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In a number of papers[1-4] it has been shown that in the first order in α the radiative corrections to the μ -meson decay result in the finite renormalization of the interaction constants (different for the vector and pseudoscalar ones), on contrast to this result the calculation of similar correction to β -decay, (eg. a neutron gives a divergent result which can not be removed by the ordinary mass renormalization.

The cause of such a different behaviour lies in the fact that the structure of the μ -decay graph is similar to that of photon emission. Indeed, the interaction Hamiltonian for μ -meson decay can be written either in the usual V–A form:

$$\mathcal{H} = \frac{G}{\sqrt{2}} \langle \nu | \gamma_\alpha (1+\gamma_5) | \mu \rangle \langle e | \gamma_\mu (1+\gamma_5) | \nu \rangle \qquad (1)$$

or in the equivalent one

$$\mathcal{H} = \frac{G}{\sqrt{2}} \langle e | \gamma_\alpha (1+\gamma_5) | \mu \rangle \langle \nu | \gamma_\alpha (1+\gamma_5) | \nu \rangle \qquad (2)$$

The transition from (1) to (2) reduces only to the transposition of two particles having identical helicity; ν and e . Radiative corrections in this expression effect only the first factor (the second one has no charged particles) which differs from the electrodynamical current $\langle e | \gamma_\mu | e \rangle$ in two respects: (1) the different mass of two particles and (2) by the presence of γ_5 (pseudovector current $\gamma_\alpha \gamma_5$).

Since the electrodynamical divergent integrals are independent of the mass of the particle then the change of mass in the transition can not violate the conclusions from the Ward's theorem[5] concerning the compensation of the vertex part and proper mass divergencies. Nothing can in this sense change the factor γ_5 since the replacement of the wave function ψ by $\gamma_5 \psi$ affects only the mass dependence.

It follows that the finite result will be obtained in the calculation of radiative corrections to the μ -meson decay (and to any other processes of μ -meson and electron interaction:

$$\mu \rightarrow e + \nu + \tilde{\nu} + \gamma \; ; \qquad e + \nu \rightarrow e + \nu \; ; \qquad \mu + \nu \rightarrow \mu + \nu$$

etc.) in any order of perturbation (in e^2).

In the case of β -decay of a neutron, the capture of meson by proton, the Hamiltonian does not reduce to the electrodynamical one. Indeed,

$$\mathcal{H} = \frac{G}{\sqrt{2}} \langle p | \gamma_\alpha (1+\gamma_5) | n \rangle \langle e | \gamma_\alpha (1+\gamma_5) | \nu \rangle \qquad (3)$$

it is impossible to exchange the particle with the same helicity and put the charged particles in the one factor, for this it is necessary to exchange n and e . However, the Hamiltonian can transform into[6].

$$\mathcal{H} = \sqrt{2}\, G \langle e \,|\, (1-\gamma_5) \,|\, \bar{p} \rangle \langle \bar{n} \,|\, (1+\gamma_5) \,|\, \nu \rangle \qquad (4)$$

which as is known is not already renormalised (even without consideration of the neutron magnetic interaction). We see that we can calculate the radiative corrections only for the processes in which other particles do not take part with the exception of electrons, μ -mesons, neutinos and γ -quanta.

This means that it is impossible at present to predict theoretically the ratio of constants calculated on the one hand from the lifetime of a neutron and on the other hand from the β -transitions between nuclei with spin zero ($0^+ \to 0^+$ transitions), and the experimental determination of this ratio is of great importance.

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