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Comment on the broad $p\pi$ enhancement in the reaction $K^+n \to K^+p\pi^-$

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We show that the Y_l^m moments of the $p\pi^-$ low-mass enhancement in the reaction $K^+n \to K^+p\pi^-$ at 9 GeV/c can be interpreted in terms of a double-Regge-pole exchange model.

Lissauer *et al.*[1] reported a study of the broad enhancement below 1.8 GeV in the π^-p mass spectrum produced in the reaction

$$K^+n \to K^+\pi^-p \tag{1}$$

by a 12-GeV/c beam. Assuming Pomeron exchange, they fitted the π^-p angular distribution in terms of $P_{1/2}$, $D_{3/2}$, and $F_{5/2}$ contributions and suggested associating these terms with the production of known resonances. Differing amounts of the three partial waves were needed for three regions of four-momentum transfer between the incident and outgoing K^+ mesons. Since a broad diffractively produced mass enhancement is not necessarily a resonance and there is no obvious substructure in the $p\pi^-$ mass spectrum, and finally since the fitted $P_{1/2}$ component peaks substantially (~200 MeV) below the mass of the $P_{1/2}$ resonance found in phase-shift analysis, we have preferred to analyze the enhancement in terms of a double-Regge-pole exchange (DRPE) model.[2]

We have analyzed a comparable sample (4838 events) of reaction (1) at 9 GeV/c. Our data give nearly identical $p\pi$ moments when treated as in Ref. 1. We have, however, previously interpreted a large fraction of the events in the low-mass $p\pi$ enhancement in terms of a double-Regge-pole exchange model and found that the model with a small number of parameters gave an excellent description of all the various one-dimensional distributions such as effective masses, four-momentum transfers, and various other standard angular distributions. We also parameterized the measured differential cross section $d\sigma/dt'$ as $Ae^{-bt'}$ (where $t' = |t - t_0|$, with t the four-momentum transfer squared between the incoming and outgoing K^+ meson and with t_0 the kinematic upper limit for t) and the model correctly reproduced the observed decrease of b with increasing $p\pi$ effective mass. In this note we show that the moments of the $p\pi$ system are also correctly predicted by the DRPE model without further parameters.

In order to isolate the diffractively produced $p\pi^-$ enhancement we required both that the $K^+\pi^-$ effective mass be greater than 1.6 GeV/c^2 (to remove the dominant K^* resonances) and that the Van Hove angle be in the sector corresponding to the diffractive production of the $p\pi$ enhancement.[3] These cuts remove less than $\frac{1}{3}$ of the data at a $p\pi$ mass of 1.6 GeV/c^2 and even less at lower masses. In Fig. 1 we present the first six moments of the $p\pi$ system (Gottfried-Jackson frame) for the same three intervals of t' as in Ref. 1. Our data are essentially the same as those of Lissauer *et al.* except that our Y_2^0 moment has less structure at low t'. Differences at large values of t' or for $p\pi$ masses greater than 1.6 GeV are induced by our cuts. The solid curves in Fig. 1 are the DRPE model prediction using the same parameters as in Ref. 2. The agreement with the data is quite good. Our first four Y_l^1 are presented in Fig. 2. Again the model prediction is in good agreement with the mass and four-momentum-transfer-dependence of the data.[4]

We therefore conclude that the DRPE model can also reproduce the internal partial waves found in the low-mass $p\pi$ enhancement. Thus the double-Regge-pole exchange model and K^* production explain all the features of reaction (1).

