EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

CERN/EP 81-77
22 July 1981

THE AMPLITUDE STRUCTURE OF THE PROCESSES

$K^- p \rightarrow \rho^- \Sigma^+(1385)$ AND $K^- p \rightarrow \phi \Sigma^0(1385)$ AT 4.2 GeV/c

M. Aguilar-Benitez^(*)

Junta de Energia Nuclear, Madrid, Spain

and

A.C. Irving

D.A.M.T.P., Liverpool University, Liverpool, England

ABSTRACT

We present model-independent transversity amplitudes for the processes $K^- p \rightarrow \rho^- \Sigma^+(1385)$ and $K^- p \rightarrow \phi \Sigma^0(1385)$ at 4.2 GeV/c. We also perform a model dependent analysis and compare the resulting helicity amplitudes with the predictions of a simple exchange model. Implications for future model building are discussed.

Submitted to Zeitschrift für Physik C

(*) Presently visitor at CERN.

1. INTRODUCTION

As stressed many times, an understanding of the dynamics behind strong interaction production processes requires complete measurements of a large variety of reactions. In the last decade a considerable effort has been devoted to obtain a direct knowledge of the amplitudes governing quasi two-body reactions and to compare their behaviour with phenomenological models. The unravelling of the scattering amplitudes from experimental data is particularly simple in hypercharge exchange reactions for which the information on the decay correlations affords their almost complete determination. In the last few years the Amsterdam-CERN-Nijmegen-Oxford and CERN-College de France-Madrid-Stockholm Collaborations have analyzed many quasi two-body hypercharge exchange reactions in a large variety of spin configurations (a list of references is given in [1]). The interest of these studies in the context of two-body phenomenology has been extensively reviewed in [2].

In general, these reactions were analyzed in the context of duality and quark model predictions as well as used to test ideas in Regge exchange phenomenology. In some cases detailed comparison with specific dynamical models were made. For the reactions involving higher spin resonances such as $0^{-\frac{1}{2}+} \rightarrow 1^{-\frac{3}{2}+}$, the large amount of information which can be extracted from the data (22 amplitude parameters) has found its major use in extensive investigations of simple quark model and duality predictions. Lesser emphasis was given to the understanding of the amplitude structure of these reactions in terms of exchanges. In this paper an attempt to understand the behaviour of the basic helicity amplitudes is presented.

The paper is organised as follows. In sect. 2 we summarize the available data for the processes $K^{-}p \rightarrow \rho^{-}\Sigma^{+}(1385)$ and $K^{-} \rightarrow \phi\Sigma^{0}(1385)$ at 4.2 GeV/c and $\pi^{-}p \rightarrow K^{0}(890)\Sigma^{0}(1385)$ at 3.95 GeV/c obtained by the Amsterdam-CERN-Nijmegen-Oxford and CERN-College de France-Madrid-Stockholm Collaboration respectively. We briefly justify merging the data for the processes with ϕ and $K^{0}(890)$ and give values of the differential cross sections, density matrix elements and polarizations using the final

statistical samples of ~ 128 events/ μb and ~ 90 events/ μb respectively. The decay angular information from the vector meson, the sequential hyperon resonance decay and the joint correlations are used in a model independent way to perform transversity amplitude analyses. In sect. 3 we present the relations among transversity and helicity amplitudes and do model dependent helicity amplitude analyses using, basically, the constraints derived in the framework of quark additivity. The amplitude analysis approach permits us to check quantitatively the validity of these assumptions. The helicity amplitudes so obtained are discussed in the context of a Reggeised Born term model. Finally, sect. 4 is devoted to a discussion of the results and to some general conclusions.

2. MODEL INDEPENDENT ANALYSIS

2.1 Experimental details

The data used for the analysis of the reactions

$$K^- p \rightarrow \rho^- \Sigma^+(1385) \quad (A)$$

$$K^- p \rightarrow \phi \Sigma^0(1385) \quad (B)$$

$$\pi^- p \rightarrow K^0(890) \Sigma^0(1385) \quad (C)$$

come from several exposures of the CERN 2 m hydrogen bubble chamber to K^- and π^- meson beams of average momentum 4.15 GeV/c and 3.95 GeV/c respectively. The statistical sensitivities are ~ 128 events/ μb for the K^- sample and ~ 90 events/ μb for the π^- sample. The events used for this paper are found in the 2-prong + vee topology.

We have extracted the reactions (A)-(C) from events with a visible Λ decay and kinematically compatible with the final states

$$K^- p \rightarrow \Lambda \pi^+ \pi^- \pi^0 \quad 62503 \text{ events} \quad (69342 \text{ events}) \quad (1)$$

$$K^- p \rightarrow \Lambda K^+ K^- \pi^0 \quad 3926 \text{ events} \quad (4301 \text{ events}) \quad (2)$$

$$\pi^- p \rightarrow \Lambda K^+ \pi^- \pi^0 \quad 5003 \text{ events} \quad (5400 \text{ events}) \quad (3)$$

where the quoted numbers of events refer to the final samples used in the analysis after applying appropriate selection criteria. In parenthesis we give the corresponding number of events weighted to account for losses due to Λ decays occurring outside the fiducial volume or too close to the production vertex (< 3 mm).

The procedures for the selection of samples of events for the final states (1)-(3), as well as other experimental details, are given in [3,4].

The cross sections corrected for throughput efficiencies and unseen decay modes are calculated to be

$$\sigma(K^- p \rightarrow \Lambda \pi^+ \pi^- \pi^0) = 904 \pm 27 \text{ } \mu\text{b}$$

$$\sigma(K^- p \rightarrow \Lambda K^+ K^- \pi^0) = 84 \pm 2 \text{ } \mu\text{b}$$

$$\sigma(\pi^- p \rightarrow \Lambda K^+ \pi^- \pi^0) = 106 \pm 5 \text{ } \mu\text{b}.$$

2.2 Total and differential cross sections

The methods used for the determination of the cross sections for the quasi two-body reactions (A), (B) and (C) have been discussed in [4]. They are based on a quantitative study of the scatter diagram (e.g. mass $\pi^- \pi^0$ versus mass $\Lambda \pi^+$ for reaction (A)) by means of the slicing techniques [5].

The number of events for the reactions (A), (B) and (C) obtained in this manner were respectively 6145 ± 300 , 630 ± 35 and 867 ± 80 . After correcting for the other decay modes of the meson and hyperon resonances the following cross sections were obtained

$$\sigma(K^- p \rightarrow \rho^- \Sigma^+(1385)) = 91 \pm 5 \text{ } \mu\text{b}$$

$$\sigma(K^- p \rightarrow \phi \Sigma^0(1385)) = 27 \pm 3 \text{ } \mu\text{b}$$

$$\sigma(\pi^- p \rightarrow K^0(890) \Sigma^0(1385)) = 30 \pm 3 \text{ } \mu\text{b}$$

and

the moduli of the twelve transversity amplitudes describing the processes and ten relative phases between these amplitudes. These 22 quantities fully summarize all the information that can be extracted from the study of the decay correlations. As will be discussed in sect. 3, the results of this model independent analysis will be used as reference to estimate the reliability of the Reggeised Born term model described in [1] and of our model-dependent helicity amplitude analysis in sect. 3.

