$\underline{\langle H \rangle \to 0}$

$W^{\pm}_{\mu}, Z_{\mu}$ $\quad (H^{\dagger}_{a} H_{a})$

$$H = \rho \begin{pmatrix} \cos\theta e^{i\alpha} \\ \sin\theta e^{i\beta} \end{pmatrix}$$

$$W_{\mu} = \widetilde{W}_{\mu} + \partial_{\mu} \phi$$

$$\begin{pmatrix} u \\ d \end{pmatrix}_L \quad u_R, d_R$$

$\underline{\underline{SU(3)_c}}$

$SU(2)_w$

$$\langle \bar{q}_L q_R \rangle \neq 0$$

$M_{W,Z} \to \infty$

$\cancel{S}\ \underline{U(2)_L \otimes U(2)_R}$

$\pi^{\pm}, \pi^0$

$\Lambda_{QCD} \sim 1\,\text{GeV} \ll M_{W,Z}$

Assumptions

1. New QCD-type Force.

$\Lambda_T \sim 100\,\text{GeV}$

2. New "quarks".

$$Q_L = \begin{pmatrix} U \\ D \end{pmatrix}_L \quad U_R, D_R$$

$$SU(N)_T \otimes \underbrace{SU(2)_W \otimes U(1)_Y}$$

$$\langle \bar{Q}_L Q_R \rangle \neq 0.$$

$$Q_L^j \qquad Q_R^j \qquad j = 1 \ldots N$$

$$\Pi^{\pm}, \Pi^{0}$$

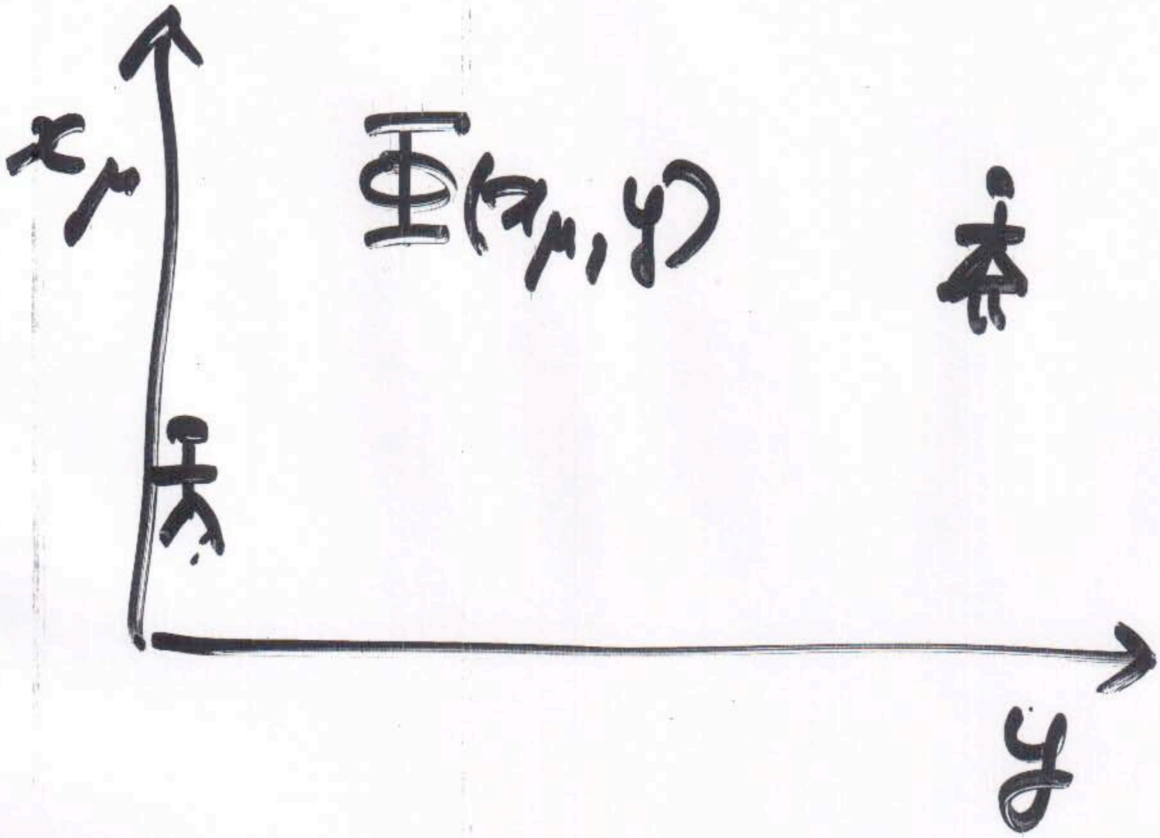
$$\boxed{H \bar{Q}_L q_R}$$

$$H \to \bar{Q}_L Q_R$$

$$\frac{\bar{Q}_L Q_R \bar{q}_L q_R}{\Lambda^2}$$

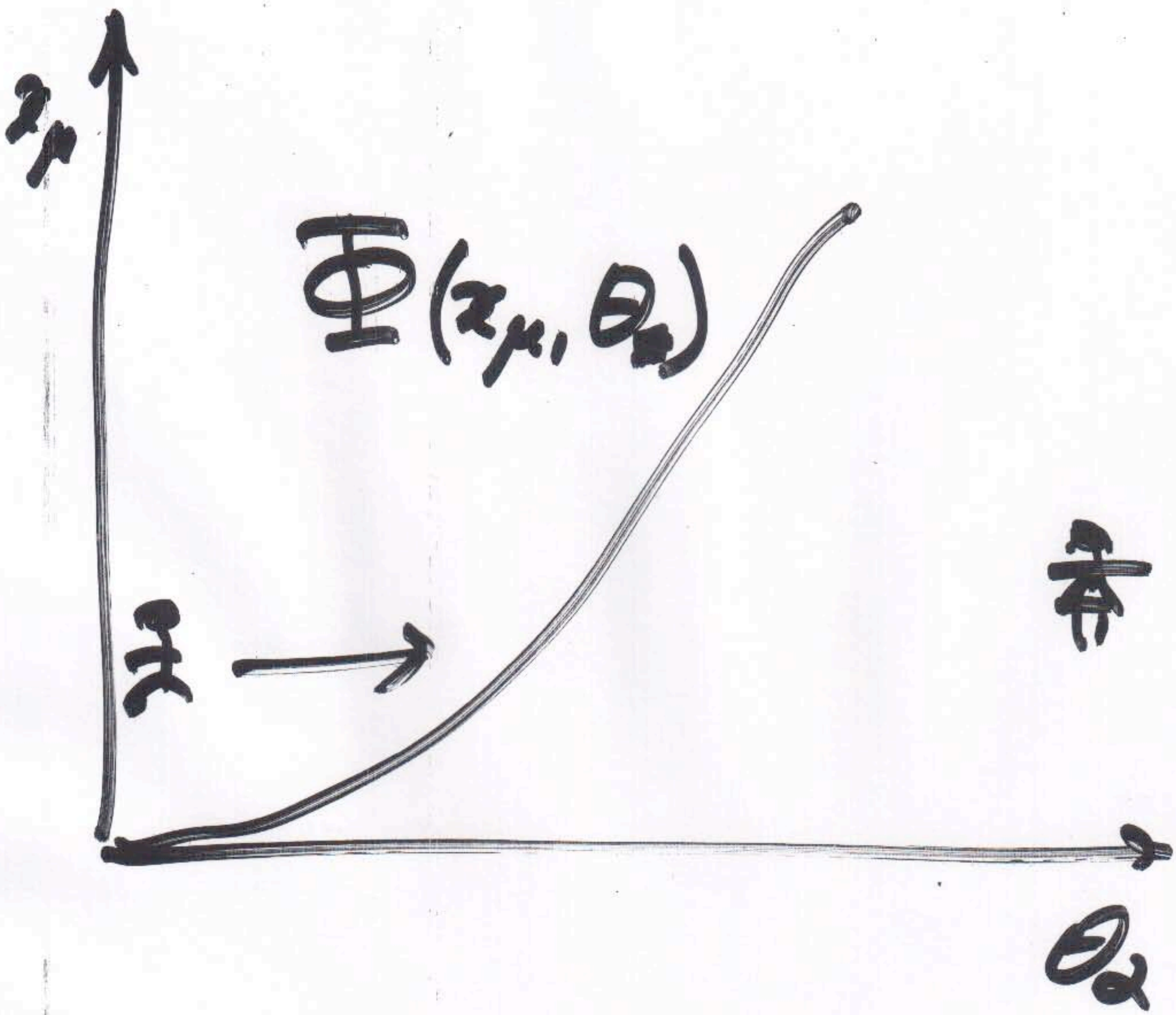
1_T ~~Le~~ Bauer.

