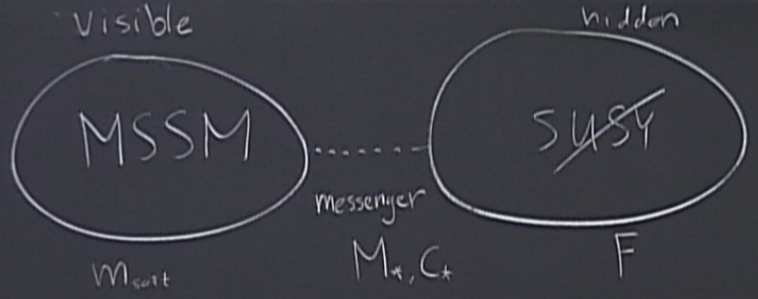
Title: Beyond Standard Model-8

Date: Feb 26, 2015 09:00 AM

URL: http://pirsa.org/15020048

Abstract:



$$m_{soft} \sim C_* \frac{F}{M_*}$$

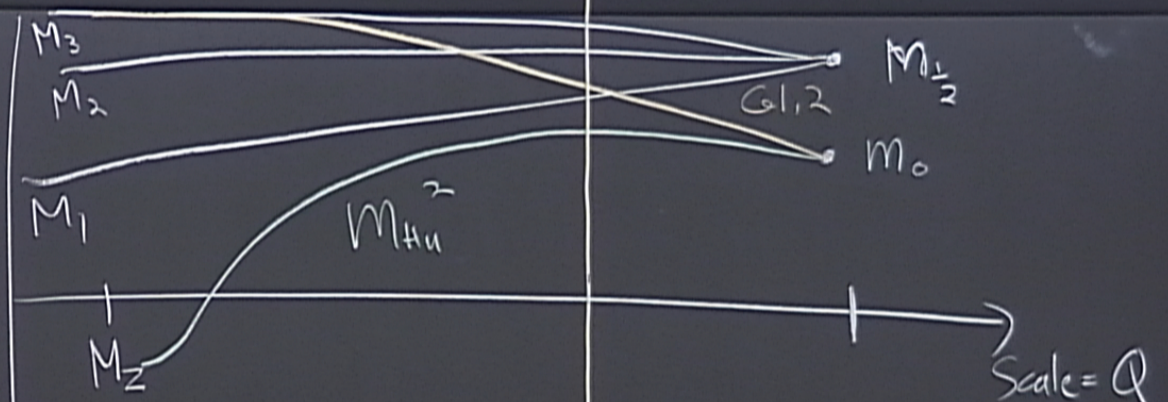
Gravity Mediation

$$m_{soft} \sim \frac{F}{M_{Pl}}$$

mSUGRA:

At scale $M_{input} \sim M_{GUT} \sim 10^{-2} M_{Pl}$

- Scalar soft masses $m_i^2 = m_0^2$ $(m^2|\phi|^2)$
- Gaugino soft masses. $M_a = m_{1/2}$ $(M_a \lambda\lambda)$
- A-terms $A_i = A_0$ $(yA\phi^3)$



$M_a / g_a^2 = \text{constant}$

Near m_Z: $M_3 : M_2 : M_1 \sim 6 : 2 : 1$

Gauge Mediation

Messengers carry SM gauge charges.

