Backward Scattering from the Veneziano Model.

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Summary. — The residue functions of the leading $Y_0^*(\Lambda_\rho, \Lambda_\gamma)$ and $Y_1^*(\Sigma_\delta, \Sigma_\rho)$ trajectories in the backward $K^+p$ scattering are parametrized according to the Veneziano model, consistent with the absence of the particles which are not found in nature. We then obtain a best fit for $K^+p$ backward scattering data from 2.0 to 7.0 GeV/c. The extrapolated residues agree approximately with experimental $Y_0^*$ and $Y_1^*$ widths.

The appealing feature of the Regge-pole model in boson-baryon backward scattering is the conjectured connection between baryon resonances and baryon exchange amplitude as expressed by trajectory functions $\gamma(\sqrt{u})$ based on the Chew-Frautschi plot and residue functions $\gamma(\sqrt{u})$. This connection has not been fully established up to the present. Arbitrariness of residue functions gave difficulty in predicting reasonable extrapolated magnitude of baryon resonance widths at baryon poles in most data fitting in backward directions.

As was shown in a previous paper (1), the Veneziano-type model for kaon-

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(1) K. Igi and J. K. Storrow: Nuovo Cimento (to be published). In an unpublished version of the CERN preprint TH. 993 (1969), the term

$$\frac{\gamma_1}{\pi} C \left( 2 - \alpha(t), \frac{3}{2} - \alpha_Y(s) \right) + \ldots,$$

was missing in eq. (1) and the term

$$\frac{2\gamma_1}{\pi} C \left( 2 - \alpha(t), \frac{3}{2} - \alpha_Y(s) \right) + \ldots,$$

was missing in eq. (2).
nucleon scattering gives a reasonable approximation to elastic widths of the
$Y^*$ resonances, forward $K^-p$ charge-exchange scattering and $K^+p$ backward
scattering at $u = 0$ at high energies. The absence of prominent resonances
in the $KN$ elastic channel makes the Veneziano model for $KN$ scattering
particularly simple, since this implies the $t$-channel trajectories are exchange-
degenerate and also the $u$-channel trajectories.

In the $t$-channel we took into account the $(\rho, A_2)$ trajectories, which were
required to be exchange-degenerate, and the $(\omega, P')$ trajectories which are also
required to be exchange-degenerate. Since the $\pi\pi$ Veneziano formula forced
the $\rho$ and $P'$ trajectories to be exchange-degenerate (2), we assumed

$$\alpha_\rho(t) = \alpha_{A_2}(t) = \alpha_\omega(t) = \alpha_{P'}(t) = \alpha(t).$$

In the $u$-channel the $Y^*_o(\Lambda_\pi, \Lambda_p)$ and $Y^*_1(\Sigma_\pi, \Sigma_0)$ trajectories, each of which are
exchange-degenerate, were assumed to be dominant.

The model appears to predict parity doubling of all resonances on the $Y^*$
trajectories. Since the particle with $J^P = \frac{1}{2}^-$ on the leading $Y^*_1$ trajectory and
also parity partners of $\Lambda(\frac{3}{2}^+, 1115)$, $\Lambda(\frac{1}{2}^-, 1520)$ and $\Sigma(\frac{3}{2}^+, 1385)$ are not found
experimentally, we eliminate them.

Then, we obtain from ref. (1) the following representations for the invariant
amplitudes $A$ and $B$, which satisfy duality (3), crossing symmetry and Regge
asymptotic behaviour:

\begin{align}
(1) \quad B_{K^p}(u, t, s) &= \sum_{i, j=0}^1 \frac{\beta^{(2)}_{i,j}}{\pi} B \left(1 - \alpha(t), \frac{1}{2} - \alpha_{X_i}(u)\right) + \\
&\quad + \sum_{i=0}^1 \frac{\beta^{(1)}_{i}}{\pi} B \left(1 - \alpha(t), \frac{3}{2} - \alpha_{X_i}(u)\right) + \frac{\gamma_1}{\pi} C \left(2 - \alpha(t), \frac{3}{2} - \alpha_{X_i}(u)\right) + \cdots = -B_{K^p}(s, t, u)
\end{align}

and

\begin{align}
(2) \quad A_{K^p}(u, t, s) &= \sum_{i, j=0}^1 \frac{\beta^{(1)}_{i,j}}{\pi} C \left(1 - \alpha(t), \frac{3}{2} - \alpha_{X_i}(u)\right) + \\
&\quad + \frac{\gamma_0}{\pi} B \left(1 - \alpha(t), \frac{1}{2} - \alpha_{X_i}(u)\right) + \cdots = A_{K^p}(s, t, u),
\end{align}

where

$$B(X, Y) = \Gamma(X)\Gamma(Y)/\Gamma(X + Y), \quad C(X, Y) = \Gamma(X)\Gamma(Y)/\Gamma(X + Y - 1),$$

$$\gamma_0 = - (m_\Lambda - m) \frac{1}{\sum_{i=0}^1 \beta^{(2)}_{i,j}}, \quad \sum_{i=0}^1 \beta^{(1)}_{i} = (1.520 - m_\Lambda) \frac{1}{\sum_{i=0}^1 \beta^{(2)}_{i,j}}$$

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