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1) This paper will be referred to as I.

Supplement to "On the Theory of the β-Disintegration and the Allied Phenomenon"

(Proc. Phys.-Math. Soc. Japan **17**, 467, (1935))[1]

~~In the pre~~ By Hideki Yukawa and Shoichi Sakata.

In the previous ~~paper~~ above titled, we calculated the probability of the transformation of ~~the~~ an isobar of atomic number Z-1 into another of atomic number Z, ~~provided that with~~ the absorption of the electron in the K-state, provided that the ~~mass~~ difference of ~~their~~ the masses of the isobars are larger than $-mc^2+\mu c^2$, in ~~In this supplement~~ conformity with Fermi's ~~The cal-~~ culation was ~~based on the interaction original form~~ ~~performed~~ according to original theory of Fermi.

~~In this short~~ supplement, we want to give ~~performed~~ ~~This was made~~ Similar calculation ~~results~~ can be ~~obtained~~ also according the modified theory of Konopinski and Uhlenbeck†, the result of which will be accounted for in this supplement. ~~the The notations will be used~~

In this case, the perturbing term in the wave equation of ~~field~~ acting on the light particle due to the ~~transition of~~ change of the atomic number of the nucleus should be rewritten in the form

$$\frac{g'}{mc^2}\tau'\rho\left(E\,U_0(\vec{r})-c\,\vec{p}\,\vec{U}(\vec{r})\right)\exp(-2\pi i\nu)t)\psi \qquad (3')$$

instead of the expression (3) in ~~the previous~~ paper I, where

$$E=i\hbar\frac{\partial}{\partial t} \qquad \vec{p}=-i\hbar\,\mathrm{grad},$$

other notations being the same as I.

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If the ~~ma~~ absolute value and the direction of the ~~mag~~ nuclear spin do not change during the transformation, U_0 ~~becomes the a function of t only~~ depends only on r, whereas $\vec{U}$ takes the form

$$\pm \frac{\vec{r}}{r} U'(r),$$

which can be proved in ~~the~~ manner that that ~~of Fermi's case.~~ in I, the proof being ~~similar~~ to ~~that of~~ the ~~previous~~

The perturbed wave equation thus becomes

$$\Big\{ \frac{ih}{2\pi}\frac{\partial}{\partial t} + e'A_0 + \varepsilon p_r c + \frac{i\varepsilon \beta_3 j h c}{2\pi r} + \beta_3 m' c^2 + \frac{g'}{mc^2}\tau'\beta\,(EU_0 - c(p_r - \frac{ih}{r})U')\exp(-2\pi i\nu t)\Big\}\psi = 0, \quad (17'')$$

~~instead of~~

from which we obtain the expression

$$P_{j,u} = \frac{4\pi g'^2}{h}\Big|\int_0^\infty \{\varphi^{(1)*}_{E',j,u}\psi^{(1)}_{E,j,u} - \varphi^{(2)*}_{E',j,u}\psi^{(2)}_{E,j,u}\}U_0\frac{E'}{mc^2} + i\Big(\frac{d\varphi^{(1)*}_{E',j,u}}{dr}\psi^{(1)}_{E,j,u} - \frac{d\varphi^{(2)*}_{E',j,u}}{dr}\psi^{(2)}_{E,j,u}\Big)U'\frac{h}{mc}\Big\}r^2dr\Big|^2 \quad (17')$$

instead of (17) in I.

After some calculation, the probability of the emission of the positron ~~becomes~~ with the disintegration of the Isobar Z

$P_+ =$

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and that of ~~the~~ with the absorption of the K electron becomes

$$P_K =$$

~~correspon instead of the~~ with~~a~~ the similar approximations ~~as those used to deduce~~

~~The difference~~ In these expressions differ ~~from the~~ corresponding expressions (27) and (32) ~~by the factors only~~ by the factors as

$$\int_0^{\Delta W - \kappa} \{ \qquad \} F(\varepsilon_+, \kappa) \, d\varepsilon_+$$

and $\{ \frac{1+\gamma}{2} (\Delta W + \gamma)^2 [\ 1 \ ]^+ \cdots \}$

~~are replaced~~ appear respectively in place of

$$\{ \qquad \} \int_0^{\Delta W - \kappa} F(\varepsilon_+, \kappa) \, d\varepsilon_+$$

~~respectively~~ and $\{ \qquad \}$

in the corresponding expressions (27) and (32) in I.

~~In the~~

The ratio

$$\sigma = \frac{P_+}{P_K}$$

in this case depends on the perturbing potential U_0, U'

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of the due to the nuclear transition, in contrast with the previous case.

~~In the special case~~ ~~If we take especially $\varkappa = 0$, i.e.~~ If the neutrino mass is zero, i.e. $\varkappa = 0$, the above expressions become

$P_+ =$

$P_K = \ldots$

In this case, the ratio is

$$\sigma = \frac{\int^{\Delta W - 2}}{\pi (\alpha Z)^{2\gamma+1} \Gamma (2\gamma+1)(\Delta W + \gamma)^4},$$

~~be is~~ which is independent of the ~~special form~~ detailed structure of the nucleus.

~~Although~~ ~~The essential difference~~ is ~~These results for~~ the above ~~effect~~ ~~results differ appreciably~~

~~Using~~ From these general expressions, we can ~~calculate~~ obtain the numerical values of the mean life time ~~for~~ of the isobar Z for special values of Z and ΔW. ~~But We can at once aware of the~~ We can expect, ~~become~~ however, the essential ~~difference~~ hardly change of the results, ~~because the factors~~

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$(\Delta W - \varepsilon_+)^2$ and $(\Delta W + \gamma)^2$ appearing in (27)'' and (32)'' are the quantities of the order of 1, as ΔW is a few multiple of mc^2 in ordinary case. in the ordinary case, in which ΔW is a few multiple of mc^2; because the expressions (27'') and (32'') become essentially the same with (27) and (32) in I, if we identify

$$\frac{1+\gamma}{2}\left|\int U_0 d\vec{r}\right|^2 + \frac{1-\gamma}{2}\left|\int \frac{U'}{3} d\vec{r}\right|^2$$

with

$$\frac{1+\gamma^2}{2}\left|\int U_0 d\vec{r}\right|^2 + \frac{1-\gamma}{2}\left|\int U' d\vec{r}\right|^2$$

in I and neglect the factors $(\Delta W - \varepsilon_+)^2$ and $(\Delta W + \gamma)^2$ in (27'') and (32'') respectively, which are the quantities of order of 1.

Thus the conclusions previously arrived at remains to hold good in the present case.

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Abstract

~~The probability of the K electron absorption of the~~

The mean life time of ~~the transformation~~ of an isobar of with atomic number Z, into another with of atomic number Z−1 with the due to the transformation absorption of the K electron was calculated according to the ~~the~~ modified theory of Konopinski and Uhlenbeck instead of Fermi's ~~theory~~ theory. There seems to be little ~~It was found~~ difference between two cases. ~~Little difference~~ No essential difference of the results was found between two cases.