proximately

$$C_{1P}=g_P{}^2(4M^2)^{-1}(\alpha Z/2\rho)^2(\alpha Z)^2\left|\rho^{-1}\int\boldsymbol{\sigma}\cdot\mathbf{r}\right|^2.$$

As a fair estimate, we consider $|\int\boldsymbol{\sigma}|\approx|\rho^{-1}\int\boldsymbol{\sigma}\cdot\mathbf{r}|\approx|\rho^{-2}\int\mathbf{r}(\boldsymbol{\sigma}\cdot\mathbf{r})|$, where we take for the tensor matrix element the ordinary allowed (not superallowed) value of the matrix element—i.e., we consider all transitions to be subject to the same "unfavored factor." Repeated occurrence of fortuitously extremely small matrix elements is unlikely, as ft values in any group tend to be pretty uniform, and major irregularities here would lead us to expect them elsewhere as well. The presence of a large nuclear force contribution to the pseudoscalar interaction would depress g_P in order to fit of the observed l-forbidden ft values. From the ratio C_{1P}/C_{0T} determined from observed ft values for the extensively studied carbon-14[7] and phosphorus-32 and neighboring allowed nuclides, we obtain $|g_P/g_T|\approx 4$ and 20, respectively; the $Z\approx 30$ group yields a ratio near 15. Even a ratio of 20, however, leads to log $ft\approx 8$ for C_{1P} for the highest Z—a trifle small to compete equally with the other interactions, and certainly inadequate to account for log $ft\approx 5.5$ among the high-Z $\Delta j=0$ (yes) group. Thus it appears that the pseudoscalar interaction does not play a detectable role in beta decay, if it is present at all.

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Ground State of Al^{26}

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It has recently been suggested[1,2] that the state in Al^{26}, which decays by positron emission with a half-life of 6.7 sec, and which was generally accepted as the ground state, might be the $T_z=0$ component of the lowest triplet with isobaric spin $T=1$ and ordinary spin $J=0^+$. The lowest $T=0$ state in Al^{26}, which might well have an ordinary spin $J=5^+$,[3] might be situated either above or below the 6.7-second state. In Li^6, B^{10}, N^{14} and Na^{22} the ground state is a $T=0$ state, while in Cl^{34} the ground state has $T=1$. In any case such a low $J=5^+$ state would have a very long half-life.

There is much conflicting experimental evidence[4–11] about the lowest levels in Al^{26} (see Table I). The differences in the threshold measured by neutron detection and by positron detection both for $Al^{27}(\gamma,n)Al^{26}$ and $Mg^{26}(p,n)Al^{26}$ point to a long-lived state in Al^{26}. Moreover, it is found that the neutron yield of the $Al^{27}(\gamma,n)Al^{26}$ reaction is three times larger than the positron yield.[12,1]

In the present investigation the $Mg^{25}(p,\gamma)Al^{26}$ reaction was used to obtain more information on the lowest states in Al^{26}. By bombarding thin targets of separated Mg^{24}, Mg^{25}, and Mg^{26} (obtained from Dr. M. L. Smith, Atomic Energy Research Establishment, Harwell, England) by protons in the energy region from $E_p=200$ to 700 kev, it was possible to assign six resonances to Mg^{25}, *viz.*, at $E_p=315$, 389, 436, 508 (possibly unresolved doublet), 586, and 620 kev. The first four resonances have been observed previously from natural magnesium targets by Tangen[13] and by Hunt and Jones.[14] Tangen assigned the 436-kev resonance to Mg^{26}, as he did not detect positrons at this resonance. Hunt and Jones interpreted also the 315- and 387-kev resonances as Mg^{26} resonances.

TABLE I. Experimental data about the position of the two lowest states in Al^{26} relative to the Mg^{26} ground state.

Reaction	$Al^{26}-Mg^{26}$ (Mev)	$Al^{26*}-Mg^{26}$ (Mev)	Ref.
$Al^{26}(\beta^+)Mg^{26}$		4.4 ± 0.5	4, 5
$Al^{26}(\beta^+)Mg^{26}$		(3.8)[a]	6
$Al^{26}(\beta^+)Mg^{26}$		(4.01)	7
$Al^{27}(\gamma,n)Al^{26}$	3.70 ± 0.20		8
$Al^{27}(\gamma,n)Al^{26}$		5.0 ± 0.4	9
$Mg^{25}(d,n)Al^{26}$	2.51 ± 0.10	4.51 ± 0.18	10
$Mg^{26}(p,n)Al^{26}$	~2.6	(4.3)	11

[a] The value has been put between parentheses, when the isotopic assignment is doubtful.

