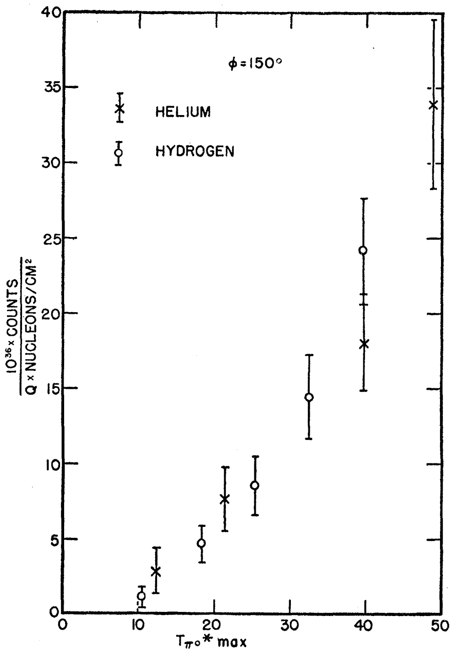

FIG. 3. Counting rates of γ-ray pairs from helium and hydrogen plotted against maximum π^0 kinetic energy in the center-of-mass system corresponding to $E_{\max}$ of betatron radiation. For helium, the dynamics for the elastic process have been used.

curve (Fig. 1) serves as an indication of the proper relation between observed counting rates and ϕ_c. At 190 Mev, both elastic and disintegration processes are allowed, but clearly the value of ϕ_c corresponding to elastic production fits better than the value corresponding to inelastic production. Apparently, therefore, the elastic process is still important at 190 Mev.

The counting rates shown in the graphs are normalized per equivalent quantum (Q) and per nucleon/cm² to permit some comparison with hydrogen production. Activation curves for helium and hydrogen at $\phi=180°$ and $\phi=150°$ are plotted in Fig. 2. The hydrogen points were observed with the same apparatus.[2] A valid comparison must take into account the difference between center-of-mass momenta in the hydrogen and helium cases. Figure 3 is obtained from Fig. 2 by changing the scale of abscissas from betatron energies to the corresponding π^0 kinetic energies in the center-of-mass system. All helium events are assumed to be elastic. If the hydrogen and helium cross sections depend on π^0 momentum in the same way, as they appear to do, then this is a meaningful comparison which indicates equal efficiencies per nucleon in hydrogen and helium at identical center-of-mass meson energies. This ratio of unity is in sharp contrast with the helium/hydrogen efficiency ratio of one-half obtained for charged mesons at higher energies.[4] Also, theoretical lower limits placed on the amount of S-wave production in hydrogen[5] suggest that the helium production efficiency should be relatively lower because of the absence of S-wave production. Cross-section calculations now in progress are necessary for a more accurate comparison.

[1] Smith, Birnbaum, and Barkas, Phys. Rev. **91**, 765 (1953); Chinowsky, Sachs, and Steinberger, Phys. Rev. **93**, 586 (1954).
[2] F. E. Mills and L. J. Koester (to be published).
[3] Panofsky, Steinberger, and Steller, Phys. Rev. **86**, 180 (1952).
[4] Jakobson, Schulz, and White, Phys. Rev. **91**, 695 (1953).
[5] K. M. Watson, Phys. Rev. **95**, 228 (1954).

Polarization in *p-p* Scattering at 415 Mev*†

J. A. KANE, R. A. STALLWOOD, R. B. SUTTON, T. H. FIELDS, AND J. G. FOX
Carnegie Institute of Technology, Pittsburgh, Pennsylvania

(Received July 19, 1954)

A POLARIZED proton beam has been obtained from the Carnegie synchrocyclotron by scattering the internal beam from a carbon target. Protons which were thereby scattered outward through an angle of about 13° passed through a 2 in. × 2 in. collimator in the shield wall. The intensity in the experimental area was measured with an ionization chamber to be about 10^5 protons $\text{cm}^{-2}\,\text{sec}^{-1}$. The beam energy as determined from a differential range curve was 415 Mev with a full width of 10 Mev.

