able conditions the ion current at this mass was only 5×10^{-15} amp.

The question may arise whether or not this peak is due to the formation of the negative deuterium ion D^-, which has a mass of two. However, the height of the peak at mass 2 was only $20 - 30$ times less than that of the H^- peak, while the ratio H/D in natural water is 6000. Furthermore, the mass 2 ions appeared only when antimony vapor was present in the ion source.

All of the above leads us to the conclusion that the negative ions with mass 2 which we observed were in fact H_2^- ions. The occurrence of fragmentary ions with mass 0.5 can serve as an additional indication of the presence of H_2^- ions within the apparatus. An apparent mass of 0.5 would be carried by an ion formed by the dissociation of an H_2^- ion outside the source.

[1] H. Eyring, J. O. Hirschfelder and H. S. Taylor, J. Chem. Phys. **4**, 479 (1936).

[2] A. Dalgarno and M. R. C. McDowell, Proc. Phys. Soc. (London) **A69**, 615 (1956).

[3] V. M. Dukel' skii, Doki. Akad. Nauk SSSR **105**, 955 (1955).

[4] V. I. Khvostenko and V. M. Dukel' skii, J. Exptl. Theoret. Phys. (U.S.S.R.) **33**, 851 (1957); Soviet Phys. JETP **6**, 657 (1958).

Translated by D. C. West
212

ON THE DETERMINATION OF THE RELATIVE PARITIES OF ELEMENTARY PARTICLES

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SINCE parity is not conserved in the weak interactions, it is of great interest to determine the parities of elementary particles by means of the strong interactions. We consider below several reactions which can be used for the determination of the relative parities of strange particles. We have in mind the following type of reaction:

$$p\,(n) + \mathrm{He}^4 \to {}_\Lambda\mathrm{He}^5 + K^+\,(K^0) \tag{1}$$

with the assumption that the spins of ${}_\Lambda He^5$ and K are $\frac{1}{2}$ and 0, respectively.

This process is completely described by a spin-space matrix $M(\mathbf{n}, \mathbf{n}')$ which gives the amplitude of the diverging wave.[1] The most general form of the matrix $M(\mathbf{n}, \mathbf{n}')$ is

$$M(\mathbf{n}, \mathbf{n}') = a + b\sigma\,[\mathbf{n} \times \mathbf{n}'], \tag{2}$$

when the product I of the parities of all four particles is equal to +1, and

$$M(\mathbf{n}, \mathbf{n}') = a\sigma\mathbf{n} + b\sigma\mathbf{n}', \tag{3}$$

when $I = -1$. Here $\mathbf{n}$ and $\mathbf{n}'$ are unit vectors parallel to the momenta of the incident and emerging particles, respectively; a and b are certain functions of the energy and of the angle between $\mathbf{n}$ and $\mathbf{n}'$. The density matrix ρ_i of the initial state has the form

$$\rho_i = A\,(1 + \sigma\mathbf{P}), \tag{4}$$

where $\mathbf{P}$ is the polarization vector of the incident particles. If the reaction takes place at threshold, or if we select only the ${}_\Lambda He^5$ particles emitted forward (i.e., $\mathbf{n} \parallel \mathbf{n}'$), then we can neglect the second term in Eq. (2). At the threshold, Eq. (3) takes the form $M = a\sigma\mathbf{n}$, and for $\mathbf{n} \parallel \mathbf{n}'$ we have $M = (a + b)\,\sigma\mathbf{n}$. The polarization vector $\mathbf{P}'$ of the ${}_\Lambda He^5$ particle in the final state is calculated by the formula[1]

$$\mathbf{P}' = \mathrm{Sp}\,(M\rho_i M^+\sigma) / \mathrm{Sp}\,(M\rho_i M^+). \tag{5}$$

Substituting Eqs. (2), (3), and (4) into (5), we get

$$\mathbf{P}' = \mathbf{P}, \qquad \text{when } I = +1, \tag{6}$$

$$\mathbf{P}' = (2(\mathbf{P}\mathbf{n})\,\mathbf{n} - \mathbf{P}), \qquad \text{when } I = -1. \tag{7}$$

If the parity is not conserved in the decay of the ${}_\Lambda He^5$, then from the angular asymmetry of the decay one can measure the direction of polarization of the ${}_\Lambda He^5$ and distinguish between the possibilities (6) and (7). We emphasize that the incident beam must be polarized, and in such a way that the polarization vector is neither parallel nor perpendicular to the direction $\mathbf{n}$. The other reactions of this general type are as follows:

$\Sigma^\pm + \mathrm{He}^4 \to {}_\Lambda\mathrm{He}^5 + \pi^\pm$ at threshold, or when the ${}_\Lambda He^5$ emerges forward; (8)

$$\Sigma^\pm + \mathrm{He}^4 \to \Lambda + \mathrm{He}^4 + \pi^\pm \text{ at threshold;} \tag{8'}$$

$$p\,(n) + \mathrm{He}^4 \to \Lambda + \mathrm{He}^4 + K^+\,(K^0) \text{ at threshold.} \tag{1'}$$

In the last two reactions He^4 can be replaced by any other nucleus with spin 0 (for example, C^{12}).

