ABSORPTION EFFECTS IN CHARGE AND HYPERCHARGE EXCHANGE REACTIONS

B. SADOULET

1. INTRODUCTION

In this talk[1], we would like to give a phenomenological interpretation of the following simple charge and hypercharge exchange reactions

$$\begin{cases} \pi^- p \to \pi^0 n & \pi^- p \to \eta n \\ K^- p \to \bar{K}^0 n & K^+ n \to K^0 p \end{cases}$$

and

$$\begin{cases} \pi^- p \to K^0 \Lambda & K^- p \to \pi^0 \Lambda \\ \pi^+ p \to K^+ \Sigma^+ & K^- p \to \pi^- \Sigma^+ \\ \bar{p}p \to \bar{\Lambda}\Lambda, \quad \bar{\Lambda}\Sigma^0 \quad + \text{ charge conjugated}, & \overline{\Sigma^+}\Sigma^+ \end{cases}$$

in the region of 5 GeV/c incident momentum.

1.1 What has been said?

These reactions have been already discussed[2] in previous talks of this meeting. We can summarize the conclusions reached as follows :

a) Exchange degeneracy of Regge Poles if reasonably good for charge exchange reactions, is badly broken in hypercharge exchange reacti around 5 GeV/c incident momentum.

b) In spite of this problem, SU3 symmetry is surprisingly good.

c) The breaking of exchange degeneracy seems to be mainly related to s channel helicity amplitude and more precisely to the imaginary part of the negative signature exchange.

d) No model with predictive power can explain the data. In particular the traditionnal absorption models fail completely in describing the $\pi^- p \to \pi^o n$ polarization and the relative magnitude of hypercharge exchange, line reversed reactions.

1.2 What will be said?

Exchange degeneracy and SU3 symmetry have the appealing feature of providing a simple description of exchange amplitudes, and may be considered as a reasonable first order. However, something is lacking: the absolute size of colliding objects and the shape of the interaction volume. In particular nowhere seem to be included absorption effects which, in our mind, are a fundamental feature of hadron interactions.

In this talk, we claim that deviations from exchange degeneracy may be due essentially to absorption effects. We try to determine from the data what are their characteristics.

2. WHY ABSORPTION?

Since it is the first time we speak of absorption in this meeting, it may be worthwhile to recall in a schematic way some of the underlying ideas.

2.1 Underlaying ideas

2.1.1 The intuitive picture

Let us consider the collision of 2 hadrons. If the impact parameter $\left[b = (J+\tfrac{1}{2})/q,\ J=\text{total spin},\ q=\text{c.m. momentum}\right]$ is comparable to the radius of the incident objects, very likely the hadrons will be nearly not disturbed: They will slightly change of quantum numbers and of direction as we observe in ordinary 2 body reactions. On the contrary if the impact parameter is small, the amount of matter each hadron has to go through, is important and they radiate. We have no more a 2 body reaction but a multibody reaction. We expect therefore in impact parameter representation that the amplitudes of 2 body reactions are depressed at low impact parameter due to the opening of these other channels. (See Fig.1). This (suspected) phenomenon is called absorption.

2.1.2 Optical versus exchange picture

Dar[3] as early as 1963 has invoked this picture and proposed an optical description of 2 body reactions. The 2 body collision takes place in an annular region of radius R and

$$\frac{d\sigma}{dt} \propto \left[J_o\left(R\sqrt{-t}\right)\right]^2 \qquad (J_o=\text{cylindrical Bessel function}).$$

The main problem with such an approach is that there is no natural prescription for the energy dependence and the phase of amplitudes.

Another approach is based on the belief that exchanges are responsible for hadron interaction and that the resulting amplitudes are depressed at low impact parameter by absorption. Such a model has been proposed in 1962 by Sopkovitch and developped especially by Gottfried and Jackson[4]. It has been soon recognised that one should not only take into account the nearest singularity but the exchange of the whole family of particles with the same naturality and internal quantum numbers: This leads to Regge poles in t channel, to which some absorption cuts should be probably added as originally proposed in 1965 by Cohen-Tannoudji et al. and Arnold[5]. In practice, starting, in the

impact parameter representation, from a Regge amplitude R(b), one multiplies it by some absorption function S(b) small at b=o and converging to 1 at large b. As sketched in Fig.1 this leads to a final amplitude T(b) = R(b) x S(b) which shows the expected features.

