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POSSIBLE STRUCTURE IN HYPERON EXCHANGE

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ABSTRACT

We point out that present data concerning hyperon exchange support the systematic appearance of structure at $u \simeq -1.0\ (GeV/c)^2$. That is interesting because, if confirmed by future experiments, it would be rather hard to explain with current high energy models.

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Dips in differential cross-sections are interesting for strong interaction phenomenology, since they provide a qualitative characterization of the data which should be accounted for by the qualitative features of proposed theoretical models. Up to now, these can be classified, by and large, in two families. In one of them one finally comes to some kind of geometric picture of the interaction process [i.e., amplitude zeros given by $J_{\Delta\lambda}(R\sqrt{-t})$ where $\Delta\lambda$ is the amount of helicity flip] [1]. In the other one, dips are essentially attributed to wrong signature zeros (WSZ) of a dominant Regge pole, though the accepted rules of the game allow here and there to invoke some substantial absorptive corrections or secondary Regge poles to shift or to avoid them [2]. Exchange degeneracy (EXD) adds further dynamical content requiring that in a forbidden channel the non-diffractive portion of the amplitude should have a vanishing imaginary part [3]. That implies that high energy exchanges should assemble in pairs of opposite signatures with equal trajectories and residues.

In this note, we make some remarks about a possible structure in hyperon exchange. Though not conclusively, present data definitely suggest the existence of such a structure, which is somewhat unexpected from strict EXD. What is more puzzling, however, is that an effect (a dip perhaps) seems to occur at more or less the same value of u (~ -1.0 (GeV/c)^2) in any process. As we shall discuss, this feature, if confirmed, would be rather hard to explain in current high energy models. That is essentially tied to the fact that hyperon exchange is made of several trajectories. Experiments aiming to clarify the situation would be, therefore, of interest.

<u>The experimental evidence</u>. High energy data concerning hyperon exchange are not very rich, especially in the region $|u| \gtrsim 1.0$ (GeV/c)^2. For $\pi^- p \to K^0 \Lambda$ there are data at 4 and 6.2 GeV/c (Beusch et al. [4]). Some effect at $u \simeq -1.0$ is clearly visible (the Figure), though an investigation at larger $|u|$ would be desirable. Preliminary data for $K^+ p \to K^+ p$ at 5 GeV/c (Baglin et al. [5]) show at the same position something which really seems to be a dip. An effect, though statistically unreliable, is observed also in $\bar{p}p \to K^- K^+$ [5].

What induces to give weight to these indications, not much impressive otherwise, is the puzzling appearance of similar structure in the production of $S = -2$ resonances. Here data are available only at lower energies. The evidence for a dip at $u \simeq -1.0$ is, however, clearer. In the Figure, the existing data (with reasonable statistics) for $K^- p \to K^0 \Xi^*(1530)^0$ and $K^- p \to K^+ \Xi^-$ are plotted. In this last process, one observes at low energy a bending of the dip towards lower $|u|$ values *) ; stability around $u \simeq -1.0$ seems to be reached above ~ 2 GeV/c. The extreme regularity of the dip structure over the whole energy range available makes it rather implausible to think that such a dip might stop surviving at higher energies.

Though the above experimental evidence is not conclusive, we believe that it is sufficiently consistent to justify some discussion of the theoretical implications of a possible dip at $u \simeq -1.0$ $(\mathrm{GeV/c})^2$ in any process involving hyperon exchange.

High energy models. Clearly EXD + WSZ would be completely inconsistent with any dip in hyperon exchange (at least in processes with a forbidden channel).

Even WSZ alone would meet with difficulties. Hyperon exchange, indeed, includes several single exchanges and there is no reason why one of them should dominate. In $K^+p \to K^+p$, for instance, one could match the dip at $u \simeq -1.0$ with the WSZ at $\alpha = -3/2$ for $\Sigma_\delta(1385)$; but this would mean to deliberately ignore that $\Lambda_\alpha(1115)$ gives a strong contribution here, as it results from our knowledge of $K^-p \to K^-p$ channel [12].

As to the geometric picture (with or without EXD), the problem is that it predicts zero positions for helicity flip shifted with respect to those for helicity non-flip. Thus it is able to explain the general presence of a dip at the same value of u only if one of the two amplitudes does always dominate. Since $u \simeq -1.0$ is rather far apart from $\cos\theta = -1$, clearly one cannot invoke a kinematical suppression of helicity flip. Therefore, the suppression of one of the two amplitudes should be dynamical. That this really happens is rather unlikely, since the mixture of natural and unnatural parity in hyperon exchange is expected to vary from one process to another. In particular, from u channel low energy information, one knows that in $K^+p \to K^+p$ $(\Lambda_\alpha, \Lambda_\gamma)$ and $(\Sigma_\delta, \Sigma_\beta)$ exchanges, of opposite parities, are more or less of the same weight, while in $\pi^-p \to K^0\Lambda$ unnatural parity $(\Sigma_\delta, \Sigma_\beta)$ exchange dominates [12].

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*) This fact is very similar to what happens in $\bar{p}p$ elastic scattering at low energy [10]. Like there, it can be understood as due to the matching of the dip with the local zero generated at the intersection of dominant s and u resonance poles [Ref. 11]. According to the considerations of Ref. 11), one might have expected to find in this process fixed t dips developing as straight lines from such intersections. The non-observation of such dips is, however, not in contrast with the conclusions contained there, according to which only in the amplitude $A(s,t)$ (free of diffraction if this mechanism conserves helicity) such a kind of Veneziano regularities are more or less systematically observed. The observed structure of the differential cross-section for Ξ^- production should then be accounted for mainly by the amplitude $B(s,t)$.

In conclusion, present data seem to suggest the existence of a dip at $u \simeq -1.0\ (GeV/c)^2$ in processes involving hyperon exchange. Confirmation of such a systematic structure would cause troubles to current high energy models. Experiments needed to clarify the situation are : i) backward production by pions of hyperons of hyperon resonances with $S = -1$; ii) backward production of cascade hyperons or cascade hyperon resonances. All that above ~ 3 GeV/c and with reasonable statistics up to $u \simeq -1.5\ (GeV/c)^2$.

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FIGURE CAPTION

Data for two-body processes near backward direction involving hyperon exchange. The figure shows evidence for the presence of structure at $u \simeq -1.0$ $(\text{GeV}/c)^2$ in all the considered processes.

a) $\pi^- p \to K^0 \Lambda$, Ref. 4) ;

b) $K^+ p \to K^+ p$ and $\bar{p}p \to K^- K^+$, Ref. 5) ;

c) $K^- p \to K^0 \Xi^*(1530)^0$, Ref. 6) ;

d) $K^- p \to K^+ \Xi^-$, Refs. 7), 8) and 9). Solid lines are to guide the eye.

HYPERON EXCHANGE