If this is indeed the case, then nonmesonic decay of hyperon fragments, with its characteristic high-energy release, need not necessarily be expected to follow closely the $\Delta I=\frac{1}{2}$ rule,[14] even though this rule seems to hold for free Λ^0 decay.

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Pion-Nucleon Interactions*

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FIGURE 1 shows the behavior of the pion-nucleon total cross sections[1] as a function of pion energy, when charge independence is assumed and the cross sections are separated into isotopic spin (T) states of $\frac{1}{2}$ and $\frac{3}{2}$. The well-known peak in the $\frac{3}{2}$ state at a pion kinetic energy of about 180 Mev appears to be satisfactorily explained by a p-wave resonance in the state of isotopic spin (T) and angular momentum (J) equal to $\frac{3}{2}$. The low value of the experimental limits on the $T=\frac{1}{2}$ cross section below 200 Mev and the peak in this cross section at about 0.9 Bev have not been satisfactorily explained to date although many attempts have been made, including notably the pion-pion interaction scheme of Dyson,[2] Takeda,[3] and Piccioni.[1]

A major difficulty of the Dyson-Takeda scheme is the expected effect of the momentum distribution of the pions in the nucleon cloud which requires too large[1] (± 1 Bev/c) a smearing out of even a sharp resonance effect. Furthermore, in a study of the inelastic pion production Walker *et al.*[4] conclude that the experimental evidence does not support this model.

In a previous publication[5] we have found it possible to explain the major features of pion production in nucleon-nucleon collisions in the 0.8- to 3.0-Bev incident energy range by assuming that all inelastic reactions proceed via excitation of one or both nucleons to an isobaric nucleon level with $T=J=\frac{3}{2}$.

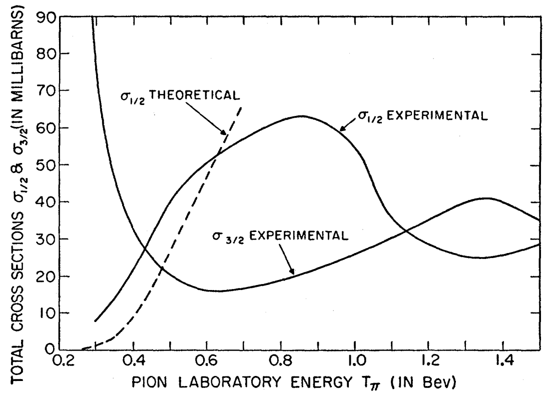

FIG. 1. Total cross sections $\sigma_{\frac{1}{2}}$ and $\sigma_{\frac{3}{2}}$ for the pion-nucleon interaction in the $T=\frac{1}{2}$ and $T=\frac{3}{2}$ states. The solid curves are based on the experimental values (reference 1). The dashed curve gives the theoretical values of $\sigma_{\frac{1}{2}}$ near threshold obtained from Eq. (1) with a suitable choice of $A_{\frac{1}{2}}$.

During this work it occurred to us that perhaps the behavior of the $T=\frac{1}{2}$ cross section could be explained by assuming that all pion-nucleon interactions of pion kinetic energy less than 1.5 Bev proceed via excitation of this one state. Hence one would not find any $T=\frac{1}{2}$ cross section until a threshold energy ($\gtrsim 200$ Mev) is reached which is sufficient to form an isobar of $T=J=\frac{3}{2}$ with a separate recoil pion. The separate recoil pion allows the total system of an isobar with $T=\frac{3}{2}$ and a separate recoil pion with $T=1$ to have a total $T=\frac{1}{2}$.

The variation of the cross section $\sigma_{\frac{1}{2}}(T_\pi)$ near threshold as a function of incident pion energy T_π was assumed in analogy to our previous treatment for nucleon-nucleon collisions to be given by

$$\sigma_{\frac{1}{2}}(T_\pi)=A_{\frac{1}{2}}\int F(T_\pi,m_I)\sigma_{\frac{3}{2}}(m_I)dm_I, \qquad (1)$$

where m_I is the total mass in the isobar rest system, $F(T_\pi,m_I)$ is the two-body phase space factor for an isobar of mass m_I and the recoil pion, $\sigma_{\frac{3}{2}}(m_I)$ is the total π^+-p scattering cross section, and $A_{\frac{1}{2}}$ is an arbitrary constant. It has been assumed that the ratio of the elastic and inelastic cross sections is independent of energy.

A plot of Eq. (1) is shown in Fig. 1 with $A_{\frac{1}{2}}$ adjusted for a reasonable fit. As one can see, the rise of the $T=\frac{1}{2}$ cross section from threshold to the region near the peak is generally similar to the prediction based on Eq. (1). Of course Eq. (1), which is the expression predicted near threshold, does not level off or saturate with increasing energy as one would expect a physical process of this type to do in general because of the fact that $\lambda\!\!\!^{-} < R$, where R is the range of interaction. Furthermore the process may involve resonance of certain waves which would lead to a peak and a decrease thereafter.