Gamma-ray energies were measured with a scintillation spectrometer ($2\times2\times3$ cm³ NaI crystal). Pulses were fed both to a one-channel differential discriminator and to an ordinary discriminator, used as a monitor. Energy calibrations were performed with a Po-Be source ($E_\gamma=4.44$ Mev) and with γ rays from the $F^{19}(p,\alpha\gamma)O^{16}$ reaction ($E_\gamma=6.13$ Mev) and from the $C^{13}(p,\gamma)N^{14}$ reaction ($E_\gamma=8.06$ Mev).

At the 436-kev resonance a γ ray of $E_\gamma=6.77\pm0.08$ Mev is observed indicating an Al^{26} state (the ground state) 3.96 ± 0.08 Mev above the Mg^{26} ground state. At all resonances a γ ray was found proceeding to an Al^{26} level 4.42 ± 0.08 Mev above the Mg^{26} ground state, corresponding to 0.46 ± 0.08 Mev above the Al^{26} ground state (see Table II). No higher energy γ rays were found at any of the six resonances investigated. There are certainly present several lower energy γ rays, but their energy has not yet been accurately determined. In a preliminary survey positrons from the Al^{26} decay were observed at all of the investigated resonances. However at the 436-kev resonance the yield is certainly low, in agreement with Tangen's observation.[13]

TABLE II. Observed γ rays at six $Mg^{25}(p,\gamma)Al^{26}$ resonances.

Resonance proton energy (kev)	$E\gamma_1$ (Mev)	$Mg^{25}+p-Al^{26}$ (Mev)	Rel.[a] int.	$E\gamma_2$ (Mev)	$Mg^{25}+p-Al^{26*}$ (Mev)	Rel.[a] int.
315			≤3	6.28	5.98	18
389			≤2	6.20	5.83	8
436	6.77	6.35	25	6.28	5.86	6
508			≤2	6.38	5.89	10
586			≤2	6.43	5.87	18
620			≤2	6.50	5.90	19

[a] The relative intensity is given in percents of the number of γ-ray pulses larger than 1 Mev.

All experimental evidence cited in this letter is compatible with the assumption that the Al^{26} ground state has isobaric spin $T=0$ and the level at 0.46 Mev $T=1$. If the ground state really has a spin $J=5^+$, it probably decays by a second forbidden β^+ transition to the Mg^{26} level at 1.83 Mev (assumedly with $J=2^+$) with a β^+ endpoint of 1.11 ± 0.08 Mev. Taking log$ft=13.0$ leads to an estimated half-life of 4×10^4 years.

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Proton-Proton Scattering from 40 to 95 Mev*

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Proton-proton scattering has been studied with the external beam of the Harvard cyclotron, using scintillation counters to detect the protons scattered from hydrocarbon targets

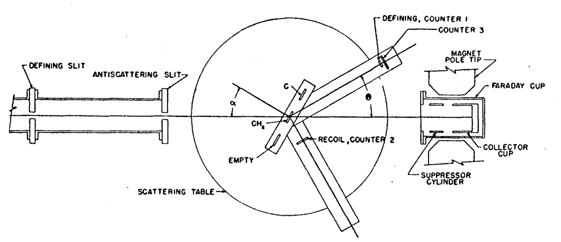

FIG. 1. Experimental equipment.

and a Faraday cup to measure the incident proton flux. The angular distribution from 90° to 40° in the center-of-mass system was observed at 95 Mev. The cross section at 90° for lower energies was obtained by degrading the beam with lithium hydride absorbers.

The experimental arrangement is shown in Fig. 1. To detect both of the protons as in the method of Wilson and Creutz[1] two arms whose angles could be accurately adjusted were mounted on the circular scattering platform. Fastened to the arms were supports for the detectors consisting of stilbene crystals mounted on 1P21 photomultiplier tubes. The pulses from the photomultipliers were fed into diode bridge coincidence circuits.[2] Coincidences between the defining counter 1 and counter 3 directly behind the defining counter as well as coincidences between the defining counter and the recoil counter 2 were obtained from the diode bridge coincidence circuits. These could then be mixed in a slow coincidence circuit to obtain threefold coincidences. At the lower energies the protons did not have sufficient energy to pass through the defining counter, and only twofold coincidences between the defining and recoil counters were measured. Throughout the experiment suitable checks on efficiency and accidentals were performed. Also, to eliminate any effects due to polarization of protons in the beam or misalignment of the scattering table, the defining counter was placed alternately on the right and left side of the beam.

