Lepton Universality

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Abstract: Here we show that the atom-like structure and dynamics of baryons are the origin of the lepton non-universality. In decays of the B mesons, we should observe about 72 muon-antimuon pairs per 100 electron-positron pairs.

1. Introduction

Lepton universality is defined as follows: All three types of charged lepton particles interact in the same way with other particles.

According to the Scale-Symmetric Theory (SST) [1], both the electron and muon have similar structures with different sizes of the components (a loop, or a torus/electric-charge with scalar central condensate which is responsible for the nuclear weak interactions).

SST shows that the B bosons are produced inside the baryons.

Here we show that the observed different branching ratios, BR, for the decays $B^o \rightarrow K_S{}^o\mu^+\mu^-$ and $B^o \rightarrow K_S{}^o e^+e^-$ follow from the atom-like structure and dynamics of baryons.

According to SST, the $\mu^+\mu^-$ pairs in B are produced near the scalar condensate in centre of the baryons so the nuclear weak interactions are responsible for the production of the $B^o{}_{\mu+\mu-}$ bosons ($K_S{}^o\ \mu^+\mu^- \rightarrow B^o{}_{\mu+\mu-}$). The coupling constant for such interactions is $\alpha_{w(p)} = 0.01872291$ [1].

Notice that particles "remember" which coupling constants were responsible for their production so in the decays of such $B^o{}_{\mu+\mu-}$ bosons appear the $\mu^+\mu^-$ pairs.

On the other hand, the e^+e^- pairs are produced outside the electrically charged core of baryons so for the production of the $B^o{}_{e+e-}$ bosons ($K_S{}^o\ e^+e^- \rightarrow B^o{}_{e+e-}$) are responsible the nuclear electroweak interactions ($\alpha_{w(p)} + \alpha_{em}$, where α_{em} is the fine structure constant). Notice that at higher energies value of the fine structure constant is higher.

2. Branching ratio

We define the branching ratio as inversely proportional to lifetime which is inversely proportional to coupling constant [1] so we have

$$BR \sim \alpha_i , \qquad (1)$$

where α_i is the coupling constant responsible for production/decay of a particle.

3. Calculations

The above remarks lead to the SST ratio, R_{SST}, of the considered here two different branching ratios for decays of the B bosons at low energies

$$R_{SST}\,(K_S^o \text{ or } K^{*+}) = BR(B^o{}_{\mu+\mu-} \rightarrow K_S^o\,\mu^+\mu^-) \,/\, BR(B^o{}_{e+e-} \rightarrow K_S^o\,e^+e^-) =$$

$$= \alpha_{w(p)} / (\alpha_{w(p)} + \alpha_{em}) = 0.71955 \approx 0.72\,. \quad (2)$$

Emphasize that the result $R_{SST} \approx 0.72$ follows from the fact that inside baryons, the electron-positron pairs are created more frequently than the $\mu^+\mu^-$ pairs.

4. Experimental data

The SST result is consistent with the last experimental data for $B^o \rightarrow K_S^o\, l^+\, l^-$ decays [2]

$$R(K_S^o) = 0.66^{+0.20}{}_{-0.14}\,(\text{stat.})\;{}^{+0.02}{}_{-0.04}\,(\text{syst.})\,. \quad (3)$$

Authors present also the second result for $B^+ \rightarrow K^{*+}\, l^+\, l^-$ decays [2], which also is consistent with the SST result

$$R(K^{*+}) = 0.70^{+0.18}{}_{-0.13}\,(\text{stat.})\;{}^{+0.03}{}_{-0.04}\,(\text{syst.})\,. \quad (4)$$

More precise experimental data will show whether our atom-like structure and dynamics of baryons are correct.

References

[1] Sylwester Kornowski (25 September 2020). “Foundations of the Scale-Symmetric Physics (Main Article No 1: Particle Physics)”
http://vixra.org/abs/1511.0188

[2] LHCb collaboration (19 October 2021).
“Tests of lepton universality using $B^o \rightarrow K_S^o\, l^+\, l^-$ and $B^+ \rightarrow K^{*+}\, l^+\, l^-$ decays”
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