Summary. — It is shown that all the available high-energy data on total
cross-sections can be incorporated within the framework of the $SU_3$
Regge-pole model. The model consists of the exchange of tensor- and
vector-meson nonets in addition to the Pomeranchuk trajectory. Some
of the points which emerge from our analysis are: i) the total cross-
sections of $\pi^+p$, $K^+p$, $pp$ eventually increase towards their respective
asymptotic limits, while those of their counterparts $\pi^-p$, $K^-p$ and $\bar{p}\bar{p}$
decrease towards their limiting values; and ii) the ratios $Re/Im$ of the
forward amplitudes are in general predicted to be large in magnitude
compared to the available data.

1. — Introduction.

The measurements on high-energy total cross-sections yield information
on the asymptotic behaviour of the elastic-scattering amplitude and afford a
test of the various relations deduced on the basis of internal symmetries. Some
of the theoretical results which are expected to be valid in the limit as $s \to \infty$
are the Pomeranchuk theorem, $SU_3$ and the universality relations of Barger-
Rubin, Levinson-Wall-Lipkin, etc. It is important to test these expectations
in the light of the existing measurements on total cross-sections and organize
all the valid results in a simple model such as a Regge-pole model.

The recent Serpukhov measurements (1,9) have shown an unmistakable
tendency for $\sigma_r(K^+p)$ to increase with energy towards $\sigma_r(K^-p)$, and the dif-

(*) To speed up publication, the authors of this paper have agreed to not receive the
proofs for correction.
(1) S. P. DENISOV, S. V. DONS KOV, YU. P. GORIN, A. I. PETRUKHIN, YU. D. PRO-
(1971); S. P. DENISOV, YU. P. DMITREVKI, S. V. DONS KOV, YU. P. GORIN, YU. M.
ferences, $\Delta(\pi p) = \sigma_\pi(\pi^- p) - \sigma_\pi(\pi^+ p)$ and $\Delta(pp) = \sigma_\pi(pp) - \sigma_\pi(pp)$, are also decreasing with energy. Thus the present data indicate that the trend for the validity of Pomeranchuk theorem has set in. An increasing $\sigma_\pi(K^+ p)$ does not necessarily signify the importance of contributions from the branch cuts in the $J$-plane, in as much as a negative contribution from an odd-$C$ trajectory exchange can make $\sigma_\pi(K^+ p)$ increase, while at the same time causing $\sigma_\pi(K^- p)$ to decrease, as the data seem to require. The power law behaviours exhibited in the plots of differences of total cross-sections $\Delta$s, as a function of $p_{\text{lab}}$, and the fact that the data (2) on $\sigma_\pi(K^+ p)$ even below 20 GeV/$c$ do not rule out a slight increase with energy make it worth-while re-examining the data on the basis of a pole model.

It may perhaps be noted that all the motivations for including the effects of cuts in phenomenological analyses refer to phenomena pertaining either to elastic scattering at $t \neq 0$ or to inelastic scattering, cross-over zeros in elastic differential cross-sections at $|t| \simeq 0.1 \text{(GeV/c)}^2$, np elastic-scattering peak in the backward direction, the $t$-dependence of the diffraction slope parameter $b$ and the Carrigan break, the presence of polarization in $\pi^- p \rightarrow \pi^- n$, the peak in photoproduction of $\pi^+$, etc. (4). We are not aware of any strong arguments which necessitate the inclusion of contributions from the cuts to the forward elastic amplitudes also. It is conceivable that the discontinuities across the branch cuts may vanish at $t = 0$ leaving only the pole contributions to the imaginary part of the forward spin-averaged elastic-scattering amplitude. Such a possibility is indeed recently suggested by the detailed $\pi^- N$ amplitude analyses (5) at 6 GeV/$c$. The detailed analysis of Johnson shows that the absorptive cut contributes dominantly to the imaginary part of the nonflip amplitude only at nonforward angles. Thus one is naturally led to inquire whether a pole model can accommodate the available data on $\sigma_\pi$.

As has been emphasized by Barger and Phillips (6), the present data up to Serpukhov energies do not allow us to meaningfully discriminate between the various rival models, including the one in which $\sigma_\pi \rightarrow 0$ as $s \rightarrow \infty$. Models in which the cuts are present contain terms with $\ln s$ factors which are very

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(4) For a recent survey of the cut models see the review article by G. C. Fox: in Phenomenology in Particle Physics (Pasadena, Cal., 1971), p. 703.
