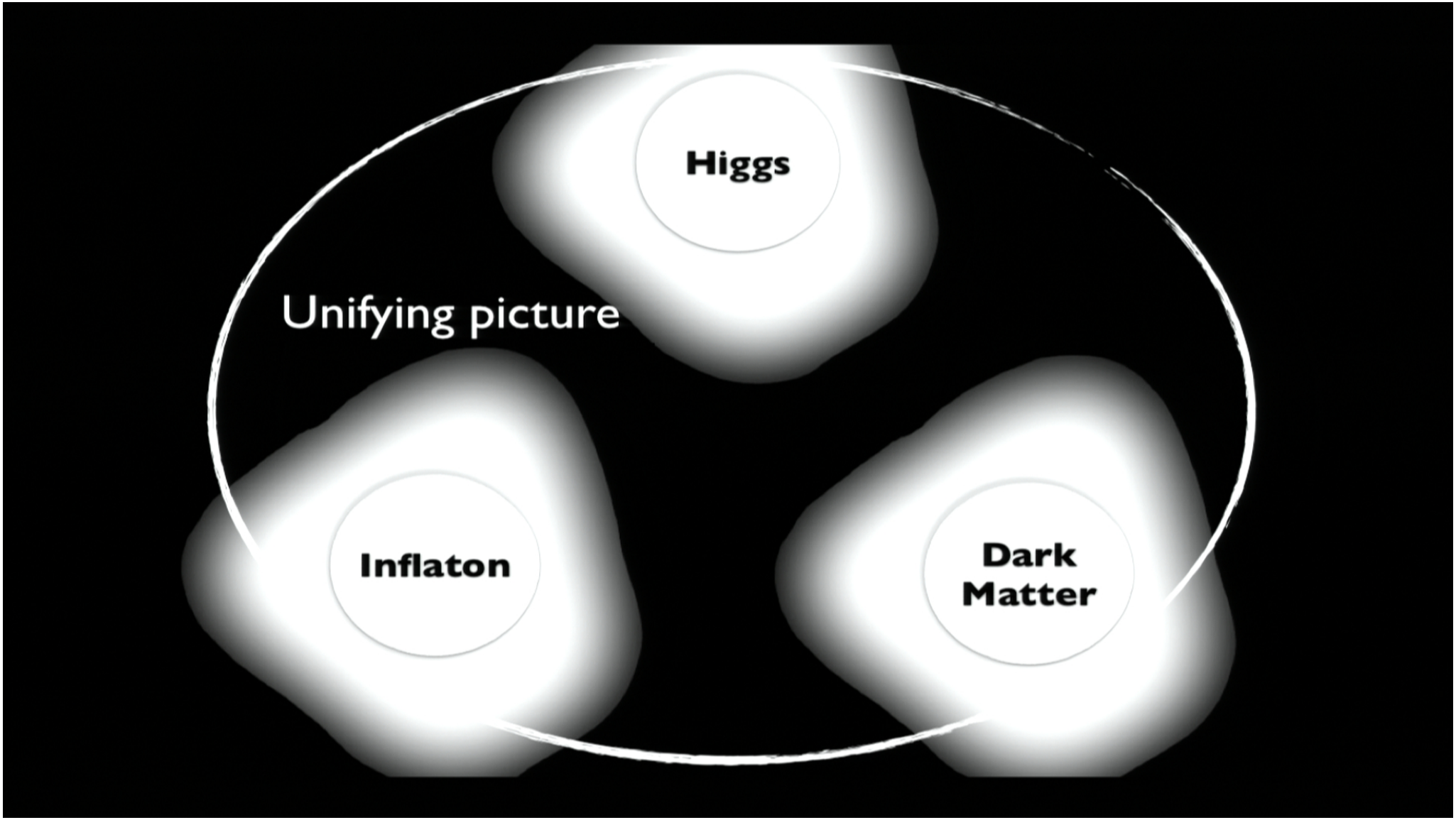
Constraining MWT

