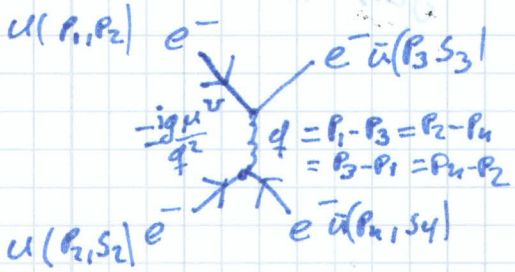
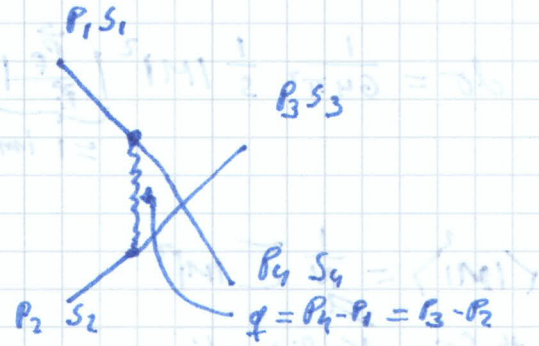
Blatt 9 KET

1)

a) $e^- e^- \to e^- e^-$





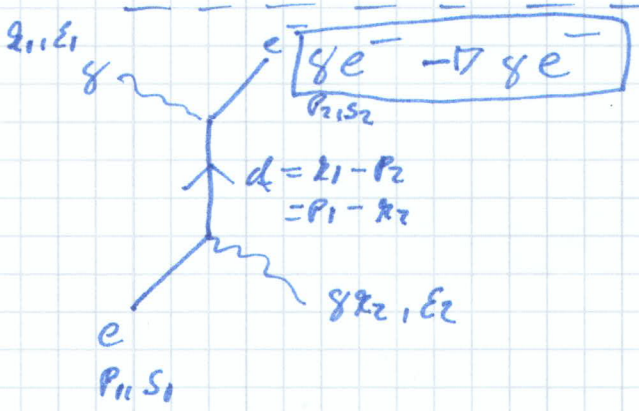
$M = M_1 - M_2$

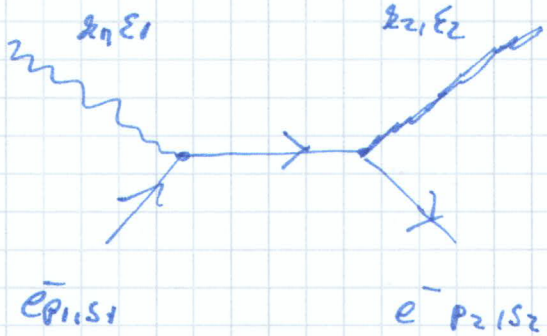
$$iM_1 = \bar{u}(p_3,s_3)\, ie\gamma_\mu\, u(p_1,s_1) \left(-\frac{ig^{\mu\nu}}{q^2}\right) \bar{u}(p_4,s_4)\, ie\gamma_\nu\, u(p_2,s_2)$$

$$= \bar{u}(p_3,s_3)\, ie\gamma_\mu\, u(p_1,s_1) \left(-\frac{i}{q^2}\right) \bar{u}(p_4,s_4)\, ie\gamma^\mu\, u(p_2,s_2)$$

$$iM_1 = -i\frac{e^2}{q^2}\, \bar{u}(p_3,s_3)\gamma u(p_1,s_1) \cdot \bar{u}(p_4,s_4)\gamma^\mu u(p_2,s_2)$$

$$M_2 = \frac{e^2}{q^2}\, \bar{u}(p_4,s_4)\gamma_\mu u(p_1,s_1)\, \bar{u}(p_3,s_3)\gamma^\mu u(p_2,s_2)$$





$M = M_1 + M_2$ Feynman slash: $\not{A} = \gamma^\mu A_\mu$

$$iM_1 = \bar{u}(p_2,s_2)\, ie\gamma^\mu \varepsilon^\mu(k_1) \cdot \frac{i(\not{q}+m)}{q^2-m^2} \cdot \varepsilon^\nu(k_2)\, ie\gamma_\nu\, u(p_1,s_1)$$

$$iM_2 = \bar{u}(p_2,s_2)\, ie\gamma_\mu\, \varepsilon^\nu(k_2) \cdot i(\not{q}+m)\, \varepsilon^\mu(k_1)\, ie\gamma_\mu\, u(p_1,s_1)$$

Fermis Goldene Regel: $d\sigma = \frac{(2\pi)^4}{4\sqrt{(p_1 p_2)^2 - m_1^2 m_2^2}} |M|^2 \, d\Phi(p_1 + p_2, p_3 \ldots p_{n+2})$

$1+2 \to 3 + \ldots n+2$

$d\sigma = \frac{1}{64\pi^2} \frac{1}{s} |M|^2 \underbrace{\left|\frac{\vec{p}_f}{\vec{p}_i}\right|}_{=1 \text{ im CMS}} d\Omega$ für $1+2 \to 3+4$

$\langle |M|^2 \rangle = \frac{1}{N} \sum |M|^2$

N: # Spin-Konfigurationen im Anfangszustand