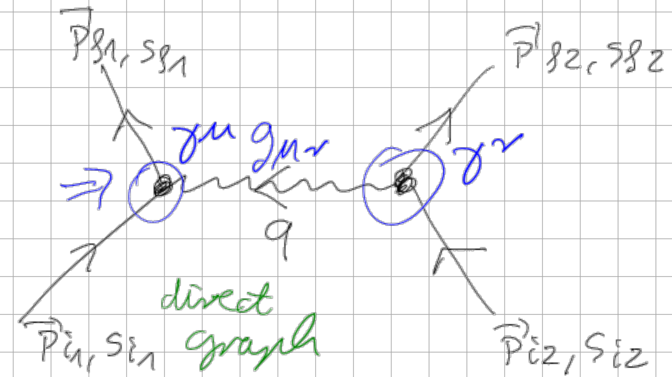
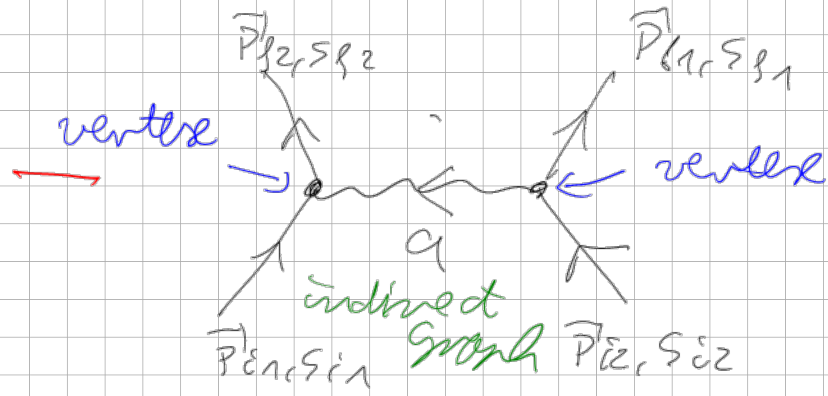
scattering amplitude:

$S^{(2)}_{fi} =$





$\boxed{q = p_{f1} - p_{i1}} = p_{i2} - p_{f2}$ $\qquad$ $q = p_{f2} - p_{i1} = p_{i2} - p_{f1}$

Feynman rules: conversion of analytic results into diagrams and vice versa

(F1) Prefactor $(2\pi\hbar)^4\,\delta(p_{f1}+p_{f2}-p_{i1}-p_{i2})$ guarantees energy-momentum conservation

(F2) Incoming electron $\hat{=} \sqrt{\dfrac{mc^2}{(2\pi\hbar)^3 E_{p_i}}}\; u(\vec p_i, s_i)$

(F3) Outgoing " $\hat{=} \sqrt{\dfrac{mc^2}{(2\pi\hbar)^3 E_{p_f}}}\; \bar u(p_f, s_f)$

(F4) a vertex $\hat{=}\; e\gamma^\mu$

(F5) Maxwell propagator $\hat{=} \dfrac{\hbar}{\varepsilon_0 c} \cdot \dfrac{g_{\mu\nu}}{q^2}$, q: momentum transfer

(F6) Phase factor: $(-i)^{\text{number of vertices}} \cdot (-i)^{\text{number of internal lines}}$ $\qquad$ $(-i)^2(-i)^1 = (-1)(-i) = i$

$q = -e$ $\qquad$ interaction Hamiltonian $\qquad$ Maxwell propagator

$$S_{fi}^{(2)} = \frac{i e^2 \hbar}{\varepsilon_0 c} (2\pi\hbar)^4 \delta(p_{f1} + p_{f2} - p_{i1} - p_{i2})$$

$$\sqrt{\frac{mc^2}{(2\pi\hbar)^3 E_{\vec{p}_{i1}}}} \sqrt{\frac{mc^2}{(2\pi\hbar)^3 E_{\vec{p}_{i2}}}} \sqrt{\frac{mc^2}{(2\pi\hbar)^3 E_{\vec{p}_{f1}}}} \sqrt{\frac{mc^2}{(2\pi\hbar)^3 E_{\vec{p}_{f2}}}} \quad M_{fi}^{(2)}$$

$$M_{fi}^{(2)} = \frac{g_{\mu\nu}}{(p_{f1} - p_{i1})^2} \bar{u}(\vec{p}_{f1}, s_{f1}) \gamma^\mu u(\vec{p}_{i1}, s_{i1}) \bar{u}(\vec{p}_{f2}, s_{f2}) \gamma^\nu u(\vec{p}_{i2}, s_{i2})$$

$$- \frac{g_{\mu\nu}}{(p_{f2} - p_{i1})^2} \bar{u}(\vec{p}_{f2}, s_{f2}) \gamma^\mu u(\vec{p}_{i1}, s_{i1}) \bar{u}(\vec{p}_{f1}, s_{f1}) \gamma^\nu u(\vec{p}_{i2}, s_{i2})$$