Results of a transversity amplitude analysis of the reactions $K^- p \rightarrow \rho^- \Sigma^+(1385)$ and $K^- p \rightarrow \phi \Sigma^0(1385)$ based on a data sample corresponding to a statistical sensitivity of ~ 65 events/ μb were presented in [6]. In a recent comparison of reactions $K^- p \rightarrow \phi \Sigma^0(1385)$ and $\pi^- p \rightarrow K^0(890) \Sigma^0(1385)$ the final statistics of 128 events/ μb and 90 events/ μb was used [5]. In this section we will present a final analysis of the reaction $K^- p \rightarrow \rho^- \Sigma^+(1385)$ based on 128 events/ μb and of the reaction $K^- p \rightarrow \phi \Sigma^0(1385)$ after, as explained above, adding the events from the reaction $\pi^- p \rightarrow K^0(890) \Sigma^0(1385)$. Details of the number of events considered for the analysis are given in table 5.

The method for extracting the transversity amplitudes has been described in [6]. The basic ingredient is the 6-angle joint decay distribution

$$\begin{aligned}
 W(\Omega_1, \Omega_{1/2}, \Omega_{3/2}) &= \frac{3}{8\pi^3} \sum_{\nu \mu \mu' \Lambda \Lambda' \lambda \lambda'} (\sum_{\mu} T_{\Lambda \mu}^m T_{\Lambda' \mu}^{m'*}) \quad (1) \\
 D_{m0}^{1*}(\Omega_1) D_{m'0}^1(\Omega_1) D_{\Lambda \lambda}^{3/2*}(\Omega_{3/2}) D_{\Lambda' \lambda'}^{3/2}(\Omega_{3/2}) D_{\lambda \nu}^{1/2*}(\Omega_{1/2}) D_{\lambda' \nu}^{1/2}(\Omega_{1/2}) \\
 F_{\lambda}^{3/2} F_{\lambda'}^{3/2} |F_{\nu}^{1/2}|^2 |F^1|^2
 \end{aligned}$$

where the helicity decay amplitudes are given by

$$|F^1|^2 = 1$$

$$|F_{\pm}^{1/2}|^2 = \frac{1}{2} (1 \pm \alpha) \quad (2)$$

$$F_{\lambda}^{3/2} = F_{-\lambda}^{3/2} = 1/\sqrt{2}.$$

The indices m , Λ , μ appearing in the transversity amplitudes, $T_{\Lambda\mu}^m$, refer respectively to the spin components of the outgoing vector meson, hyperon resonance and target proton along the appropriate quantization axis.

Ω_1 , $\Omega_{1/2}$, $\Omega_{3/2}$ are the decay angles of the vector meson, Λ , $\Sigma(1385)$. For the vector meson and $\Sigma(1385)$, s-channel transversity reference frames are used^(*), for the Λ baryon a helicity frame was considered. The parametric estimation-moduli and phases of $T_{\Lambda\mu}^m$ - was performed using a maximum likelihood method. More details on the approach as well as description of checks on the quality and uniqueness of the solutions can be found in [6].

In tables 6 and 7 and in figs 3-6 we present the results of the analysis. The moduli of the amplitudes are normalized according to

$$\sum_{m\Lambda\mu} |T_{\Lambda\mu}^m|^2 = 1 \quad (3)$$

The phases of the "proton up" and "proton down" transversity amplitudes are defined relative to $T_{3/2\ 1/2}^1$ and $T_{1/2-1/2}^1$, respectively.

3. MODEL DEPENDENT ANALYSIS

The transversity amplitudes presented in sect. 2 contain the maximum information obtainable from unpolarised measurements alone. Since our

(*) The transversity frames have as z quantization axis the normal to the production plane. The y axis is defined along the vector meson or $\Sigma(1385)$ line-of-flight in the overall center-of-mass. The x axis is defined by the cross product $y \times z$.

present understanding of exchange dynamics is largely based on the phenomenology of helicity amplitudes, one would like to try and extract these from the transversity amplitudes.

3.1 Model independent relations

For our choice of quantization axes,

$$(x, y, z)_{\text{helicity}} = (-x, z, y)_{\text{transversity}},$$

the transversity and helicity amplitudes are related by

$$T_{m', m}^M = \sum_{\mu, \lambda, \lambda'} D_{m\lambda}^{1/2*} \left(\frac{\pi}{2} \right) D_{m'\lambda'}^{3/2} \left(\frac{\pi}{2} \right) D_{M\mu}^1 \left(\frac{\pi}{2} \right) H_{\lambda', \lambda}^m \quad (4)$$

where $M(\mu)$, $m'(\lambda')$, $m(\lambda)$ are the transversities (helicities) of the vector meson, hyperon and nucleon respectively (all three Euler angles in $D^J(\frac{\pi}{2})$ are $\pi/2$).

It is convenient to use helicity amplitudes which, asymptotically ($s \rightarrow \infty$), correspond to exchange of fixed naturality

$$\begin{aligned} N_{\lambda', \lambda} &= \frac{1}{\sqrt{2}} (H_{\lambda', \lambda}^1 + H_{\lambda', \lambda}^{-1}) \\ U_{\lambda', \lambda}^1 &= \frac{1}{\sqrt{2}} (H_{\lambda', \lambda}^1 - H_{\lambda', \lambda}^{-1}) \\ U_{\lambda', \lambda}^0 &= H_{\lambda', \lambda}^0 \end{aligned} \quad (5)$$

In terms of these, the relation between transversity and helicity amplitudes eq. (4) becomes

$$\begin{aligned} T_{\lambda'}^0 &= M_{\lambda'} N_{\lambda'} \\ T_{\lambda'}^{(-)} &= i M_{\lambda'} U_{\lambda'}^1 \\ T_{\lambda'}^{(+)} &= M_{\lambda'} U_{\lambda'}^0 \end{aligned} \quad (6)$$

where

$$\underline{N}^M = \frac{1}{2} \begin{pmatrix} -i & 1 & -\sqrt{3} & -i\sqrt{3} \\ i & 1 & -\sqrt{3} & i\sqrt{3} \\ -i\sqrt{3} & -\sqrt{3} & -1 & i \\ i\sqrt{3} & -\sqrt{3} & -i & -1 \end{pmatrix} \quad (7)$$

and

$$\begin{aligned} \underline{N} &= \{N_{3-}, N_{3+}, N_{1-}, N_{1+}\} \\ \underline{U}^\mu &= \{U_{3+}^\mu, U_{3-}^\mu, U_{1+}^\mu, U_{1-}^\mu\} \\ \underline{T}^0 &= \{T_{3-}^0, T_{3+}^0, T_{1+}^0, T_{1-}^0\} \\ \underline{T}^{(\pm)} &= \frac{1}{\sqrt{2}} \{T_{3+}^1 \pm T_{3-}^1, T_{1-}^1 \pm T_{1+}^1, T_{1-}^1 \pm T_{1+}^1, T_{1-}^1 \pm T_{1+}^1\} \end{aligned} \quad (8)$$

