OBSERVATION OF SOME EXOTIC HIGH ENERGY INTERACTION WITHOUT PION PRODUCTION—EXOTON?

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ABSTRACT

This paper reports the observation of events in proton-nuclei collision in emulsion at (200 - 400) GeV/c and pion-nuclei collision at 50 and 200 GeV/c unaccompanied by pion production. These events constitute approximately 1-2% of the total events. All possible measures were taken to ensure that these events are not really accompanied by charged or neutral pion. It was also ascertained that these events are not background due to some other process. This observation indicates a picture of the collision process which differs much from the pictures applied in any of the existing models.

1. Introduction

This paper reports the observation of some interesting events produced in interactions of (200 - 400) GeV/c protons and 50 and 200 GeV pion with emulsion nuclei. Some events have been observed where pion has not been produced at all. It is generally believed that every hadron of sufficient high energy when traversing massive atomic nucleus at small impact parameter creates multiple secondary particles, which are mainly pion. Our observation are not in agreement with expectations. Events have been observed in which high energy proton at different accelerator energies, traversing through nuclear emulsion cause no pion production. Thus this observation seems to indicate a new form of high energy interactions unknown so far.
2. Experimental details

The scanning of the plates was performed on a Leitz-Wetzlar microscope provided with a Brower travelling stage. The plates were scanned using oil immersion 100 x objective in conjunction with 16.8 x ocular. Scanning was done from the entrance edge of the plates. To avoid contamination by secondaries only those stars due to the entrance of proton beam making an angle $< 10^\circ$ from the original proton beam direction were taken. Each of the events were observed with utmost care under high magnification for distance greater than 2000 micron downstream from the vertex for any neutral particle decay or any interaction. Scanning was done by three independent observers. The scanning efficiency for observing charged particles or neutral particles decay is almost about 100%.

According to the emulsion terminology the tracks associated with each one of the interaction are classified into the following types

(a) Shower tracks $(n_s)$ for which $b^* < 1.4$ where $b^*$ is the normalized blob density.

(b) Grey tracks $(n_g)$ for which $b^* \geq 1.4$ and $g^* \leq 6$, where $g^*$ is the normalized grain density

(c) Black tracks $(n_{bl})$ for which $g^* > 6$.

The shower tracks are attributed to mainly pions, grey tracks to recoil nucleons and black tracks to evaporated fragment from the highly excited nuclei.

All possible measures were taken to ensure that these events are not really accompanied by any charged or neutral pion.

1. To exclude the possibility of the presence of neutral pion careful scanning was done to see if there is any downstream materialisation of gamma from a neutral pion. The searching volume was: radius $>$ 200 micron and distance (from the interaction point) $> 3$ cms. No electron-positron pair was revealed in all the cases, which shows conclusively the absence of any neutral pion.
2. It was ascertained by relative scattering method that the incident particles were protons.

3. It was noted that no other primary or secondary interaction was observed in the vicinity of these events.

4. From the observation (2) above it can also be inferred that these events are not due to peripheral charge exchange collision like

\[ p + A \rightarrow p^* + A' \]

\[ \rightarrow n + \pi^0 \]

5. It was also ascertained that these events are not background due to some other process.

These observations undoubtedly support the fact that the events singled out are cases of interactions without any pion (charged or neutral) production.

Similar high energy hadronic collision without pion creation was observed by Strugalski (1978) in bubble chamber (Pion - Xenon nuclei collision events) and a few events at 300 GeV/c by Ghosh et al (1980) which has been reported earlier. It is interesting to observe that at each energy the number of such events amounts to 1-2% of the total events scanned which is also in agreement with Strugalski (1978).

This experimental investigation of the proton-nucleus collision indicates a picture of the collision process which differs much from the pictures applied in any of the existing models.

The theory is yet to be proposed to explain the origin of these 'new' type of events. Nevertheless it is very interesting and worthwhile to discover these type of interactions because it may throw some light on the new possibilities for the investigation of hadron structure.
<table>
<thead>
<tr>
<th>Incident particle</th>
<th>Energy (GeV)</th>
<th>Total No. of Events</th>
<th>Type +</th>
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<tr>
<td>p</td>
<td>400</td>
<td>405</td>
<td>4 + 0, 13 + 4, 5 + 8, 3 + 1, 4 + 0</td>
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<tr>
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<td>480</td>
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<td>p</td>
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<td>405</td>
<td>5 + 4, 4 + 5, 14 + 3, 5 + 1, 4 + 0</td>
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<tr>
<td>π⁻</td>
<td>50</td>
<td>300</td>
<td>4 + 5, 6 + 5, 5 + 0, 5 + 2</td>
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<tr>
<td>π⁻</td>
<td>200</td>
<td>300</td>
<td>3 + 5, 4 + 0, 5 + 3, 11 + 2</td>
</tr>
</tbody>
</table>

References:

Strugalski, Z. (1978), JINR E1-11975
(1978), JINR E1-11976