2.1.3 Attitude in front of exchange degeneracy

In 1968, duality and the apparent absence of exotic resonances led to the concept of exchange degeneracy of Regge poles. At that time begins the opposition of two schools.

Michigan school[6] proposed the strong cut Regge absorption model (SCRAM) where the absorption is so strong that exchange degeneracy has no reason to be true for Regge poles. In particular none of the zeros predicted by exchange degeneracy is used in the Regge input. If valid at all, exchange degeneracy is considered as an approximate property of the final amplitude T(b). Harari recently has proposed to implement this property automatically through the so called dual absorptive model.

The so-called Argonne School[7] (also well represented in Europe: Saclay, Orsay, CERN, etc.) on the contrary considers that exchange degenerate Regge poles are probably a reasonable first order in the description of hadron collision. The resulting amplitudes have then to be corrected for absorption. This approach has the advantage of leaving relatively little freedom in the properties of exchanges and will be adopted in the following.

2.2 Qualitative results of this absorptive approach

With this assumption of exchange degenerate Regge poles modified by absorption, what kind of qualitative results are expected?

2.2.1 Qualitative difference between charge and hypercharge exchange reactions.

Simple SU3 considerations[8] show that the charge exchange reaction we are considering are dominated by the s channel helicity flip $^{S}f_{+-}$ of the baryon while hypercharge exchange reactions are dominated by

helicity non flip $^{s}f_{++}$:

But absorption modifies mainly helicity non flip amplitudes. This may be seen on Fig.2.

Let us consider an helicity non flip amplitude

$$^{s}f_{++}(t) = e^{at} \qquad (t = \text{momentum transfer})$$

and analyse it in impact parameter b:

$$^{s}f_{++}(b) = \frac{1}{2a} \exp(-b^2/4a).$$

This gaussian function has its maximum at b=o and the effect of absorption is drastic: The resulting differential cross section has a large tail which may be interpretated as a signature of absorption effects. On the contrary a helicity flip amplitude

$$^{s}f_{+-}(t) = \sqrt{-t}\ e^{at}$$

gives

$$^{s}f_{+-}(b) = \frac{b}{4a^2} \exp(-b^2/4a)$$

which is hardly modified at all by absorption.

Therefore, charge exchange reactions are expected in this absorptive approach, to present features predicted by exchange degeneracy, while in hypercharge exchange the picture is completely disturbed by absorption.

2.2.2 Results of conventional absorption models.

In spite of this nice qualitative prediction, "conventional absorption models" disagree strikingly with the data. We call "conventional" those models where the absorptive function S(b) is identified with the asymptotic S matrix of elastic scattering (or some suitable mean of elastic scattering in the initial and final state). Then you predict:

$$\left(\frac{d\sigma}{dt}\right)_{\pi p \to \bar{K}Y} > \left(\frac{d\sigma}{dt}\right)_{\bar{K}p \to \pi Y}$$

(where Y is an hyperon) and a wrong baryon polarization in charge exchange scattering. This is due to the fact that of the two terms 1 and $e^{-i\pi\alpha}$ the Regge signature factor, the later is less absorbed than the former since its rotating phase increases the proportion of high partial waves*. We will argue that in fact just the opposite happens around 5 GeV/c showing that s-u crossing properties of absorption are not as simple as usually assumed.

3. OUR MODEL

In the absence of a firm theoretical basis for absorptive corrections, we adopt the approach of fixing the Regge poles through theoretical and phenomenological considerations; we then determine what kind of absorptions we should apply.

