$$\mu^- \to e^- + \nu_\mu + \bar{\nu}_e \qquad (2.14)$$

$$\mu^- + p \to n + \nu_\mu \qquad (2.40)$$

$$\Sigma^- \to n + e^- + \bar{\nu}_e \qquad (2.45)$$

$\Sigma^- \to \Lambda e^- \bar{\nu}_e$

$\Xi^- \to \Lambda + \pi^-$

$\Xi^- \to n + \pi^-$

$\Sigma^+ \to n e^+ \nu_e$

$$\Gamma(\Sigma^+ \to n e^+ \nu_e)/\Gamma(\Sigma^- \to n e^- \bar{\nu}_e) < 0.04 \qquad (2.50)$$

$K^+ \to \pi^+ e^+ e^-$

$K^+ \to \pi^0 e^+ \nu_e$

Taking into account the charge assignments $Q_u = 2/3$ and $Q_d = Q_s = -1/3$, as well as the strangeness of the *s*-quark being -1 (the *u* and *d* quarks of course have zero strangeness), it is easy to see that weak hadronic transitions mediated

$$\pi^- \to l^- + \bar{\nu}_l \qquad (2.60)$$

$\pi^+ \to l^+ + \nu_l$

$$R_{e/\mu} = \frac{\Gamma(\pi^- \to e^- + \bar{\nu}_e)}{\Gamma(\pi^- \to \mu^- + \bar{\nu}_\mu)} \qquad (2.71)$$

$BR(K^- \to \mu^- + \bar{\nu}_\mu) \doteq 63.5\%$

$\tau^- \to \pi^- + \nu_\tau$

$$\mathcal{M}(\tau^- \to \pi^- + \nu_\tau) = -G_F \cos\theta_C f_\pi \bar{u}(k) \not{p}(1 - \gamma_5) u(q) \qquad (2.76)$$

$$\frac{\Gamma(\tau^- \to K^- + \nu_\tau)}{\Gamma(\tau^- \to \pi^- + \nu_\tau)} = \tan^2\theta_C \frac{f_K^2}{f_\pi^2} \frac{(1 - m_K^2/m_\tau^2)^2}{(1 - m_\pi^2/m_\tau^2)^2} \qquad (2.78)$$

$\tau^- \to K^- + \nu_\tau$

$$\pi^+ \to \pi^0 + e^+ + \nu_e \qquad (2.81)$$

$\pi^- \to \pi^0 e^- \bar{\nu}_e$

$$\mathrm{BR}_{exp}(\pi^+ \to \pi^0 e^+ \nu_e) = (1.025 \pm 0.034) \times 10^{-8} \qquad (2.82)$$
$$\Gamma_{theor}(\pi^+ \to \pi^0 e^+ \nu_e) \doteq 2.62 \times 10^{-22} MeV \qquad (2.106)$$
$$n \to p + e^- + \bar{\nu}_e \qquad (1.1)$$
$$[G] = M^{-2} \qquad (1.15)$$

transition $O^{14} \to N^{14*} + e^+ + \nu$, while the free neutron decay or the tritium decay $H^3 \to He^3 + e^- + \bar{\nu}$ can serve as examples of mixed transitions.

transition $O^{14} \to N^{14*} + e^+ + \nu$

$\bar{\nu} + p \to n + e^+$

$W^+ \to e^+ + \nu_e$ while its hermitean conjugate leads to $W^- \to e^- + \bar{\nu}_e$).

$\nu\bar{\nu} \to W^- W^+$.

$e^- e^+ \to W^- W^+$

$\bar{\nu} e \to W^- \gamma$

This indicates that the Higgs mechanism within a gauge theory is essentially the only means of saving the good asymptotic behaviour of scattering amplitudes involving massive vector bosons and hence is of vital importance for perturbative renormalizability. It is also not difficult to see that the interactions (6.76) and (6.77) lead to the right high-energy behaviour of the tree-level amplitudes for processes $WW \to HH$ and $ZZ \to HH$. In particular, one may observe that the contribution of the direct *WWHH* interaction (6.77) compensates the high-energy (quadratic) divergences produced by the second-order graph involving the *W* exchange and two *WWH* vertices; an analogous mechanism operates in the $ZZ \to HH$ channel as well. The corresponding calculation is left to the reader as an instructive exercise. Note that converse is also true:

processes $e^+e^- \to Z_L Z_L$ or $e^+e^- \to Z_L H$

$$\Gamma\left(H \to e^+e^-\right) : \Gamma(H \to \mu^+\mu^-) : \Gamma(H \to \tau^+\tau^-) = m_e^2 : m_\mu^2 : m_\tau^2 \qquad (6.89)$$