were measured for each of the four possible configurations of the magnetic fields shown in Fig. 1. The photomultipliers were magnetically shielded to reduce effects incurred upon reversing the magnetic fields. After each change in the fields the single rates were carefully adjusted to the unique values employed throughout the experiment.

The thin stilbene crystals were less than 0.4 percent efficient for detection of photons but were very nearly 100 percent efficient for forward direction Compton electrons. Thus far we have not made an accurate measurement of the fraction of the singles rates which was caused by photons or by Compton electrons produced in the magnetizing coils rather than the Fe foils. However, geometrical considerations indicate that Compton electrons from the coils correspond to photons scattered at $\theta \lesssim 135°$ and, hence, for these electrons $E \lesssim 0.06$ Mev. The efficiency for their coincidence detection by the circuit employed was small relative to that for the forward direction electrons ($E \approx 0.34$ Mev). Hence, the coincidence circuit was biased strongly against detection of electrons other than those in the forward direction produced in the Fe foils.

Another possible contribution to the coincidence rate was the result of the 1.3-Mev gamma-ray following the beta-transition of Na^{22}. However, the possibility of observing these gammas in

TABLE I.[a] Observed coincidence rates.

Mag. fields S_1	S_2	Coinc. counts	Time (min)	Coinc./min	Average
←	←	12,850	425	30.23	
←	←	19,270	637	30.24	
→	→	10,866	350	30.98	
→	→	19,730	683	28.90[b]	
→	→	5227	174	30.06	
→	→	9437	316	29.90	
→	→	18,807	622	30.26	
		76,457	2524		30.29±0.11
→	←	6313	220	28.70	
→	←	9472	327	28.97	
→	←	18,432	625	29.51	
←	→	20,480	694	29.60	
←	→	8877	310	28.65	
		63,574	2176		29.22±0.12

[a] Difference = 1.07±0.23; percent difference = 3.5±0.75 percent.
[b] At the end of this run the single counting rate of one counter failed to repeat. Hence, this low rate is not included in the computation of the average coincidence rate for the first field configuration. Subsequent data confirmed previous coincidence rates for this configuration. If one includes this run, the observed difference is 2.6±0.07 percent.

coincidence with an annihilation quantum was small since the 1.3-Mev gammas are of spherical directional symmetry while the relative direction of an annihilation pair is π-radians. This argument is supported experimentally by previous work.[6]

The collected data from 12 independent runs and the difference in coincidence rates for the indicated field configurations are presented in Table I. From Eq. (2) and the knowledge that a coincident photon pair are left and right or right and left circularly polarized, one deduces for the expected coincidence rates for $\theta_1 = \theta_2 = \pi$

$$\Phi_1\Phi_2 = C^2(A^2+B^2), \quad \text{for} \quad \begin{cases} \rightarrow \rightarrow \\ \leftarrow \leftarrow \end{cases},$$

$$\Phi_1\Phi_2 = C^2(A^2-B^2), \quad \text{for} \quad \begin{cases} \rightarrow \leftarrow \\ \leftarrow \rightarrow \end{cases}.$$

After substituting appropriate values for k_0, k, etc., and taking into account that only 2.2 of the 26 orbital electrons in Fe are polarized, one finds for the expected difference 0.9 percent. The expected difference has also been computed for $k_0 \gtrsim 1.5$ by Halpern,[3] whose result predicts a 2 percent difference in a coincidence experiment of this kind.

The somewhat greater observed difference, 3.5±0.8 percent, may be a discrimination by the coincidence circuit against the detection of K and L shell (unpolarized) Compton electrons. It is known[8] that orbital binding changes the intensity of the scattered radiation and gives rise to a coherent (unshifted) scattering in addition to Compton scattering. We have been unable to find a computation of this effect for high energy photons scattered in Fe. This possibility is being investigated further.

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Phenomena Associated with Negative μ-Mesons Stopped in Photographic Emulsions*

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ELECTRON sensitive Ilford G-5 plates of 400-micron thickness were exposed behind absorbers in the 145-Mev negative π-meson beam from the University of Chicago cyclotron. The geometry of the exposures is shown in Fig. 1. A fraction of the π-mesons decay in flight before entering the Cu absorbers. The μ-mesons from the decay of the π-mesons in the forward direction have an additional range of about one inch in Cu compared to the range of the π-mesons. The additional range of the μ-mesons makes it possible to separate the μ-mesons from the π-mesons.

Meson tracks were studied which entered the emulsions within 45° of the direction of the π-meson beam and which stopped in the emulsion further than 30 microns from the surfaces. A total of 1008 meson endings was studied. In 8 cases it is difficult to determine the phenomena associated with the mesons. In 6 cases a track of an electron of a few hundred kev is associated with each meson. The electron tracks are due either to decay electrons or to electrons which were ejected in the process of capture of the mesons. In 2 cases the mesons either produced one-prong stars or were scattered through a large angle near the end of the tracks. In 32 cases the mesons produced stars of one or more prongs of length greater than 10 microns. The prong distribution of these stars and the prong distribution of negative π-meson stars[1] are given in Table I. The prong distribution of the 32-meson stars indicate that nearly all of these stars are due to negative μ-mesons rather than negative π-mesons. No protons of energy greater than 30 Mev were observed from any of the stars. One of the stopped mesons ejected a single proton of 20 Mev. It seems probable that the event is due to a negative π-meson. It is possible that a portion of the 2- and 3-prong stars were produced by negative π-mesons. However, the various energies of the charged particles from the 2- and 3-prong stars are considerably lower than the energies of the charged particles from negative π-meson

TABLE I. Prong distribution of μ^- and π^- meson stars.