$$m_{soft} = \frac{g^2}{(4\pi)^2}\frac{F}{M_*}$$

$$W_{mess} = \lambda X Q^c Q + M_* Q^c Q$$

susy

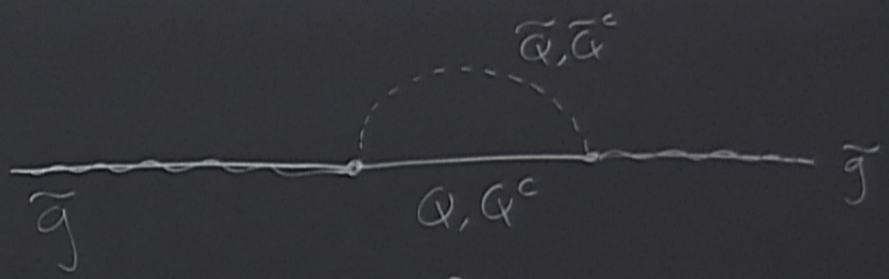
F_X

Messengers

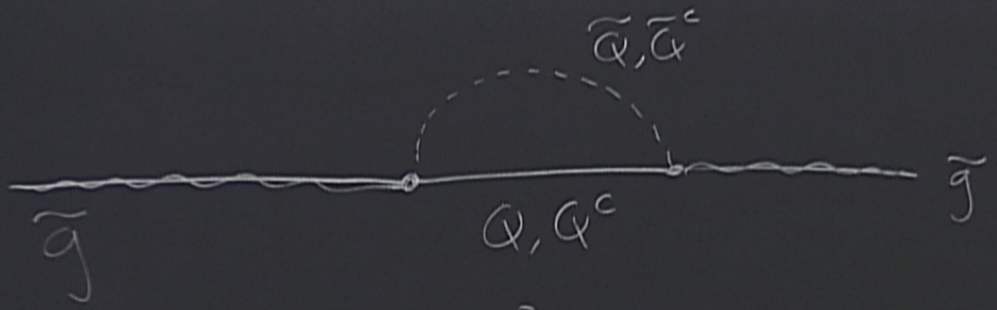
$5 + \bar{5}$ of $SU(5)$

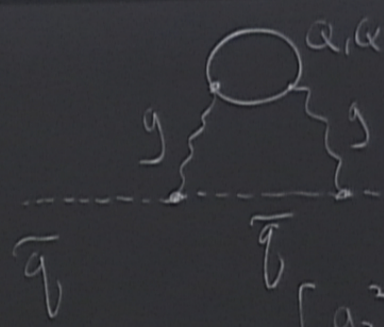
$$m_{Q,Q^c} = M_*$$

$$m^2_{\tilde{Q},\tilde{Q}^c} = M_*^2 \pm F_X$$



$$M_3 = \frac{g_3^2}{(4\pi)^2}\frac{F_X}{M_*}$$





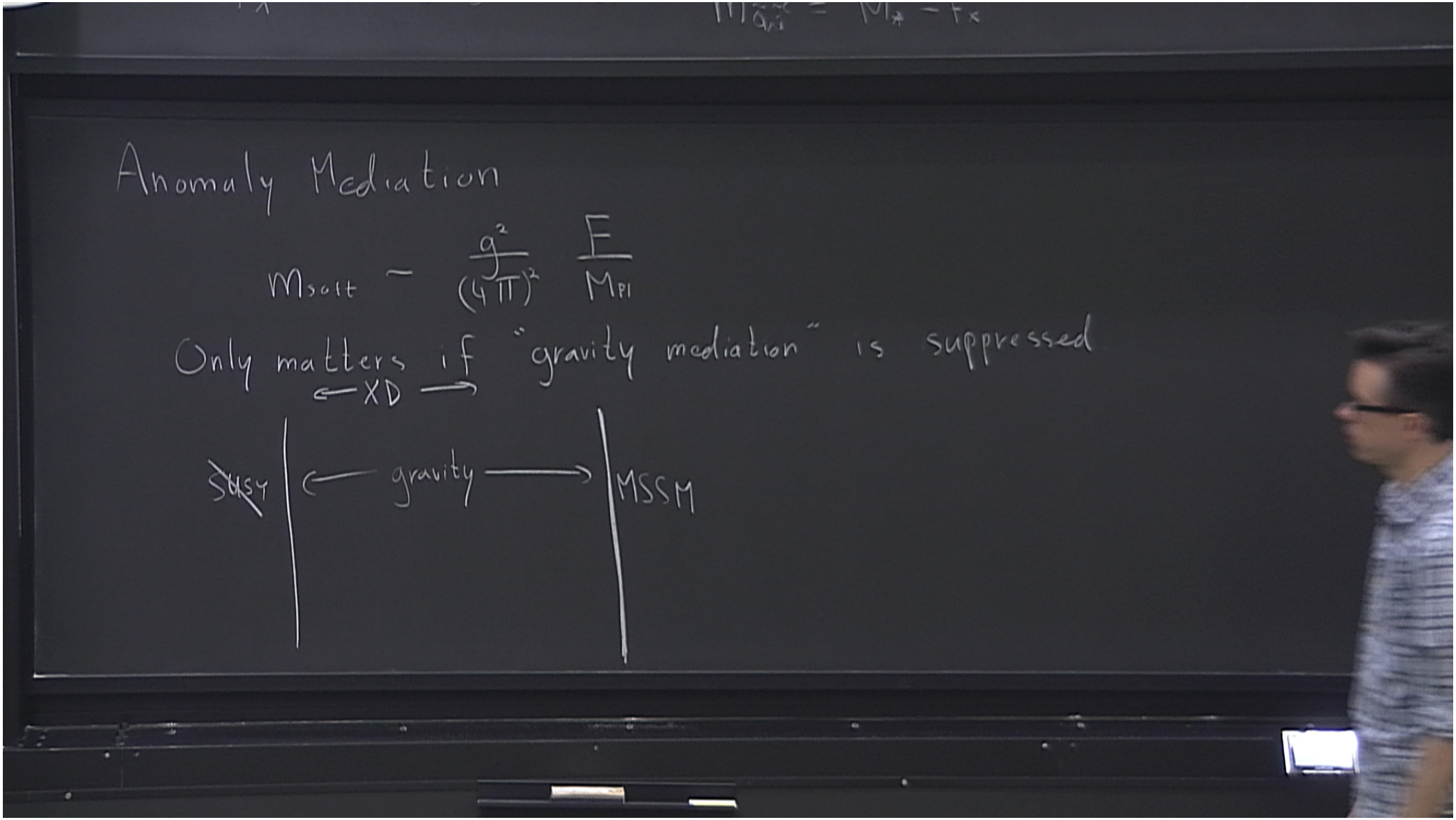
$$M_3 \simeq \frac{g_3^2}{(4\pi)^2} \frac{F_X}{M_*}$$