3.2 Model amplitude analysis

Because the phase between the two sets of amplitudes $\{T_{m,+}^M\}$ and $\{T_{m,-}^M\}$ is not measured, we cannot use eqs (5)-(8) by themselves to obtain the helicity amplitudes $\underline{N}^1$, $\underline{U}^0$ and $\underline{U}^0$ which have a simple interpretation in terms of exchanges. To circumvent this, we shall use the model dependent method of Irving [7] to provide extra constraints which does allow a complete solution (up to an overall phase). The constraints are [7]

$$\begin{aligned} N_{3-} &= U_{3-}^1 = U_{3-}^0 = 0 \\ N_{1-}/N_{3+} &= U_{1-}^1/U_{3+}^1 = U_{1-}^0/U_{3+}^0 = 1/\sqrt{3} \end{aligned} \quad (9)$$

so that the independent amplitudes can be taken as

$$N_{3+}, N_{1+}, U_{3+}^1, U_{1+}^1, U_{3+}^0, U_{1+}^0 \quad (10)$$

As discussed in [7], the relations (eq. (9)) are slightly less stringent than the class A quark additivity relations. The latter include the extra relation $N_{1+} = 0$ which leads to the familiar Stodolsky-Sakurai result [8] for $0^- 1/2^+ \rightarrow 0^- 3/2^+$ processes that $\rho_{33} = 3/8$. This is known to be violated at small t and so we allow the less restrictive conditions (eq. (9)). However, we expect $|N_{1+}|$, to be quite small since the above violation is small.

In the forward region ($0.0 < |t'|^{(*)} < 1.2 \text{ GeV}^2$) the integrated cross sections were measured to be

$$\sigma(K^- p \rightarrow \rho^- \Sigma^+(1385)) = 71 \pm 3 \text{ } \mu\text{b}$$

$$\sigma(K^- p \rightarrow \phi \Sigma^0(1385)) = 25 \pm 3 \text{ } \mu\text{b}$$

$$\sigma(\pi^- p \rightarrow K^0(890) \Sigma^0(1385)) = 25 \pm 2 \text{ } \mu\text{b}.$$

For further analysis, samples of reactions (A), (B) and (C) were obtained by selecting events from the final states (1), (2) and (3) according to the following simultaneous mass selections

$$(1) \quad 0.66 \leq M(\pi^- \pi^0) \leq 0.88 \text{ GeV}, \quad 1.34 \leq M(\Lambda \pi^+) \leq 1.44 \text{ GeV}$$

$$(2) \quad 1.00 \leq M(K^+ K^-) \leq 1.04 \text{ GeV}, \quad 1.34 \leq M(\Lambda \pi^0) \leq 1.44 \text{ GeV}$$

$$(3) \quad 0.84 \leq M(K^+ \pi^-) \leq 0.94 \text{ GeV}, \quad 1.34 \leq M(\Lambda \pi^0) \leq 1.44 \text{ GeV}.$$

In these samples, the percentage of background contamination for reaction (A), (B) and (C) was calculated to be 35 ± 3 , 18 ± 5 , 29 ± 7 respectively. In the forward region ($0.0 < |t'| < 1.2 \text{ GeV}^2$) they are reduced to the values 19 ± 2 , 15 ± 5 , $20 \pm 7\%$ respectively.

The differential cross sections for $|t'| < 1.2 \text{ GeV}^2$ were calculated using all the events in the resonance overlap regions and the background effects were neglected. Simple background subtraction techniques were used to show that no significant effects are introduced by neglecting the background. The study performed in [4] showed that the sizes and shapes of the differential cross sections for reactions (B) and (C) were equal within the errors. The equality of the differential cross sections is predicted by SU(3) and factorization (or additive quark model) and works remarkably well for hypercharge exchange processes. More detailed tests performed in terms of density matrix elements and transversity amplitudes confirmed the validity of the SU(3) predictions.

(*) t is defined as the square of the four-momentum transfer from the target to the outgoing $\Sigma(1385)$. t' is $t - t_{\min}$.

In view of these results and to improve the statistical quality of the data, the samples for reactions (B) and (C) were combined and attributed to reaction (B).

In fig. 1 and tables 1 and 2 we present the differential cross sections for reactions (A) and (B). We have plotted $\frac{1}{2} \sigma(K^- p + \rho^- \Sigma^+(1385))$ which in the forward direction is essentially $2\sigma(K^- p + \rho^0 \Sigma^0(1385))$ due to the absence of significant $I = 3/2$ t channel exchange.

Combining SU(3), factorization and exchange degeneracy one expects the following relation between ρ and ϕ production

$$2\sigma(K^- p + \rho^0 \Sigma^0(1385)) = \sigma(K^- p + \phi \Sigma^0(1385)).$$

The data shown in fig. 1 indicate that over most of the t' range the "real" reaction (described by a non-planar duality diagram) $K^- p + \rho^0 \Sigma^0(1385)$ has a considerably larger cross section than the "rotating" reaction (described by planar duality diagram) $K^- p + \phi \Sigma^0(1385)$.

Using the values of the vector meson s -channel helicity density matrix elements obtained from the final data samples and given in tables 3 and 4, we have constructed the distributions $\sigma_+ = (\rho_{11} + \rho_{1-1}) d\sigma/dt'$, $\sigma_0 = \rho_{00} d\sigma/dt'$ and $\sigma_- = (\rho_{11} - \rho_{1-1}) d\sigma/dt'$ which to order $1/s$ project out the contributions due to natural and unnatural (helicity 0 and 1 states) parity exchanges. These distributions are shown in fig. 2. They indicate that the difference between the "real" and "rotating" comes mainly from unnatural parity cross section (both the helicity 0 and 1 states). We shall comment further on this in sect. 3.3.

2.3 Transversity amplitude analysis

As discussed in [6], it is possible to extract from the information contained in the six angle joint decay distribution of the processes

$$\begin{array}{ccc} K^- p + \rho^- & & \Sigma^+(1385) \\ & \searrow \swarrow & \searrow \swarrow \\ & \pi^- \pi^0 & \Lambda \pi^+ \\ & & \searrow \swarrow \\ & & p \pi^- \end{array} \quad (A)$$

In previous applications of the method to charge exchange processes [7,9], this meant determining 11 quantities (the absolute phase of U_{1+}^0 is set to 0) from 20 measurements. Because the problem was overconstrained, the goodness of fit gave some idea of the validity of the model assumptions (basically quark additivity). The agreement was quite satisfactory. Here, we are determining 11 quantities from 48 experimental observables (describable in terms of 22 independent transversity amplitude parameters, see sect. 2) so that we should have a very stringent test of the assumptions (9).