	Number of prongs of the star 1	2	3	4	5
No. of μ^- meson stars of N prongs	27	4	1	...	...
Percentage of μ^- mesons which produced N-prong stars	2.6	0.5	0.1	...	...
Percentage of π^- mesons which produced N-prong stars	21	27	15	7.8	1.8

stars. For this reason it is assumed that all of the 2- and 3-prong stars were produced by negative μ-mesons. The percentage of stopped negative μ-mesons which produce stars in emulsions is then 3.1 ± 0.6 percent. This percentage of stars produced by negative μ-mesons appears to be somewhat lower than the percentages reported by George and Evans[2] and Fry[3] who found that 8.7 ± 1.7 and about 8 percent of the μ-mesons which were captured produced stars. Since 61 percent of the negative μ-mesons are captured in the emulsion, the percentage of captured negative μ-mesons which produce stars is then $(3.1/0.61)=5.2\pm1$, which is to be compared with 8.7 ± 1.7 found by George and Evans. The low percentage of stars produced by negative μ-mesons indicate that the nuclear capture of negative μ-mesons results in very little excitation of the nucleus.

A search was made for decay electron tracks associated with the end of 500 of the 1000 meson endings. In 196 cases a decay electron

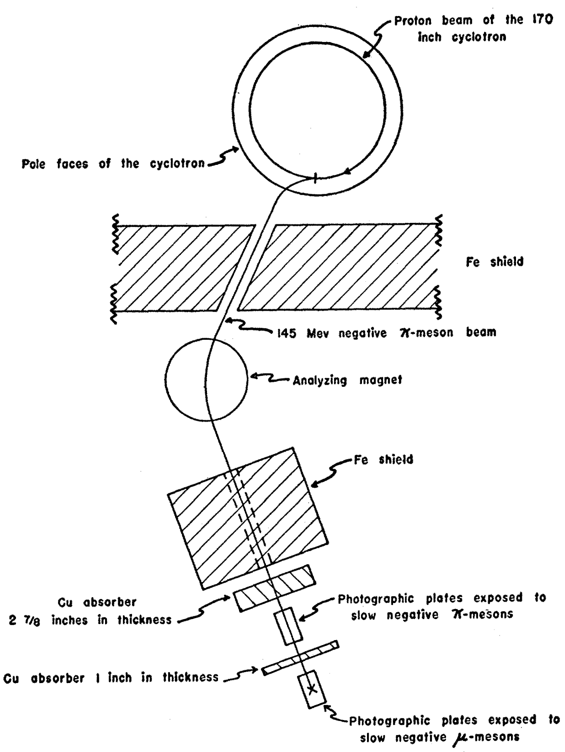

FIG. 1. The geometry of the exposure of photographic plates to slow negative μ-mesons.

track was observed from the end of the meson track. In 288 cases the meson tracks stopped without associated tracks other than low energy electron tracks[4] ($15<E_e<100$ kev). The percentage of negative μ-mesons which decay in photographic emulsions is then $(196/500)(100)=39\pm3$. In order to estimate the efficiency of detecting the decay electrons from μ-mesons, 88 positive π-μ decays were studied in plates from the same batch of emulsion. The decay electron tracks were observed from the end of the μ-meson tracks in all but two cases. It is known that mesons which stop in a material of $Z=11$ have about equal probabilities of capture and decay.[5] If it is assumed[6] that the capture probability is proportional to Z^4, then nearly all of the negative μ-mesons which stop in gelatin should decay, while essentially all of the μ-mesons which stop in silver bromide crystals should be captured. Since the emulsions consist of crystals of Ag and Br imbedded in gelatin, the relative numbers of mesons which stop in the crystals and in the gelatin would seem to be proportional to the stopping power of the two materials for very low energy mesons. Using the percentage of negative μ-mesons which decay and the composition of the emulsions, the ratio of the stopping power per atom of Ag or Br to the average stopping power per atom in the gelatin, for low energy mesons, is found to be 4.8. If the stopping power per atom is incorrectly assumed to be proportional to Z, the ratio of the two stopping powers is about 12.

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Striations in the Hydrogen Glow Discharge

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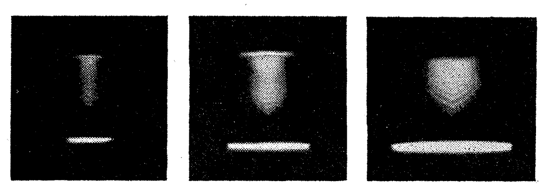
IN a recent letter, Fowler[1] states that the striations obtained in a low pressure hydrogen glow discharge do not form opposite the entrance to a side arm of the main tube. He suggests that striations can only exist when completely bounded on their periphery by solid matter. This condition does not hold for pressures $\sim$760 mm Hg, as can be seen from the enclosed photographs (Fig. 1) and those of Fan,[2] showing the striations in a high pressure glow discharge in hydrogen.

For low pressure discharges, Druyvesteyn and Penning[3] state that for striations to appear in hydrogen the product of pressure (p mm Hg) and tube radius (R cm) must satisfy the empirical relation

$$pR=m,$$

where $m\sim2$ but depends on the current.



(a) (b) (c)

FIG. 1. Striations in a high pressure glow discharge in hydrogen, at 1 atmos pressure. Length = 3 mm. (a) Current = 0.1 amp, (b) current = 0.25 amp, (c) current = 0.5 amp.

The side arm in Fowler's apparatus increases the effective radius of the main tube at the junction of the side arm with the main tube, and it may be that at this point the product $p\times$effective radius has a value greater than that necessary to cause striations. On the other hand, Lau and Reichenheim[4] have concluded that the recombination of H atoms to H_2 molecules at the walls is important for the appearance of striations.

A satisfactory theory of striations has not yet been put forward, and it appears indeed that the complete interpretation of striation phenomena will not be easy.

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