

problem sheet 2

to be handed in by Wednesday 10.5.2017 (12:00) to the letterbox 37 (foyer of Staudingerweg 7)

### 1. Renormalisation of the fermion propagator (70 P.)

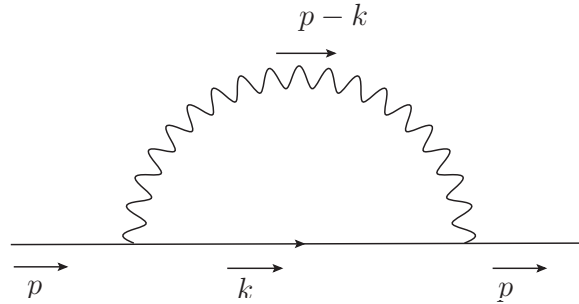


Figure 1: Loop correction to the fermion propagator on one-loop level.

Calculate the diagram sketched in figure 1:

- Write down the amplitude using Feynman rules, do not include the propagators of the external fermion lines.
- Introduce Feynman parameters to combine the denominator.
- Complete the square in the denominator, shifting  $k \rightarrow \ell$ . The denominator should become

$$[\ell^2 - \Delta + i\epsilon]^2, \quad (1)$$

with

$$\ell = k - xp \quad \text{and} \quad \Delta = -x(1-x)p^2 + (1-x)m^2. \quad (2)$$

- Rewrite the numerator in terms of  $\ell$ , remember you can drop odd powers.

### 2. Gordon identity (30 P.)

In the lecture you used the Gordon identity

$$\bar{u}(p')\gamma^\mu u(p) = \bar{u}(p') \left[ \frac{p'^\mu + p^\mu}{2m} + \frac{i\sigma^{\mu\nu}q_\nu}{2m} \right] u(p), \quad (3)$$

where  $q = p' - p$ , to determine the structure of the electron vertex function  $\Gamma^\mu$  (see section 8.1).

Use the anticommutation relations of the gamma matrices and the Dirac equation to proof this identity.