③ SUSY



$$\Phi(x_\mu, y) = \sum e^{iny} \phi^{(n)}(x)$$

$y \to \theta_\alpha$ $\quad$ $\underline{\alpha = 1, \dots 4}$



$$\Phi(x_\mu, \theta) = \varphi(x) + \bar{\theta}\chi + \bar{\theta}\theta F + \bar{\theta}\gamma_5\theta M + \bar{\theta}\gamma_5\gamma_\mu\theta V^\mu + \bar{\theta}\theta\bar{\theta}\lambda + \bar{\theta}\theta\bar{\theta}\theta D$$

$$\theta\theta\theta\theta\theta = 0$$

$$\theta_a\theta_b = -\theta_b\theta_a$$

$$\boxed{\begin{array}{l}\theta \to \theta + \varepsilon \\ x_\mu \to x_\mu + c\,\bar{\theta}\gamma_\mu\gamma_5\varepsilon\end{array}}$$

$$z^\pm_\mu = x_\mu \pm \tfrac{1}{4} i\,\bar{\theta}\gamma_5\gamma_\mu\theta$$

$$\theta_\pm = \frac{1 \pm i\gamma_5}{2}\theta$$

$$\boxed{z^\pm_\mu,\ \theta_\pm}$$

$$\Phi(z^+_\mu, \theta_+) =$$

$$= \varphi + \bar{\theta}_+\psi + \bar{\theta}_+\theta F$$

$$\boxed{\Phi \to \varphi,\ \psi_+}$$

MSSM

Q_L, u_R, d_R, L_L, e_R

$$W = H_u Q u + H_d Q d$$
$$+ H_d L e + \left[u d d + \ldots \right.$$
$$+ \mu H_u H_d$$

$$\boxed{H Q u + \epsilon H^* Q d}$$

B L - violation

$\mathbb{Z}_2$ - parity (matter, R)

$$(u, d, e, Q, L) \to -(u, d, e, Q, L)$$

$SO(10) \supset Z_2$

$16 = (u, d, Q, L, e, \nu)$

Z_2

$Q \rightarrow \tilde{Q}$ squark

$\ell \rightarrow \tilde{\ell}$ slepton

$H \rightarrow \tilde{H}$ Higgsino

$W_\mu \leftrightarrow \lambda$ Gaugino.

