

Title: Particle Physics Lecture

Speakers: Asimina Arvanitaki

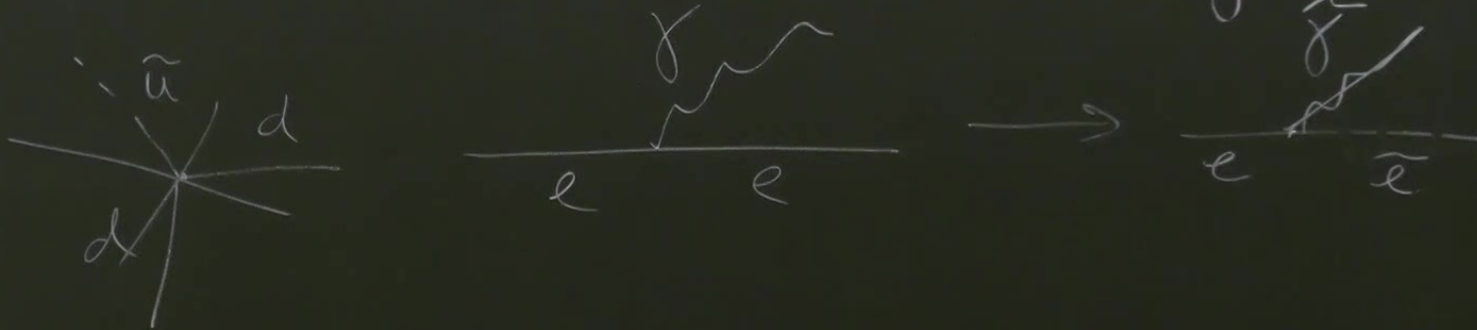
Collection: Particle Physics

Date: March 08, 2024 - 11:30 AM

URL: <https://pirsa.org/24030019>

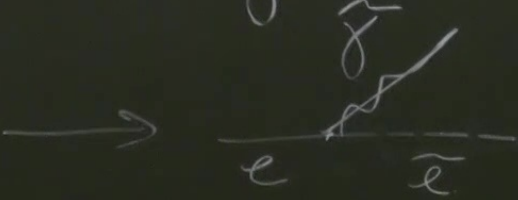
$$\mu H_u H_d + \lambda_u H_u Q U + \lambda_d H_d Q D + \lambda_e H_d L E$$

$$+ \cancel{\lambda' L L E} + \cancel{\lambda'' Q D L} + \cancel{\lambda''' U D D} + \cancel{\kappa L H_u} \rightarrow R\text{-parity}$$

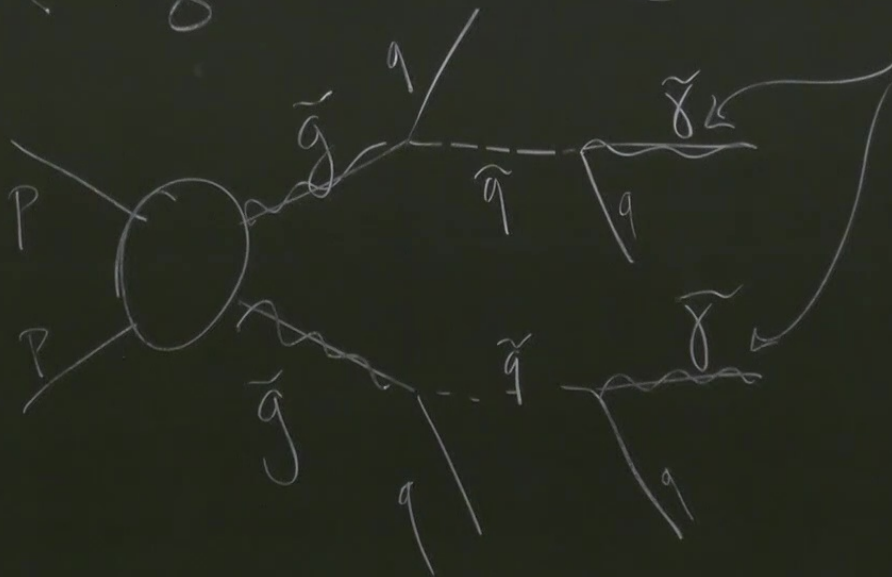
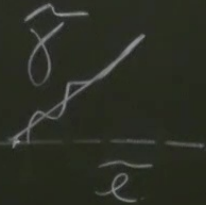


