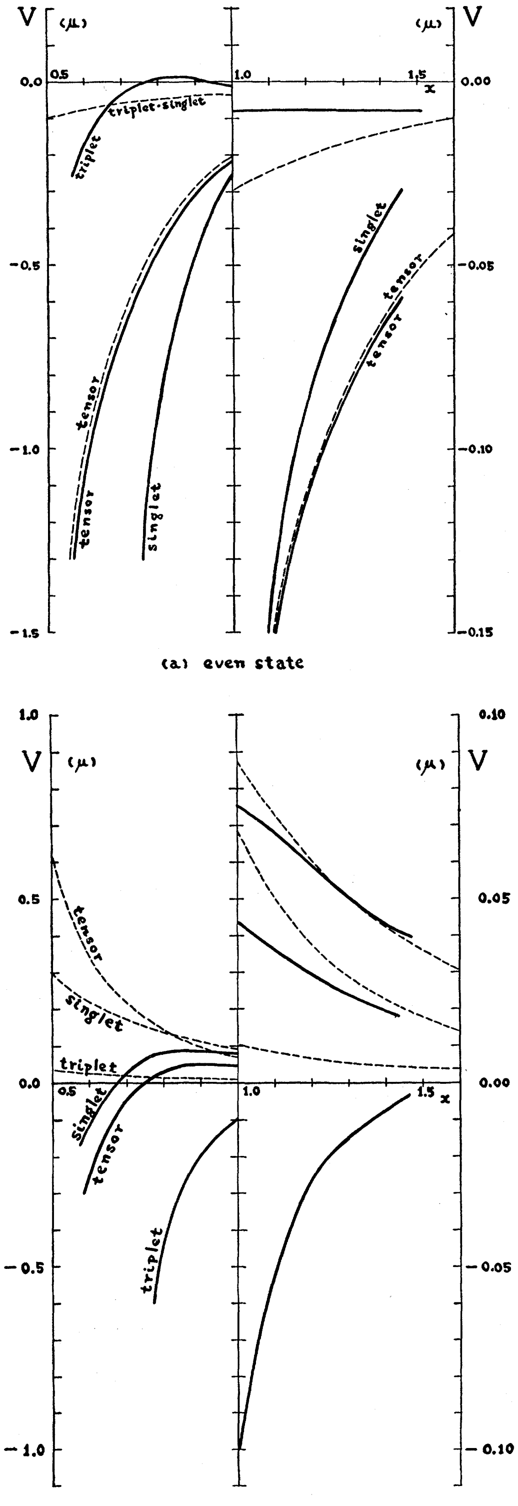

FIG. 1. The one-pion and two-pion exchange potentials. The solid curves are our results $V_2+V_4+V_{ss}+V_{sp}$, while the dotted lines indicate the one-pion exchange potential V_2 with $f^2/4\pi=0.08$. V and x are measured in units of the pion mass and the pion Compton wavelength, respectively.

does not seem important since multiple production of pions is extremely small at low energy.

Results of the analyses of low-energy experimental data in terms of this potential are as follows. As a whole, there are no appreciable corrections to the key features of the second- and fourth-order perturbation theoretical potential[5] which was favorable for the previous analysis.[6] However, there are desirable corrections to all weak points in the previous analyses. Some examples of features which are much improved by the present potential are (i) the *P*-wave phase shift analysis[6] of the *p-p* scattering below 4.2 Mev when one considers the effect due to the vacuum polarization,[7] and (ii), the interpretation of the scattering length and the effective range in the singlet even state.[8]

A more detailed account will be published presently in *Progress of Theoretical Physics*.

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Circular Polarization of Inner Bremsstrahlung*

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THE purpose of this note is to point out that by measuring the circular polarization of the inner bremsstrahlung photons accompanying beta decay one can gain exactly the same information as in a measurement of the longitudinal polarization of the electrons. Although, for a given beta source the inner bremsstrahlung intensity is much lower (10^{-3} to 10^{-4}) than the electron intensity, the fact that one usually[1] interposes a device to rotate the electron spin in order to detect its polarization means that the intensities are roughly comparable *at their respective detectors*. In addition, since the photon detector can be used as an energy analyzer, one can simultaneously measure the polarization at several values of the photon energy. The result may well be that the inner bremsstrahlung measurement is capable of greater precision than the electron measurement.

In order to compare the expressions for electron and inner bremsstrahlung polarization we quote here the result of Curtis and Lewis[2] for the longitudinal polarization[3] of electrons emitted with total energy W in an allowed beta decay:

$$P(W)=dv/(1+b/W). \quad (1)$$

The quantities d and b are combinations of coupling constants and nuclear matrix elements,[4] and we have chosen units such that $\hbar=c=m=1$.