We have measured the asymmetries produced when this beam underwent second scatterings coplanar with the first. The asymmetry, $\epsilon(\theta)$, is defined as $[I(\theta)-I(-\theta)]/[I(\theta)+I(-\theta)]$, where $I(\theta)$ is the intensity of protons scattered through an angle θ, and where positive values of θ are in the same sense as the first scattering.

Measurements of ϵ have been made by using carbon as the second scatterer in order to determine the degree of polarization of the beam. If the first and second scatterings were identical, the polarization, P, would be given by $P=\epsilon^{\frac{1}{2}}$, with ϵ the asymmetry observed in the second scattering. From the results of such an experiment we estimate that our beam polarization is between 40 and 50 percent.

The reality of the observed asymmetries was tested by scattering our normal unpolarized external beam[1]

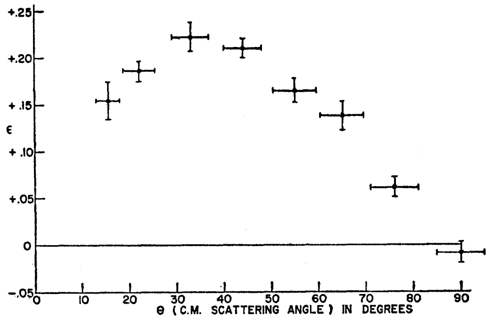

FIG. 1. Polarization in *p-p* scattering. The observed values for ϵ (defined in test) are shown *versus* the center-of-mass scattering angle. The vertical errors are the standard deviations from counting statistics. The horizontal bars indicate the angular resolution.

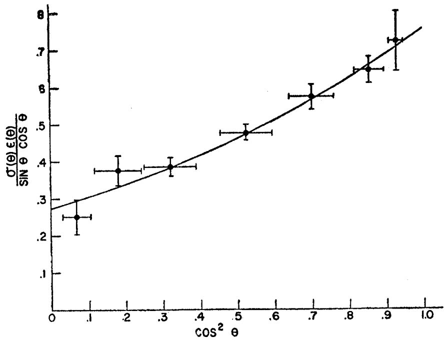

FIG. 2. The data of Fig. 1 are plotted in the form $\epsilon\sigma/\sin\theta\cos\theta$ *versus* $\cos^2\theta$. The equation of the solid line is given in the text.

from the second carbon target. The asymmetry observed was 0.004±0.007 at a scattering angle of 10°.

A measurement has been made of the angular distribution of the asymmetry produced by scattering the polarized beam from liquid hydrogen. The scattered protons were detected with a counter telescope, which, at each angle θ, included a copper absorber of sufficient thickness such that only elastically scattered protons were counted, i.e., no particles accompanying meson production were counted.

Figure 1 shows the observed asymmetries. The polarization in p-p scattering can then be obtained from ϵ through the relation $P_H(\theta)=\epsilon(\theta)/(0.45\pm0.05)$. Figure 2 is a plot of $\sigma(\theta)\epsilon(\theta)/\sin\theta\cos\theta$ *vs* $\cos^2\theta$, where θ is the center-of-mass scattering angle, and $\sigma(\theta)$ is the unpolarized scattering cross section normalized to 1 at 90°.[2] If $\sigma(\theta)\epsilon(\theta)/\sin\theta\cos\theta$ is assumed to vary as $\alpha+\beta\cos^2\theta+\gamma\cos^4\theta$ (only ^3P and ^3F states contributing), a least squares fit to the observed values yields the solid line of Fig. 2.

The equation of this line gives

$$\sigma(\theta)P_H(\theta)=\frac{\sigma(\theta)\epsilon(\theta)}{(0.45\pm0.05)}$$
$$=K\sin\theta\cos\theta(1+b\cos^2\theta+c\cos^4\theta),$$

with $K=0.62\pm0.14$, $b=1.0\pm0.7$, $c=0.63\pm0.77$, where b and c are connected by the relation $c=1.6\pm0.3-0.98b$.

