INFORMATION ON MASTER'THESIS

1. Full name: Nguyen Duc Vinh 2. Sex: Male

3. Date of birth: 07.02.1978 4. Place of birth: Thai Nguyen

5. Decision to recognize students of :2714QĐ-CTSV on May 18/12/2008

6. The changes in the training process: No

7. Title of dissertation:

"To the pair Squark Susy-QCD in e^+e^- processes with complex parameters,"

8. Major: Theoretical Physics and Mathematical Physics 9. Code: 60.44.01

10. Scientific staff guide:

TS. Pham Thuc Tuyen - Physical Sciences - University of Natural Sciences

11. Summary results of the thesis:

Interaction Lagrangian and Feynman rules in the MSSM

To obtain the mass spectrum of particles in a physical theory we have carried out standard procedures symmetry breaking with the average value of the Higgs vacuum. I will choose the vacuum average of the two Higgs multi-line as follows:

to satisfy the equation : $\langle H^1 \rangle = \frac{1}{\sqrt{2}}\begin{pmatrix} \upsilon_1 \\ 0 \end{pmatrix}, \quad \langle H^2 \rangle = \frac{1}{\sqrt{2}}\begin{pmatrix} 0 \\ \upsilon_2 \end{pmatrix}$

υ_1, υ_2 to satisfy the equation

$$\left[\frac{e^2}{8\sin^2\theta\cos^2\theta}\left(\upsilon_1^2 - \upsilon_2^2\right) + m_{H_1}^2 + |\mu|^2\right]\upsilon_1 = -\mu_S \upsilon_2$$

$$\left[-\frac{e^2}{8\sin^2\theta\cos^2\theta}\left(\upsilon_1^2 - \upsilon_2^2\right) + m_{H_2}^2 + |\mu|^2\right]\upsilon_2 = -\mu_S \upsilon_1$$

Charge e of the particles related to the coefficients related $g_{1,2}$ through a parameter θ called the Weinberg angle. $e = g_1 \cos\theta = g_2 \sin\theta$

Lagrangian interaction between the quark and the gauge field photon (γ), wion, Zion and gluon (g):

$$L_{qq\gamma} = -ee_q \bar{q}\gamma^\mu q A_\mu$$

$$L_{qqZ} = -\frac{g}{\cos\theta_W}\bar{q}\gamma^\mu \left\{ \left(I_{qL}^3 - e_q \sin^2\theta_W \right) P_L - e_q \sin^2\theta_W P_R \right\} q Z_\mu$$

$$= -\frac{g}{\cos\theta_W}\bar{q}\gamma^\mu \left(C_{qL} P_L + C_{qR} P_R \right) q$$

$$C_{qL,R} = I_{qL,R}^3 - e_q \sin^2\theta_W$$

$$L_{qqW} = -\frac{g}{\sqrt{2}}\left(W_\mu^+ \bar{t}\gamma^\mu P_L b + W_\mu^- \bar{b}\gamma^\mu P_L t \right)$$

$$L_{qqg} = -g_s T_{rs}^a G_\mu^a \bar{q}_r \gamma^\mu q_s$$

Interaction between the super-partner of the quark (scalar quark) with the standard. They are:

- Squark-squark-photon

$$L_{\tilde{q}\tilde{q}\gamma} = iee_q \left(\tilde{q}_L^* \overleftrightarrow{\partial}^\mu \tilde{q}_L + \tilde{q}_R^* \overleftrightarrow{\partial}^\mu \tilde{q}_R \right) A_\mu$$

$$= iee_q A_\mu \left(R_{i1}^{\tilde{q}} R_{j1}^{\tilde{q}} + R_{i2}^{\tilde{q}} R_{j2}^{\tilde{q}} \right) \tilde{q}_j^* \overleftrightarrow{\partial}^\mu \tilde{q}_{\mathbf{i}}$$

$$= iee_q \delta_{ij} A_\mu \tilde{q}_j^* \overleftrightarrow{\partial}^\mu \tilde{q}_i$$

Squark-squark-Z^0

$$L_{\tilde{q}\tilde{q}Z} = \frac{ig}{\cos\theta_W} Z_\mu \left(C_{qL} \tilde{q}_L^* \overleftrightarrow{\partial}^\mu \tilde{q}_L + C_{qR} \tilde{q}_R^* \overleftrightarrow{\partial}^\mu \tilde{q}_R \right) = \frac{ig}{\cos\theta_W} c_{ij} Z_\mu \tilde{q}_j^* \overleftrightarrow{\partial}^\mu \tilde{q}_i$$