$\vdots \qquad \vdots$

$$\boxed{\Delta M^2 \sim m_{SUSY}^2}$$

Soft breaking

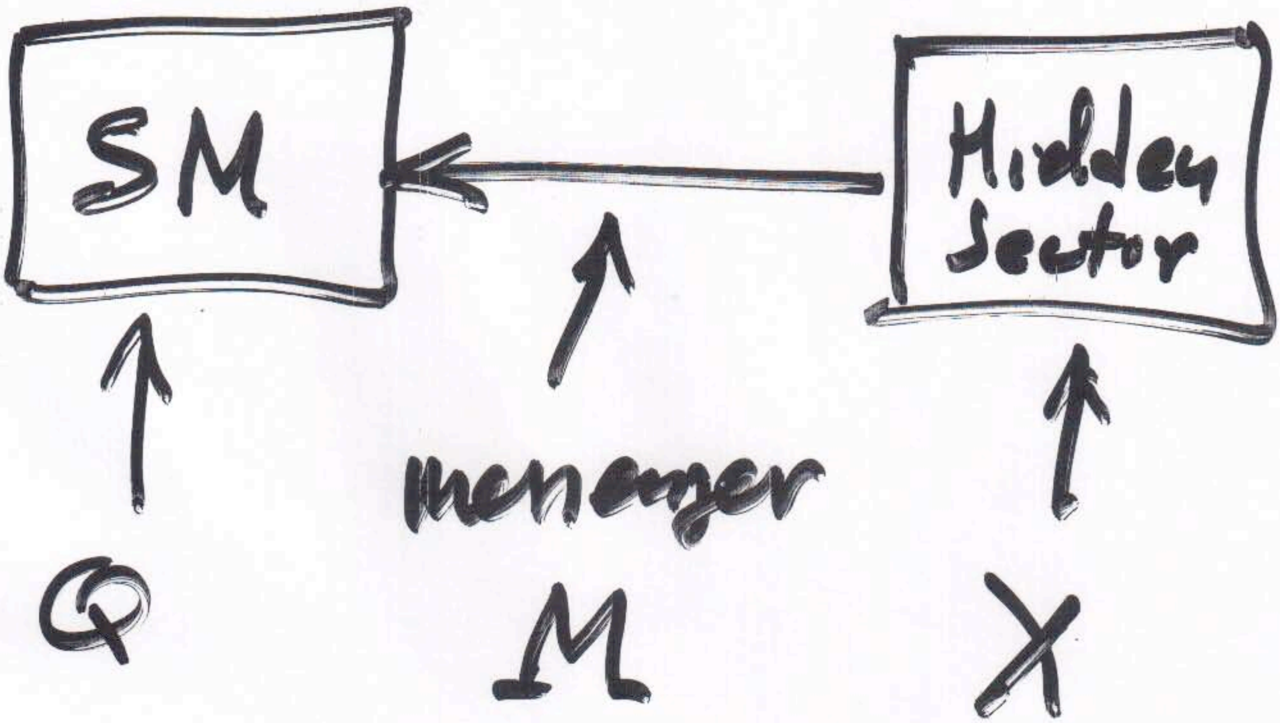
$$m^2_{\text{partners}} \gg m^2_{SM}$$

$$m^2_{ij}\, \tilde{Q}^{*i} \tilde{Q}^j + \hat{m}^2_{ij}\, \tilde{l}^{*i} \tilde{l}^j$$

$+ \cdots$

$$A_{ijk}\, H Q u + \cdots$$

$$\sum m_\lambda \bar{\lambda} \lambda$$



limit $M \to \infty$

$$\int d^4\theta \, \frac{X^\dagger X \, Q^\dagger Q}{M^2} + \ldots$$

m^2_{SUSY}

HP and SUSY.

$$\psi \to e^{i\gamma_5 \alpha} \psi$$

$$\phi^* \phi$$

$$\Phi \longleftrightarrow \psi \longrightarrow \text{chiral sym}$$

$$m_\phi = m_\psi$$

Gravity-mediation

$$\boxed{m_{susy}^2 \sim \frac{\langle X_F \rangle^2}{M_p^2}}$$

Gauge-mediation.

$$m_{susy}^2 \sim \frac{\langle X_F \rangle^2}{M_{gauge}^2}$$

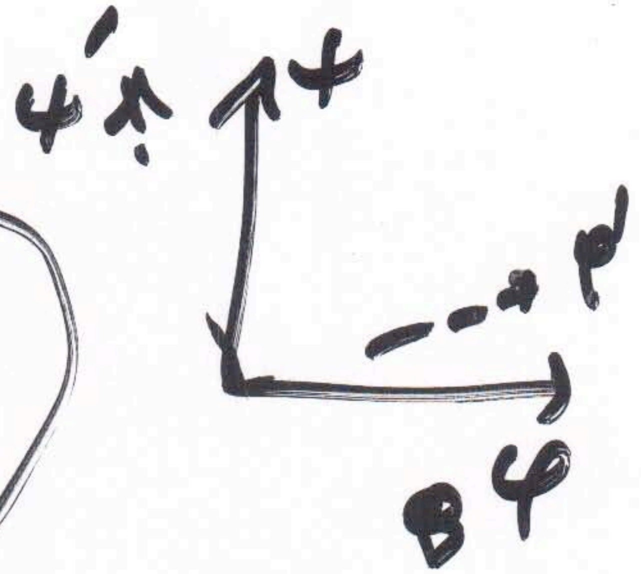
$$\begin{pmatrix} & & \\ & 3\times 3 & \\ & & \end{pmatrix}$$

δ

$$\boxed{\Theta = \frac{\langle G\tilde{G}\rangle}{\Lambda_{QCD}^4}}$$

ψ, ϕ

$$\boxed{\begin{aligned} \delta\psi &= \varepsilon\phi \\ \delta\phi &= \varepsilon\psi \end{aligned}}$$



$$\psi' = \psi + \delta\psi = \psi + \varepsilon\phi$$

$$\varphi' = \varphi + \delta\varphi = \varphi + \varepsilon\psi$$