$$m_{\tilde{q}}^2 = \left[\frac{g_3^2}{(4\pi)^2}\right]^2 \left(\frac{F_X}{M_*}\right)^2$$

corrections from integrating out messengers

M_*

$M_*^2 \pm F_X$


Anomaly Mediation
$m_{soft} \sim \frac{g^2}{(4\pi)^2} \frac{F}{M_{Pl}}$
Only matters if "gravity mediation" is suppressed
← XD →
susy
← gravity →
MSSM

Anomaly Mediation

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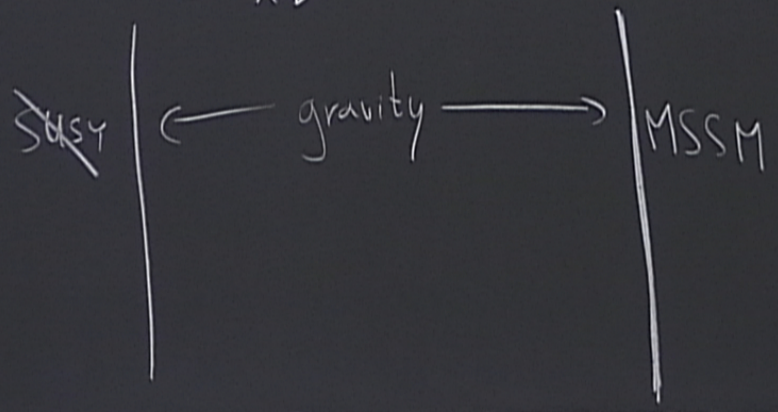

Spontaneous SUSY $\Rightarrow$ massless goldstino

ψ couples to MSSM with strength $1/F$.

Extent MSSM to include gravity as an EFT.

