Il processo $e^+e^- \to \mu^+\mu^-$ in approssimazione di Born nel Modello Standard

Mario Ciacco
Matricola 835681

ABSTRACT

I Introduzione

$$|\mathcal{M}|^2 = |\mathcal{M}_1 + \mathcal{M}_2 + \mathcal{M}_3 + \mathcal{M}_4|^2 \tag{1}$$

II L'interazione con il campo scalare

$$\mathcal{L}_s = (D_\mu \Phi)^\dagger D^\mu \Phi + \frac{\lambda}{4!}\left(|\Phi|^2 + F^2\right)^2, \qquad \lambda > 0 \tag{2}$$

$$\Phi = \begin{pmatrix} 0 \\ F \end{pmatrix} + \begin{pmatrix} \phi_1 \\ \phi_2 \end{pmatrix} = \begin{pmatrix} 0 \\ F \end{pmatrix} + \frac{1}{\sqrt{2}} \begin{pmatrix} \sqrt{2}\phi_1 \\ H + i\phi^0 \end{pmatrix} \tag{3}$$

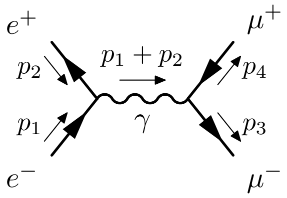
$$\mathcal{L}_{sf} = \sum_{i=e,\mu} y_i \bar{\psi}_{i,L} \Phi \psi_{i,R} + h.c. \tag{4}$$

$$y_j = \frac{1}{\sqrt{2}} g \frac{m_j}{M_W} \tag{5}$$

$$\begin{aligned} \mathcal{L}_{sf} \Longrightarrow & \frac{y_j}{\sqrt{2}} \begin{pmatrix} \bar{\nu}_j & \bar{\ell}_j \end{pmatrix} \left(\frac{1+\gamma^5}{2}\right) \begin{pmatrix} - \\ \sqrt{2}F + H + i\phi^0 \end{pmatrix} \left(\frac{1+\gamma^5}{2}\right) \ell_j + h.c. \\ = & y_j \bar{\ell}_j F \ell_j + \frac{y_j}{\sqrt{2}} \bar{\ell}_j H \ell_j + i \frac{y_j}{\sqrt{2}} \bar{\ell}_j \gamma^5 \phi^0 \ell_j \end{aligned} \tag{6}$$

$$\frac{m_\mu}{M_W} \simeq 10^{-3} \tag{7}$$

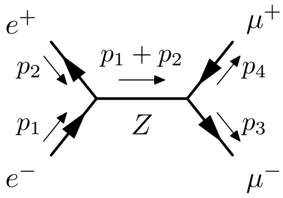
III La sezione d'urto differenziale



$$\Longrightarrow \mathcal{M}_1 = (-ie)^2\, \bar{v}(p_1)\gamma^\mu u(p_2) \frac{-i g_{\mu\nu}}{(p_1+p_2)^2} \bar{u}(p_3)\gamma^\nu v(p_4)$$

$$\begin{aligned} \frac{1}{4}\sum_{Spin} |\mathcal{M}_1|^2 = & \frac{1}{4} e^4 \frac{1}{(p_1+p_2)^2} \mathrm{tr}\{(\not{p}_2 + m_e)\gamma^\nu(\not{p}_1 - m_e)\gamma^\mu\} \\ & \times \mathrm{tr}\{(\not{p}_4 - m_\mu)\gamma_\nu(\not{p}_3 + m_\mu)\gamma_\mu\} \end{aligned} \tag{8}$$

$$\frac{1}{4}\sum_{Spin} |\mathcal{M}_1|^2 = \frac{2e^4}{s^2}\{(u - m_e^2 - m_\mu^2)^2 + (t - m_e^2 - m_\mu^2)^2 + 2(m_e^2 + m_\mu^2)s\} \tag{9}$$

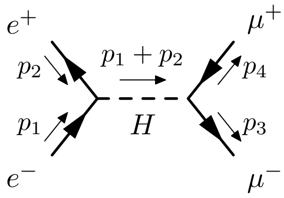


$$\Longrightarrow \mathcal{M}_2 = \left(\frac{ig}{4c}\right)^2 \bar{v}(p_1)\gamma^\mu(V+\gamma^5)u(p_2)\frac{-ig_{\mu\nu}}{(p_1+p_2)^2 - M_Z^2}\bar{u}(p_3)\gamma^\nu(V+\gamma^5)v(p_4)$$

$$\begin{aligned}\frac{1}{4}\sum_{Spin}|\mathcal{M}_2|^2 = 2\left(\frac{g}{4c}\right)^4 \frac{1}{(s-M_Z^2)^2}\{&[(V^2+1)^2+4V^2](u-m_e^2-m_\mu^2)^2 \\ &+[(V^2+1)^2-4V^2](t-m_e^2-m_\mu^2)^2 \\ &+2(V^4-1)[(m_\mu^2+m_e^2)s-4m_\mu^2m_e^2] \\ &+8m_\mu^2m_e^2(V^2-1)^2\}\end{aligned} \tag{10}$$

$$\begin{aligned}\frac{1}{4}\sum_{Spin}\mathcal{M}_1\mathcal{M}_2^\dagger = 2e^2\left(\frac{g}{4c}\right)\frac{1}{s(s-M_Z^2)}\{&(V^2+1)(u-m_e^2-m_\mu^2)^2 \\ &+(V^2-1)(t-m_e^2-m_\mu^2)^2 \\ &+2V^2(m_e^2+m_\mu^2)s\}\end{aligned} \tag{11}$$

IV L'ampiezza del diagramma con linea interna di Higgs



Riferimenti bibliografici

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[2] Martinus Veltman. *Diagrammatica: The Path to Feynman Diagrams*. Cambridge University Press, 1994.

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