$$m_h^2 \leq \frac{g_1^2 + g_2^2}{8} v^2 = m_Z^2 = (90 \text{ GeV})^2$$

R-parity

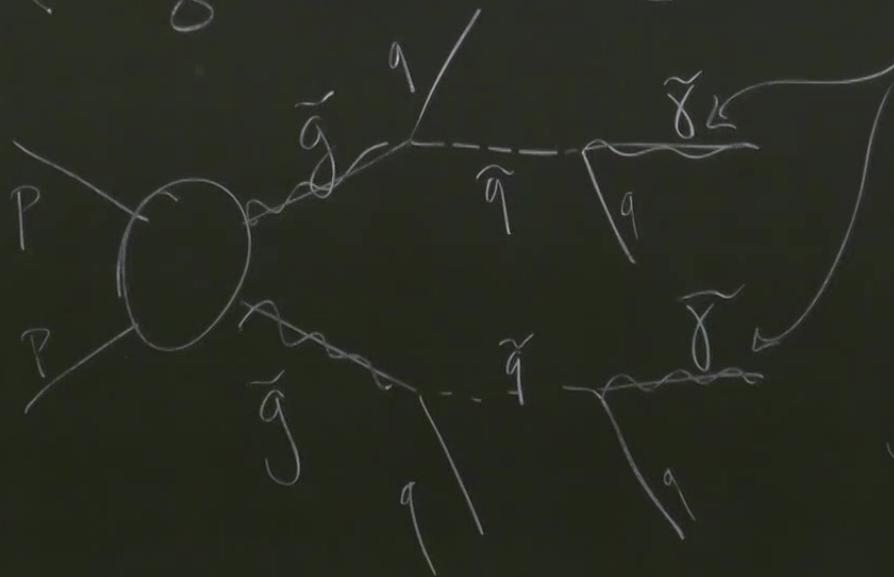
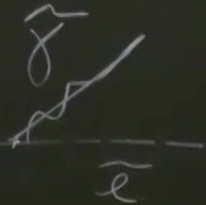


$$m_h^2 \leq \frac{g_1^2 + g_2^2}{8} v^2 = m_Z^2 \approx (90 \text{ GeV})^2$$



LOST/MISSING ENERGY

$$m_h^2 \leq \frac{g_1^2 + g_2^2}{8} v^2 = m_Z^2 = (90 \text{ GeV})^2$$

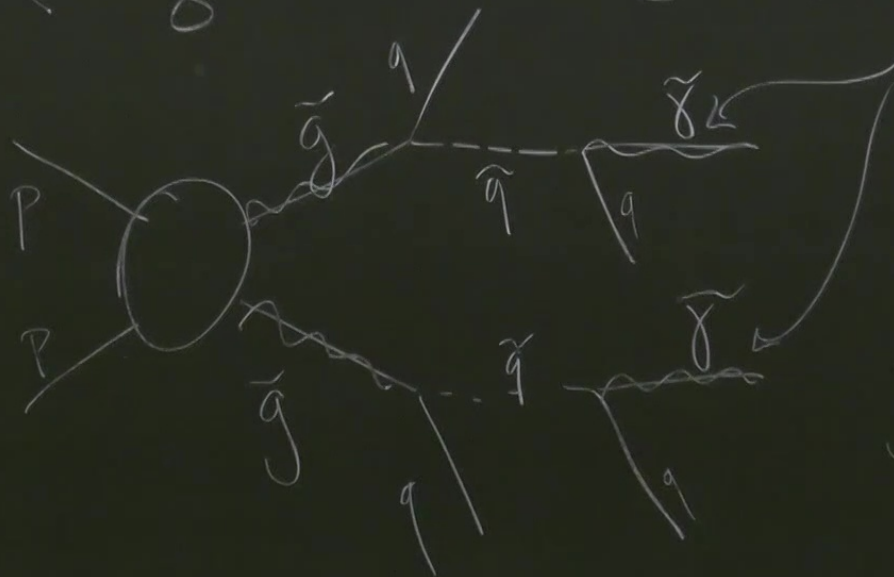
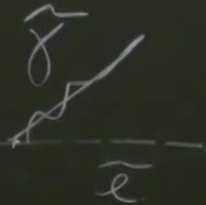


