Letters to the Editor

SCATTERING OF 7–8 Bev NEGATIVE PIONS ON NUCLEONS WITH LARGE MOMENTUM TRANSFER

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In the study of the scattering of high-energy elementary particles, cases associated with a large momentum transfer between the colliding particles as a result of their interaction are of great interest.

Examples of such processes are reactions in which the particles are scattered at c.m.s. angles close to 180°. The study of such reactions, in particular, can serve as a check of the conclusions of Gell-Mann and Zachariasen [1] that large momentum transfers should still occur at high energies. Moreover, Pomeranchuk has shown (see, for example, [12]) that the pole of the diagram in the figure should give an appreciable contribution to the cross section for the scattering of high-energy π^+ mesons by protons at 180° c.m.s. The angular distribution of the scattered π^+ mesons described by this diagram should have a maximum at 180° with a width of about 30° at 7–8 Bev/c; this corresponds to the backward scattering of π^+ mesons in the l.s. An estimate of the cross section for such a process gives the value $d\sigma/d\Omega\ (180°) \approx 0.5$ mb/sr. The total cross section for the scattering of 7–8 Bev/c π^+ mesons backward in the l.s. should then also be ≈ 0.5 mb.

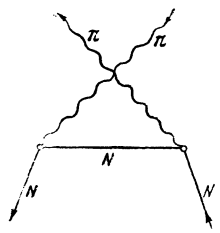
We have studied the following reactions in which π^- mesons are scattered backward in the l.s. on nucleons:

$$\pi^- + n \rightarrow \pi^- + n, \quad (1)$$

$$\pi^- + p \rightarrow \pi^- + p, \quad (2)$$

$$\pi^- + p \rightarrow \pi^0 + n. \quad (3)$$

Reaction (1) is the charge-conjugate analog of the above-mentioned reactions involving the scattering of π^+ mesons by protons. Consequently, the characteristics discussed above should be present in this case, too. [2] It is also obvious that the diagram should give a contribution to the cross section



of reaction (3). This is not the case, however, for the scattering of π^- mesons on protons of type (2) because of the law of charge conservation.

The experiment was performed with a 24-liter propane bubble chamber placed in a magnetic field of 13 700 oe. The chamber was exposed to a 7–8 Bev/c π^- meson beam.

To find events corresponding to reaction (3), two observers scanned independently about 30 000 photographs. They recorded cases in which the primary mesons vanished. The efficiency for finding such events was $\sim 95\%$. A total of 579 cases in which the vanishing of the pions was associated with 230 γ quanta was found. The γ quanta had an angle of emission $\theta \geq 90°$ l.s. in only three cases. From this we can estimate the upper limit of the cross section σ_3 for reaction (3), since if the π^0 meson is scattered backward in the l.s., at least one γ quantum from the decay of this π^0 should also be emitted backward. This estimate is

$$\sigma_3\,(\geqslant 90°) \lesssim 0.1 \text{ mb}$$

To find events corresponding to reactions (1) and (2), we scanned twice about 6000 photographs. We recorded cases with negative relativistic particles emitted at an angle $\geq 90°$ l.s. (process 1) and similar cases accompanied by the forward emission of a charged particle (process 2). The efficiency of finding such events was close to 100%.

As a result, we found four events which did not contradict the kinematics of reaction (1). Under the assumption that the carbon nuclei behave as a single effective quasi-free neutron, [3] we obtained an estimate of the upper limit of the cross section for this reaction:

$$\sigma_1\,(\geqslant 90°) \lesssim 0.06 \text{ mb}$$

The result is in agreement with a similar estimate made by Bayukov et al. [2] for 2.8-Bev/c π^- mesons.

We also found three cases which did not contradict the kinematics of the elastic scattering of π^- mesons backward in the l.s. on protons. This corresponds to the cross section

$$\sigma_2\,(\geqslant 90°) \lesssim 0.02 \text{ mb}$$

The estimate of the cross sections for processes (3) and particularly (1) obtained in this way is considerably less than that calculated from the diagram, which apparently indicates that other possible processes compete with this diagram. Moreover, the estimates of the cross sections for all three scattering processes are of the same order of magnitude, i.e., there is no difference between processes to which this diagram gives a contribution and those for which a contribution is impossible.

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ANISOTROPY OF THE ODD PHOTOMAGNETIC EFFECT

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It has been shown previously [1,2] that the even photomagnetic effect in germanium is markedly anisotropic. The odd photomagnetic effect is usually considered to be isotropic. When there is a strictly linear variation of the odd photomagnetic e.m.f. on the magnetic field strength, it is expected to be anisotropic for a cubic crystal. However, it is known that for sufficiently strong magnetic fields the odd photomagnetic e.m.f. in germanium ceases to vary linearly with the field, and even passes through a maximum at some value of the field. In these conditions the possibility of anisotropy arising even in the odd photomagnetic effect is not excluded.

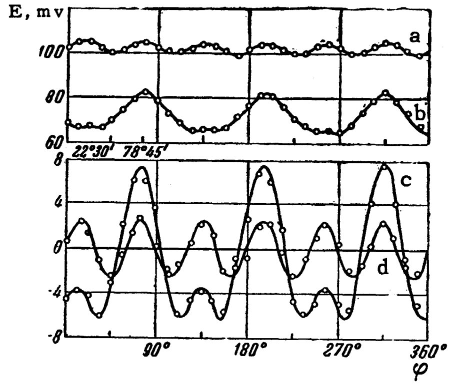

FIG. 1

To clarify the question of the existence of anisotropy in the odd photomagnetic effect, we have studied single-crystal specimens of n- and p-germanium in magnetic fields up to 25 000 oe. The specimens studied, like those described previously, [1] were in the form of circular discs with 32 electrodes around the periphery. The specimens could be rotated about an axis coinciding with the normal to the plane of the disc. The angle φ between the crystallographic axes and the direction of the magnetic field was thereby changed. Also the specimens could be turned so that the angle θ between the normal to the specimen surface and the direction of the magnetic field was changed.

Figure 1a shows the anisotropy curve of the odd effect, i.e., the variation of the odd photomagnetic e.m.f. on the angle φ for a specimen of p-germa-

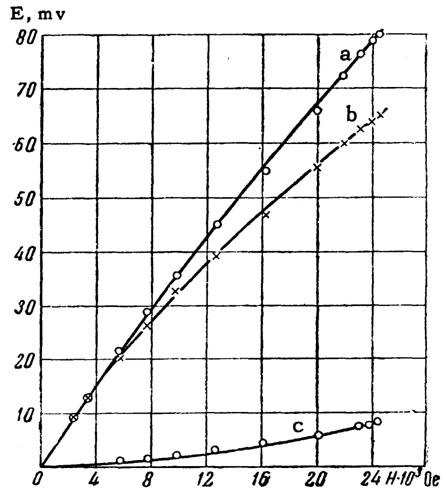

FIG. 2