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# PROPOSAL TO THE TRACK CHAMBER COMMITTEE FOR AN EXPOSURE OF THE 81 cm DEUTERIUM BUBBLE CHAMBER WITH $\pi^+$ OF 4 GeV/c

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We propose to study the $\pi^+$ interactions at $\simeq$ 4 GeV/c in the 81 cm bubble chamber filled with deuterium.

## 1. Study of non-strange neutral mesonic systems

A reaction such as

$$\pi^+ (P_S - N) \rightarrow P_S + P + X^o \qquad (1)$$

where $X^o$ is a neutral non-strange mesonic object and $P_S$ the proton spectator has been used in the past by several authors to study $\omega$ and $\eta$. We would like to extend this study to higher mass values of $X^o$ and give particular attention to the production and decay of $f^o$.

We intend to put a special emphasis on those events in which the nucleon suffers a low momentum transfer ($< 800$ MeV/c) which are easy to detect through the high bubble density of the recoil proton and which are typical of peripherism.

The study of $X^o$ can then be divided into three classes :

(a) For those $X^o$ which have a permitted neutral decay mode, as it is expected to be the case for $f^o$, the missing mass spectrum



should exhibit peaks. Since up to now the existence of $f^o$ has been suggested only through its $\pi^+\pi^-$ decay mode it would be of great interest to observe its existence through the $\pi^o\pi^o$ mode.

It should be noticed that, while the study of such neutral objects through their $\pi^+\pi^-$ decay modes is somewhat obscured by the abundant production of $\rho^o$ with its large width, such an effect should not occur here, the two $\pi^o$ decay of $\rho^o$ being forbidden by isospin conservation.

(b) Of course the decay of $X^o$ into two or four charged pions can also be studied, as well as those decays in which one extra $\pi^o$ may be implied.

(c) For $X^o$ with a mass higher than 1 GeV the possible decay into two $K^o$ has to be looked for. Among other questions the possible decay of $f^o$, and the proposed $K\bar{K}$ resonance at 1020 MeV will come out, if they do exist, from the study of the events

$$\pi^+ + (P_S - N) \rightarrow P_S + P + K_1^o + K_1^o$$

$$\rightarrow P_S + P + K_1^o + (\text{neutral with mass equal to K})$$

2. Study of strange neutral mesonic systems

Such a study is made possible when the neutron, instead of going to a proton, goes to a $\Sigma^+$.

$$\pi^+ + (P_S - N) \rightarrow P_S + \Sigma^+ + Z^o$$

$Z^o$ is then a neutral mesonic system of strangeness +1.

Just as in the preceding case $Z^o$ can be studied either by its neutral decay mode through the missing mass spectrum or by its charged decay modes.

Events of this type will be easy to detect due to the characteristic aspect of the $\Sigma^+$ track.

Excited states of $K^o$ should appear in this way (see also 3b below).

3. Other points of interest as possible by-products

(a) It has already been shown by the Columbia-Rutgers groups that $\rho^o$ and $\omega$ were essentially produced associated with the 3/2 3/2 $I^{++}$ isobar in the reaction $\pi^+ + P \rightarrow \rho^o$ or $\omega^o + I^{++}$. The initial state of the proposed reaction being 1/3 in the T = 3/2 and 2/3 in the T = 1/2 state, it should be possible to investigate if the same kind of correlation occurs through the T = 1/2 channel since the ratio of the different charge combinations is quite different in both cases

| | $(N\pi^+)(\pi^+\pi^-)$ | $(P\pi^-)(\pi^+\pi^o)$ | $(P\pi^o)(\pi^+\pi^-)$ | $(P\pi^+)(\pi^-\pi^o)$ |
|---|---|---|---|---|
| T = 1/2 | 1 | 8 | 2 | 18 |
| T = 3/2 | 2 | 1 | 4 | 9 |

The possible associated production of $f^o$ and of the 3/2 3/2 $I^{++}$ isobar can also be studied in the events

$\pi^+ + (P_S - N) \rightarrow P_S + (P\pi^o) + (\pi^+\pi^-)$ and $\rightarrow P_S + (N\pi^+) + (\pi^+\pi^-)$

(b) If there exists an excited K with T = 3/2, it would be possible to detect it through the reaction

$$\pi^+ + (P_S - N) \rightarrow P_S + \Sigma^- + K^{++} (\rightarrow K^+ + \pi^+)$$

or through $\pi^+ + (P_S - N) \rightarrow P_S + \Sigma^+ + K^{o**} (\rightarrow K^+ + \pi^-)$

