

Lecture 15

MSSM at one loop

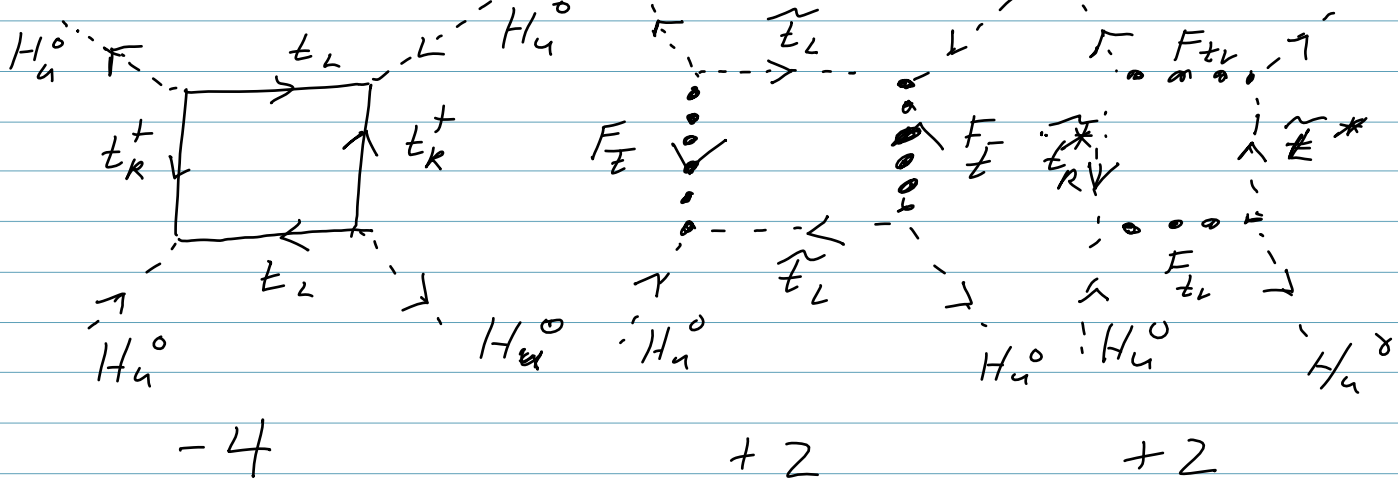
$$M_{H^0}^2 < |\cos 2\beta| M_Z^2 = \frac{|V_d^2 - V_u^2|}{V^2} \frac{(g^2 + g'^2)V^2}{4}$$

$$= \frac{(g^2 + g'^2)|V_d^2 - V_u^2|}{4}$$

CF SM

$$M_{H^0}^2 = \lambda V^2$$

Loop corrections to quartic couplings



$$m_t < \mu < \tilde{m}_{\tilde{t}_1}, \tilde{m}_{\tilde{t}_2}$$

$$\beta_\lambda = \frac{d\lambda}{d\ln\mu} \sim \text{negative}$$

yukawas don't enter in β_g at 1-loop

$$\lambda(m_{\tilde{t}}) = \lambda(m_t) + \int_{m_t}^{m_{\tilde{t}}} \beta_\lambda d\ln\mu$$

$$\lambda(m_{\tilde{t}}) = \lambda_{\text{susy}}(m_{\tilde{t}}) + \frac{N_c |V_t|^4}{16\pi^2} \ln\left(\frac{m_{\tilde{t}_1} m_{\tilde{t}_2}}{m_{\tilde{t}}^2}\right)$$

can split $\tilde{m}_{\tilde{t}_1}, \tilde{m}_{\tilde{t}_2}$

(95)

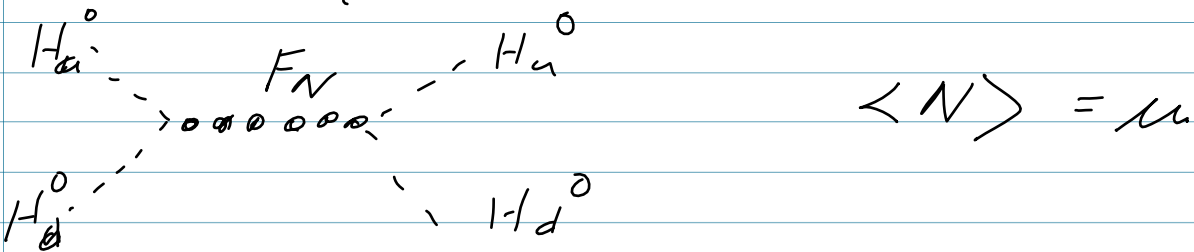
$$m_t = Y_t \frac{V_u}{\sqrt{2}} = \frac{Y_t V \sin \beta}{\sqrt{2}}$$

$$Y_t = \frac{\sqrt{2} m_t}{V \sin \beta}$$

after re-diagonalizing + small correction

$m_h < 130 \text{ GeV}$ in MSSM
assuming that Y_t is pert. up to M_{cut}

adding ~~new~~ field $W = Y_N N H_u H_d$



$$m_h < 150 \text{ GeV}$$

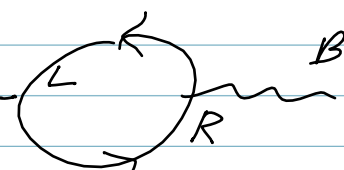
assuming Y_N perturbative up to M_{cut}

gauge extensions ...

Precision Electroweak

$$\mathcal{L}_{\text{eff}} \supset = -\frac{S g g'}{16\pi^2} W^{\mu\nu} B_{\mu\nu}$$

$$Q = T^3 + Y$$

$$\Pi^{3B}(p) \sim \int \frac{d^4k}{(2\pi)^4} \text{Tr} \left[\frac{1}{\not{k} + \not{p} - m} \gamma^{\mu} \frac{1}{\not{k} - m} \gamma^{\nu} \right] \sim m^2 \text{Tr} T^3 \frac{1}{k}$$


$$\text{Tr} T^3 \frac{1}{L} = 0 \quad \text{Tr} T^3 \frac{1}{R} = \text{Tr} T^3 Q = 1$$

$$\Pi^{3B}(p) \sim m^2 \int d^4k F(p, k, m)$$

$$\approx m^2 \sum_n \left(\frac{p^2}{m^2} \right)^n a_n \quad \text{dimensionless}$$

$$(m \gg m_Z)$$

$$\left. \frac{d\Pi^{3B}}{dp^2} \right|_{p^2=0} = a_1 \frac{m^2}{\bar{m}^2} N_c$$

non-decoupling as $m \rightarrow \infty$
 $m \propto \sqrt{v}$

S counts # particles in EWSB sector

superpartner mass: $m_{sp}(m_{soft}, M, V)$

$$\lim_{m, m_{soft} \rightarrow \infty} m_{sp} \rightarrow \infty$$

V fixed

All superpartners decouple from EWSB
 if sufficiently heavy