LOST/MISSING ENERGY

quarks  $\rightarrow$  jets

jets +

$$m_h^2 \leq \frac{g_1^2 + g_2^2}{8} v^2 = m_Z^2 = (90 \text{ GeV})^2$$

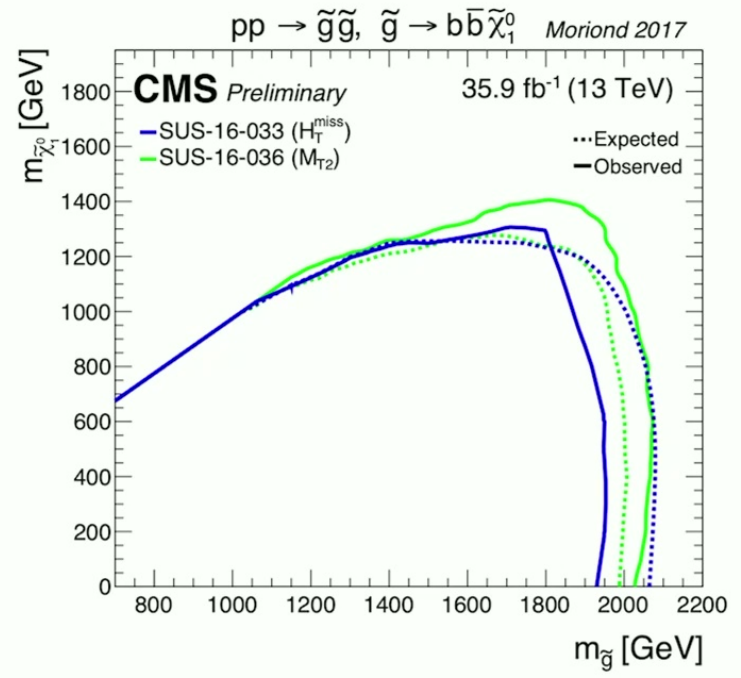
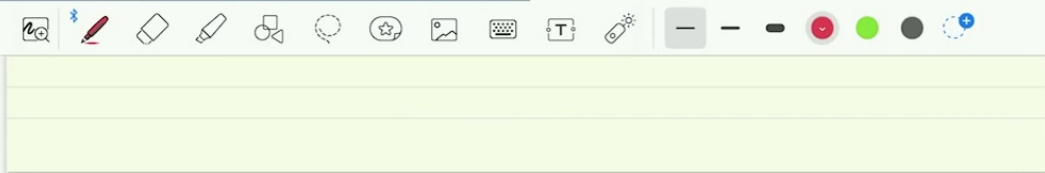


LOST/MISSING ENERGY

quarks → jets

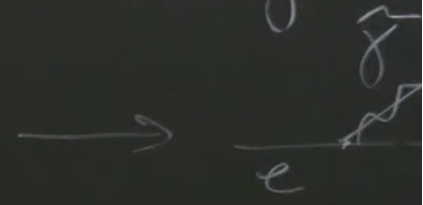
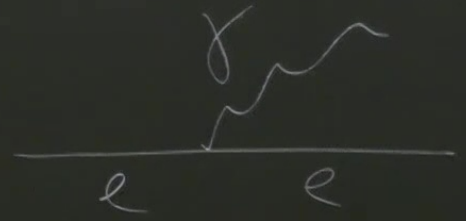
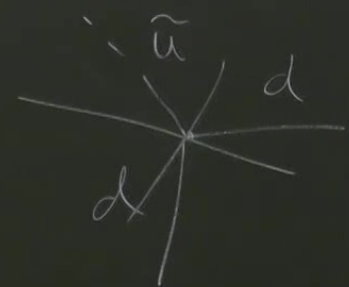
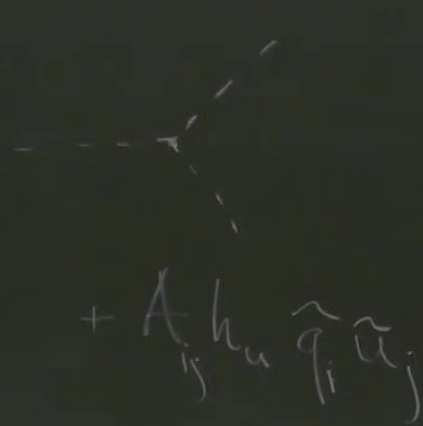
jetst #



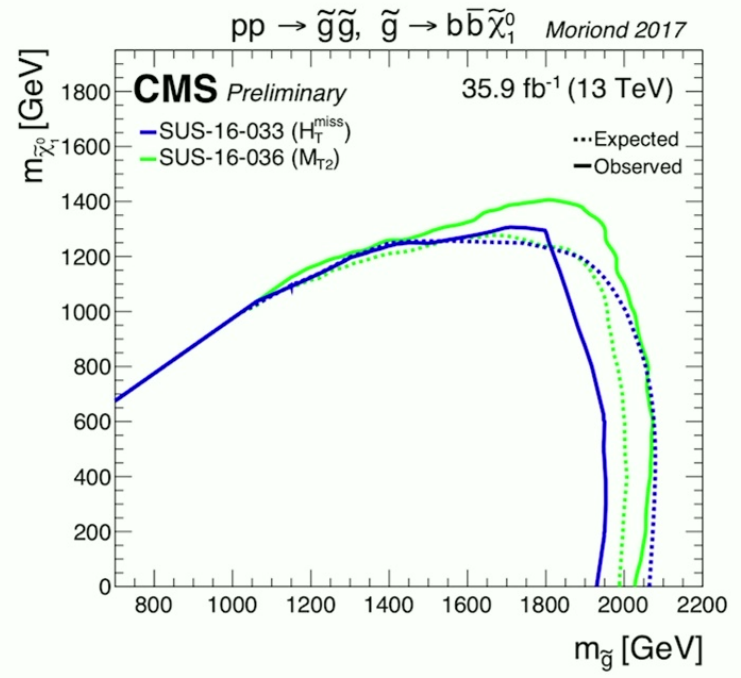


$$W = \mu H_u H_d + \lambda_u H_u Q U + \lambda_d H_d Q D + \lambda_e H_d L E$$

$$+ \cancel{\lambda' L L E} + \cancel{\lambda'' Q D L} + \cancel{\lambda''' U D D} + \cancel{\lambda'''' H_u} \rightarrow R\text{-parity}$$



