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DUALITY VERSUS s CHANNEL HELICITY CONSERVATION
IN DIFFRACTION DISSOCIATION

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ABSTRACT

General s channel helicity conservation is shown to be incompatible with the multiperipheral description of diffraction dissociation and hence with the inter-relation between s channel resonances and t channel exchanges provided by duality.

The recent observation of s channel helicity conservation (SCHC) in diffractive S photoproduction ¹⁾ and similar results in dispersion theoretical investigations of elastic π -N scattering ²⁾ led to the hypothesis that such behaviour is a common feature of all diffractive resonance production ³⁾. If one takes this extreme attitude then, by duality arguments ⁴⁾, which, together with resonance saturation, allow an expansion of t channel exchanges in terms of direct channel resonances (see Fig.1), one arrives at the conclusion that SCHC should hold for the whole of the diffraction dissociation. In the present letter, we want to show that in its usual form the reggeized multi-peripheral matrix element ⁵⁾ is not compatible with SCHC.

The argument is, in fact, very simple. Consider the diffraction dissociation

$$a + b \rightarrow a' + c + d, \quad (1)$$

where, for convenience, all particles are taken as spinless (see Fig.2). s channel helicity conservation, in this case, means that in the (cd) rest system, the projection of the (cd) angular momentum along the direction of the recoil particle a' vanishes. This in turn implies that the matrix element for reaction (1) must be invariant under rotation of $\vec{q}_c$ ($= -\vec{q}_d$) around the "helicity direction" $\vec{q}_{a'}$, i.e., it should not depend on the azimuthal angle φ defined by

$$\cos \varphi = \frac{\vec{y} \cdot (\vec{z} \times \vec{q}_c)}{|\vec{z} \times \vec{q}_c|}, \quad \sin \varphi = \frac{-\vec{x} \cdot (\vec{z} \times \vec{q}_c)}{|\vec{z} \times \vec{q}_c|} \quad (2)$$

with

$$\vec{z} = \frac{\vec{q}_{a'}}{|\vec{q}_{a'}|}, \quad \vec{y} = \frac{\vec{q}_a \times \vec{q}_{a'}}{|\vec{q}_a \times \vec{q}_{a'}|}, \quad \vec{x} = \vec{y} \times \vec{z}.$$

For an extension of these considerations to particles with spin, see Refs. 6) and 7).

The multiperipheral matrix element for reaction (2), on the other hand, is usually written as ⁵⁾

$$M = \sum_i \beta(t_{aa'}) S_{ac} \alpha_p(t_{aa'}) \gamma_i(t_{aa'}, t_{bd}, \omega_c) \beta_i(t_{bd}) S_{cd} \alpha_i(t_{bd}) \quad (3)$$

$$+ (c \rightarrow d),$$

where $t_{xy} = (q_x - q_y)^2$, $s_{xy} = (q_x + q_y)^2$, $m_x^2 = q_x^2$; $x, y = a, a', b, c, d$ (see Fig. 2), α_p is the pomeron trajectory. The sum runs over all possible Regge trajectories α_i , β and β_i denote the pomeron and one-Regge vertex functions times signature factors, γ_i is the double Regge vertex, while ω_c is the Toller angle of the configuration given in Fig. 2. In the applications, one normally neglects the ω dependence; then, among the independent variables appearing in (3), only t_{bd} and t_{bc} depend on y , and the only combination of these, which is independent of y , reads

$$t_{bc} + t_{bd} = t_{aa'} + m_c^2 + m_d^2 + m_b^2 - s_{cd}. \quad (4)$$

Therefore, unless the t_{bc} , t_{bd} dependence drops out as well, the matrix element (3) is in conflict with SCHC. Furthermore, allowing an ω dependence in $\gamma_i(t_{aa'}, t_{bd}, \omega)$ does not help; the elimination of the y dependence, if at all possible this way, would completely change the multiperipheral character of the matrix element.

Thus, in the description of diffraction dissociation, at least one of the following three concepts has to be abandoned :

1. the factorized multiperipheral Regge form of pomeron exchange;
2. SCHC for diffractive resonance production in general.

It might well be that SCHC holds only for elastic reactions.

The S^0 photoproduction then has to be interpreted in terms of an elastic matrix element continued in an external mass (vector meson dominance); this S is no longer dual to any t channel exchange ⁸⁾. In this context, it is of particular interest to test $\gamma p \rightarrow \pi^+ \pi^- p$ with linearly polarized photons

outside the $\mathbf{S}$ band, where SCHC predicts the 2π system to decay isotropically in $\mathbf{y} + \phi$ and like $\cos^2(\phi - \mathbf{y})$ or $\sin^2(\phi - \mathbf{y})$ (or a mixture thereof) depending on whether the pomeron behaves as a natural or unnatural parity object ⁹⁾ (ϕ is the angle that the photon polarization vector is rotated around the photon direction out of the reaction plane defined by the proton momenta ¹⁰⁾). Present experiments appear to have too low statistics to draw any definite conclusions for $m_{\pi\pi} \geq 900$ MeV ¹¹⁾.

3. Duality plus resonance saturation in the diffraction dissociation. If one does not require a dual resonance description of the dissociation vertex, one could imagine the resonance contributions obeying SCHC and, in addition, OPE terms not subject to SCHC. This, however, appears difficult to incorporate into a picture in which the pomeron is obtained by unitarity bootstrap from (non-pomeron) dual amplitudes. In any case, the generally accepted interpretation of the A_1 phenomenon as a strong support for duality ¹²⁾ would have to be reconsidered, since the Deck effect violates SCHC.

In conclusion, SCHC has such a strong impact on duality considerations for diffractive production reactions that one should further investigate its range of validity ⁷⁾, in particular in those regions of phase space where multiperipherism is expected to hold best.

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R E F E R E N C E S

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FIG.1

FIG.2