- Squark-squark-$W^\pm$

$$L_{\tilde{q}\tilde{q}'W} = \frac{ig}{\sqrt{2}}\left(W_\mu^+ \tilde{t}_L^* \overleftrightarrow{\partial}^\mu \tilde{b}_L + W_\mu^- \tilde{b}_R^* \overleftrightarrow{\partial}^\mu \tilde{t}_R \right) = \frac{ig}{\sqrt{2}}\left(R_{i1}^{\tilde{q}} R_{j1}^{\tilde{q}} W_\mu^+ \tilde{t}_j^* \overleftrightarrow{\partial}^\mu \tilde{b}_i + R_{i2}^{\tilde{q}} R_{j2}^{\tilde{q}} W_\mu^- \tilde{b}_j^* \overleftrightarrow{\partial}^\mu \tilde{t}_i \right)$$

- Squark-squark-gluon

$$L_{\tilde{q}\tilde{q}g} = ig_s T_{rs}^a G_\mu^a \left(\tilde{q}_{Lr}^* \overleftrightarrow{\partial}^\mu \tilde{q}_{Ls} + \tilde{q}_{Rr}^* \overleftrightarrow{\partial}^\mu \tilde{q}_{Rs} \right) = ig_s T_{rs}^a \delta_{ij} G_\mu^a \tilde{q}_{jr}^* \overleftrightarrow{\partial}^\mu \tilde{q}_{is}$$

The interaction between the quark with the five Higgs field in:

$$L_{qqH} = s_1^q h^0 \bar{q} q + s_2^q H^0 \bar{q} q + s_3^q A^0 \bar{q}\gamma^5 q + H^+ \bar{t}\left(s_4^t P_L + s_4^b P_R \right) b + H^- \bar{b}\left(s_4^b P_L + s_4^t P_R \right) t$$

Interaction between the squark and Higgs boson can be written in general as follows: $L_{\tilde{q}\tilde{q}H} = H_k \left(\tilde{q}_L^{\beta *}, \tilde{q}_R^{\beta *} \right) \hat{G}_k^\alpha \begin{pmatrix} \tilde{q}_L^\alpha \\ \tilde{q}_R^\alpha \end{pmatrix} = \left(G_k^\alpha \right)_{ij} H_k \tilde{q}_j^{\beta *} \tilde{q}_i^\alpha$

Quark-squark-chargino

$$
\begin{aligned}
L_{q\tilde{q}\tilde{\chi}^+} &= g\bar{t}\left(-U_{1j}P_R + Y_tV_{2j}P_L\right)\tilde{\chi}_j^+\tilde{b}_L + g\bar{t}\left(Y_bV_{2j}P_R\right)\tilde{\chi}_j^+\tilde{b}_R \\
&+g\bar{b}\left(-V_{1j}P_R + Y_bU_{2j}P_L\right)\tilde{\chi}_j^{+c}\tilde{t}_L + g\bar{b}\left(Y_tV_{2j}P_R\right)\tilde{\chi}_j^{+c}\tilde{t}_R \\
&+g\bar{\tilde{\chi}}_j^+\left(-U_{1j}P_L + Y_tV_{2j}P_R\right)t\tilde{b}_L^* + g\bar{\tilde{\chi}}_j^+\left(Y_bV_{2j}P_L\right)t\tilde{b}_R^* \\
&+g\bar{\tilde{\chi}}_j^{+c}\left(-V_{1j}P_L + Y_bU_{2j}P_R\right)b\tilde{t}_L^* + g\bar{\tilde{\chi}}_j^{+c}\left(Y_tV_{2j}P_L\right)b\tilde{t}_R^* \\
&= g\bar{t}\left(l_{ij}^{\tilde{b}}P_R + k_{ij}P_L\right)\tilde{\chi}_j^+\tilde{b}_L + g\bar{t}\left(Y_bV_{2j}P_R\right)\tilde{\chi}_j^+\tilde{b}_R \\
&+g\bar{b}\left(-V_{1j}P_R + Y_bU_{2j}P_L\right)\tilde{\chi}_j^{+c}\tilde{t}_L + g\bar{b}\left(Y_tV_{2j}P_R\right)\tilde{\chi}_j^{+c}\tilde{t}_R \\
&+g\bar{\tilde{\chi}}_j^+\left(-U_{1j}P_L + Y_tV_{2j}P_R\right)t\tilde{b}_L^* + g\bar{\tilde{\chi}}_j^+\left(Y_bV_{2j}P_L\right)t\tilde{b}_R^* \\
&+g\bar{\tilde{\chi}}_j^{+c}\left(-V_{1j}P_L + Y_bU_{2j}P_R\right)b\tilde{t}_L^* + g\bar{\tilde{\chi}}_j^{+c}\left(Y_tV_{2j}P_L\right)b\tilde{t}_R^*
\end{aligned}
$$

