PRODUCTION IN A REGGE POLE AND L-EXCITATION SCHEME MODEL

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ABSTRACT

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

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Recently evidence has been given by Focacci et al. 1) in the reaction $\bar{\tau}^- p \rightarrow px^- \bar{\tau}$ 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 Dalitz 3) in his review on the quark model with L excitations. Although the author does not believe *) in the quark model in its simple form 5), somehow it gives suggestive results for mass spectra and we, therefore, try to test it by considering $\delta^-$ 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 scattering 6). The results of this analysis are not complete, though we hope to have them soon, but, meantime, we discuss a Regge pole model **). Morrison 9) has recently presented evidence that $A_1$ and $A_2$ ***), which would be fellow I spin 1 members with $\delta^-$ of the Borch and Gatto 10) scheme, have production cross-sections which are roughly independent of the incident energy of the pion. This suggests Pomeranchuk exchange in the Regge scheme for $A_1$ and $A_2$ and for spin and parity reasons this is allowed. For the $\delta^-$, however, since it has $J^P=0^+$ in our approach, $\rho$ exchange is forbidden and one must exchange a lower trajectory, such as the $\psi$, B meson, etc. To obtain a simple estimate of the $\delta^-$ 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 Low 8)] 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 $\pi^+ \pi^- \pi^0$ mode observed by Morrison has $J^P=2^-$. 

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Typical numbers for the right-hand side, where $\sigma_{\text{ch.ex. or inelastic}}$ represents cross-sections for reactions such as $\pi^- p \rightarrow \eta n$, $\pi^- p \rightarrow \eta^0 n$, $\eta^- p \rightarrow K^0 n$, and $\eta^- p \rightarrow \rho^- p$ are at $\sim 3$ 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 $\sigma_{A_1, A_2}$ production should be $\sim 400$ mb at 4 GeV $\pi^-$ incident energy, whence in our very simple-minded approach we get $\sigma_{\text{prod.}} \approx 4$ 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 $\sigma_{\text{tot}}$ they must use a model such as $d\sigma/dt \propto e^{-8t}$ in order to obtain $\sigma_{\text{tot}}$ as $\sim 7.0 \pm 2.5$ b/(GeV/c)$^2$. Possibly because of the weak coupling of $\eta$ to nucleons expected in SU(3) with a $D/P$ ratio $\approx \frac{3}{2}$, or the non-existence of a $B$ trajectory, the reaction could go by a different path, such as:

\[ \begin{array}{c}
\eta^- \\
\downarrow \\
\eta^{*++} \\
\uparrow \\
\rho^- \\
\end{array} \]

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.

If one then accepts the idea that $\delta^-$ production is proceeding by "background" trajectories in the meson exchange channel, one obtains a prediction that $\sigma_{\text{tot}}$ for $\delta^-$ production should fall as $(p\text{ incident})^{-1}(2\pm 0.5)$, Ref. 12). We understand this is not incompatible with the present data.
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REFERENCES

1) M.N. Focacci et al., "Mass spectrum of charged bosons from 550 to 2450 MeV observed in missing mass spectrometer", submitted to the Berkeley Conference.


4) R.H. Dalitz and D.G. Sutherland, Phys.Rev. 145, 1180 (1966) and comments in Ref. 3).