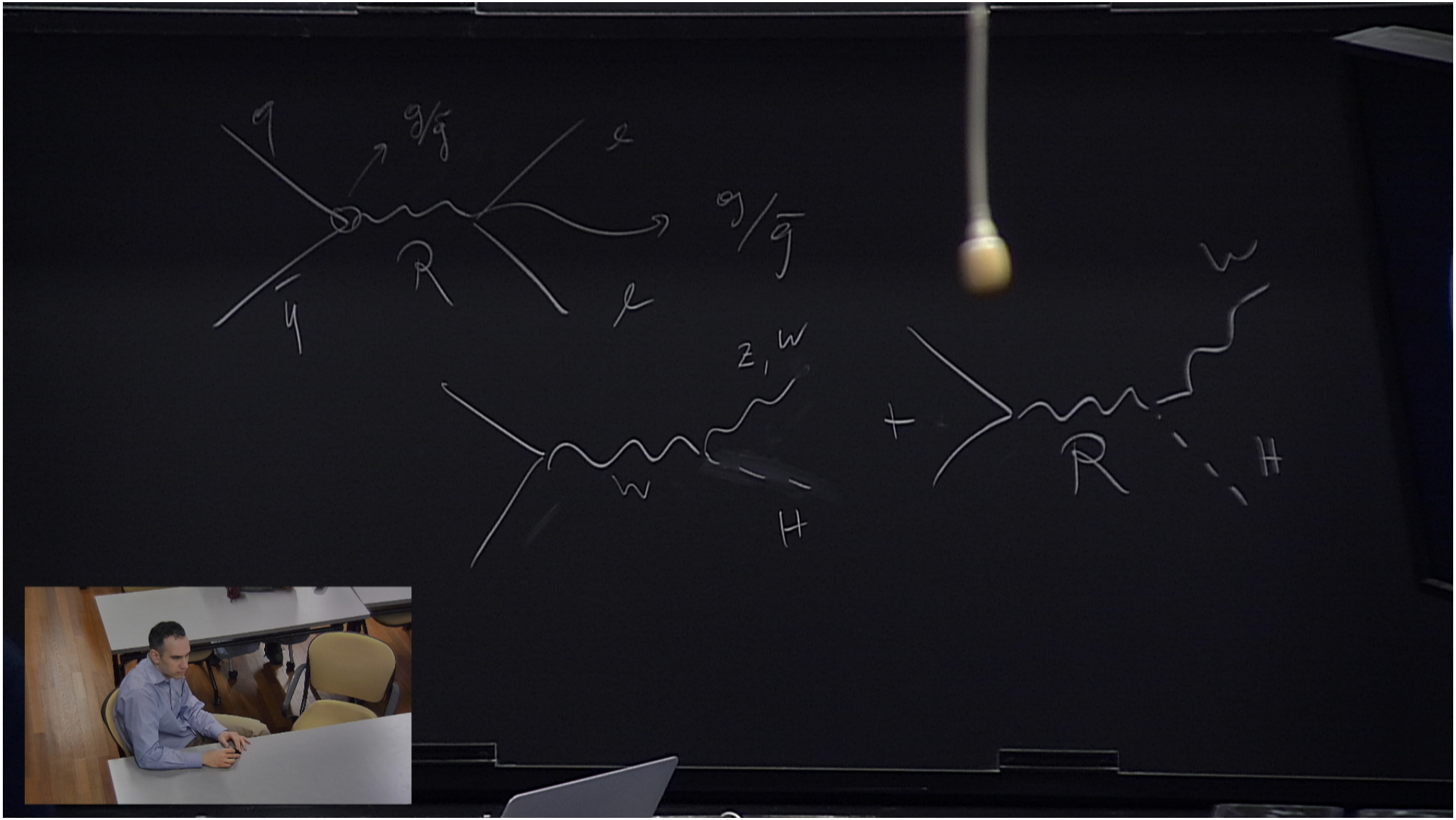


Andersen, Hapola, Sannino 11