Quark-squark-neutralino

$$
\begin{aligned}
L_{q\tilde{q}\tilde{\chi}^0} &= g\bar{q}\left(f_{Lk}^qP_R + h_{Lk}^qP_L\right)\tilde{\chi}_k^0\tilde{q}_L + g\bar{q}\left(h_{Rk}^qP_R + f_{Rk}^qP_L\right)\tilde{\chi}_k^0\tilde{q}_R + H.c \\
&= g\bar{q}\left(a_{ik}^{\tilde{q}}P_R + b_{ik}^{\tilde{q}}P_L\right)\tilde{\chi}_k^0\tilde{q}_i + g\,\bar{\tilde{\chi}}_k^0\left(a_{ik}^{\tilde{q}}P_L + b_{ik}^{\tilde{q}}P_R\right)\bar{q}\tilde{q}_i^*
\end{aligned}
$$

- Quark-squark-gluino

$$
\begin{aligned}
L_{q\tilde{q}\tilde{g}} &= -\sqrt{2}g_sT_{rs}^a\left[\left(\bar{q}_rP_R\tilde{g}^a\tilde{q}_{Ls} - \bar{q}_rP_R\tilde{g}^a\tilde{q}_{Rs}\right) + \left(\bar{\tilde{g}}^aP_Lq_r\tilde{q}_{Ls}^* - \bar{\tilde{g}}^aP_Lq_r\tilde{q}_{Rs}^*\right)\right] \\
&= -\sqrt{2}g_sT_{rs}^a\left[\bar{q}_r\left(R_{i1}^{\tilde{q}}P_R - R_{i2}^{\tilde{q}}P_L\right)\tilde{g}^a\tilde{q}_{is} + \bar{\tilde{g}}^a\left(R_{i1}^{\tilde{q}}P_L - R_{i2}^{\tilde{q}}P_R\right)q_r\tilde{q}_{is}^*\right]
\end{aligned}
$$

- Gluon-gluino-gluino

$$
L_{g\tilde{g}\tilde{g}} = \frac{ig_s}{2}f_{abc}G_\mu^a\bar{\tilde{g}}^b\gamma^\mu\tilde{g}^c
$$

Squark-squark-gauge boson-gauge boson

$$
\begin{aligned}
L_{\tilde{q}\tilde{q}\gamma\gamma} &= e^2e_q^2A_\mu A^\mu\left(\tilde{q}_L^*\tilde{q}_L + \tilde{q}_R^*\tilde{q}_R\right) = e^2e_q^2\delta_{ij}A_\mu A^\mu\tilde{q}_j^*\tilde{q}_i \\
L_{\tilde{q}\tilde{q}ZZ} &= \frac{g^2}{\cos^2\theta_W}Z_\mu Z^\mu\left(C_{qL}^2\tilde{q}_L^*\tilde{q}_L + C_{qR}^2\tilde{q}_R^*\tilde{q}_R\right) \\
&= \frac{g^2}{\cos^2\theta_W}Z_\mu Z^\mu\left(C_{qL}^2R_{i1}^{\tilde{q}}R_{j1}^{\tilde{q}} + C_{qR}^2R_{i2}^{\tilde{q}}R_{j2}^{\tilde{q}}\right)\tilde{q}_j^*\tilde{q}_i \\
&= \frac{g^2}{\cos^2\theta_W}z_{ij}Z_\mu Z^\mu\tilde{q}_j^*\tilde{q}_i
\end{aligned}
$$

Four squark interactions

$$L_{\tilde{q}\tilde{q}\tilde{q}\tilde{q}} = -\frac{1}{2} g_s^2 T_{mn}^a T_{rs}^a \left(R_{i1}^{\alpha} R_{j1}^{\alpha} - R_{i2}^{\alpha} R_{j2}^{\beta} \right) \tilde{q}_{jm}^{\alpha *} \tilde{q}_{in}^{\alpha} \left(R_{k1}^{\beta} R_{l1}^{\beta} - R_{k2}^{\beta} R_{l2}^{\beta} \right) \tilde{q}_{kr}^{\beta *} \tilde{q}_{ls}^{\beta} =$$

$$= -\frac{1}{2} g_s^2 T_{mn}^a T_{rs}^a S_{ij}^{\alpha} S_{kl}^{\beta} \tilde{q}_{jm}^{\alpha *} \tilde{q}_{in}^{\alpha} \tilde{q}_{kr}^{\beta *} \tilde{q}_{ls}^{\beta}$$

