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Abstract

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On the Problem of Computing Regge Poles

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In the preceding paper (^1) we showed that the Regge pole determining diffraction scattering at high energies has the following properties:

1. $L(t)$ is holomorphic in the t-plane with a cut from $t = 4$ to infinity.

2. $dL/dt > 0$ for $t < 4$.

3. $L(0) = 1$.

Let us add the following properties: from the unitarity relation and properties 1-3 it follows that:

4. $\operatorname{Im} L = 0((t-4)^{\operatorname{Re} L(4)+3/2})$ as $t \to 4+0$.

5. The Riemann surface corresponding to the branch point at $t = 4$ is two-sheeted (since the latter corresponds to a two-particle singularity).

6. $L(t) \leqslant 2$ for $t < 4$, since experimentally no bound state is observed with quantum numbers $* \ I = 0,\ J = 2$.

7. There are no states with imaginary mass ("ghost" states).

A. From properties 2-6 it follows that $\operatorname{Re} L(4) = 2$.

In order to satisfy 1, represent L in the form of a power series (approximately in the form of a polynomial) in the variable (^2)

$$\eta = -t\,[2 + \sqrt{4-t}]^{-2}. \tag{1}$$

B. For $t > 4$ the coefficients of $i(t-4)^{1/2},\ \ldots,\ i(t-4)^{5/2}$ are equal to zero (see property 4 and condition A).

C. $L(t) > 0$ at least on the interval where the "elastic"approximation is applicable **, i.e. for $|t| \lesssim 16$ (see property 7). This condition can be satisfied if one assigns a value to L at infinity. It seems natural to us to choose $L(\infty) = L(-\infty) = 0$ (L is continuous at infinity).

Conditions A, B, C give 6 equations for the coefficients of η^n in the series for the function L. Therefore we set

$$L(t) \approx 1 + \sum_{n=1}^{5} c_n \eta^n \tag{2}$$

and thus find a system of 6 linear equations for the coefficients c_n.

The solution obtained, as was to be expected, satisfies the imposed conditions for $|t| \lesssim 16$. In fact L vanishes at $t \approx -32$, but this point already lies outside the region of applicability of our approximation.

On the basis of formula (2) and equation (5) of paper (^1), one can compute the πN diffraction-scattering distribution. The results obtained agree satisfactorily with the experimental data at pion energies of 5 and 7 GeV in the laboratory system ***.

* This remark belongs to I. Ya. Pomeranchuk (private communication).
** It is, of course, possible that at the point where $L = 0$ the residue of the pole also vanishes; however, at present we have no indications of this.
*** E. Fenyves, private communication.

Let us note that condition B apparently plays an important role. If one works without it and approximates $L(t)$ by a polynomial of the fourth degree, then the solution gives $L(\infty) = L(-\infty) = -6$, and the "ghost state" appears already at $t \simeq -9$. Obviously, $0 \leq L(\infty) < 1$, and one may hope that, if its value is varied, the "ghost state" disappears altogether and good agreement with the experimental data can be obtained.

There is reason to hope that the procedure set out above can be formulated as a general method for obtaining Regge poles.

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CITED LITERATURE

1. G. Domokosh, Joint Inst. Nucl. Res., preprint, D-900, 1960.

2. C. Lovelace, *Diffraction Scattering and Mandelstam Representation*, Preprint, 1961.

Note: Figure translations are in progress. See original paper for figures.