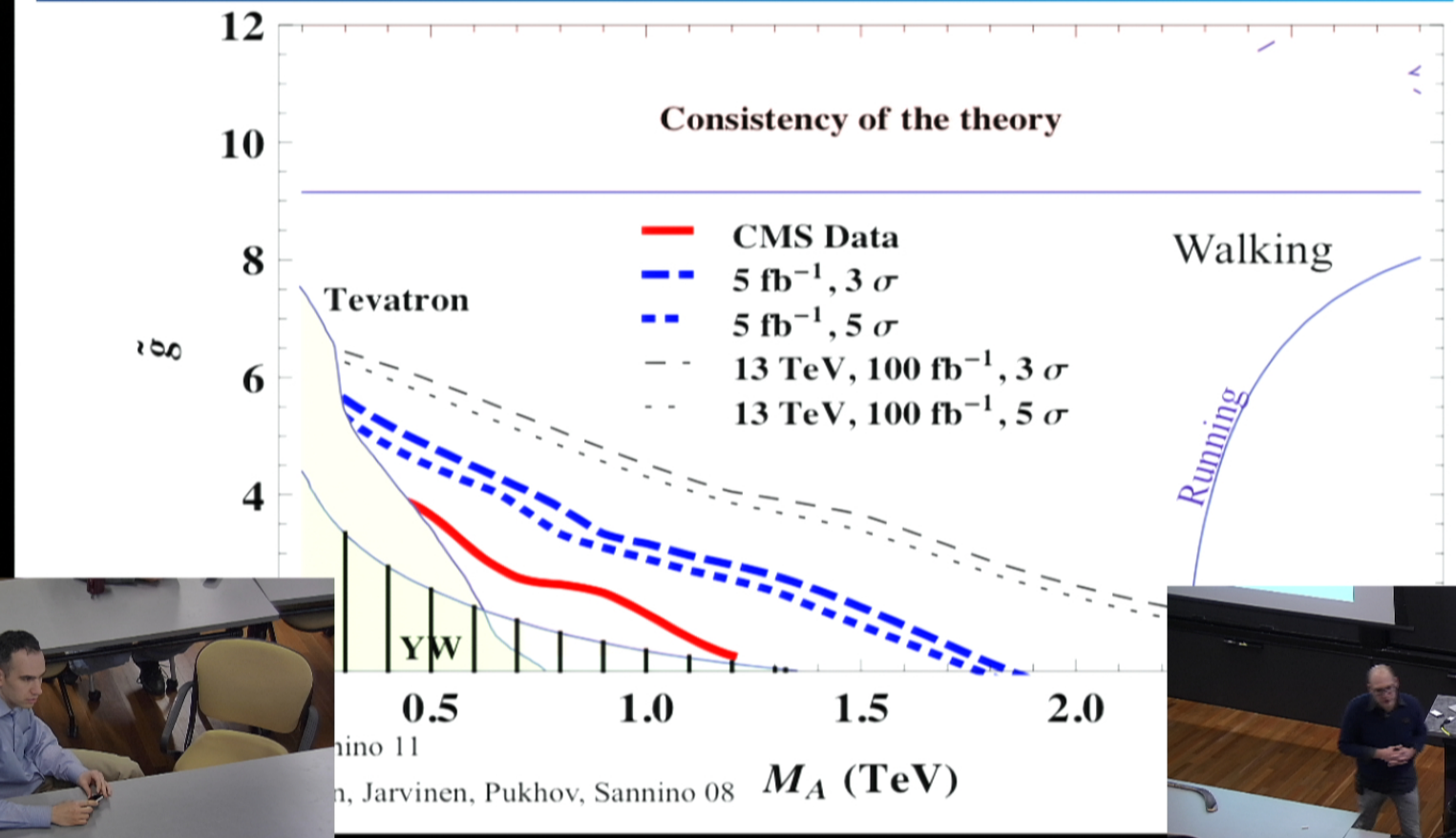
Belyaev, Foad, Frandsen, Jarvinen, Pukhov, Sannino 08

