CERTAIN CASES OF ELASTIC SCATTERING OF POSITRONS FROM π^+-μ^+-e^+ DECAY BY EMULSION ELECTRONS

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We consider π^+-μ^+-e^+ decay events involving two electron tracks originating at the end of a muon track. It is suggested that such cases that occur near the μ-e decay point are due to elastic scattering of positrons by emulsion electrons.

In a systematic scanning of approximately 80,000 π^+-μ^+-e^+ decays in a NIKFI-R emulsion, exposed in the pion beam of the synchrocyclotron of the Joint Institute for Nuclear Research, we observed two events of π^+-μ^+-e^+ decay, in which two electron tracks lead from each end of the track of the stopped muon (Fig. 1).

In the first of these events the angle between the tracks of electrons 1 and 2 was 27 ± 1°, the ionization of the two electrons was a minimum, and their energy, determined by the multiple-scattering method, was 51 ± 16 Mev and 3 ± 1 Mev. In the second case the angle between the tracks was 32 ± 3°, and the energy of electron 1, having a minimum ionization, was 34 ± 7 Mev. The energy of the second electron could not be determined, since the length of the track was merely ~ 25 microns.

Events in which two electrons were produced at the end of a muon track were also observed before, both in cloud chambers and in emulsion.[1,2] However, these were negative-muon decays in which a slow Auger electron was emitted, through conversion of the meso-atomic x-radiation, along with a fast decay electron. In our case we could not assume the emission of Auger electrons, since here the muons were the decay products of pions stopped in the emulsion, which proves beyond any doubt their positive charge. It is impossible to attribute the apparent paired emission of an electron to an apparent superposition of the end of the background-electron track on the ordinary π^+-μ^+-e^+ decay, since the probability of such an event is rather small under our conditions. In addition to the above events, while scanning electron tracks (in 9000 decays gathered for a different purpose), we observed seven characteristic "forks" of elastic e^+-e^- scattering (Fig. 2). In these cases the track leading from the end of the muon passes a certain distance in the emulsion and splits up; the resultant two relativistic tracks make angles θ_1 and θ_2 with the direction of the initial track.

Table I shows the angles of emergence and the distances from the end of the muon track to the scattering point, observed in our seven events. The left column contains the sums of the three-

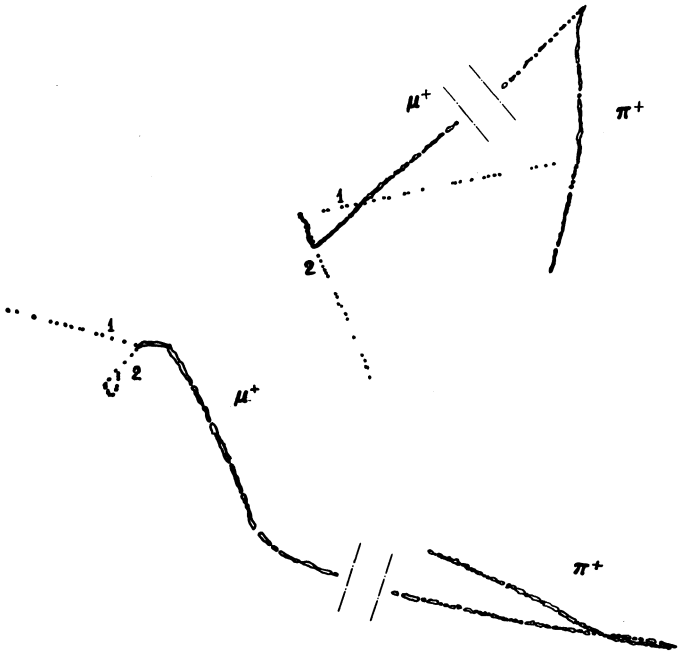

FIG. 1

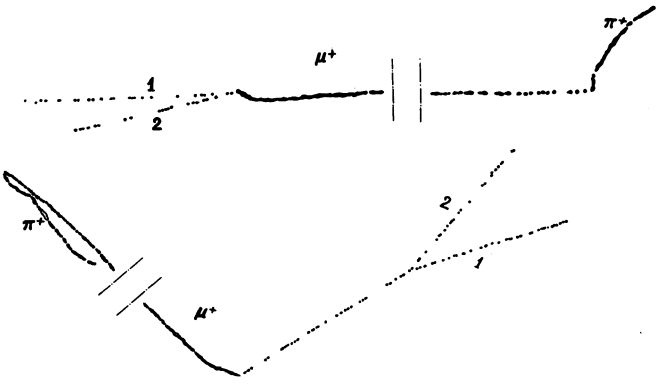

FIG. 2

TABLE I

Event No.	Path of initial particle	$\theta_{1,2}$ (deg)	$\theta_{1,3}$ (deg)	$\theta_{2,3}$ (deg)	Sum of angles (deg)
1	550	11.5	180	169	360.5
2	400	17.5	175	166	358.5
3	275	19.5	169.5	169	358
4	240	41	162.5	157	360.5
5	115	21	171	167.5	359.5
6	15	18	178	161	357
7	5	15.5	—	—	—

TABLE II

Event No.	E_0 (Mev)	E_1 (Mev)	E_2 (Mev)	E_0, by scatter angles, (Mev)
1	27±7	33±5	8±2	26±4
2	17±6	17±2	10±2	18±3
3	31±14	24±11	11±3	32±6
4	11±4	7±1	6±1	5±1
5	—	32±13	17±15	21±4
6	—	36±14	2±1	10±2
7	—	22±4	5±1	—

dimensional angles between the branches of the fork for all cases, in which all three branches of the fork are sufficient long and permit measurement of the angles. The obvious complanarity of these cases is convincing proof that elastic scattering indeed has taken place here.

It is difficult to verify whether the law of conservation of energy holds for these cases, because the tracks, as a rule, are too short and do not permit an accurate determination of the energy. On the average, the statistical accuracy in the determination of the energy is close to 30%. Energies measured with such an accuracy, as seen in Table II, do not contradict each other or the values calculated on the basis of energy and momentum conservation for elastic collisions.

We observed seven such "forks" in a total length of positron track of approvimately 10 meters. If we calculate from this the cross section of the collision between the decay positron and the emulsion electron, we find it to be approximately 6×10^{-27} cm, which is in good agreement with the positron-electron elastic-scattering cross section calculated by the Bhabha formula.[3]

We thus have seven events, for which the appearance of elastic scattering of a decay positron by an emulsion electron is proved with sufficient assurance. From column 2 of Table I it is seen that in the last two cases the e^+-e^- scattering occurred every close to the end of the muon track, at distances of 15 and 5 μ respectively. It is natural to assume that the case of two electron tracks diverging from the end of a muon track, which we have discussed at the beginning (Fig. 1), is indeed an example of a scattering that occurs near the decay point, so close to the end of the muon track that the vertex of a fork coincides with the point of decay. That the angles between the electron tracks do not exceed 90° in either case is also typical of a scattering event.

The probability of e^+-e^- scattering at a distance not exceeding 3 μ at the end of the muon track is 1.5×10^{-6}. The expected number of events of such a scattering is approximately 0.1 or 0.2 This number indicates that the foregoing explanation does not contradict the experiments.

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[1] A. Bennetti and G. Temanini, Nuovo cimento **8**, 693 (1951).

[2] W. F. Fry, Nuovo cimento **10**, 490 (1953).

[3] H. J. Bhabha, Proc. Roy. Soc. **A154**, 195 (1936).

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