KEY ADDITION FOR CARRYING SQUARK QCD WITH COMPLEX PARAMETER

The mix of boxer's arm moves and squark Then, the partial width of decay $\tilde{q}_i$ ($\tilde{q}_i = \tilde{t}_i,\ \tilde{b}_i$) into final state fermions are

$$\Gamma\left(\tilde{q}_i \to q + \tilde{\chi}_k^0\right) = \frac{g^2 \lambda^{\frac{1}{2}} \left(m_{\tilde{q}_i}^2, m_q^2, m_{\tilde{\chi}_k^0}^2 \right)}{16\pi m_{\tilde{q}_i}^3} \times$$

$$\left[\left(\left| a_{ik}^{\tilde{q}} \right|^2 + \left| b_{ik}^{\tilde{q}} \right|^2 \right) \left(m_{\tilde{q}_i}^2 - m_q^2 - m_{\tilde{\chi}_k^0}^2 \right) - 4\,\mathrm{Re}\left(a_{ik}^{\tilde{q}*} b_{ik}^{\tilde{q}} \right) m_q m_{\tilde{\chi}_k^0} \right]$$

and

$$\Gamma\left(\tilde{q}_i \to q + \tilde{\chi}_k^0\right) = \frac{g^2 \lambda^{\frac{1}{2}} \left(m_{\tilde{q}_i}^2, m_q^2, m_{\tilde{\chi}_k^0}^2 \right)}{16\pi m_{\tilde{q}_i}^3} \times$$

$$\left[\left(\left| a_{ik}^{\tilde{q}} \right|^2 + \left| b_{ik}^{\tilde{q}} \right|^2 \right) \left(m_{\tilde{q}_i}^2 - m_q^2 - m_{\tilde{\chi}_k^0}^2 \right) - 4\,\mathrm{Re}\left(a_{ik}^{\tilde{q}*} b_{ik}^{\tilde{q}} \right) m_q m_{\tilde{\chi}_k^0} \right]$$

Partial width of decay $\tilde{q}_i$ ($\tilde{q}_i = \tilde{t}_i,\ \tilde{b}_i$) of the final state boson (gauge and Higgs) would be:

$$\Gamma\left(\tilde{q}_i \to \mathrm{W}^{\pm} + q'_k\right) = \frac{g^2 \left|A^W_{\tilde{q}_i\tilde{q}_j}\right|^2 \lambda^{\frac{3}{2}}\left(m^2_{\tilde{q}_i}, m^2_W, m^2_{q'_j}\right)}{16\pi m^2_W m^3_{\tilde{q}_i}}$$

$$\Gamma\left(\tilde{q}_i \to Z + \tilde{q}_1\right) = \frac{g^2 \left|B^Z_{21}\right|^2 \lambda^{\frac{3}{2}}\left(m^2_{\tilde{q}_2}, m^2_Z, m^2_{\tilde{q}_1}\right)}{16\pi m^2_Z m^3_{\tilde{q}_2}}$$

$$\Gamma\left(\tilde{q}_i \to H^{\pm} + \tilde{q}'_j\right) = \frac{g^2 \left|C^H_{\tilde{q}'_j\tilde{q}_i}\right|^2 \lambda^{\frac{3}{2}}\left(m^2_{\tilde{q}_i}, m^2_{H^{\pm}}, m^2_{q'_j}\right)}{16\pi m^3_{\tilde{q}_i}}$$

$$\Gamma\left(\tilde{q}_i \to H_i + \tilde{q}_1\right) = \frac{g^2 \left|C\left(\tilde{q}_1^{\dagger} H_i \tilde{q}_2\right)\right|^2 \lambda^{\frac{1}{2}}\left(m^2_{\tilde{q}_2}, m^2_{H_i}, m^2_{\tilde{q}_1}\right)}{16\pi m^3_{\tilde{q}_2}}$$

We have the following comments received on the results above. The process $e^+e^- \to \tilde{q}_i\overline{\tilde{q}}_j$ occurs via s-channel transmission with a photon and $Z-$boson particle

12. Applicability in practice: The estimated number may be partially verifiable credibility of the results obtained using experimental results from LEP, LEP2.
13. The following research: Results of calculation for all possible schema can conclude about the complexity of the parameters in the MSSM
14. All works published related essays: No

December 20, 2011

Signature:

Nguyen Duc Vinh