The probability per unit time for emission of an inner bremsstrahlung photon with energy between k and $k+dk$ and with polarization $\mathbf{e}$, calculated by using the beta interaction of Lee and Yang,[4] is[5]

$$S(\mathbf{k},\mathbf{e})dkd\Omega_k=\left(\frac{e^2}{16\pi^5}\right)dkd\Omega_k\left(\frac{\xi}{k}\right)$$
$$\times[I_1+bI_2-dI_3 i(\mathbf{k}\cdot\mathbf{e}\times\mathbf{e}^*)]. \quad (2)$$

The quantities I_1, I_2, and I_3 depend upon the end point energy, W_0, of the beta spectrum as well as on the photon energy k. If one introduces the quantity $x=W_0-k$ and the corresponding momentum $s=(x^2-1)^{\frac{1}{2}}$, the I's may be expressed as

$$I_1=W_0^2A(x)-W_0B(x)+C(x), \quad (3a)$$

$$I_2=2xA(x)-B(x), \quad (3b)$$

$$I_3=W_0^2A(x)-W_0B(x)+D(x), \quad (3c)$$

where

$$A(x)=\left(\frac{1}{3}x^3+\frac{1}{2}x\right)\ln(x+s)-\left(\frac{11}{18}x^2+\frac{2}{9}\right)s,$$

$$B(x)=\left(\frac{1}{2}x^4+\frac{1}{2}x^2-\frac{1}{16}\right)\ln(x+s)-\left(\frac{7}{8}x^3+\frac{1}{16}x\right)s,$$

$$C(x)=\left(\frac{7}{30}x^5-\frac{3}{16}x\right)\ln(x+s)$$
$$-\left(\frac{689}{1800}x^4-\frac{1021}{3600}x^2-\frac{4}{75}\right)s,$$

$$D(x)=\left(\frac{1}{6}x^5-\frac{1}{16}x\right)\ln(x+s)-\left(\frac{19}{72}x^4-\frac{23}{144}x^2\right)s.$$

From the expression (2), we see that the circular polarization of the inner bremsstrahlung photons is

$$P(k)=dI_3/(I_1+bI_2), \quad (4)$$

where the sign of the polarization has been chosen to be positive for left circularly polarized photons. Comparison of this expression with the expression (1) for the electron polarization shows us that, in principle, the quantities d and b can be determined equally well by measuring either the electron or photon polarization as a function of their respective energies. We might also note that if the electrons are polarized in their direction of motion then the inner bremsstrahlen will be left circularly polarized, and vice versa. As an example, in Fig. 1 the expected polarization is shown as a function of k for P^{32} ($W_0=4.335$) assuming $d=1$ and $b=0$, which would be the case if the two-component neutrino theory[6] were correct and there were no Fierz interference terms.

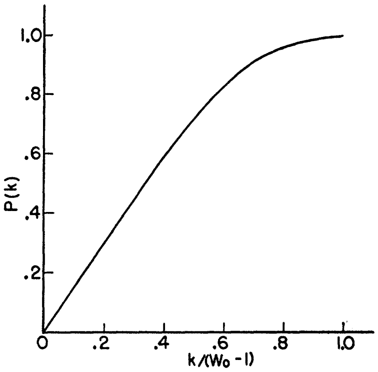

FIG. 1. Polarization of the inner bremsstrahlen from P^{32} ($W_0=4.335$) assuming $d=1$ and $b=0$. (Units are such that $\hbar=m=c=1$.)

* Supported in part by U. S. Atomic Energy Commission.

[1] An exception is the experiment of Goldhaber, Grodzins, and Sunyar [Phys. Rev. **106**, 826 (1957)] where the circular polarization of the outer bremsstrahlung produced by the electrons is measured. Another exception would be the measurement of Møller scattering of polarized electrons on polarized electrons.

[2] R. B. Curtis and R. R. Lewis, Phys. Rev. (to be published).

[3] Following H. A. Tolhoek, Revs. Modern Phys. **28**, 277 (1956), the polarization of a beam consisting of particles in two states 1, 2 with intensities I_1, I_2, respectively, is $P=(I_1-I_2)/(I_1+I_2)$.

[4] The quantities b and ξ are those defined by T. D. Lee and C. N. Yang, Phys. Rev. **104**, 254 (1956); the quantity d is defined in reference 2 by the equation $\xi d=|M_F|^2[C_SC_S'^*-C_VC_V'^*+\text{c.c.}]+|M_{GT}|^2[C_TC_T'^*-C_AC_A'^*+\text{c.c.}]$.

[5] In this expression the effect of the Coulomb field has been neglected. First-order Coulomb corrections are not difficult to obtain. [See R. R. Lewis and G. W. Ford, Phys. Rev. (to be published).]

[6] T. D. Lee and C. N. Yang, Phys. Rev. **105**, 1671 (1957).

Influence of Strong Magnetic Field on Depolarization of Muons*

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THE decay positrons from cyclotron-beam muons have the angular distribution $(1+a\cos\theta)$.[1–3] The strongest asymmetry which has been observed is $a=-0.25\pm0.01$ and occurs when μ^+ are stopped in such substances as carbon, aluminum, copper, and bromoform.[1–3] Other materials give a values ranging from