We have repeated the amplitude analysis of sect. 2 using eqs (5)-(8) and taking the moduli and phases of the amplitudes (10) as basic parameters in the maximum likelihood fit. The results for the s-channel helicity amplitudes are given in tables 8 and 9 (as in eq. (3) these amplitudes are normalized to unity). The corresponding transversity amplitudes (derived from (6)) are compared in figs 3-6 with those obtained in the model independent analysis of sect. 2. The agreement is excellent. A quantitative comparison of the two sets of values by a χ^2 test is given in table 10. The results provide good support for the validity of assumptions (9).

In figs 7 and 9 we present the helicity amplitude moduli normalized to the differential cross sections for the processes $K^- p \rightarrow \rho^- \Sigma^+(1385)$ and $K^- p \rightarrow \phi \Sigma^0(1385)$ (i.e. the moduli of tables 8, 9 times the square root of $d\sigma/dt'$). In figs 8 and 10 we show the relative phases of these amplitudes. The following general features of both reactions are evident.

The helicity non-flip amplitude U_{1+}^0 ($n = |\mu - \lambda' + \lambda| = 0$) is large and shows a prominent peak at low $|t'|$ (presumably K exchange). The helicity flip amplitude U_{3+}^0 ($n = 1$) shows a forward dip and flatter t' dependence, as expected because of the angular momentum factor $(-t')^{n/2}$. The natural parity exchange amplitude N_{1+} is expected to be zero in the simplest quark models and indeed turns out to be rather small. In contrast, the other natural parity exchange amplitude N_{3+} is expected, and found, to be large particularly at large t' ($N_{3+} \sim -(t')^{n/2} = -t'$).

To help interpret the results in more detail it is useful to compare them with the predictions of a simple exchange model.

3.3 Reggeised Born term model

In figs 7-10 we show the predictions of the reggeised Born model QUADREM of [2]^(*). In this model, a typical amplitude has the simple form (see ref. [2] for details)

$$H_{\lambda', \lambda}^{\mu} = (-t)^{\frac{n+x}{2}} \beta_1 \beta_2 \Gamma(1-\alpha) \frac{1}{2} (1 \pm e^{-i\pi\alpha}) (\alpha' s)^{\alpha}$$

where $n = |\lambda' - \lambda - \mu|$ = overall helicity flip

$n + x = |\lambda' - \lambda| + |\mu|$ = sum of helicity flips at each vertex

β_i = coupling at vertex i

$\alpha = \alpha_0 + \alpha' t$, the exchanged regge trajectory.

All parameters β_1 , β_2 , α_0 , α' are already determined [2]. For the processes under discussion, the relevant exchanges are (exchange-degenerate) $K(890)$, $K(1420)$ and K , K_B regge trajectories.

In the present application we have altered this "zero parameter" model in two ways:

(a) We have included in each amplitude an extra factor $(e^{bt})^n$ where n is the net helicity flip and $b \approx .4 \text{ GeV}^{-2}$. This is because the basic helicity factor $(\sqrt{-t})^n$ produces an exaggerated flattening of the t dependence in high spin amplitudes at large t .

(*) for comparison with the present amplitudes we have changed to the "anti-Jacob and Wick" phase conventions (an extra sign $(-)^{\lambda' - \lambda}$ is included).

(b) Comparison of the SU(3) related processes $K^-p \rightarrow \rho^- \Sigma^+(1385)$ (K exchange) and $\pi^+p \rightarrow \rho^0 \Delta^{++}$ (π exchange) shows that [2] $\rho_{00} d\sigma/dt(K^-p \rightarrow \rho^- \Sigma^+(1385))/\rho_{00} d\sigma/dt(\pi^+p \rightarrow \rho^0 \Delta^{++}) \approx 1/6 \cdot (t-m_\pi^2)^2/(t-m_K^2)^2$. No energy dependent factor $s^{2(\alpha_\pi - \alpha_K)}$ arising from Reggeisation appears to be necessary. To take account of this apparent lack of energy dependence in the SU(3) breaking we have retained the QUADREM trajectories $\alpha_K = \alpha'(t-m_K^2)$ in the propagator factor $\Gamma(1-\alpha_K)$ [2] but used $\alpha_K = 0 + \alpha't$ in the phase and energy dependence factors. This prescription allows a good account of the SU(3) breaking observed in comparison of the present data for $K^-p \rightarrow \rho \Sigma(1385)$ and the data for $K^+p \rightarrow K^0(890) \Delta^{++}$ [10]. This observation could be taken as some evidence against the Reggeisation of pseudoscalar trajectories [11].

The overall agreement between the Regge model and the extracted amplitudes is impressive in view of the complexity of the process and the simplicity of the basic model predictions. In the following, we make some remarks for each reaction under study.

- $K^-p \rightarrow \rho^- \Sigma^+(1385)$

The relative size and shape of $|U_{1+}^0|$ and $|U_{3+}^0|$ is the same in the model and in the amplitude analysis. The pole-cut cancellation which occurs in the model at $-t' \sim .15$ is seen in the data for $|U_{3+}^0|$ and its phase (relative to U_{1+}^0). The pole-cut cancellation in $|N_{3+}|$ at $-t' \sim .3$ shows up in the data as a break in slope at this t' value. $|N_{1+}|$ is zero in the model and, as already noted, is small in the amplitude analysis. Because the model assumes exchange degeneracy, all phases in this channel are either $0(2\pi)$ or π . The amplitude analysis phases (relative to U_{1+}^0) do indeed cluster near these values with relatively weak t' dependence. Note that the predicted phase of N_{1+} is undefined since its modulus is zero in the model.

- $K^-p \rightarrow \phi \Sigma^0(1385)$

Here the amplitude data are less plentiful and the model predictions less impressive. The lack of a cancellation predicted for N_{3+} in this channel (as opposed to the first reaction) is consistent with the data.

For U_{3+}^1 , however, the agreement is not good. The fact that the amplitude phases appear to wander much more in this channel than in $K^-p \rightarrow \rho^- \Sigma^+(1385)$ may be connected with the duality argument that the underlying pole amplitudes are real in the latter but complex and t dependent in the former.

Note that, at small t' , the model amplitudes for unnatural parity exchange show the "real" greater than "rotating" effect observed in $\rho_{00} d\sigma/dt$ and discussed in sect. 2.2. This is due to the difference in kinematics between the two processes^(*). At fixed t' , one is further from the K exchange pole in the "rotating" process so that, despite exchange degeneracy of the couplings, a smaller amplitude results. At larger t' , where such effects are negligible, our simple model is unable to account for the "real" greater than "rotating" effect. In fact, more sophisticated models fail to account for similar effects seen in analogous but much simpler processes [2].

4. DISCUSSION AND CONCLUSIONS

It is clear from the above analysis that the model assumptions of ref. [7] work as well for the present hypercharge-exchange processes as they do for the related charge exchange processes [7,9]. In both cases the relative importance of the various amplitudes is in good agreement with the predictions of exchange models (basically, π and K exchange models). The particularly simple Reggeised Born term model (QUADREM) of ref. [2] describes the basic exchange structure but cannot reproduce all the detailed features of these richly structured processes.