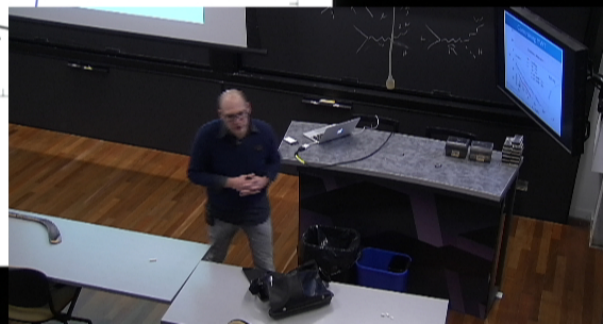

q
g/q
q
g/q
R
q
Z, W
W
H
+
W
R
H

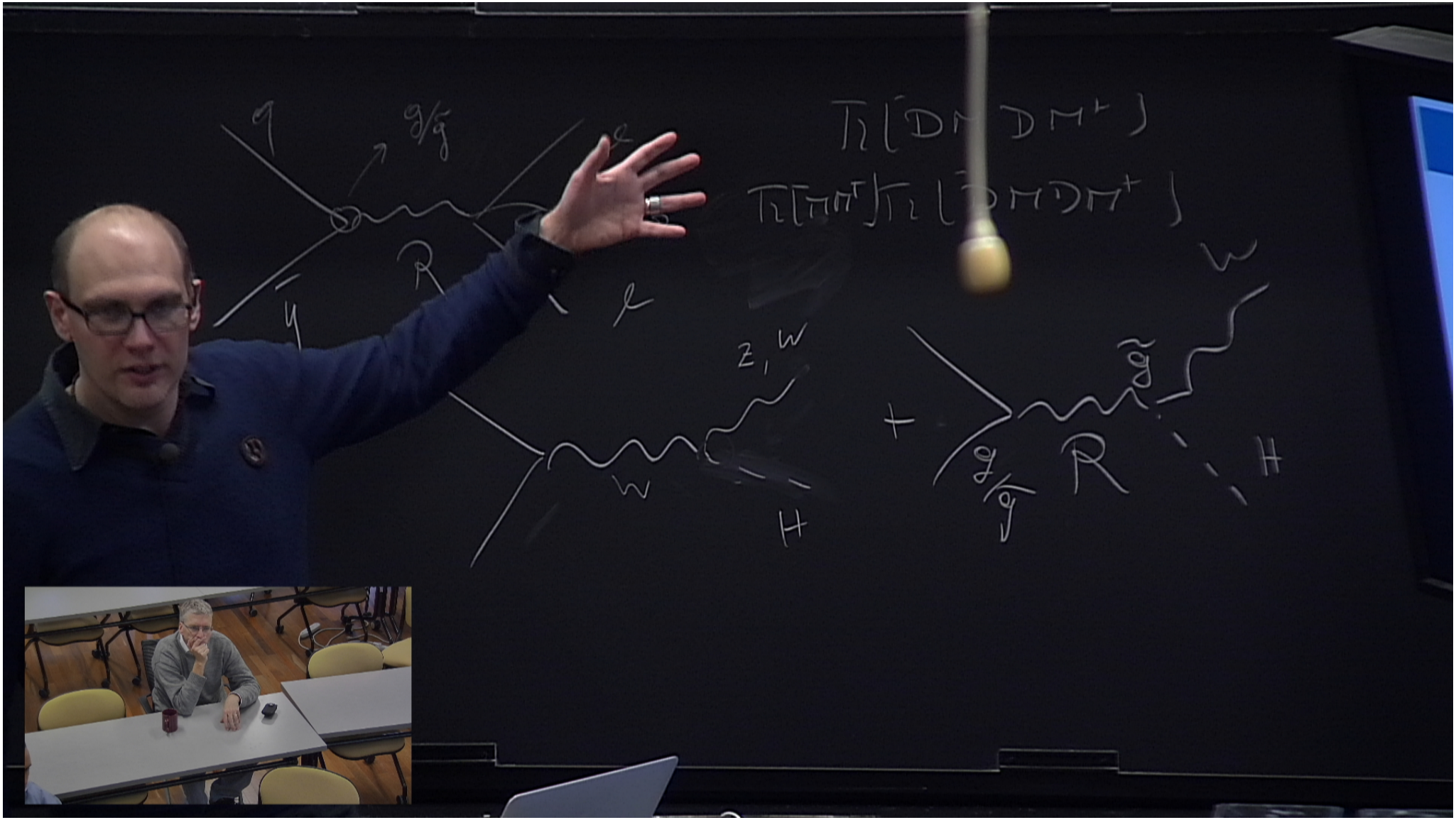

Higgs
Unifying picture
Inflaton
Dark
Matter


q
g/q
q
g/q
R
q
q
Z, W
W
H
+
W
R
H

Constraining MWT






g/q
R
Z, W
W
H
+
g/q
R
H