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COMMENTS ON THE BROKEN EXCHANGE-DEGENERATE REGGE POLE MODEL FOR np AND $p\bar{p}$ CHARGE EXCHANGE

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COMMENTS ON THE
BROKEN EXCHANGE-DEGENERATE REGGE POLE MODEL
FOR np AND p$\bar{p}$ CHARGE EXCHANGE*

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ABSTRACT

We point out that formulas given by Pal on np and p$\bar{p}$ CEX for exchange-degenerate and broken exchange-degenerate Regge pole models can be better rationalized by considering π as simultaneously an M = 0 singlet and an M = 1 parity doublet and satisfying threshold behavior.

We have seen that np and p$\bar{p}$ CEX (charge-exchange) and charged-pion photoproduction differential cross section produce sharp forward peaks.[1] The pion conspiracy was popular and attractively economical in fitting those processes, it certainly is not unique,[2] and it causes difficulties in other processes via factorization.[3] We want to show here that the factorization difficulties resulting from the conspiracy hypothesis can be avoided if we take into consideration the pion as an M = 0 singlet and an M = 1 parity doublet simultaneously. The M = 0 pion is an evasive one with the usual pion-nucleon coupling constant at the pion pole, and an M = 1 is a parity doublet satisfying the conspiracy relation. An M = 0 pion singlet and an M = 1 parity doublet were considered simultaneously in np CEX.[4] Only an M = 1 pion parity doublet was considered by Pal[5] in the np and $p\bar{p}$ CEX broken exchange-degenerate Regge pole model. Now an M = 0 evasive pion should occur in invariant amplitudes $G_i(s,t,u)_{t=0,1}$[6] in the following manner:

$$G(s,t,u)_{T=0,1} = G_2(s,t,w)_{T=0,1} = G_5(s,t,w)_{T=0,1}$$

$$= -\frac{g^2}{\pi}\alpha'(t)\,\Gamma[-\alpha(t)]\,(1+e^{-i\pi\alpha(t)})\,(-\tfrac{3}{2},\tfrac{1}{2})\,(\frac{s}{s_0})^{\alpha(t)},$$

$$G_3(s,t,u)_{T=0,1} = G_4(s,t,u)_{T=0,1} \tag{1}$$

$$= \frac{g^2}{\pi}\alpha'(t)\,\Gamma[-\alpha(t)]\,(1+e^{-i\pi\alpha(t)})\,(-\tfrac{3}{2},\tfrac{1}{2})\,(\frac{s}{s_0})^{\alpha(t)}$$

for the pion exchange in the t channel, and therefore,

$$\phi_2(s,t)_{T=0,1} = \phi_4(s,t)_{T=0,1}$$

$$= -\frac{t}{2\sqrt{s}}\frac{g^2}{\pi}\alpha'(t)\,\Gamma[-\alpha(t)]\,(1+e^{-i\pi\alpha(t)})\,(-\tfrac{3}{2},\tfrac{1}{2})\,(\frac{s}{s_0})^{\alpha(t)} \tag{2}$$

and all other $\phi_i(s,t)$ are zero. For the pion exchange in the u-channel,

$$G_1(s,u,t)_{T=0,1} = G_4(s,u,t)_{T=0,1} = G_5(s,u,t)_{T=0,1}$$

$$= -\frac{g^2}{\pi}\alpha'(u)\,\Gamma[-\alpha(u)]\,(1+e^{-i\pi\alpha(u)})\,(\tfrac{3}{2},\tfrac{1}{2})\,(\frac{s}{s_0})^{\alpha(u)} \tag{3}$$

$$G_2(s,u,t)_{T=0,1} = G_3(s,u,t)_{T=0,1}$$

$$= \frac{g^2}{\pi}\alpha'(u)\Gamma[-\alpha(u)]\,(1+e^{-i\pi\alpha(u)})\,(\frac{s}{s_0})^{\alpha(u)}\,(\frac{3}{2},\ \frac{1}{2}) \ , \tag{4}$$

and therefore

$$\phi_2(s,u)_{T=0,1} = -\frac{u}{2\sqrt{s}}\frac{g^2}{\pi}\alpha'(u)\Gamma[-\alpha(u)]\,(1+e^{-i\pi\alpha(u)})\,(\frac{s}{s_0})^{\alpha(u)}\,(\frac{s}{s_0})^{\alpha(u)}(\frac{3}{2},\frac{1}{2}),$$

$$\phi_3(s,u)_{T=0,1} = \frac{u}{2\sqrt{s}}\frac{g^2}{\pi}\alpha'(u)\,\Gamma[-\alpha(u)]\,(1+e^{-i\pi\alpha(u)})\,(\frac{s}{s_0})^{\alpha(u)}\,(\frac{3}{2},\ \frac{1}{2}) \ , \tag{5}$$

and all other $\phi_i(s,u)$ are zero.

In Ref. 5, the residues were not properly rationalized, and therefore they did not satisfy correct threshold behavior for $\phi_5(s,t,u)$ only. Choosing the same invariant amplitudes in Ref. 5 for the t-channel pion exchange, one has conspiracy π_c and its exchange degenerate B_c

$$\phi_5(s,t)_{T=0,1}$$

$$\frac{\text{large s}}{\text{fixed t}} \sim -(-\frac{3}{2},\ \frac{1}{2})\frac{\beta(-t)^{1/2}(s+t-4m^2)^{1/2}}{m}\ \frac{(bs)^{\alpha(t)-1}}{\alpha(0)\Gamma[\alpha(t)]\sin\pi\alpha(t)} \tag{6}$$

instead of

$$\phi_5(s,t)_{T=0,1}\ \frac{\text{large s}}{\text{fixed t}} \sim -(-\frac{3}{2},\ \frac{1}{2})\,\beta_t(1+\frac{s}{m^2})^{1/2}\ \frac{m(bs)^{\alpha(t)-1}}{\sin\pi\alpha(t)\,\alpha(0)\Gamma[\alpha(t)]}$$

In Ref. 5, it does not satisfy correct threshold behavior[7] $\propto (-t)^{1/2}$ for small t. For the u-channel pion exchange, one has

$$\phi_5(s,u)_{T=0,\,1} \xrightarrow[\text{fixed } u]{\text{large } s} \sim -\left(\frac{3}{2},\ \frac{1}{2}\right) \beta(-u)^{1/2} \frac{(s+u-4m^2)^{1/2}}{m} \frac{(bs)^{\alpha(u)-1}}{\alpha(0)\,\Gamma[\alpha(u)]\ \sin\pi\alpha(u)}. \qquad (7)$$

It satisfies the correct threshold behavior $\propto (-4)^{1/2}$ for small u.

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FOOTNOTE AND REFERENCES

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