The deviations from models are most transparent in terms of helicity amplitudes. For example, the large dip predicted in $|N_{3+}|$ for $K^-p \rightarrow \rho \Sigma(1385)$ reflects the naive assumption of 180° phase difference between pole and cut. The amplitude "data" show a much less dramatic

(*) The "rotating" process was, for the purpose of the kinematics, taken to be $\pi^-p \rightarrow K^0(890)\Sigma^0(1385)$ since these reactions provided the majority of the statistics (sect. 2.1).

interference and so point the way to an improved model. On the other hand, discrepancies in predictions for double density matrix elements or for transversity amplitudes provide little or no insight. From fig. 4 it seems that minor alterations to cut phases and t dependences (theoretically not very well constrained anyhow) would lead to a fairly accurate description of the helicity amplitudes and hence the experimental data themselves.

The set of processes $\pi N \rightarrow \rho \Delta$, $\pi N \rightarrow \omega \Delta$, $KN \rightarrow K(890)\Delta$, $\bar{K}N \rightarrow \bar{K}(890)\Delta$ (charge exchange) and $KN \rightarrow \rho \Sigma(1385)$, $KN \rightarrow \phi \Sigma(1385)$, $\pi N \rightarrow K(890)\Sigma(1385)$ (hypercharge exchange) provides a very stringent testing ground for models which describe spin effects, pseudoscalar exchange, and embody duality, SU(3) and quark model constraints. We suggest that the amplitude results of refs [7,9] and this analysis provide an important starting point for building such models. This process of model building followed by amplitude analysis and by further attempts to refine the models is what finally led to the death of πN and KN charge exchange phenomenology in the mid-seventies. It may well be that a similar stage has been reached for these more complicated processes and that no useful purpose is served by attempting to refine the present basic models. Even so, we feel it is still worthwhile building up a collection of amplitude systematics from existing data (on as wide a variety of processes as possible) for testing future strong interaction models. The amplitudes presented here should be particularly suitable for this purpose.

Acknowledgements

We thank the Amsterdam-CERN-Nijmegen-Oxford and CERN-College de France-Madrid-Stockholm Collaborations for permission to use their data.

REFERENCES

- [1] M. Aguilar-Benitez et al., Z. Phys. C8 (1981) 313.
- [2] A.C. Irving and R.P. Worden, Phys. Reports 34 (1977) 3.
- [3] M.J. Losty et al., Nucl. Phys. B133 (1978) 38.
- [4] M. Aguilar-Benitez et al., Z. Phys. C6 (1980) 195.
- [5] M. Aguilar-Benitez et al., Phys. Rev. D6 (1972) 29.
- [6] M. Aguilar-Benitez et al., Nucl. Phys. B124 (1977) 189.
- [7] A.C. Irving, Nucl. Phys. B63 (1973) 499.
- [8] L. Stodolsky and J.J. Sakurai, Phys. Rev. Lett. 11 (1963) 90.
- [9] J.F. Owens et al., Nucl. Phys. B112 (1976) 514;
- [10] G. Ciapetti et al., Nucl. Phys. B54 (1973) 58.
- [11] R.D. Field and D.P. Sidhu, Phys. Rev. D10 (1974) 89.

TABLE CAPTIONS

- Table 1 Differential cross section for the reaction $K^-p \rightarrow \rho^- \Sigma^+(1385)$.
- Table 2 Differential cross section for the reaction $K^-p \rightarrow \phi \Sigma^0(1385)$.
- Table 3 Density matrix elements of the ρ^- , $\Sigma^+(1385)$ and $\Sigma^+(1385)$ polarisation in the reaction $K^-p \rightarrow \rho^- \Sigma^+(1385)$.
- Table 4 Density matrix elements of the ϕ , $\Sigma^0(1385)$ and $\Sigma^0(1385)$ polarisation in the reaction $K^-p \rightarrow \phi \Sigma^0(1385)$.
- Table 5 Definitions of the amplitude analysis samples.
- Table 6 s-channel transversity amplitudes for the reaction $K^-p \rightarrow \rho^- \Sigma^+(1385)$.
- Table 7 s-channel transversity amplitudes for the reaction $K^-p \rightarrow \phi \Sigma^0(1385)$.
- Table 8 s-channel helicity amplitudes for the reaction $K^-p \rightarrow \rho^- \Sigma^+(1385)$.
- Table 9 s-channel helicity amplitudes for the reaction $K^-p \rightarrow \phi \Sigma^0(1385)$.
- Table 10 Comparison of the results obtained in the model independent and model dependent amplitude analyses.

TABLE 1

Differential cross section for the reaction $K^-p \rightarrow \rho^- \Sigma^+(1385)$

$ t' $ (GeV^2)	$d\sigma/dt'$ ($\mu\text{b}/\text{GeV}^2$)
.00 - .02	267.0 ± 19.8
.02 - .04	218.0 ± 17.6
.04 - .07	187.7 ± 13.6
.07 - .10	139.3 ± 11.3
.10 - .15	131.1 ± 9.0
.15 - .20	97.8 ± 7.5
.20 - .25	76.8 ± 6.5
.25 - .30	76.8 ± 6.5
.30 - .35	77.6 ± 6.5
.35 - .40	52.8 ± 5.2
.40 - .45	60.4 ± 5.6
.45 - .50	55.8 ± 5.4
.50 - .55	43.8 ± 4.7
.55 - .60	48.6 ± 5.0
.60 - .70	32.5 ± 2.9
.70 - .80	32.0 ± 2.9
.80 - .90	23.7 ± 2.5
.90 - 1.00	25.8 ± 2.6
1.00 - 1.10	24.2 ± 2.5
1.10 - 1.20	19.6 ± 2.2

TABLE 2

Differential cross section for the reaction $K^-p \rightarrow \phi \Sigma^0(1385)$

$ t' $ (GeV ²)	$d\sigma/dt'$ ($\mu\text{b}/\text{GeV}^2$)
.00 - .05	52.9 ± 5.8
.05 - .10	38.2 ± 4.9
.10 - .15	42.4 ± 5.1
.15 - .20	34.9 ± 4.4
.20 - .25	34.9 ± 4.4
.25 - .30	29.4 ± 3.9
.30 - .35	28.6 ± 3.9
.35 - .40	26.9 ± 3.8
.40 - .45	24.8 ± 3.7
.45 - .50	20.6 ± 3.2
.50 - .55	21.4 ± 3.3
.55 - .60	18.9 ± 3.2
.60 - .65	15.1 ± 2.7
.65 - .70	12.6 ± 2.3
.70 - .75	13.9 ± 2.7
.75 - .80	10.1 ± 2.2
.80 - .90	8.8 ± 1.4
.90 - 1.00	6.9 ± 1.4
1.00 - 1.10	6.1 ± 1.1
1.10 - 1.20	5.5 ± 1.1

TABLE 3

Density matrix elements of the ρ^- , $\Sigma^+(1385)$ and $\Sigma^+(1385)$
polarization in the reaction $K^-p \rightarrow \rho^- \Sigma^+(1385)$