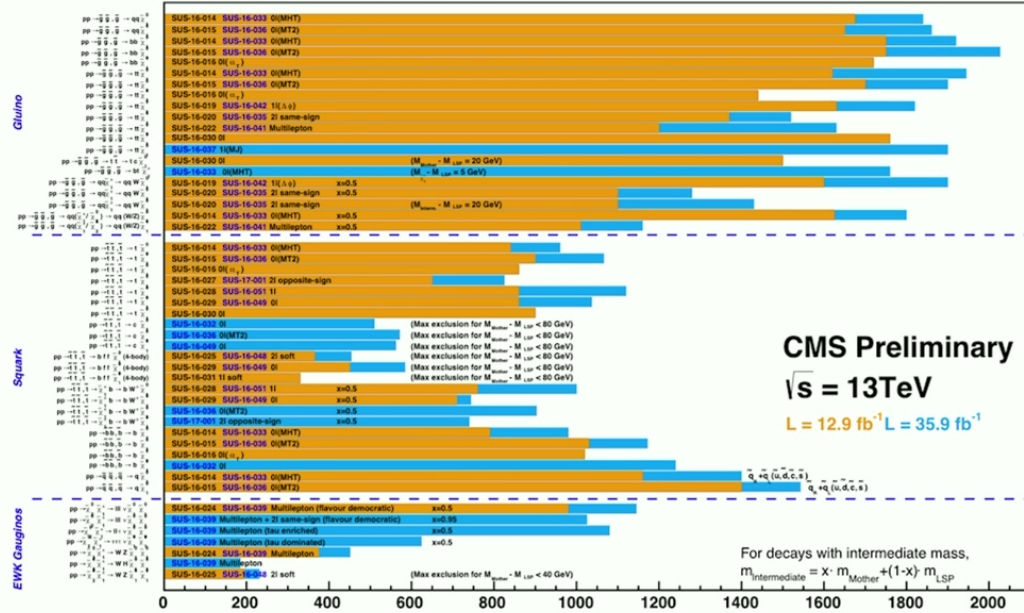






### Selected CMS SUSY Results\* - SMS Interpretation

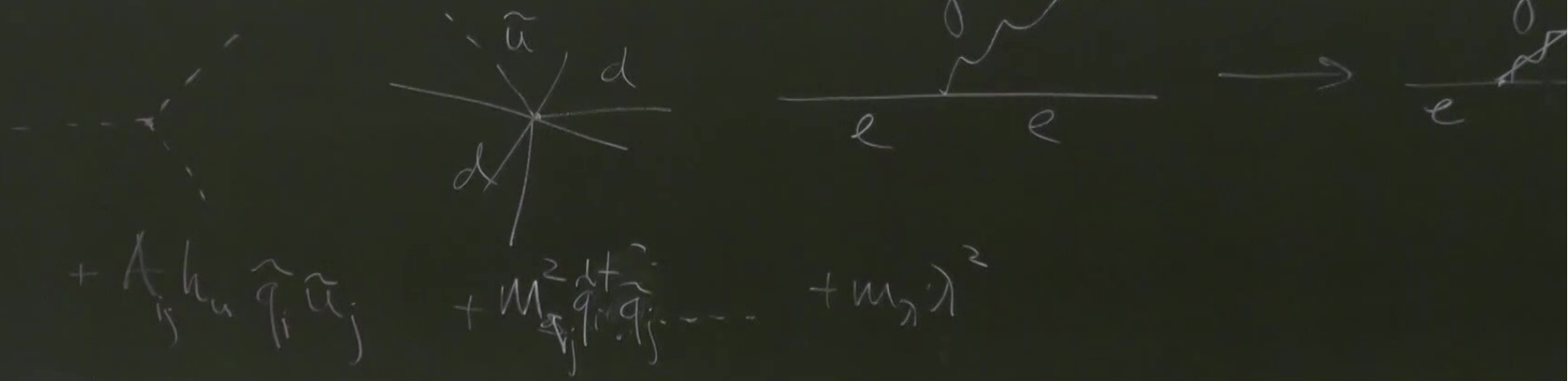
ICHEP '16 - Moriond '17

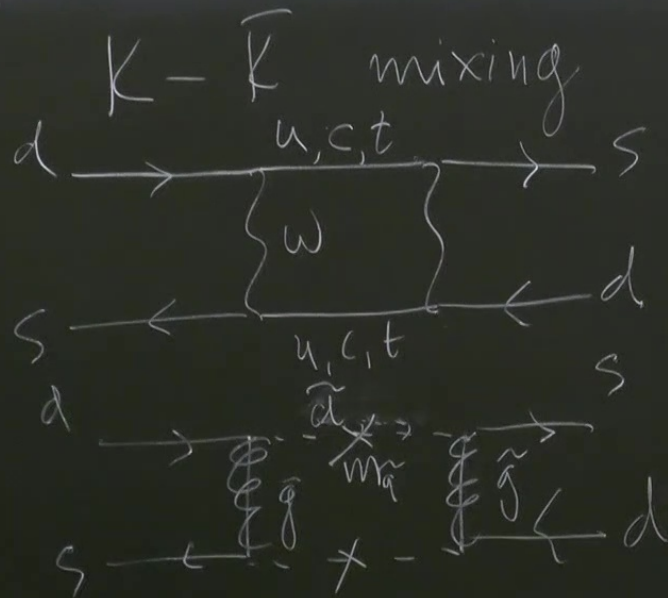


\*Observed limits at 95% C.L. - theory uncertainties not included  
Only a selection of available mass limits. Probe \*up to\* the quoted mass limit for  $m_{\text{LSP}} = 0$  GeV unless stated otherwise