We note that, in the reactions (1) and (1′), the polarization vectors of the $_{\Lambda}He^5$ and Λ depend only on the vectors **P** and **n** and the relative parities of K and Λ. Therefore, a case of the reaction (1′) can be simply added in with the cases of reaction (1).

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[1] L. Wolfenstein and J. Ashkin, Phys. Rev. **85**, 947 (1952); R. Oehme, Phys. Rev. **98**, 147 (1955).

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213

EMISSION OF Λ^0 PARTICLES UPON CAPTURE OF K MESONS BY NUCLEI IN EMULSION

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An Ilford G-5 emulsion stack (each pellicle was 600 microns thick) was exposed at the Bevatron in Berkeley† to K^- mesons with a momentum near 300 Mev/c. In scanning this stack three Λ^0 decays were found in the immediate vicinity of σ_K stars (see Table I, events 1, 2 and 17). Similar events have been observed by others.[1-3] In this connection we attempted to establish a correlation between the parent event and the Λ^0 decay, when it was impossible to observe them in a single field of view of the microscope. The pellicles were area-scanned with a magnification of 225 in a strip 1.5 cm × 10 cm, in which practically all K^- mesons were expected to have been stopped. We recorded σ_K stars, two-prong stars, and all proton tracks starting in the pellicle and longer than 500 microns. The beginning of each track was examined under great magnification in order to find a second track of small ionization, if such exists. This was necessary since some two-prong stars might have been overlooked in scanning with low magnification because of the low sensitivity of the emulsion (g_{min} = 16 grains in 100 microns). All events in which the direction of the fast particle agreed with that of the beam were at once rejected as stars produced by π^- contamination in the K^- beam. The Λ^0 decays were picked out from the set of two-prong stars thus found. First we measured the proton range, the ionization of the fast particle, and the opening angle. Using these data one can select those stars for which the relation between proton momentum, pion ionization, and opening angle in the decay $\Lambda^0 \rightarrow p + \pi^-$ is satisfied. Following the track of the fast particle enables one to determine whether it is a π^- meson; from the range of this particle and the data obtained before one can compute the Q value. Thus 18 Λ^0 decays were found.

A search for parent events was made within cones, whose axes were in the direction of flight of the Λ^0 particles as determined from the proton and pion momenta; the vertex angle of the cones was 5°, and the heights were set by the boundaries of the scanned strip. Parent events were found for 13 Λ^0 particles.

The results of the measurements are given in Table I. Column 4 gives the angle $\Delta\varphi$ between the decay plane and the line joining the point of decay with the parent event; column 5 gives the projection of the angle between this line and the direction of flight of the Λ^0 particle upon the emulsion plane. As is evident from Table I, the actually observed spread of the angles $\Delta\varphi$ and $\Delta\alpha$ is less than the average value of the quoted errors. This is probably connected with the restrictions placed upon the magnitudes of $\Delta\varphi$ and $\Delta\alpha$ in selecting the parent events. For example, if one considered only those events for which $|\Delta\alpha| \leq \sqrt{D}$, where $\sqrt{D}$ is the rms error in the determination of the direction of flight of the Λ^0 particles, then such a "cutoff" leads to $|\overline{\Delta\alpha}| \approx 0.3\sqrt{D}$; a Gaussian distribution of errors is assumed here.

The type of the parent event is given in column 6.

As is evident from Table I, for five events no parent σ_K star was found. The pertinent Λ^0 particle might have been formed in a nuclear explosion produced outside the scanned region by a stopped K^- meson. Nor can we exclude that the parent σ_K star was not found because of nuclear scattering of the Λ^0 particle. Moreover it is possible that the parent event lies outside the scanned cones.

For 18 identified Λ^0 particles (the total volume of the cones was 0.17 cm^3), one could anticipate 4 spurious parent events. In fact one such event was found. Of course, to reduce the number of spurious events one should decrease the density of exposure.