$ \tau' $ (GeV ²)	ρ_{00}	$\text{Re} \rho_{10}$	ρ_{1-1}	$\rho_{\frac{1}{2}\frac{1}{2}}$	$\text{Re} \rho_{\frac{3}{2}\frac{1}{2}}$	$\text{Re} \rho_{\frac{3}{2}\frac{-1}{2}}$	P
.00 -	.59 ± .05	.04 ± .03	.00 ± .04	.35 ± .04	-.03 ± .03	.03 ± .03	.29 ± .11
.02 -	.68 ± .05	.13 ± .03	-.07 ± .03	.36 ± .04	.05 ± .04	-.01 ± .04	.14 ± .12
.04 -	.43 ± .05	.12 ± .03	-.03 ± .04	.36 ± .04	-.02 ± .04	.00 ± .03	-.16 ± .12
.07 -	.61 ± .05	.13 ± .04	-.04 ± .04	.39 ± .04	.08 ± .04	-.11 ± .03	-.24 ± .11
.10 -	.51 ± .04	.19 ± .03	-.09 ± .03	.29 ± .03	.08 ± .03	.02 ± .03	-.08 ± .11
.15 -	.46 ± .05	.19 ± .03	-.09 ± .04	.34 ± .04	.06 ± .04	-.08 ± .03	.56 ± .10
.20 -	.48 ± .06	.22 ± .03	-.16 ± .04	.34 ± .04	.07 ± .04	-.11 ± .04	.25 ± .12
.25 -	.45 ± .06	.21 ± .03	-.14 ± .04	.29 ± .04	.14 ± .04	-.16 ± .04	.00 ± .12
.30 -	.49 ± .05	.21 ± .03	-.08 ± .05	.24 ± .04	.10 ± .04	.02 ± .04	-.16 ± .14
.35 -	.38 ± .06	.19 ± .04	-.22 ± .05	.30 ± .05	.11 ± .05	-.04 ± .05	-.19 ± .16
.40 -	.39 ± .06	.23 ± .03	.03 ± .06	.26 ± .05	.20 ± .04	-.02 ± .05	.29 ± .16
.45 -	.26 ± .06	.16 ± .03	-.11 ± .06	.21 ± .05	-.01 ± .05	-.07 ± .05	.51 ± .14
.50 -	.23 ± .06	.20 ± .04	-.10 ± .06	.18 ± .05	.10 ± .05	-.06 ± .06	-.07 ± .21
.55 -	.20 ± .07	.17 ± .04	-.19 ± .06	.22 ± .05	.15 ± .05	-.04 ± .05	.54 ± .14
.60 -	.42 ± .06	.18 ± .04	-.12 ± .05	.23 ± .04	.14 ± .04	.01 ± .05	-.03 ± .17
.70 -	.33 ± .06	.20 ± .04	-.13 ± .05	.32 ± .04	.22 ± .05	-.03 ± .04	.13 ± .13
.80 -	.36 ± .07	.20 ± .04	-.09 ± .06	.17 ± .05	.05 ± .05	-.01 ± .06	.53 ± .15
.90 -	.24 ± .06	.14 ± .04	-.05 ± .06	.22 ± .05	.13 ± .05	-.22 ± .05	-.28 ± .15
1.00 -	.31 ± .07	.18 ± .04	-.09 ± .06	.19 ± .05	.14 ± .05	-.02 ± .05	.51 ± .16
1.10 -	.10 ± .06	.12 ± .04	-.02 ± .07	.08 ± .05	.02 ± .05	-.04 ± .06	-.32 ± .16

TABLE 4

Density matrix elements of the ϕ , $\Sigma^0(1385)$ and $\Sigma^0(1385)$
polarization in the reaction $K^- p \rightarrow \phi \Sigma^0(1385)$

$ t' $ (GeV ²)	ρ_{00}	$\text{Re} \rho_{10}$	ρ_{1-1}	$\rho_{\frac{1}{2}\frac{1}{2}}$	$\text{Re} \rho_{\frac{3}{2}\frac{1}{2}}$	$\text{Re} \rho_{\frac{3}{2}-\frac{1}{2}}$	P
.00 - .04	.34 $\pm$.07	-.03 $\pm$.04	.06 $\pm$.06	.37 $\pm$.07	-.01 $\pm$.05	.11 $\pm$.07	-.07 $\pm$.19
.04 - .10	.47 $\pm$.07	.02 $\pm$.05	-.01 $\pm$.06	.23 $\pm$.06	.08 $\pm$.06	-.12 $\pm$.06	-.32 $\pm$.20
.10 - .15	.37 $\pm$.08	-.05 $\pm$.04	.07 $\pm$.07	.31 $\pm$.06	-.03 $\pm$.06	-.01 $\pm$.06	.18 $\pm$.19
.15 - .20	.37 $\pm$.08	.08 $\pm$.04	.06 $\pm$.07	.31 $\pm$.07	.12 $\pm$.08	-.03 $\pm$.05	.13 $\pm$.16
.20 - .30	.24 $\pm$.05	.04 $\pm$.03	.06 $\pm$.05	.30 $\pm$.06	.07 $\pm$.05	.03 $\pm$.04	.45 $\pm$.13
.30 - .40	.28 $\pm$.06	-.06 $\pm$.04	.10 $\pm$.05	.37 $\pm$.06	.07 $\pm$.05	-.04 $\pm$.05	.36 $\pm$.14
.40 - .50	.24 $\pm$.07	.00 $\pm$.04	.01 $\pm$.07	.25 $\pm$.07	.11 $\pm$.05	-.03 $\pm$.06	.54 $\pm$.19
.50 - .60	.43 $\pm$.08	.02 $\pm$.04	.04 $\pm$.06	.24 $\pm$.06	.05 $\pm$.06	.09 $\pm$.03	-.08 $\pm$.09
.60 - .80	.43 $\pm$.07	.05 $\pm$.05	.00 $\pm$.04	.18 $\pm$.05	.03 $\pm$.06	.01 $\pm$.03	.18 $\pm$.13
.80 - 1.20	.40 $\pm$.06	.09 $\pm$.04	.01 $\pm$.05	.32 $\pm$.04	.05 $\pm$.05	-.15 $\pm$.02	.32 $\pm$.08

TABLE 5

Definitions of the amplitude analysis samples

Reaction	$ t' $ Interval (GeV^2)	No. events
$\text{K}^- \text{p} \rightarrow \rho^- \Sigma^+(1385)$	0.00 - 0.05	483
	0.05 - 0.10	318
	0.10 - 0.20	472
	0.20 - 0.40	585
	0.40 - 0.60	432
	0.90 - 1.20	286
$\text{K}^- \text{p} \rightarrow \phi \Sigma^0(1385)$	0.00 - 0.20	370
	0.20 - 0.60	455
	0.60 - 1.20	236