$$W = \mu H_u H_d + \lambda_u H_u Q U + \lambda_d H_d Q D + \lambda_e H_d L E$$

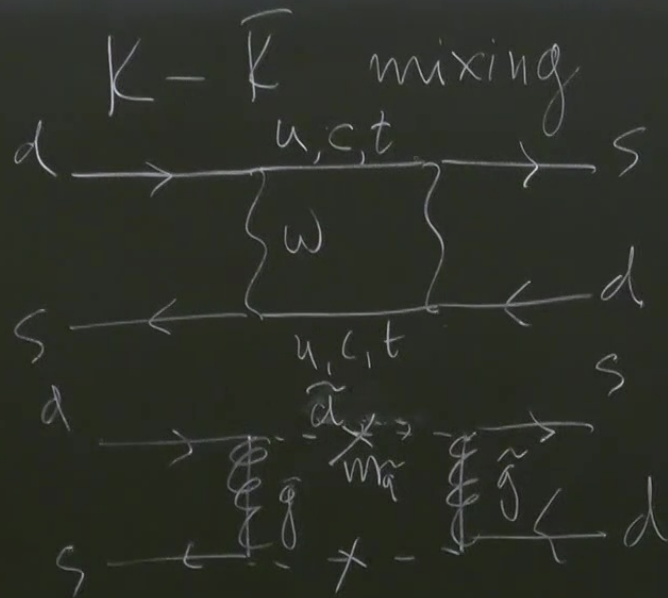
$$+ \cancel{\lambda' L L E} + \cancel{\lambda'' Q D L} + \cancel{\lambda''' U D D} + \cancel{\kappa L H_u} \rightarrow R\text{-parity}$$





$M_{\text{susy}} > 100 - 1000 \text{ TeV}!$   
 Where is SUSY?



