disagreement with experiment) is a tremendous improvement over the Gartenhaus potential alone. Indeed, the over-all agreement between the predictions based on Eq. (1) and the wide range of available scattering data is sufficiently encouraging to justify the hope that a potential description of the two-nucleon interaction, at least up to 150 Mev, is attainable and that the essential features of such a potential model are contained in Eq. (1).

Work now in progress includes pushing the calculations down below 40 Mev for the p-p scattering (taking more accurate account of the Coulomb force) and above 150 Mev. An attempt is also being made to examine the effects of varying the five parameters in the potential defined by Eq. (1). There is no reason why a potential model should continue to hold at higher energies,[11] say at 300 Mev, and it is hoped to ascertain the character of the additional velocity dependence (if any) of the two-nucleon interaction at the higher energies.

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Evidence Against Spin 1 for the τ Meson*

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NOW that a large number of τ^+ mesons with low-energy π^- mesons have been found, it is possible to devise a fairly sensitive and model-independent test for odd spin. Because of conservation of angular momentum, the low-energy negative pions must have the momentum dependence p^n where $n\geq 2$ for τ^+ mesons of odd spin. For small p, this is independent of the energy dependence and "interaction radius" of the decay interaction.[1] For an even-spin τ meson, n can be zero. In this letter the present world data will be shown to be consistent with $n=0$ and strongly inconsistent with $n=2$. A test somewhat similar to the one used here was made by Orear, Harris, and Taylor[2] using their 71 τ^+ mesons. They obtained odds of 10^3 to 1 against (1+) compared to (0−).

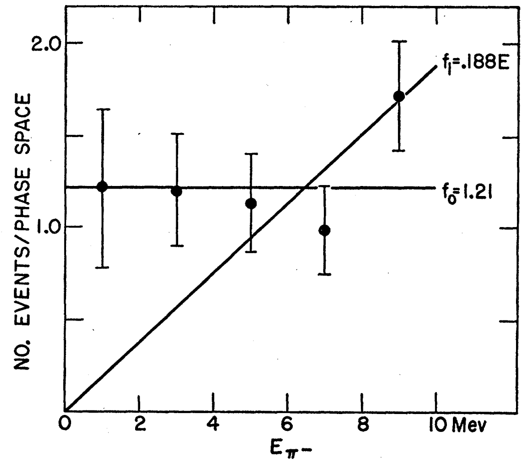

FIG. 1. The number of events per unit phase space in 2-Mev intervals is plotted *vs* π^- energy. The two lines f_1 and f_0 are least-squares fits using the momentum dependence p^2 and p^0 respectively.

In the present analysis only the τ^+ mesons with π^- energies less than 10 Mev are used. In this region $kR<0.1$ for $R=\hbar/M_\tau c$. Systematic scanning in K^+ beams from the Bevatron and Cosmotron has yielded a total of 835 analyzed τ^+, 92 of which have π^- under 10 Mev.[2-9] These 92 events are divided into 2-Mev intervals and plotted in Fig. 1. As a preliminary test, least-squares fits are made to the two momentum dependences $n=0$ and $n=2$. It is seen that the fit to the $n=0$ curve is much better than that to the $n=2$ curve. The true curve should give a least-squares sum of 4.0 on the average. The least-squares sum is 2.7 for the $n=0$ curve and 12.1 for the $n=1$ curve. The χ^2 probability of getting a fit no better than that of the $n=0$ curve is 0.60, and the probability of getting a fit no better than the $n=2$ curve is 0.015. In this particular application, the χ^2 type of test is weak because it doesn't make use of some valuable information. For example, it is quite improbable to obtain a π^- of 0.36 Mev if the τ has spin 1. By lumping this event in a group of 7 others from 0 to 2 Mev, one is throwing away valuable information. For this problem the general statistical procedure would be to form the likelihood ratio of spin 1 to spin zero using the energy values of each individual event.[10] Let $f_0(\epsilon)$ be the spin-zero distribution function and $f_1(\epsilon)$ be the spin-one function, where ϵ is the π^- kinetic energy divided by 50 Mev. Since we only have knowledge of the shapes of f_0 and f_1 in the region of small ϵ, they must be given the same normalization in this region if the test is to be a comparison of one shape against another:

