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 δ^- PRODUCTION IN A REGGE POLE AND L- EXCITATION SCHEME MODEL

D. G. Sutherland
CERN - Geneva

ABSTRACT

The cross-section for δ^- production is crudely estimated by Regge pole arguments, assuming δ^- to have $J^{PC} = 0^{++}$ as suggested by L - excitation schemes. A cross-section of 4 - 13 μb is estimated as compared with experimental value $7 \pm 2.5 \mu\text{b}$.

Recently evidence has been given by Focacci et al.¹⁾ in the reaction $\pi^- p \rightarrow p X^-$ for a narrow peak at 963 ± 5 MeV with $I=1$ ²⁾. It is interesting to speculate that this may be the 0^{++} meson (J^{PC} being our notation) discussed by Dalitz³⁾ in his review on the quark model with L excitations. Although the author does not believe^{*)} in the quark model in its simple form⁵⁾, somehow it gives suggestive results for mass spectra and we, therefore, try to test it by considering δ^- production although there is no evidence that $J^P=0^+$ and its narrow width is rather worrying.

Our first inclination was to try the quark model for high energy scattering⁶⁾. The results of this analysis are not complete, though we hope to have them soon, but, meantime, we discuss a Regge pole model^{**)}. Morrison⁹⁾ has recently presented evidence that A_1 and A_2 ^{***)}, which would be fellow I spin 1 members with δ^- of the Borchini and Gatto¹⁰⁾ scheme, have production cross-sections which are roughly independent of the incident energy of the pion. This suggests Pomeron exchange in the Regge scheme for A_1 and A_2 and for spin and parity reasons this is allowed. For the δ^- , however, since it has $J^P=0^+$ in our approach, ρ exchange is forbidden and one must exchange a lower trajectory, such as the ω , B meson, etc. To obtain a simple estimate of the δ^- cross-section, we may then argue that

$$\frac{\sigma_{\delta^- \text{ production}}}{\sigma_{A_1, A_2 \text{ production}}} \approx \frac{\sigma_{\text{ch.ex. or inelastic}}}{\sigma_{\pi N \text{ total}}}$$

*) This may be seen by taking a linear combination of results in Ref. 4) and remarks in Ref. 3). However, for curious psychological reasons, this was not done in Ref. 4).

**) See Cabibbo et al.⁷⁾. We feel, however, that there is some reason to doubt the algebra which they employ [see Johnson and Low⁸⁾] and still more reasons to doubt their saturation hypothesis.

***) Though it should be noted that there exists some question as to whether there are one or two peaks in the " A_2 " and as to whether the $\pi^+ \pi^- \pi^\pm$ mode observed by Morrison has $J^P=2^-$.

Typical numbers for the right-hand side, where σ represents cross-sections for reactions such as $\sigma_{\pi^- p \rightarrow \eta n}$, $\sigma_{\pi^- p \rightarrow \pi^0 n}$, $\sigma_{K^- p \rightarrow \bar{K}^0 n}$, and $\sigma_{\pi^- p \rightarrow \rho^- p}$ are at ~ 3 GeV/c incident pion momentum, as in Ref. 1), $1/30$ to $1/100$ depending on the particular reaction chosen.

Using Morrison's data, one obtains $\sigma_{A_1, A_2 \text{ production}}$ should be ~ 400 mb at 4 GeV π^- incident energy, whence in our very simple-minded approach we get $\sigma_{\delta^- \text{ prod.}} \sim 4$ to 13 mb.

This compares very amusingly with the result of Ref. 1). These authors only have $d\sigma/dt$ at $t \sim 0.15(\text{GeV}/c)^2$ and to get σ_{tot} they must use a model such as $d\sigma/dt \propto e^{-8t}$ in order to obtain σ_{tot} as $\sim 7.0 \pm 2.5$ b/(GeV/c)². Possibly because of the weak coupling of ψ to nucleons expected in SU(3) with a D/F ratio $\cong \frac{3}{2}$, or the non-existence of a B trajectory, the reaction could go by a different path, such as :

In this case $d\sigma/dt$ would be peaked backwards rather than forwards. However, the t value $0.15(\text{GeV}/c)^2$ corresponds to a u value of several $(\text{GeV}/c)^2$ and would lead to a total cross-section of several mb, if one assumes a slope of the form e^{uA} with $A = 1-10/(\text{GeV})^2$. This we believe to be unreasonable in view of experience with other baryon exchange cross-sections 11).

If one then accepts the idea that δ^- production is proceeding by "background" trajectories in the meson exchange channel, one obtains a prediction that σ_{tot} for δ^- production should fall as $(p \text{ incident})^{-(2 \pm 0.5)}$, Ref. 12). We understand this is not incompatible with the present data.

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