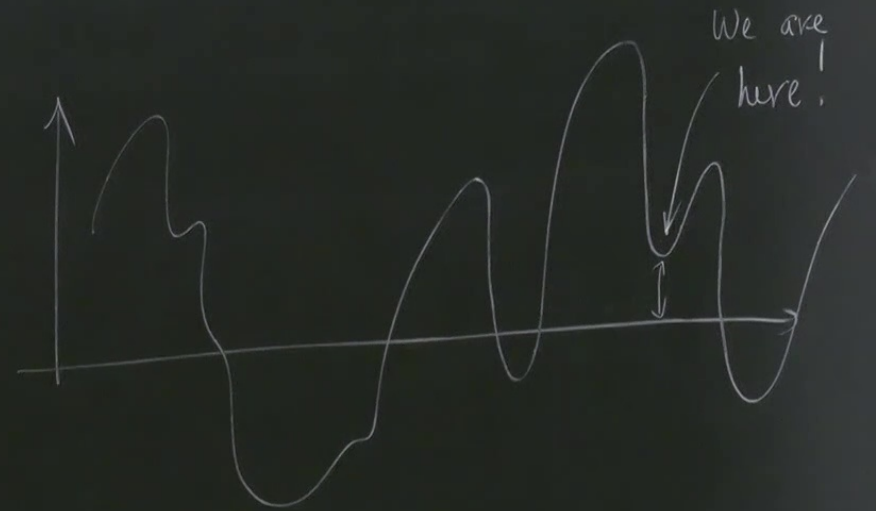
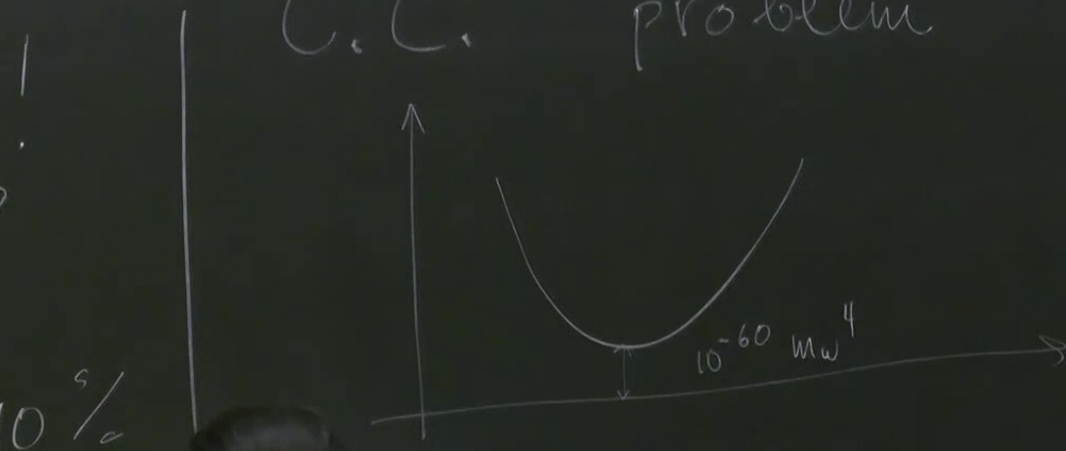


$M_{\text{susy}} > 100 - 1000 \text{ TeV}!$   
 Where is SUSY?

$$F. T. = \frac{m_h^2}{m_{\text{N.P.}}^2} = 1\% - 10\%$$



C.C. problem





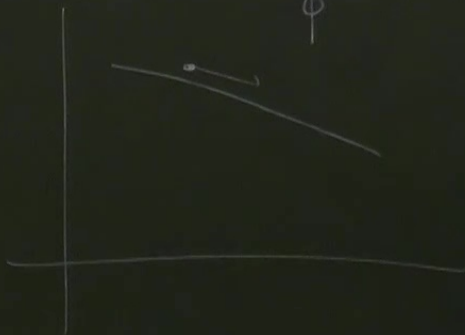
2000 Bousso + Polchinski

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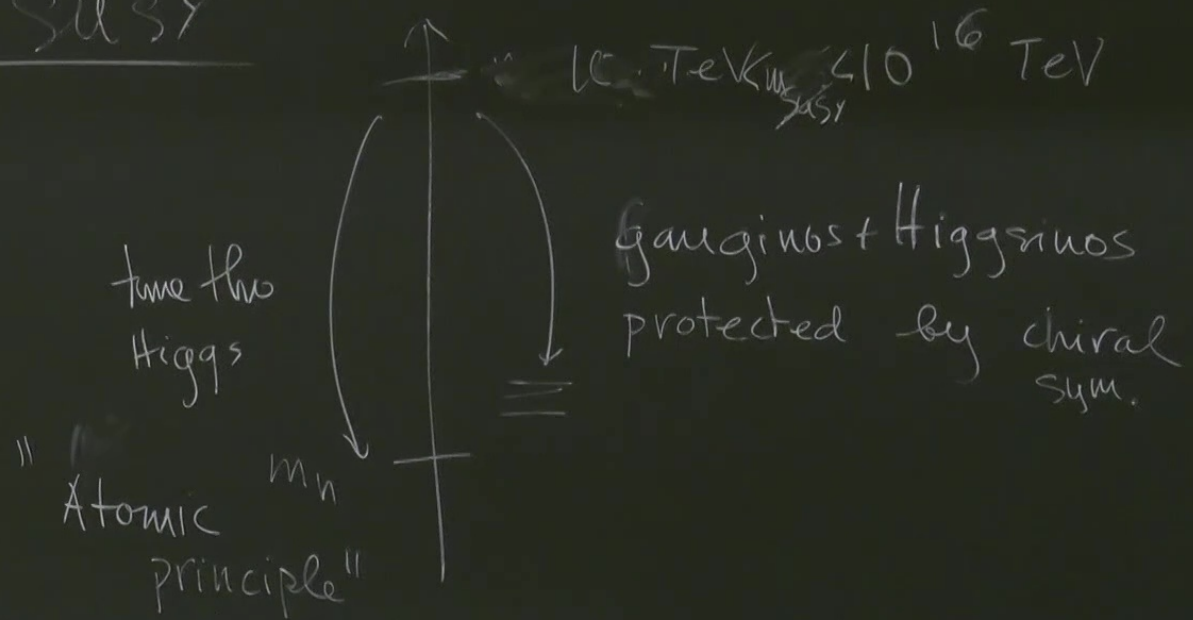
String Theory can have as many as

