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To Jens Vigen <Jens.Vigen@cern.ch>

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Carmen Vasini

Correlation between Circularly Polarized γ -Rays and β -Particles

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CERN Geneva

(ricevuto il 24 Giugno 1957)

As suggested by LEE and YANG ⁽¹⁾ one can demonstrate the non conservation of parity in β decay by measuring the circular polarization of γ rays following β transitions as a function of the angle between the momenta of β and γ . We have performed such an experiment by measuring the transmission of γ rays through magnetized iron. The experimental arrangements are shown in the following diagrams. We favoured the measurement of the transmission ⁽²⁾ to differential scattering ⁽³⁾ of γ rays by magnetized iron due to the ease with which energy discrimination can be achieved in the former case. One thereby eliminates effects due to scattering from the surroundings. The magnetic flux density in the iron could also easily be controlled, and was kept sufficiently high always to saturate the iron.

If we denote the $\beta\gamma$ coincidence rate with the magnetic field pointing towards and away from the source by C_{down} and

C_{up} respectively we have

$$R = \frac{C_{\text{down}} - C_{\text{up}}}{\frac{1}{2}(C_{\text{down}} + C_{\text{up}})} = P \cdot 2 \tanh(N\nu\sigma T),$$

where $P = (N_r - N_l)/(N_r + N_l)$, N_r and N_l being the number of right circularly polarized and left circularly polarized (angular momentum of photon in direction of propagation) γ rays respectively. N is the number of atoms per unit volume in the iron, ν is the number of polarized electrons per iron atom and is equal to 2.06, σ is the part of the total Compton cross section dependent on polarization and T is the thickness of the iron. According to SKYRME ⁽⁴⁾

$$P = -\alpha\lambda\bar{\beta} \cos \theta,$$

where θ is the angle between β and γ , $\bar{\beta}$ is the average velocity of the electrons (about 0.6 in our case), λ is a function of the β interaction coupling constants and α is a quantity dependent on the spin sequence of the nucleus and the multipole order of the γ rays ⁽⁴⁾ ($\alpha = \frac{1}{3}$ in our case). According to the two component neutrino theory of Lee and

⁽¹⁾ T D LEE and C N YANG: *Phys. Rev.*, **104** 254 (1956)

⁽²⁾ S B GUNST and L A PAGE: *Phys. Rev.* **92** 970 (1953)

⁽³⁾ F P CLAY and F I HEREFORD: *Phys. Rev.* **85** 675 (1952); J C WHEATLEY, W J HUISKAMP, A N DIDDENS, M J STEENLAND and H A TOLHOEK: *Physica* **21** 841 (1955)

⁽⁴⁾ T H R SKYRME: private communication of calculations by him and F MANDL

while, experiments by SCHOPPER ⁽⁶⁾ and by BOEHM and WAPSTRA ⁽⁷⁾, both of whom measured the differential scattering of γ rays in a magnetized iron cylinder, gave the following results for ^{60}Co :

SCHOPPER

$$\lambda\alpha = -0.41 \pm 0.07,$$

BOEHM and WAPSTRA

$$\lambda\alpha = -0.40 \pm 0.09$$

Forming an average of the three values

⁽⁶⁾ H. SCHOPPER: *Phil. Mag.* **2**, 710 (1957)

⁽⁷⁾ F. BOEHM and A. H. WAPSTRA: in press

one obtains

$$\lambda\alpha = -0.377 \pm 0.046$$

Besides the statistical error one should bear in mind that the β 's may differ somewhat in the different experiments. The results do not contradict the two component neutrino theory of Lee and Yang.

Note added in proof

We have recently measured for ^{22}Na $\alpha\lambda = +0.34 \pm 0.14$ in agreement with ⁽⁶⁾ and ⁽⁷⁾; and the circular polarization of Bremsstrahlung from ^{90}Y and ^{32}P in agreement with M. GOLD HABER *et al.* and K. W. McVOY: *Phys. Rev.* **106**, 826 (1957).