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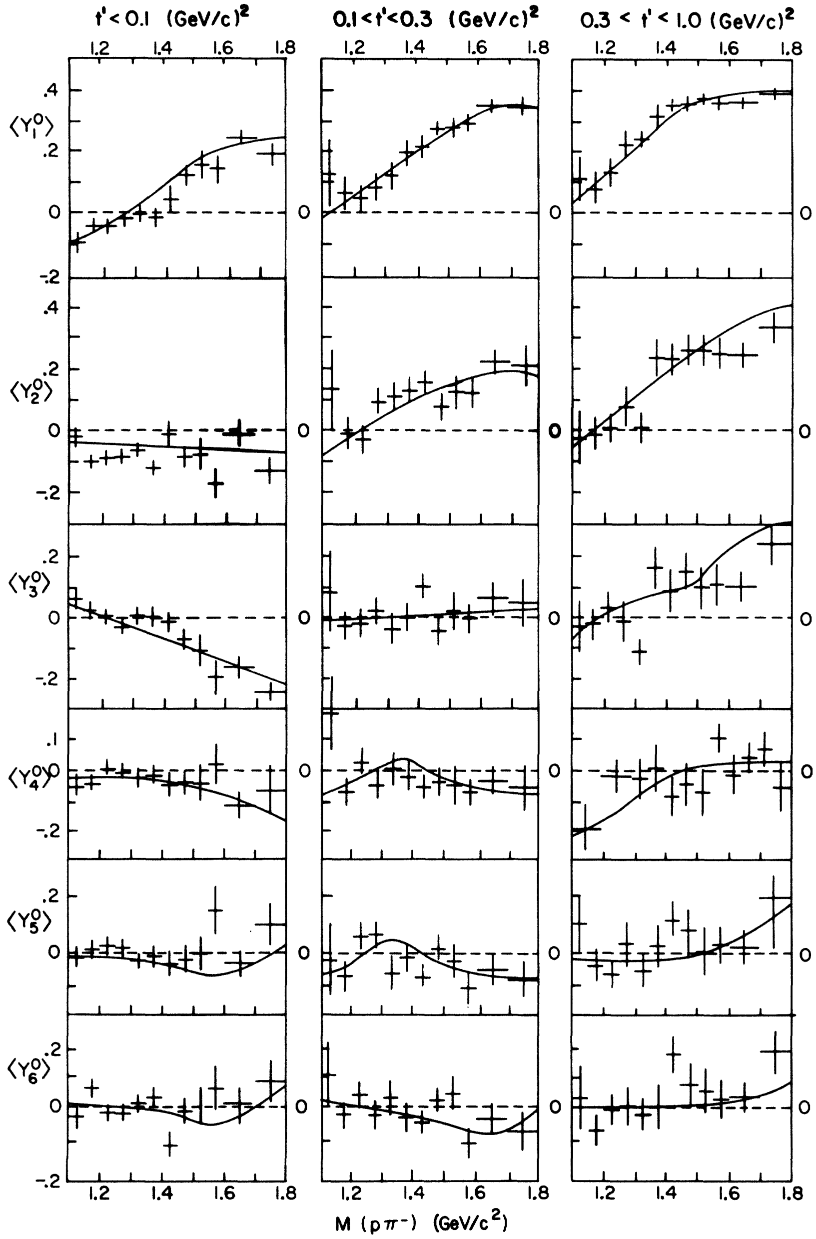

FIG. 1. Y_l^0 moments for $l = 1, 6$ as a function of the $p\pi$ effective mass for three regions of t' ($t' < 0.1$, $0.1 < t' < 0.3$, and $0.3 < t' < 1.0$ GeV^2/c^2).

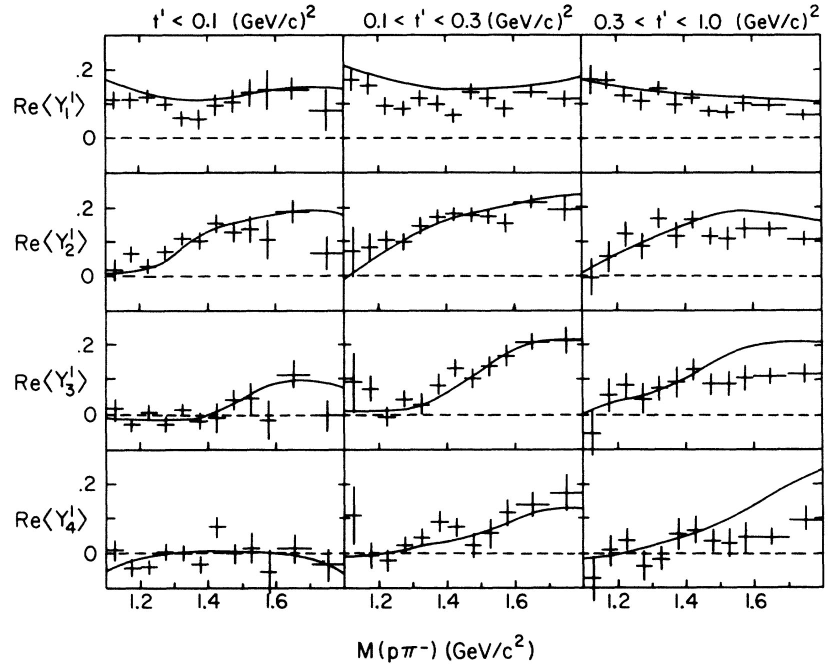

FIG. 2. $\mathrm{Re}Y_l^1$ moments (l =1,...,4) as a function of the $p\pi$ effective mass for three regions of t' (t' < 0.1, 0.1< t' < 0.3, and 0.3 < t' < 1.0 GeV^2/c^2).

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[1]D. Lissauer, A. Firestone, J. Ginestet, G. Goldhaber, and G. H. Trilling, Phys. Rev. D 6, 1852 (1972).

[2]W. L. Yen, F. T. Meiere, D. D. Carmony, D. Cords, A. F. Garfinkel, F. J. Loeffler, R. L. McIlwain, L. K. Rangan, R. L. Lander, D. Pellett, and P. M. Yager, Phys. Rev. D 9, 1210 (1974).

[3]See Ref. 2 for details. The model is that of E. L. Berger, Phys. Rev. 179, 1567 (1969). We also required that the proton momentum be less than 1.2 GeV/c.

[4]All other moments are consistent with zero. The m=1 moments shown are nearly consistent with zero if the cuts of Ref. 1 are used. Reference 1 reported that all $m \neq 0$ moments were consistent with zero.