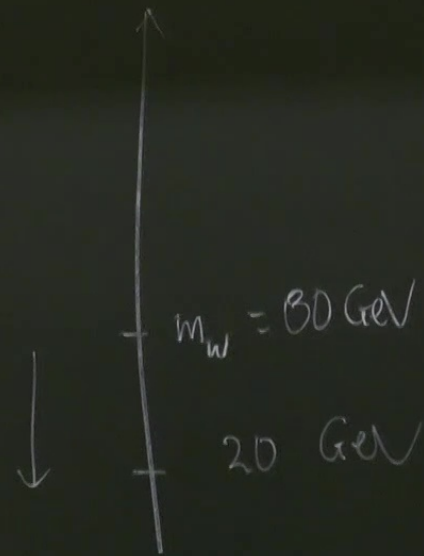
$10^{500}$  vacua

$$\frac{\phi}{\phi} < H$$

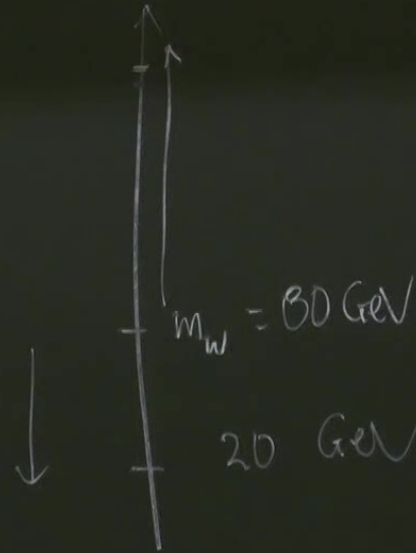
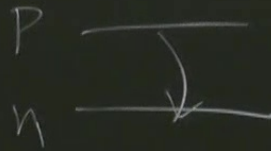


# Split SUSY

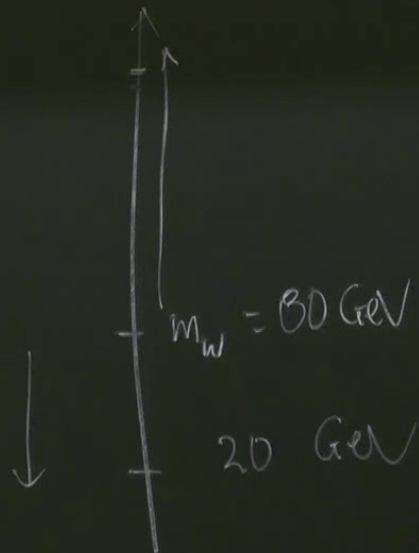
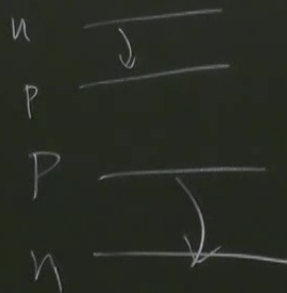




$$E_{EM} = \frac{Q}{r}$$



$$E_{EM} = \frac{\alpha}{r}$$

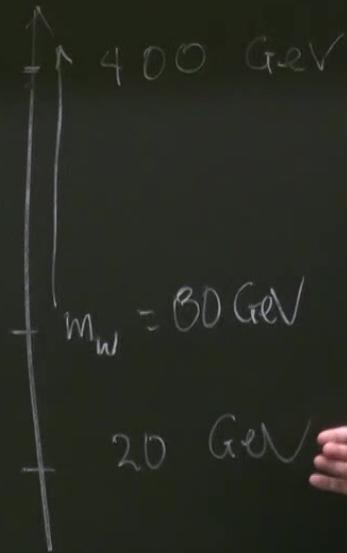
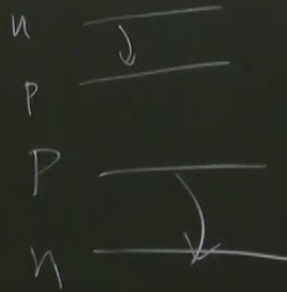




$$m_u = 2 \text{ MeV}$$

$$m_d = 4-5 \text{ MeV}$$

$$E_{EM} = \frac{\alpha}{r} = \frac{1}{137} = \frac{1}{200 \text{ MeV}} = 1 \text{ MeV}$$