SUSY $\Rightarrow$ $(G, \tilde{G}_\mu)$ $\longrightarrow$ supergravity

$s=2$ $s=\frac{3}{2}$ = gravitino

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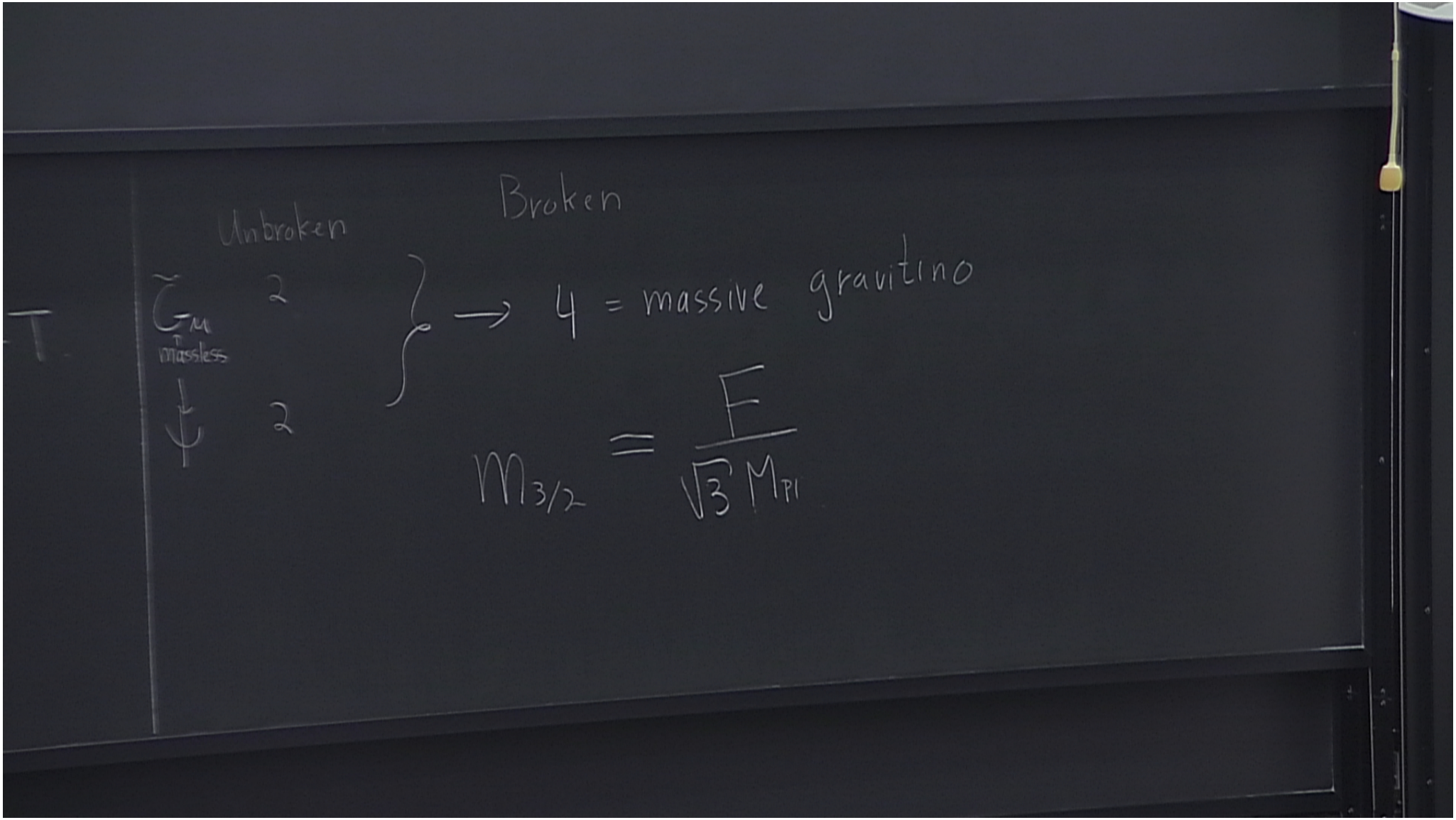
↳ 2 DOF if massless.


Unbroken
Broken
$\tilde{G}_\mu$
massless
2
2
4 = massive gravitino
$m_{3/2} = \frac{F}{\sqrt{3} M_{Pl}}$

$m_{soft} \sim m_{3/2}$; gravity

$m_{soft} > m_{3/2}$; gaage

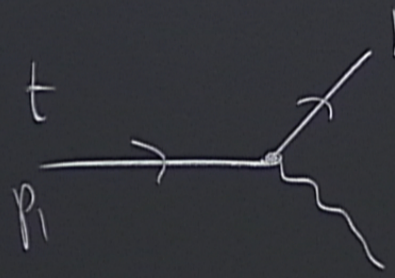
$m_{soft} < m_{3/2}$, anomaly

$$-\mathcal{L} \supset \frac{1}{M_{Pl}} (\partial_\mu \bar{f}) \bar{F} \gamma^\mu \gamma^\nu \tilde{G}_\nu + \frac{1}{8 M_{Pl}} \overline{\tilde{G}_\mu [\gamma^\nu \gamma^\rho] \gamma^\mu \lambda} F_{\nu\rho} + h.c.$$

