Interaction by particle exchange

Feynman diagrams

Feynman diagrams are a useful way of representing processes. In order to obtain the matrix element $\mathcal{M}$ from such processes, the following rules are followed:

initial-state particle:	$u(p)$
final-state particle:	$\overline{u}(p)$
initial-state antiparticle:	$\overline{v}(p)$
final-state antiparticle:	$v(p)$
initial-state photon:	$\varepsilon_\mu(p)$
final-state photon:	$\varepsilon_\mu^*(p)$
photon propagator:	$-\frac{ig_{\mu\nu}}{q^2}$
fermion propagator:	$-\frac{i(\gamma^\mu q_\mu + m)}{q^2 - m^2}$
QED vertex:	$-iQe\gamma^\mu$

the quantity $-i\mathcal{M}$ is then equal to the product of the individual contributions of each particle, antiparticle, virtual particle, and vertex in the diagram. For example, the diagram:

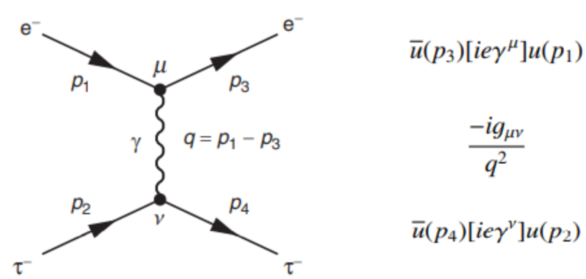

Fig. 5.7 The Feynman diagram for the QED scattering process $e^-\tau^- \to e^-\tau^-$ and the associated elements of the matrix element constructed from the Feynman rules. The matrix element is comprised of a term for the electron current, a term for the tau-lepton current and a term for the photon propagator.

has matrix element given by:

$$-i\mathcal{M} = [\overline{u}(p_3)\{ie\gamma^\mu\}u(p_1)]\frac{-ig_{\mu\nu}}{q^2}[\overline{u}(p_4)\{ie\gamma^\nu\}u(p_2)],$$