In the present crude model one can just expect to explain the threshold and the general behavior of the

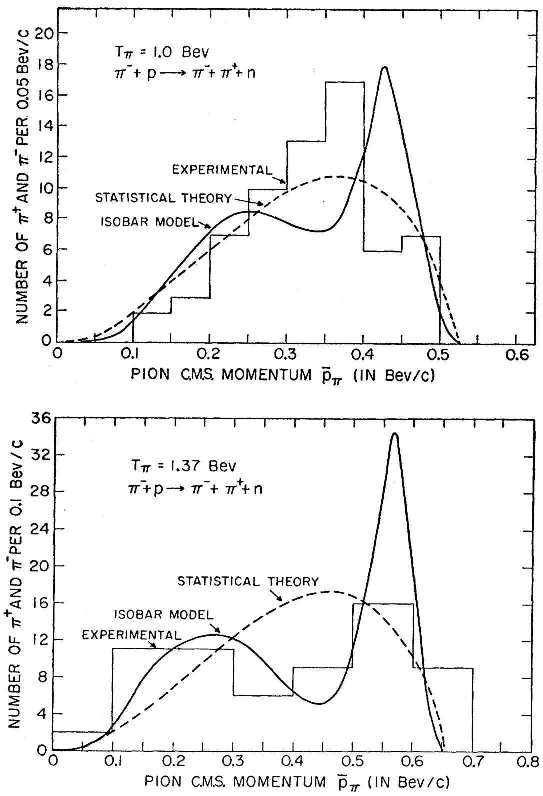

FIG. 2. Center-of-mass momentum spectra of π^+ and π^- mesons from the reaction $\pi^- + p \rightarrow \pi^- + \pi^+ + n$. (a) Incident pion energy $T_\pi = 1.0$ Bev. The histogram represents the data of Walker *et al.* (reference 4). (b) Incident pion energy $T_\pi = 1.37$ Bev. The histogram represents the data of Eisberg *et al.* (reference 6). In each case, the solid curve was obtained from the present isobar model. The dashed curve gives the result of the Fermi statistical theory. The two theoretical curves have been normalized to the number of observed cases.

rise in the $T=\frac{1}{2}$ cross section. A detailed consideration of the behavior at and beyond the peak would require a more detailed treatment of the process which will be presented at a later date.

One should note that more than half of the experimental[4,6] $T=\frac{1}{2}$ cross section is inelastic. The elastic portion of the cross section contains an elastic contribution which may be composed partly of a general background and partly of the elastic diffraction scattering accompanying the inelastic cross section. The large inelastic cross section is what one expects from the pion decay of the isobar.

Feld[7] has previously suggested the use of an isobar in these interactions to reduce the requirement for waves of high angular momentum in order to fit the magnitude of the observed peak in the $T=\frac{1}{2}$ state.

Of course one would expect this process of isobar formation to occur also in the $T=\frac{3}{2}$ state, since an isobar with $T=\frac{3}{2}$ and a pion with $T=1$ can combine to form a $T=\frac{3}{2}$ state. It should be noted that the $T=\frac{3}{2}$ cross section $\sigma_{\frac{3}{2}}$ is increasing fairly rapidly from 0.6 Bev to $\sim$1.0 Bev and reaches a peak at 1.3 Bev (see Fig. 1). If one subtracts the tail of the low-energy resonance the effect becomes more pronounced, and suggests a lower energy threshold for the remainder of the cross section for this effect. The higher energy peak could possibly still be consistent with the formation of a $T=J=\frac{3}{2}$ isobar since the arbitrary coefficient A with which the integral of Eq. (1) is multiplied could be smaller in the $T=\frac{3}{2}$ case and hence the saturation effects for this rising integral could set in at a higher energy.

Of course the formation of a $T=\frac{5}{2}$ isobar or some other process involving production of two additional pions could occur.[8]

The predicted momentum spectra for the inelastic pion processes have been calculated[9] for isotropic decay of the isobars, and are compared to the statistical theory and to the available experimental results[4,6] in Figs. 2(a) and 2(b). It is clear that the predictions of the present model are in reasonable agreement with the experimental data[4,6] within their large statistical uncertainties.

The most distinctive characteristic of these theoretical pion spectra is the double peak. The lower energy peak is due to decay pions from the isobar while the well-defined high-energy peak is due to the recoil pions. Clearly, better experimental data are needed to check these predictions accurately.

The authors are indebted to Dr. R. Serber for stimulating discussions and several important suggestions concerning this problem. We also wish to thank Dr. L. C. L. Yuan for valuable comments.

* Work performed under the auspices of the U. S. Atomic Energy Commission.

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Magnetic Resonance Determination of the Magnetic Moment of the μ Meson*

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IN a previous experiment,[1] the g value of the positive muon was found to be $+2.00 \pm 0.10$. This is a first report on a more precise determination of the magnetic