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J. Phys. Soc. Jpn. 55 (1986) Suppl. p. 1026-1027

7.4 Search for the circular polarization of the 1081 keV γ-ray in ^{18}F

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Measurements of the circular polarization P_γ of the 1081 keV γ-ray in ^{18}F have been already performed by different authors[1,2,3]. The weighted average of the published results is $P_\gamma = (-8 \pm 12)\ 10^{-4}$. Two new measurements have been now completed at Queen's University[4] and in Florence: they substantially reduce the statistical uncertainty in P_γ.

The measurement in Florence, has been performed at the KN 3000 accelerator using the reaction $^{16}O(^3He,p)^{18}F$ at an energy of 3.4 MeV and with a beam current of $\sim 8\mu A$. Technical details of the experimental set-up (window-less water target, four prong polarimeter with four matched Hp Ge detectors, high throughput linear shapers, Camac based data acquisition system, measurement control by means of an HP 2108 computer) can be found in references 5,6,7).

Data analysis consists in the evaluation of the asymmetry of the 1081 keV γ-line together with the asymmetry of four further γ-lines (at 937,1020,1042,1164 keV) and of neighbouring background regions. The polarization of the 1081 keV γ-line comes out to be P_γ (1081 keV)$=(2.7 \pm 5.7)\ 10^{-4}$. This result when combined with the previous ones and with that obtained at Queen's University: P_γ (1081 keV)$=(1.6 \pm 5.6) * 10^{-4}$, leads to a grand average of $P_\gamma = (1.1 \pm 3.8)\ 10^{-4}$. Neglecting contributions arising from vector meson exchange, the following upper constraint (at 1σ confidence level) can be set for the weak πNN coupling constant: $|f_\pi| \lesssim 1.5\ 10^{-7}$. This limit rules out a large part of DDH[8] reasonable range $0 < |f_\pi| \lesssim 11\ 10^{-7}$ and is more than 3 times lower than the DDH best value $f_\pi = 4.6\ 10^{-7}$. Comparison with QCD calculations shows that the present upper limit of $|f_\pi|$ is lower by a factor of 1.3 with respect to the minimum value reported till 1981[9,10], while it is quite compatible with the expected range of f_π values of ref. 11 $f_\pi = (0.62 \div 3.0)\ 10^{-7}$ and ref. 12 $f_\pi = -(0.88 \div 2.3)\ 10^{-7}$.

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