Problem sheet 1
to be handed in on Tuesday 02.05.2017 (12:00) to the letterbox 37 (foyer of Staudingerweg 7)

1. **Bhabha Scattering** (80 Points)

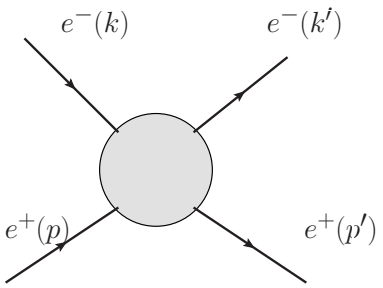

Figure 1: Bhabha scattering $e^+e^- \to e^+e^-$.

(a) **(15P.)** The scattering of a positron and an electron is called Bhabha scattering. Sketch the leading order Feynman diagram(s) for this process and write down the according amplitude using the Feynman rules. Please use the notation from Fig. 1 for the momenta.

(b) **(35P.)** Calculate the mean squared amplitude $\overline{|\mathcal{M}|^2}$, summed over initial and averaged over outgoing spins.

Use that one can neglect the electron mass in this process $m_e = 0$.

(c) **(10P.)** Express $\overline{|\mathcal{M}|^2}$ in terms of the Mandelstam variables, here defined as:

$$s = (k+p)^2 = (k'+p')^2 \tag{1}$$
$$t = (k-k')^2 = (p-p')^2 \tag{2}$$
$$u = (k-p')^2 = (p-k')^2 \,. \tag{3}$$

(d) **(20P.)** Show that the differential cross section $d\sigma/d\cos(\theta)$ is given by

$$\frac{d\sigma}{d\cos(\theta)} = \frac{\pi\alpha^2}{s}\left(u^2\left(\frac{1}{s}+\frac{1}{t}\right)^2 + \left(\frac{t}{s}\right)^2 + \left(\frac{s}{t}\right)^2\right) . \tag{4}$$

2. **Møller Scattering** (20 Points)
The scattering of two electrons is called Møller scattering. Sketch the leading order Feynman diagrams and use the symmetry of this process compared to Bhabha scattering to deduce its differential cross section.