TABLE 6

s-channel transversity amplitudes for $K^- p \rightarrow \rho^- \Sigma^0(1385)$

$ t' $ (GeV ²)	0.00 - 0.05	0.05 - 0.10	0.10 - 0.20	0.20 - 0.40	0.40 - 0.60	0.60 - 0.90	0.90 - 1.20
T_{31}^1	.625 ± .034	.459 ± .056	.594 ± .036	.385 ± .076	.469 ± .048	.539 ± .047	.431 ± .058
T_{11}^1	.141 ± .061	.199 ± .069	.129 ± .055	.155 ± .084	.121 ± .050	.198 ± .062	.085 ± .066
T_{11}^0	.203 ± .047	.132 ± .075	.184 ± .052	.246 ± .048	.188 ± .084	.314 ± .045	.416 ± .047
T_{31}^0	.156 ± .067	.147 ± .076	.228 ± .065	.083 ± .048	.188 ± .073	.059 ± .103	.121 ± .068
T_{31}^{-1}	.129 ± .043	.175 ± .079	.226 ± .041	.463 ± .068	.307 ± .054	.127 ± .060	.282 ± .060
T_{11}^{-1}	.205 ± .062	.238 ± .059	.288 ± .052	.075 ± .069	.237 ± .051	.171 ± .081	.304 ± .067
T_{1-1}^1	.414 ± .049	.165 ± .059	.442 ± .053	.363 ± .042	.343 ± .059	.317 ± .100	.297 ± .062
T_{3-1}^1	.222 ± .055	.197 ± .055	.289 ± .067	.222 ± .050	.296 ± .060	.160 ± .114	.415 ± .052
T_{3-1}^0	.070 ± .059	.067 ± .063	.083 ± .059	.085 ± .055	.267 ± .092	.078 ± .075	.177 ± .067
T_{1-1}^0	.297 ± .044	.375 ± .042	.203 ± .053	.246 ± .044	.347 ± .050	.276 ± .054	.309 ± .061
T_{1-1}^{-1}	.159 ± .053	.024 ± .058	.186 ± .058	.141 ± .054	.313 ± .072	.415 ± .096	.216 ± .056
T_{3-1}^{-1}	.356 ± .042	.642 ± .045	.222 ± .112	.522 ± .199	.224 ± .140	.377 ± .200	.114 ± .088
δ_{1-1}^1	.24 ± .52	5.97 ± .32	4.45 ± .54	4.34 ± .47	1.89 ± .88	3.71 ± .59	4.71 ± .84
δ_{11}^0	1.95 ± .32	1.81 ± .62	.75 ± .42	5.07 ± .31	5.01 ± .37	4.49 ± .44	3.58 ± .30
δ_{31}^0	.99 ± .52	1.15 ± .76	5.40 ± .47	3.71 ± .62	1.84 ± .64	2.31 ± 1.07	6.06 ± .87
δ_{31}^{-1}	6.06 ± .26	.07 ± .47	5.28 ± .17	5.03 ± .12	4.28 ± .13	4.40 ± 0.65	4.24 ± .20
δ_{-11}^{-1}	5.48 ± .36	4.74 ± .30	3.75 ± .19	4.12 ± .83	2.79 ± .28	2.01 ± .49	2.91 ± .81
δ_{-3-1}^1	.20 ± .29	5.95 ± .55	.42 ± .62	5.36 ± .27	5.00 ± .23	5.62 ± .65	4.06 ± .29
δ_{3-1}^0	.78 ± .94	2.36 ± 1.11	6.22 ± .36	2.42 ± .45	2.60 ± .84	5.89 ± 1.78	3.11 ± .60
δ_{-1-1}^0	2.21 ± .29	1.88 ± .46	1.56 ± .42	.19 ± .31	6.19 ± .63	6.28 ± 1.00	1.14 ± 1.70
δ_{1-1}^{-1}	6.05 ± .34	4.56 ± 1.34	5.46 ± .30	5.30 ± .30	4.51 ± .21	4.97 ± .48	4.69 ± .31
δ_{-3-1}^{-1}	5.31 ± .22	4.55 ± .44	4.48 ± .40	3.00 ± .22	2.95 ± .28	3.30 ± .46	.91 ± .53

TABLE 7

s-channel transversity amplitudes for $K^-p \rightarrow \phi \Sigma^0(1385)$

$ t' $ (GeV ²)	0.0 - 0.2	0.2 - 0.6	0.6 - 1.2
T_{31}^1	.358 ± .105	.600 ± .032	.585 ± .056
T_{111}^1	.170 ± .077	.108 ± .068	.065 ± .103
T_{11}^0	.471 ± .051	.442 ± .042	.325 ± .058
T_{31}^0	.107 ± .063	.067 ± .065	.240 ± .082
T_{31}^{-1}	.338 ± .124	.061 ± .041	.055 ± .093
T_{111}^{-1}	.144 ± .076	.161 ± .055	.234 ± .085
T_{1-1}^1	.154 ± .100	.296 ± .056	.439 ± .061
T_{3-1}^1	.178 ± .086	.223 ± .054	.270 ± .086
T_{3-1}^0	.023 ± .082	.161 ± .067	.169 ± .135
T_{1-1}^0	.312 ± .064	.422 ± .049	.327 ± .073
T_{1-1}^{-1}	.267 ± .118	.085 ± .065	.079 ± .074
T_{3-1}^{-1}	.501 ± .095	.225 ± .063	.158 ± .045
δ_{111}^1	5.06 ± .68	5.25 ± .64	6.23 ± 1.00
δ_{111}^0	1.74 ± .37	1.27 ± .20	.61 ± .31
δ_{31}^0	1.58 ± 0.84	1.01 ± 1.01	3.42 ± .59
δ_{31}^{-1}	.20 ± .28	4.22 ± .78	5.42 ± 1.72
δ_{111}^{-1}	1.09 ± .99	1.52 ± .33	5.40 ± .38
δ_{3-1}^1	0.66 ± .44	5.74 ± .33	3.34 ± .36
δ_{3-1}^0	5.42 ± 2.23	2.82 ± .37	1.68 ± 1.05
δ_{1-1}^0	1.50 ± .46	1.34 ± .24	6.08 ± .86
δ_{1-1}^{-1}	0.05 ± .40	4.18 ± .80	4.78 ± 1.03
δ_{3-1}^{-1}	4.17 ± .27	.32 ± .34	4.20 ± .55

TABLE 8
s-channel helicity amplitudes for the reaction $K^- p \rightarrow \rho^- \Sigma^+(1385)$

