ОБЪЕДИНЕННЫЙ ИНСТИТУТ ЯДЕРНЫХ ИССЛЕДОВАНИЙ

V.S.Evseev

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ON COUPLING CONSTANTS IN μ^--CAPTURE

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In Ref[1] a qualitative attempt was made to interpret a large experimental value of the asymmetry coefficient $\bar{a}$ in the angular distribution of neutrons from μ^--capture in Ca[2]. Assuming the constant of induced pseudoscalar coupling g_P to have a large value and introducing the constant of scalar induced coupling g_s, one can explain a large value of $\bar{a}$. According to Weinberg[3] g_s belongs to the "second class" interactions. However, numerical calculations have shown that the set of constants proposed in[1] gives a poor description of some processes in μ^--capture. The matter is that the authors of [1] estimated the probability of μ^--capture in hydrogen by Adams's formulae listed in Ref.[7]. These formulae pretend to be more accurate due to the account of relativistic effects. Primakoff's and Adams's formulae give different results in the presence of g_s: according to Adams's formulae the addition $g_s - g_V$ increases the probability $\Lambda\uparrow\downarrow$ of μ^--capture from the singlet state of the hydrogen meso-atom while a large value of g_P decreases it and this results in getting a value for $\Lambda\uparrow\downarrow$ (see Table), close to that obtained experimentally. If in Adams's formula for $\Lambda\uparrow\downarrow$ we change the sign before g_s for the opposite one, the result will be about the same as given by Primakoff's ones.

The present article suggests a new set of coupling constants with increased values of g_A and g_P and including g_s.

As is shown by numerical calculations, the new set of constants describes satisfactorily all the main processes in the He μ^--capture.

The calculation was carried out on the basis of the effective Hamiltonian as suggested by Primakoff[4] with five constants; for G_V, G_A and G_P, the following expressions were used[4,5]:

$$G_V = g_V(1+\gamma) + g_s$$

$$G_A = g_A - (g_V + g_M)\gamma$$

$$G_P = (g_P - g_A - g_V - g_M)\gamma$$

$$\gamma = 0{,}055 \text{ (for light nuclei).}$$

Table 1 gives the results of the calculations of the main effects for the usual set of constants (in the $g_V^{(\beta)}$ units):

$$\left.\begin{aligned} g_V &= 0{,}97 \\ g_A &= -1{,}22 \\ g_M &= 3{,}58 \\ g_P &= -9{,}80 \end{aligned}\right\} (a)$$

(at $g_A^{(\beta)} / g_V^{(\beta)} = -(1{,}223 \pm 0{,}025)$ and for the proposed set of five constants:

$$\left.\begin{array}{ll} g_V = 0{,}97 & g_P = -20{,}7 \\ g_A = -1{,}50 & g_S = -1{,}00 \\ g_M = 3{,}58 & \end{array}\right\} (\beta)$$

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Table 1

Effects	Theoretical values (α)	Theoretical values (β)	Experimental values
Probability of μ^--capture in liquid hydrogen Λ, sec^{-1}	$610 \pm ?$ xx/ (4,6,7) $565 \pm ?$ x/	$470 \pm ?$ xx/ $420 \pm ?$ x/	445 ± 35 xxx/
Angular distribution of neutrons from μ^--capture in Ca^{40}	(for $\gamma_{Ca} = 0{,}044$ xxxx/) $-(0{,}32^{+0}_{-?})$ /1,2/	(for $\gamma_{Ca} = 0{,}044$) $-(0{,}86 \pm ?)$	$-(1{,}00 \pm 0{,}15)$ /2/
$\mu^- + He^3 \to H^3 + \nu$ Probability sec^{-1} $\Lambda_{He^3 \to H^3} \approx R \equiv G_F^2 + 3G_G^2$	$(R = 5{,}92)$ from 1400 ± 140 /18/ to 1500 ± 150 /17/	$(R = 6{,}30)$ from 1490 ± 150 to 1600 ± 160	1500 ± 60 /9,10/
$\mu^- + C^{12} \to B^{12} + \nu$ Probability sec^{-1} $\Lambda_{C^{12} \to B^{12}} \approx G_G^2$	$(G_G^2 = 1{,}63)$ from 6900 ± 1400 /18/ to 7300 ± 1500 /11,12/	$(G_G^2 = 2{,}10)$ from 8600 ± 1700 to 9400 ± 1900	from 6310 ± 240 /13,14/ to 9180 ± 500
Hyper-fine structure effect $\frac{\Delta\Lambda}{\bar{\Lambda}} \| F$	$0{,}71 \pm ?$ /4,15/	$0{,}38 \pm ?$	$0{,}60 \pm 0{,}07$ /16/
Shapiro-Blokhintsev effect (19) $\frac{\Lambda_0}{\Lambda_1} \approx K \equiv \frac{(G_P - G_A)^2}{G_V^2 + 2G_A^2}$	$(K = 0{,}104)$ $(0{,}66 \div 0{,}95)$ /18,20/	$(K = 0{,}032)$ $(0{,}20 \div 0{,}29)$	$0{,}38 \pm 0{,}07$ /18/

x/ According to Primakoff's formulae /14/.

xx/ According to Adams's formulae /7/ with a changed sign before g_S.

xxx/ Weighted mean for all experiments (L.Wolfenstein, Proc. of the International Conf. on High Energy Physics, Geneva, 1962, p. 821 (1962).

xxxx/ An average neutron energy recorded in experiment /1,2/ at the threshold $E_n = 20$ MeV close to $\bar{E} = 20$ MeV and neutrino enrgy $E_\nu = 80$ MeV, i.e. $\gamma_{Ca} = 0{,}044$.

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