This contrasts with results at about 320 Mev[3,4] which seem to require considerably different values[5] for the coefficients of $\cos^2\theta$ and $\cos^4\theta$. Furthermore, our data agree with Chicago results[6] at 439 Mev within the somewhat larger statistical errors of the latter.

We are indebted to Professor L. Wolfenstein for many valuable discussions.

---

[*] This research was supported in part by the U. S. Atomic Energy Commission.

[†] To be submitted by J. A. Kane in partial fulfillment of the requirements for the degree of Doctor of Philosophy at Carnegie Institute of Technology.

[1] Kane, Stallwood, Sutton, Fields, and Fox, Phys. Rev. **95**, 662 (1954).

[2] Sutton, Fields, Fox, Kane, Mott, and Stallwood, Phys. Rev. **95**, 663 (1954). We have used this $\sigma(\theta)$, measured at 437 Mev, which shows a rise of about 20 percent from 90° c.m. to 17° c.m. At 415 Mev, $\sigma(\theta)$ may have less angular dependence. However, even a completely isotropic cross section would not change the expression for σP_H outside the quoted errors.

[3] Chamberlain, Segrè, Tripp, Wiegand, and Ypsilantis, Phys. Rev. **93**, 1430 (1954).

[4] Marshall, Marshall, and de Carvalho, Phys. Rev. **93**, 1431 (1954).

[5] L. Marshall in *Proceedings of the Fourth Annual Rochester Conference on High Energy Nuclear Physics* (University of Rochester Press, Rochester, 1954), p. 12.

[6] De Carvalho, Heiberg, Marshall, and Marshall, Phys. Rev. **94**, 1796 (1954).

Mesonic Corrections to the Beta-Decay Coupling Constants

R. J. FINKELSTEIN AND S. A. MOSZKOWSKI
University of California, Los Angeles, California

(Received July 29, 1954)

RECENT analysis of the ft values in superallowed beta transitions have indicated that the Fermi and Gamow-Teller coupling constants (g_F and g_{GT}) are of approximately the same absolute magnitude.[1–5] Nevertheless, as several authors have pointed out,[6,7] the experimental data now require one to conclude that g_{GT}^2 is slightly larger than g_F^2. It is the purpose of this letter to suggest that such a difference may not be a property of the fundamental beta interaction itself, but that it is, at least partially, a consequence of certain radiative effects, involving primarily the emission and reabsorption of a π^0 meson.

The recently determined accurate ft values for O^{14} (3275±75)[8] and Cl^{34} (3220±200)[9,10] (which are almost certainly 0→0 transitions with $|\int 1|^2=2$, $|\int\sigma|^2=0$, assuming only charge independence), provide a direct determination of g_F. In the notation of Gerhart[8] we have

$$[|\int 1|^2+R|\int\sigma|^2]\times ft=6550\pm150\text{ sec},\qquad(1)$$

where $R=g_{GT}^2/g_F^2$.

For transitions between ground states of mirror nuclei which have closed shells of 0, 2, 8, 20 protons and neutrons ± one nucleon, the single-particle estimates[11] $|\int\sigma|_{\text{S.P.}}^2$ for the G-T matrix elements should be reasonably good. We have used the four known mirror transitions of this kind for which the ft values are known fairly accurately[12] to attempt an approximate determination of the ratio R.[13] The results are shown in Table

TABLE I. Values of g_{GT}^2/g_F^2 deduced from beta transitions between nuclei with closed shells of protons and neutrons ±1 nucleon.

Transition	ft[a]	$\lvert\int 1\rvert^2$	$\lvert\int\sigma\rvert_{\text{S.P.}}^2$	$R=g_{GT}^2/g_F^2$[b]
n^1-H^1	1280±250	1	3	$1.37^{+0.4}_{-0.3}$
H^3-He^3	1014±20	1	3	1.82±0.1
$O^{15}-N^{15}$	3950±200	1	0.33	1.97±0.4
$F^{17}-O^{17}$	2320±100	1	1.4	1.30±0.15

[a] See reference 12.
[b] See reference 13.