$$\int_0^{0.2} f_0\rho d\epsilon = \int_0^{0.2} f_1\rho d\epsilon,$$

where $\rho(\epsilon)$ is the phase space. For $f_0=1$, $f_1=8.42\epsilon$. The relative probability of spin 1 to spin zero is then

$$\frac{P_1}{P_0} = \prod_{i=1}^{92} \frac{f_1(\epsilon_i)}{f_0(\epsilon_i)} = 10^{-4.0}. \quad (1)$$

It should be emphasized that this factor of $10^{4.0}$ against spin 1 is an underestimate of the odds against spin 1 (or any odd spin). This is because above 10 Mev the shape f_1 is normally expected to depart appreciably from the data (the data are close to isotropic in ϵ). The most generous one can be toward spin 1 is to assume that f_1 is a perfect fit to the data above 10 Mev and that it goes as p^2 from 0 to 10 Mev. This is exactly what was done in Eq. (1). A momentum dependence faster than $n=2$ would give an even worse fit. The above procedure was repeated using only the data below 5 Mev (31 events). This should be a weaker test because now f_1 is permitted to be a good fit all the way down to 5 Mev. In this case the normalizations are $f_0=1$ and $f_1=16.7\epsilon$ which gave odds of 24 to 1 against f_1.

The effect of Coulomb enhancement should not appreciably alter the p^2 dependence of spin 1. As has been pointed out,[11,12] the entire low-energy region of the spectrum might be boosted up as much as 10%. In fact one might expect the enhancement factor to increase with p in this energy region.[13] Such a Coulomb-corrected f_1 would give a worse fit than the f_1 used in Eq. (1). When the energy region 0 to 10 Mev is considered by itself, the relativistic corrections are negligible and have not been made. Over this region the nonrelativistic phase space is proportional to the relativistic phase space to within 1%. The result given by Eq. (1) still holds if one employs an arbitrary mixture of both parity states. Such mixing would make odd spin an even worse fit. Corrections for detection bias would also increase the odds against spin 1.

The conclusion is that it is extremely unlikely that the τ meson has spin 1 or any odd value. Spins 0 and 2 are both quite consistent with the data and there seems to be no way to distinguish them by means of a Dalitz-type analysis alone.[2] If there is only one K meson, it most probably has either spin 0 or 2. The continued absence of the mode $K^+ \rightarrow \pi^+ + \gamma$ is evidence against spin 2.[14]

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Energy Dependence of the Asymmetry in the Beta Decay of Polarized Muons*

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In an earlier report, we described experiments which established the existence of polarized muons in momentum-selected cyclotron pion beams.[1] These experiments also established the angular distribution of positrons arising from polarized muon decay to be of the form

$$f(\theta) = 1 + a\cos\theta, \quad (1)$$

and gave preliminary evidence for the behavior of the asymmetry parameter, a, as a function of positron energy. We present here additional results on the energy dependence as deduced from measurements of the asymmetry (peak to valley) as a function of positron range in carbon. Comparison is made with the predictions of the two-component neutrino theory.[2] Larsen, Lubkin, and Tausner[3] have employed these results to determine the additional parameters of a four-component neutrino theory.[4]

The experimental arrangement is identical with that described in reference 1 except that, for points of very large carbon thickness, three counters were used in the electron detection telescope in order to reduce background and to decrease the importance of higher order radiative effects. To minimize systematic errors, the current in the precession coil was alternated regularly between +170 ma and −170 ma to give peak-to-valley ratios of the resulting positron counting rate. That is,