The targets employed in this phase of the experiment were two thicknesses of polyethylene with carbon targets of approximately equal stopping power. At 90° in the center-of-mass system the cross section was also checked with a polystyrene target. Because of the low incident beam intensity it was necessary to use a geometry in which genuine coincidences from carbon could not be neglected, and this contribution to the coincidence rate in the polyethylene was therefore suitably subtracted. With the thickness of targets necessary to obtain reasonable counting rates it was impossible to detect both protons corresponding to angles smaller than 40° in the center-of-mass system. It is hoped that this region as well as the angles up to 90° will be investigated soon with liquid hydrogen targets.

The number of protons in the beam was measured with a Faraday cup. The energy of the incident particles was determined by finding the fraction of particles penetrating known amounts of aluminum. In this way it was found that the full width at half-maximum was 2 Mev at the full energy of 95 Mev and increased to a width of 4.8 Mev at a mean energy of 41 Mev. The total charge collected on the Faraday cup was measured using a Brown vibrating reed electrometer modified to operate with a specially constructed capacitor mounted in the Faraday cup vacuum system. It was found that the charge collected on the cup was independent of parameters of the cup system such as electrical and magnetic suppression of secondaries as well as distance of the front foil and other geometrical considerations.

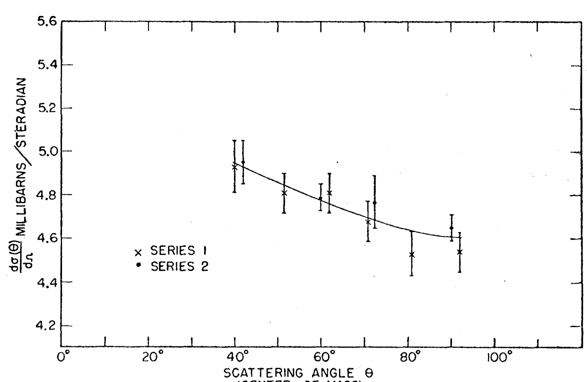

FIG. 2. Angular distribution at 95 Mev—counting statistics only.

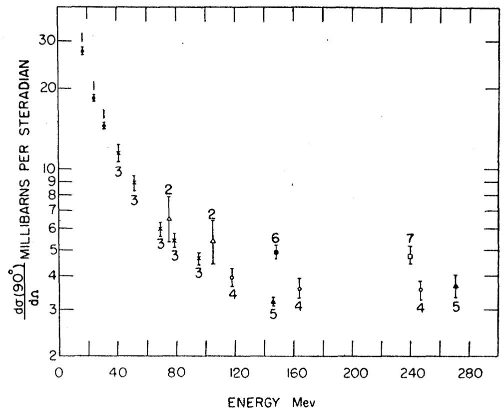

FIG. 3. Cross sections at 90° center-of-mass. 1. Berkeley, reference 7; 2. Harvard, reference 6; 3. Harvard, present data; 4. Berkeley, reference 3; 5. Chicago, reference 8; 6. Harwell, reference 5; 7. Rochester, reference 4.

The angular distribution obtained at 95 Mev is shown in Fig 2; counting statistics only are shown. When possible systematic errors are included, the reliability of the ratio of the cross sections at 90° and 40° is estimated to be 4 percent. In Fig. 3, the cross sections at 90° in the center-of-mass system are compared to results previously reported.[3-8] The estimated errors for the absolute cross section listed by the authors are shown except in the Chicago results where only a preliminary estimate is available.

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Polarization by *p-p* Collision at 439 Mev*

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PREVIOUS measurements of asymmetry of *p-p* scattering for polarized protons of 340[1] and 310[2] Mev indicate that at these energies triplet states of angular momentum greater than 1 have become important in *p-p* collisions. This is made evident by the fact that the asymmetry of scattering varies as $\sin\theta\cos\theta$ if only ^3P states act, but at 310 and 340 Mev it is fitted by $\sin\theta\cos\theta$ $(a+b\cos^2\theta+c\cos^4\theta+\cdots)$ where b and c are probably larger than a. Terms other than the first can arise only by interference in triplet states of angular momentum greater than 1.

We report here a measurement of asymmetry of *p-p* scattering with 439-Mev polarized protons, from which we hoped to learn