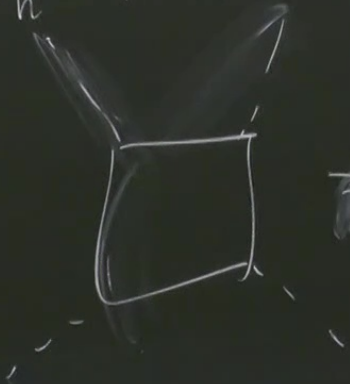
Heavy scalar super-partners:

gluino is long-lived

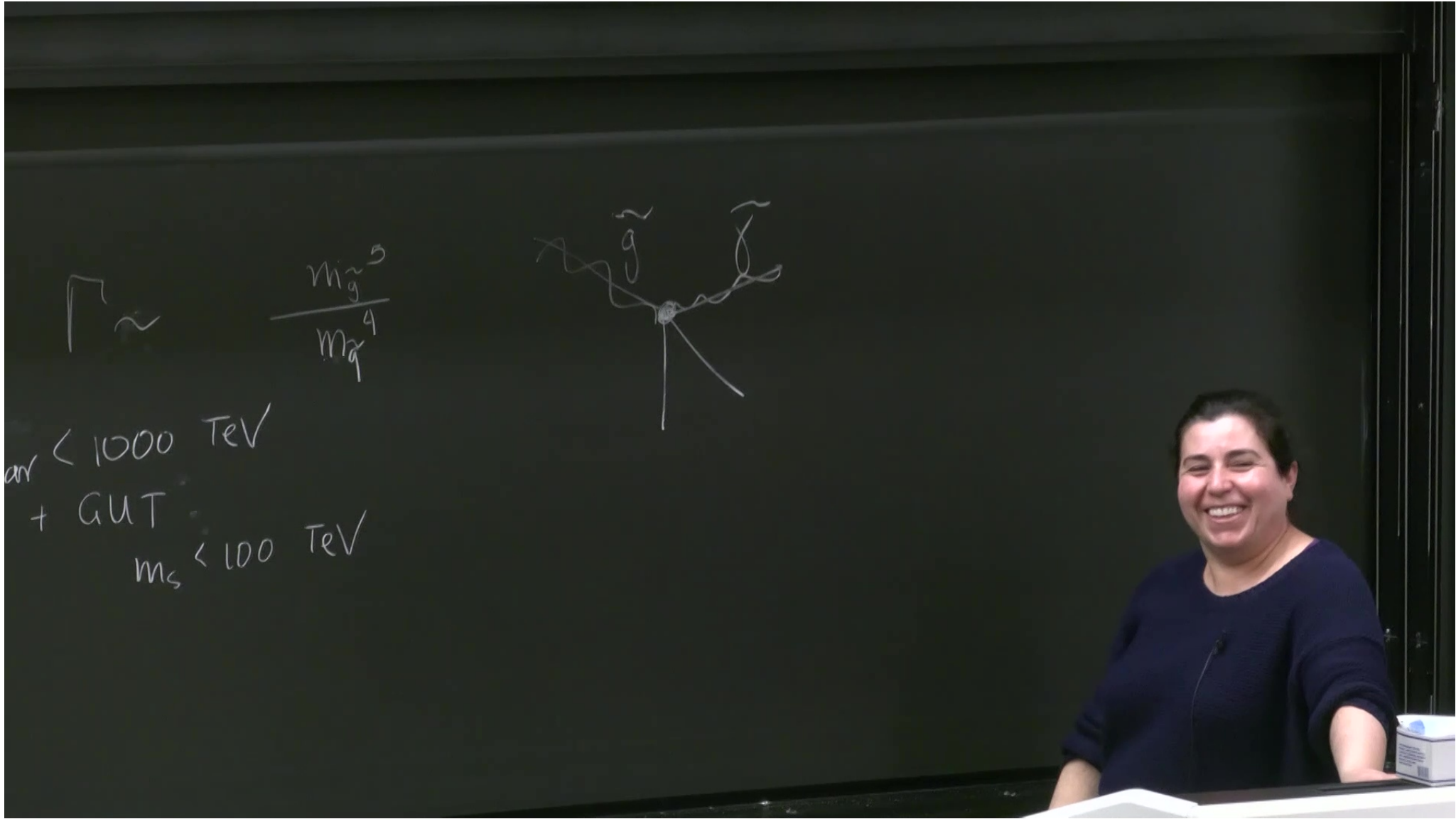
$$m_h = 125 \text{ GeV}$$

$$10 \lesssim m_{\text{scalar}} \lesssim 1000 \text{ TeV} \\ + \text{GUT}$$

$$m_s \lesssim 100 \text{ TeV}$$



$$\Rightarrow \lambda_h = \frac{3}{4\pi^2} y^4 \log \frac{m_{\text{GUT}}}{m_f}$$



$$\Gamma \sim \frac{1}{192\pi^3} \frac{m_g^2}{m_q^4}$$

$m_g < 1000 \text{ TeV}$   
 + GUT  
 $m_q < 100 \text{ TeV}$

