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There is now a general interest in detecting the form factor, which is usually expressed as a term of 'weak magnetism' and a term of pseudoscalar coupling added to the usual V-A Fermi weak interaction theory[1]. But, unfortunately, this effect is, in general, so small in the β -decay phenomena that it is difficult to detect experimentally. Up to now this effect cannot be said to be established[2]. Recently, we carried out a calculation for the processes of μ -capture without the emission of a neutron or proton under the assumption that the initial nucleus has spin ½, and jumps into a final state with spin 3/2. We assume the density matrix of the initial state to be [3]

$$\frac{1}{4}\left(1+\vec{\sigma}_N\cdot\vec{\xi}_N+\vec{\sigma}_\mu\cdot\vec{\xi}_\mu+\epsilon\,\vec{\sigma}_N\cdot\vec{\sigma}_\mu\right) \qquad (1)$$

where $\vec{\xi}_N$ and $\vec{\xi}_\mu$ are the polarization of the nucleus and the μ -meson, which are equal to each other in the triplet state and equal to zero for the singlet state, ϵ is a number which is equal to 1/3 for the pure triplet state and equal to -1 for the pure singlet state. For mixed state, the density matrix can still be written in the above form, but with different value of ϵ varying from -1 to 1/3, which characterizes the population of singlet and triplet state. The form factor is assumed here to be the same as that assumed by Chou Kuang-chao et al.[4] We neglect the momentum of proton and μ -meson in the initial state. Following the standard method of calculation we obtain the following transition probability of the nucleus transiting from the spin ½ to the spin 3/2 state:

$$W=\frac{G^2 Z^3}{2\pi^2 a_\mu^3}N_0\,|M_{G.T.}|^2 q^2\left(1-\frac{q}{Am_p}\right)$$

$$N_0=(1+\epsilon)\left[\lambda^2+\frac{\lambda\beta}{3}(2\mu+2-f+\lambda)-\frac{\beta^2}{12}(\mu+1)(2f-\mu-2\lambda-1)\right] \qquad (2)$$

$$+\frac{\beta^2}{12}(\mu+f+1-\lambda)^2$$

where G is the Fermi constant, a_μ is the Bohr orbit of μ -mesic hydrogen atoms, q is the energy of neutrino, λ is the ratio of Gamow-Teller constant to the Fermi constant and is equal to 1.25 in the β -decay; μ is the anomalous gyromagnetic ratio which characterizises the term of weak magnetism and is equal to 3.7, f is the pseudoscalar coupling constant which is estimated as 8λ for processes of the μ -capture by proton. $\beta=\frac{q}{m_p}$, A is the number of nucleons in the nucleus. $|M_{G.T.}|^2$ is the square of the matrix element for Gamow-Teller transition which is shown by Joffe[5] to be

$$|M_{G.T.}|^2=|M_{G.T.}^{\beta}|^2\left(1-\frac{1}{3}q^2\langle r^2\rangle_A\right) \qquad (3)$$

$M_{G.T.}^{\beta}$ is the matrix elements for the corresponding β -decay, $\langle r^2\rangle_A$ is the square of the radius of the charge corresponding to the axial vector transition and is equal to the square of the radius in the magnetic radiative transition of nuclei belong to the same isotopic multiplet.

We can see from formula (2), if the nucleus is captured in the singlet state, i.e. $\epsilon = -1$, and consider all the form factors being removed by putting $\mu = f = 0$, $\lambda = 1$, then this process will be completely forbidden within the limits of approximation we make here. But if the form factor is taken into account, then this process is possible and the transition probability is approximately 1/8 of the ordinary transition. Thus, the experiments on capture in singlet state can be used as a test for form factors. Why in this calculation have we obtained such a result? The reason is that in allowed transitions the neutrino is always in the $J = \frac{1}{2}$ state, when μ -meson is captured in the singlet state, this process will be completely forbidden by conservation of angular momentum, except there are higher waves of neutrinos's wave function. As we know, the form factor is always accompanied by higher waves of neutrino. Thus, when the large background of the $J = \frac{1}{2}$ wave is removed by conservation of angular momentum, the contribution of form factor will become the most important term in comparison with the other ones we neglect here. Evidently, similar situation occurs in the nuclei with a spin greater than $\frac{1}{2}$.

As we know[6], when the μ -meson is captured in the K -orbit of a nucleus in the metallic state, the μ -meson in the upper hyperfine structure state has a great probability for transition to the lower state and gives its energy to the conducting electron. For example, in Al the transition probability is of order of 10^6 sec.$^{-1}$. Thus, for light nuclei we can detect the form factor by comparing the transition probability of capture in metallic state and in ionic crystal state where we can expect that the population of two hyperfine structure state is determined by the ordinary statistical distribution provided that there does not exist any other special mechanism. Besides, the μ -meson in the upper hyperfine structure state also can transit into the lower state by means of a magnetic dipole transition. As is known this process is proportional to the 9-th power of the effective charge[7]. Thus, for heavy nuclei or the nuclei having an effective charge $Z^* > 35$, nearly all of the μ -mesons in the upper hyperfine structure state will transit into the lower state. Of course, the magnetic dipole transition can be influenced by means of a strong magnetic field, and then we can adjust the population by means of a magnetic field.

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