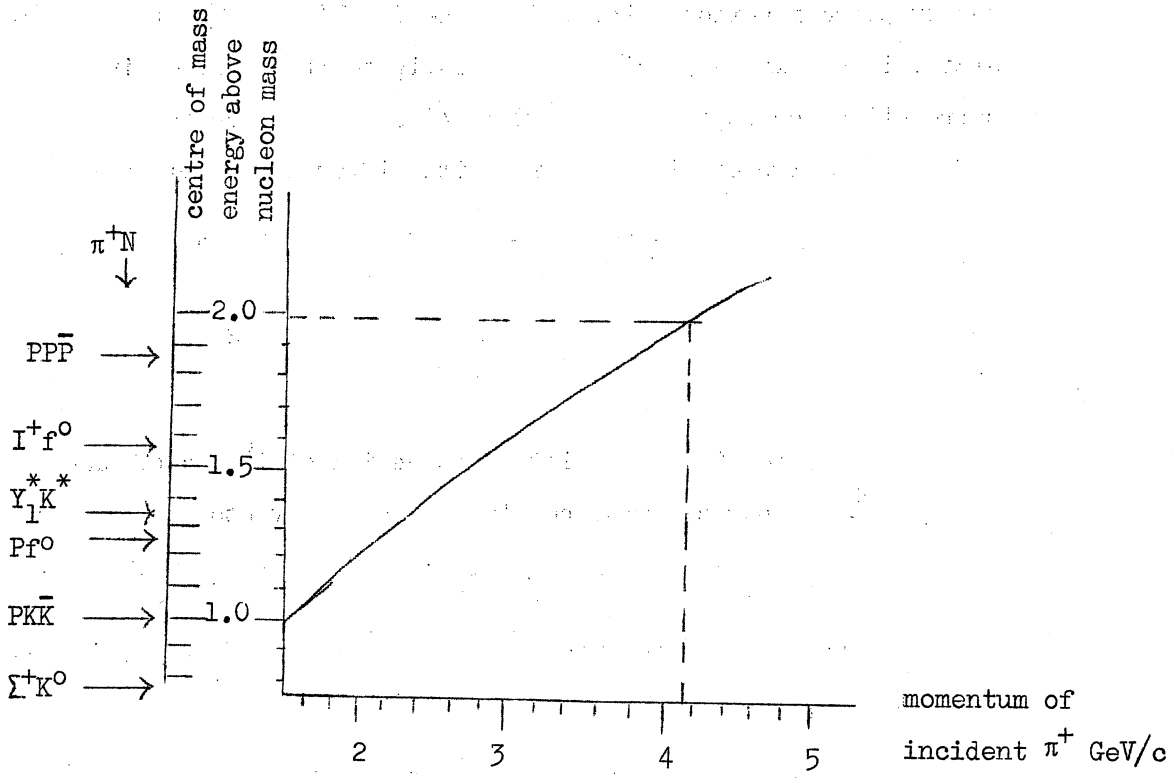
(c) The threshold of the reaction

$$\pi^+ + (P_S - N) \rightarrow P_S + P + P + \bar{P}$$

lies in the vicinity of the region of interest. By choosing an energy slightly above this threshold it could be possible to measure the cross-section for the process if it is not too low. Such events will appear as a triplet of two positive and one negative particles in the forward direction.

4. Choice of energy

On the figure below some of the thresholds of interest have been plotted.



We propose to use an incident $\pi^+$ momentum of 4.2 GeV/c which leaves 2 GeV of available energy above the nucleon mass in the centre of mass of the $\pi$-nucleon system.

This will give an upper limit for the mass of the non-strange mesonic systems of 2 GeV and for that of strange mesonic systems of 1.75 GeV. However, due to the limitations introduced by phase space at the upper limit of the mass spectrum the practical limit will be about 200 MeV lower than the theoretical one.

The lower limit of square momentum transfer to the target nucleon of reaction (1), neglecting Fermi motion, is 1.5 $m_\pi^2$ if $X^o$ has the 1250 MeV mass currently admitted for $f^o$.

Particular care should be taken to reduce the energy spread of the beam. It should not exceed $\pm$ 1% and efforts should be made to go somewhat below this value.

5. Number of photographs

We estimate to $10^5$ the number of photographs that would be necessary for this work.