Übungen zu Physik an Hadron-Collider SS 2011
Prof. Karl Jakobs, Dr. Iacopo Vivarelli
Übungsblatt Nr. 6

Die Lösungen müssen bis 11 Uhr am Donnerstag den 23.6.2011 in die Briefkästen im Erdgeschoss des Gustav-Mie-Hauses eingeworfen werden!

---

1. **Weak interactions**

   - Show that the $V-A$ expression for the "charged" weak current can be rewritten as a pure vectorial current involving the left-handed components of the involved fermions. That is, show the equivalence of the two expressions below (focusing in the notation on a $We\nu$ vertex) [**2 points**]:

$$\bar{\nu}\gamma_\mu \frac{1}{2}\left(1-\gamma_5\right) u_e = \bar{\nu}_L \gamma_\mu e_L \tag{1}$$

   - In a similar way, show that the expression for the weak neutral current can be rewritten as a current involving left handed fermion components plus a current involving right-handed fermion components. That is, show that [**2 points**]:

$$\bar{e}\gamma_\mu \frac{1}{2}\left(g_V - g_A\gamma_5\right) e = \bar{e}_L g_L \gamma_\mu e_L + \bar{e}_R g_R \gamma_\mu e_R \tag{2}$$

2. **Electroweak unification**

   In the unified electroweak theory, the electroweak current can be written as:

$$-ig\vec{j_\mu}\cdot\vec{W}^\mu - i\frac{g'}{2} j_\mu^Y B^\mu \tag{3}$$

   where $\vec{j}_\mu$ is the weak isospin current, j_μ^Y is the hypercharge current, $\vec{W}^\mu$ and B^μ are the gauge fields.

   - Write down the expression for the 4 physical fields $W^\pm, A, Z$ in terms of the quantities appearing on the expression above and the weak mixing angle θ_W [**2 points**].
   - Given the relationship between the electromagnetic current and $\vec{j}_\mu$,j_μ^Y, what is the relation between the electric charge and g, g'? [**2 points**]
   - From the neutral current interaction term, derive an expression for the vectorial and axial couplings C_V, C_A to fermions in terms of the hypercharge and weak isospin of the fermions. [**2 points**]