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BETA INTERACTION AND NUCLEON FORMFACTOR

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ONE of the characteristic features of β-interaction is the rapid increase with energy of processes induced by it. However the existence of strong interactions leads to the acquisition of a formfactor by nucleons which may substantially change the energy dependence of β processes. The study of β transitions at high energies, for example the transformation of an electron into a neutrino

$$e + p \rightarrow n + \nu, \tag{1}$$

can be used for the measurement of this formfactor.

At the present time one may, apparently, consider as established[1,2] the fact that β interaction consists of the vector and axial-vector interactions. The general expression for the matrix element for the process (1) should have the following form:[3,4]

$$M = \frac{g}{\sqrt{2}} (\bar{u}_\nu \gamma_\mu (1+\gamma_5) u_e) \times \left\{\bar{u}_n \left[a\gamma_\mu + i\frac{b}{M}\hat{q}\gamma_\mu + \gamma_5\left(c\gamma_\mu + \frac{id}{M}q_\mu\right)\right] u_p\right\}. \tag{2}$$

Here u_ν, u_e, u_n, u_p are the neutrino, electron, neutron, and proton amplitudes respectively; q is the electron-neutrino momentum difference; a, b, c and d are real functions of q^2 determining the vector (a, b) and axial vector (c, d) vertex functions of the nucleon. If the Gell-Mann and Feynmann hypothesis[1] is correct, then the vector β-interaction vertex function is identically the same as the electro-magnetic vertex function. Therefore the functions $a(q^2)$ and $b(q^2)$ may be determined from electron scattering experiments.[5]

The differential cross section for process (1) is

$$d\sigma = \frac{g^2}{(4\pi)^2} do \frac{1}{\varepsilon^2 + M^2}\Big\{(a^2 + c^2)\left(4f^4 - 2f^2q^2 + \frac{q^4}{2}\right) - (a^2 - c^2) M^2q^2 + (ac + 2bc)(q^4 - 4f^2q^2) + b^2\left(q^4 + \frac{4q^2f^4}{M^2} - \frac{2f^2q^4}{M^2}\right) + 2abq^4\Big\},$$

$$q^2 = \varepsilon^2(1 - \cos\vartheta), \quad f^2 = \varepsilon^2(1 + \sqrt{1 + M^2/\varepsilon^2}),$$

where M is the nucleon mass, ϵ and θ are the energy and scattering angles in the barycentric systems. We have assumed that the electron energy is high compared to the electron rest mass. In that case the last term in (2), containing the function $d(q^2)$, does not contribute to the cross section.

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