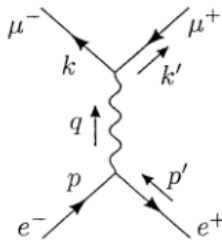# Exercise sheet XII

January 21 [solution: start January 30, continue February 6]

Problem 1 [*Simplest QED process:* $e^+e^- \to \mu^+\mu^-$] Calculate the unpolarized cross section for the process $e^+e^- \to \mu^+\mu^-$ to lowest order of perturbation theory. Assume that electrons are massless and muons have mass m_μ.

The amplitude for the considered process is given by the following diagram:

We will follow the derivation by M. Peskin, V. Schroeder, *An Introduction to Quantum Field Theory* (Section 5.1).

The final formula for the total cross section should be obtained in the following form:

$$\sigma_{\text{total}} = \frac{4\pi\alpha^2}{3E_{\text{cm}}^2}\sqrt{1 - \frac{m_\mu^2}{E^2}}\left(1 + \frac{1}{2}\frac{m_\mu^2}{E^2}\right), \tag{1}$$

where α is the fine-structure constant, E_{cm} is the centre-of-mass energy, $E = E_{\text{cm}}/2$.