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Vigner, Baz and Okun(1,2,3)showed that the energy dependence of the cross section of a reaction going through a definite channel has an anomaly in the region of the threshold at which a new reaction channel opens up. In this connection L.I. Baz, L.B. Okun and Ya.A. Smorodinsky pointed out to us the usefulness of investigating the energy dependence of the pion-nucleon cross section near the threshold of meson production. $(\pi+N\rightarrow 2\pi+N)$ in order to get information on the π-π interaction. In the experiments we have been performing in the energy interval 150-180 MeV we did not observe any anomaly* in the energy dependence of the total π^{-}-p cross section. However it soon became clear to us that a precision investigation of the energy dependence of the π^{-}-p cross section with high energy resolution is of greatest interest(and not only near the threshold of meson production), because it may give some information on the existence of ρ^{0} mesons.

The aim of the present paper is to describe the principle and to assess the possibilities of a method** apt to search for ρ^{0} mesons:

Such a method is in our opinion more real than other methods suggested up till now[4].

The method consists in searching for a relatively nerrow anomaly in the energy dependence of the π^{-}-p cross section, inasmuch as such an anomaly would in principle give evidence on the existence of ρ^{0} mesons. As a metter of fact it is to be expected that in the reactions $\pi^{-}+p\rightarrow\pi^{-}+p$ and $\pi^{-}+p\rightarrow\pi^{0}+p$ there arises an anomaly in the cross section energy dependence at the threshold of the $\pi^{-}+p\rightarrow\rho^{0}+n$ reaction. From an experimental point of view it is quite convenient, as a first step, to look for an anomaly in the energy dependence of the <u>total</u> π^{-}-p cross section. Subsequent investigations of the angular distribution in the region of the anomaly (if any) would be very interesting and could give information on the relative parity of ρ^{0} and π mesons.

The width of the anomaly depends upon the interaction radius R and can be obtained from the condition $KR \ll 1$, where K is the wave vector of the produced ρ^{0} mesons[2] in the center of mass system. Assuming $R\sim\frac{\hbar}{m_{\rho}c}$ the <u>maximum</u> width ΔE of the anomaly in the energy dependence of the total π^{-}-p cross section turns out to be about 40 MeV for a ρ^{0} mass value of $\sim$ 400 MeV/c^2. Here ΔE is the lab.system energy interval of inpinging pions beyond which the anomaly in no way can be noticed. The anomaly width can be considerably smaller than ΔE, and consequently the experiment must be performed with very good energy resolution.

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* It is not difficult to see that the threshold anomaly practically disappears when there are three particles in the final state.

** It became known to us recently that V.I. Goldansky and Ya.A. Smorodinsky came to analogous conclusions(private communication).

It was assumed above that the life-time of the ρ° mesons is big in comparison with a typical nuclear time $\frac{\hbar}{m_\pi c^2}$, i.e. that the ρ° meson production threshold is quite definite. The relative amplitude of the anomaly $\frac{\Delta\sigma}{\sigma}$ is of the order of $\frac{(\sigma_{\pi^- p \to \rho^\circ n})_{K=\frac{1}{R}}}{\sigma^{tot}_{\pi^- p}}$, and might attain values of a few per cent.

The above suggest method is apt to search for any neutral meson with sufficiently small natural width. We are concerned here with ρ° mesons, and assume that they differ from π° mesons only in the value of the isotopic spin ($T_{\rho^\circ}=0$). In this case the ρ° meson cannot decay quickly either into 2π mesons (because of parity conservation) or into three π mesons (because the quantum number G is conserved[4,5]) and will decay through the channel $\rho^\circ \to \gamma + \gamma$ or, if its mass is sufficiently high, through the channel $\rho^\circ \to \pi + \pi + \gamma$. If the mass of ρ° meson is considerably larger than 560 MeV/c^2 the decay into four π mesons will occur with the typical nuclear life time. In such a case the method suggested above does not work*.

Independently of the ρ° meson nature the question arises as to whether either the pick observed in the energy dependence of the cross section for photo-pion production in hydrogen[6] or the picks observed recently in the energy dependence of the $\pi^- - p$ total cross section at energies 700 and 1000 MeV[7] are connected with threshold effects. If seems to us that the answer is negative: these picks apparently have too large width to be caused by threshold effects.

If one or both of these picks were connected with ρ° mesons the interaction would be a resonant one and the mass of ρ° mesons should be considerably smaller than ~ 600 or ~ 800 MeV/c^2.

Generally speaking the most typical difference between a resonance maximum and a threshold anomaly (in the case when such anomaly appears in form of a pick and not in form of a minimum or a step) is the value of their width.

As for the mass difference of π° and ρ° mesons, all the available experimental evidence in the region of high energy physics suggests that interaction in different isotopic spin states have quite different intensities. This is just what causes particles belonging to one isotopic multiplet to transform one into another (charge exchange phenomena). In particular, as Ya.B. Zeldovich pointed out to us, the very existence of the charge exchange scattering of antiprotons ($\tilde{p} + p \to \tilde{n} + n$) indicates a considerable difference of π° and ρ° masses.

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* Barrier effects connected with high orbital momenta can slow down very considerably[4] the ρ° meson decay into four mesons if the ρ° mass is only slightly larger than the mass of four pions.

In the next paper we shall describe the main characteristics of the experimental technique with which at present search for ρ° meson experiments are being conducted and the first results obtained.

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