For $E \gg m_{3/2}$, $\tilde{G}_\mu \to \sqrt{\frac{2}{3}} \partial_\mu \psi / m_{3/2}$

$\Rightarrow$ $1/F$ coupling goldstino equivalence principle

$$\text{prop} = \frac{i\left(-\eta_{\mu\nu} + p_\mu p_\nu / m_W^2\right)}{p^2 - m_W^2 + i\epsilon}$$



$$\Gamma \sim \frac{g^2}{4\pi} \cdot m_t \qquad \text{(DA)}$$

$$-iM = -i\bar{u}_2 \gamma^\mu P_L u_1 \cdot \epsilon^*_\mu(p_3)$$

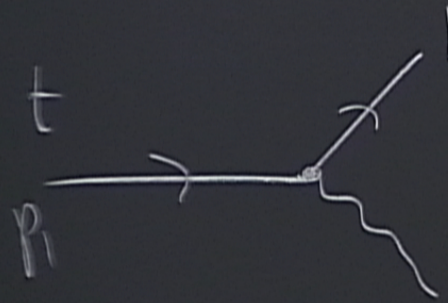
$$\overline{|\mathcal{M}|^2} = \sum_{\text{spins}} \sum_{\text{pol}} |\mathcal{M}|^2$$

m_t^2 / m_W^2

$$= \mathrm{tr}\left[(\not{p}_2 + m_b)\gamma^\mu P_L (\not{p}_1 + m_t)\gamma^\nu P_L\right]\left(-\eta_{\mu\nu} + p_{3\mu}p_{3\nu}/m_W^2\right)$$

$$\Gamma \sim \frac{g^2}{4\pi}\cdot\left(\frac{m_t}{m_W}\right)^2 m_t \sim \frac{y_t^2}{4\pi} m_t$$

$$\text{prop} = \frac{i(-\eta_{\mu\nu} + p_\mu p_\nu / m_W^2)}{p^2 - m_W^2 + i\epsilon}$$



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$$y_t \, \bar{b} \gamma^\mu P_L t \cdot (\partial_\mu \phi)$$

ϕ = goldstone boson

Aside

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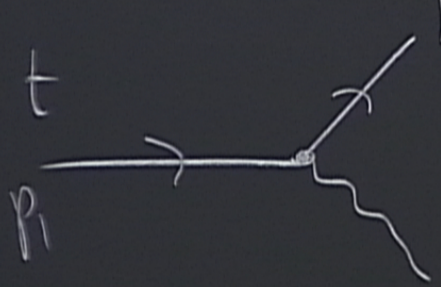

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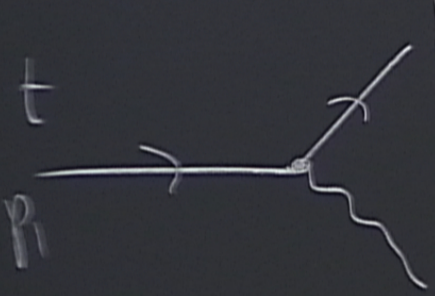

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$$y_t \, \bar{b} t \cdot \phi$$

// goldstone boson

1. Dark Matter and the LSP

LSP = lightest superpartner = stable

Cosmology => em neutral and colour neutral

=> $\underset{\xi}{\tilde{\chi}^0_1}$, ~~$\tilde{\nu}$~~, $\tilde{G}$ allowed candidates

Gauge Med $\Rightarrow \tilde{G}$ = LSP

NLSP = lightest SM superpartner

$\tilde{X} \longrightarrow X + \tilde{G}^{\mu}$

"NLSP" "SM state"

$\Gamma(\tilde{X} \to X \tilde{G}) \sim \frac{m_{\tilde{X}}^5}{m_{3/2}^2 M_{Pl}^2} \sim \frac{m_{\tilde{X}}^5}{F^2}$