$ t' $ (GeV ²)		0.00 - 0.05	0.05 - 0.10	0.10 - 0.20	0.20 - 0.40	0.40 - 0.60	0.60 - 0.90	0.90 - 1.20
MODULI	U_{3+}^0	.182 ± .057	.354 ± .055	.472 ± .071	.509 ± .070	.415 ± .078	.438 ± .089	.355 ± .089
	N_{3+}	.340 ± .057	.349 ± .090	.316 ± .042	.290 ± .058	.444 ± .039	.351 ± .091	.488 ± .069
	N_{1+}	.040 ± .071	.125 ± .105	.046 ± .064	.144 ± .053	.098 ± .060	.142 ± .082	.161 ± .095
	U_{3+}^1	.284 ± .047	.293 ± .075	.017 ± .071	.340 ± .041	.373 ± .062	.417 ± .062	.552 ± .030
	U_{1+}^1	.354 ± .059	.414 ± .067	.559 ± .049	.514 ± .080	.509 ± .104	.459 ± .063	.279 ± .082
	U_{1+}^0	.753 ± .054	.608 ± .081	.504 ± .060	.322 ± .062	.229 ± .073	.343 ± .088	.218 ± .132
PHASES	U_{3+}^0	5.62 ± .32	.18 ± .24	5.72 ± .18	5.29 ± .16	5.39 ± .19	5.49 ± .20	5.37 ± .26
	N_{3+}	2.45 ± .17	2.37 ± .26	1.80 ± .23	.45 ± .27	6.10 ± .30	5.54 ± .26	4.89 ± .41
	N_{1+}	5.29 ± 1.88	.84 ± .87	2.66 ± 1.26	.21 ± .45	5.55 ± .62	5.87 ± .65	3.68 ± .58
	U_{1+}^1	2.89 ± .23	2.23 ± .26	1.32 ± 3.41	5.99 ± .25	5.02 ± .23	4.99 ± .22	4.70 ± .28
	U_{1+}^1	5.54 ± .18	6.02 ± .38	5.84 ± .14	5.54 ± .15	5.52 ± .20	5.05 ± .20	4.98 ± .38

TABLE 9

s-channel helicity amplitudes for the reaction $K^-p \rightarrow \phi \Sigma^0(1385)$

$ t' (\text{GeV}^2)$		0.00 - 0.20	0.20 - 0.60	0.60 - 1.20
MODULI	U_{3+}^0	$.358 \pm .072$	$.151 \pm .051$	$.440 \pm .084$
	N_{3+}	$.469 \pm .056$	$.528 \pm .028$	$.443 \pm .071$
	N_{1+}	$.211 \pm .086$	$.184 \pm .051$	$.184 \pm .086$
	U_{3+}^1	$.300 \pm .098$	$.327 \pm .052$	$.388 \pm .053$
	U_{1+}^1	$.387 \pm .120$	$.410 \pm .038$	$.291 \pm .059$
	U_{1+}^0	$.470 \pm .102$	$.504 \pm .065$	$.401 \pm .080$
PHASES	U_{3+}^0	$5.29 \pm .22$	$4.23 \pm .39$	$5.34 \pm .19$
	N_{3+}	$1.81 \pm .28$	$1.43 \pm .15$	$1.24 \pm .28$
	N_{1+}	$3.29 \pm .43$	$1.71 \pm .44$	$.20 \pm .58$
	U_{3+}^1	$1.00 \pm .38$	$3.74 \pm .17$	$3.42 \pm .25$
	U_{1+}^1	$4.99 \pm .23$	$4.43 \pm .13$	$5.87 \pm .27$

TABLE 10

Comparison of the results obtained in the model independent and model dependent amplitude analysis

Reaction $K^- p \rightarrow \rho^- \Sigma^+(1385)$		
$ t' $ (GeV ²)	χ^2 (12 moduli)	χ^2 (10 phases)
.00 - .05	7	7
.05 - .1	7	5
.1 - .2	16	16
.2 - .4	13	14
.4 - .6	18	20
.6 - .9	13	10
.9 - 1.2	13	12
Reaction $K^- p \rightarrow \phi \Sigma^0(1385)$		
$ t' $ (GeV ²)	χ^2 (12 moduli)	χ^2 (10 phases)
.0 - .2	6	15
.2 - .6	3	7
.6 - 1.2	8	14

FIGURE CAPTIONS

- Fig. 1 Differential cross sections for the reactions $K^-p \rightarrow \rho^- \Sigma^+(1385)(\bullet)$ and $K^-p \rightarrow \phi \Sigma^0(1385)(0)$. The cross section for $K^-p \rightarrow \rho^- \Sigma^+(1385)$ has been multiplied by a factor 1/2.
- Fig. 2 (a)-(c) Natural and unnatural parity exchange contributions to the differential cross sections for reactions $K^-p \rightarrow \rho^- \Sigma^+(1385)(\bullet)$ and $K^-p \rightarrow \phi \Sigma^0(1385)(0)$: (a) $\sigma_+ = \rho_+ d\sigma/dt'$; (b) $\sigma_0 = \rho_{00} d\sigma/dt'$; (c) $\sigma_- = \rho_- d\sigma/dt'$. The cross section for $K^-p \rightarrow \rho^- \Sigma^+(1385)$ has been multiplied by a factor 1/2.
- Fig. 3 Moduli of the s-channel transversity amplitudes for the reaction $K^-p \rightarrow \rho^- \Sigma^+(1385)$. Symbol $(\bullet)$ refers to the model independent analysis described in sect. 2 and symbol (0) to the model dependent analysis discussed in sect. 3.
- Fig. 4 Relative phases of the s-channel transversity amplitudes for the reaction $K^-p \rightarrow \rho^- \Sigma^+(1385)$. Symbol $(\bullet)$ refers to the model independent analysis described in sect. 2 and symbol (0) to the model dependent analysis discussed in sect. 3.
- Fig. 5 Moduli of the s-channel transversity amplitudes for the reaction $K^-p \rightarrow \phi \Sigma^0(1385)$. Symbol $(\bullet)$ refers to the model independent analysis described in sect. 2 and symbol (0) to the model dependent analysis discussed in sect. 3.
- Fig. 6 Relative phases of the s-channel transversity amplitudes for the reaction $K^-p \rightarrow \phi \Sigma^0(1385)$. Symbol $(\bullet)$ refers to the model independent analysis described in sect. 2 and symbol (0) to the model dependent analysis discussed in sect. 3.

FIGURE CAPTIONS (Cont'd)

- Fig. 7 Moduli of the s-channel helicity amplitudes times $(d\sigma/dt')^{1/2}$ for the reaction $K^-p \rightarrow \rho^- \Sigma^+(1385)$. The curves are the predictions of the Reggeised Born term model discussed in sect. 3.
- Fig. 8 Phases of the s-channel helicity amplitudes for the reaction $K^-p \rightarrow \rho^- \Sigma^+(1385)$. The curves are the predictions of the Reggeised Born term model discussed in sect. 3. (The phase of N_{1+} is undefined since its modulus is predicted to be zero).
- Fig. 9 Moduli of the s-channel helicity amplitudes times $(d\sigma/dt')^{1/2}$ for the reaction $K^- \rightarrow \phi \Sigma^0(1385)$. The curves are the predictions of the Reggeised Born term model discussed in sect. 3.
- Fig. 10 Phases of the s-channel helicity amplitudes for the reaction $K^-p \rightarrow \phi \Sigma^0(1385)$. The curves are the predictions of the Reggeised Born term model discussed in sect. 3.

Fig. 1

Fig. 2

Fig. 3

Fig. 4

Fig. 5

Fig. 6

Fig. 7

Fig. 8

Fig. 9

$$\bar{K}p \rightarrow \phi \Sigma^0 (1385)$$

Fig. 10