3.1 Regge pole amplitudes

We assume that the Regge poles are exchange degenerate and SU3 symmetric (allowing only a splitting of the masses). Their trajectories are assumed to be linear and their reduced residues constant (see ref.1 for further details). Extrapolation to K* and K** poles allows us to fix the scale factor s_o ($.86 \pm .1$ GeV^2) and the K*πK residue. We are then left with 4 "free" parameters, the two s-channel helicity amplitude residues of one reaction e.g. $\pi^- p \to \pi^o n$ and the two D/F ratios for s channel helicity flip and non flip amplitudes. In fact these four parameters are not completely arbitrary as several independent phenomenological considerations fix their order of magnitude[8].

---

* In case of hypercharge exchange, difference of elastic cross sections is not sufficient to reverse the effect.

3.2 Absorption

We have parametrized our absorption in the form

$$S(b) = 1 - k \exp\left(\frac{-b^2}{4a} e^{i\phi}\right)$$

k is the strength of absorption of the s wave (when $\phi=o$), a is related to the width of absorption and ϕ is some phase shift. This parametrization in the conventional language corresponds to absorption by a non flat Pomeron. In order to keep the intuitive picture outlined above, we have decided to use the same absorption function for s channel helicity non flip and flip amplitudes.

3.3. Fits

We fixed by hand the four free parameters of Regge poles in the neighbourhood of generally accepted values and determine the absorption parameters for each reaction at each energy through computer fits. Some iterations have been necessary to obtain a consistent picture: reasonable fits and reasonable absorption parameters. Our D/F ratios are equal to those of Irving-al[9].

For hypercharge reactions we have fitted the differential cross sections, and we have for each case three variable parameters: k, a, ϕ. Some results are given in Fig.4. We then predict the polarisation (Fig.5) which are in good agreement with the existing data (except for $\bar{p}p \to \bar{\Lambda}\Lambda$. We refer the reader to Ref.1 for a discussion of that problem).

For charge exchange reactions, the situation is more complicated. As indicated by our results in hypercharge exchange reactions, the absorption parameters k, a, ϕ are different for the 1 and $e^{-i\pi\alpha}$ terms of the signature factor. We have therefore six unknown which cannot safely be determined from a differential cross section. We have therefore chosen to fit the $\pi^- p \to \pi^o n$ amplitudes* as determined at 6 GeV/c by Halzen and Michael[10], and the polarization (in order to take into

---

* Rotated in order to reproduce the $I_t=o$ phase of the five pole model of Barger and Phillips[11].

account correlations). The results are given in Fig. 6. We give also the differential cross section (not fitted) in order to show the extrapolation of our fitted amplitudes to $|t|>.625$ GeV^2. The wrong position of the dip in $\pi^- p \to \pi^o n$ is due to our insistance on the ρ trajectory to be linear and go through the A_2. If we assume then SU3 symmetry and that the absorption function behaves as an SU3 singlet we may make the predictions of

$$K^- p \to \bar{K}^o n$$

$$K^+ n \to K^o p$$

$$\pi^- p \to \eta n \quad \text{(assuming moreover that } \eta \text{ belongs to an SU3 octet)}$$

$$\pi^+ p \to K^+ \Sigma^+ \quad \text{(with the D/F ratios of Irving et al.).}$$

The agreement as shown in Fig. 7 is reasonable. The $\pi^- p \to \eta n$ d is probably due to a too strong absorption of helicity flip amplitude.

4. WHAT DO WE LEARN ABOUT ABSORPTION ?

From the previous figures, it is seen that we are able to give an unified description of charge and hypercharge exchange reactions in the framework of exchange degeneracy and SU3, at the price, however, of adjusting absorptive corrections. It remains to be shown that these corrections are consistent. From the large set of absorption parameters we obtained(*), we can abstract the following characteristics:

4.1 Effective absorption behaves approximately as a SU3 singlet

This can be seen from the similarity of the parameters obtained for charge and hypercharge exchange meson induced reactions and may be

(*) For the numerical values we refer the reader to our article[1].

illustrated by the fact that our predictions at 7 GeV/c for $\pi^+p \to K^+\Sigma^+$ from $\pi^-p \to \pi^o n$ is quite good (Fig. 7)*).

The only problem we have, in that respect, is that our helicity flip amplitude for the production of Λ is too high. This is reflected by large values of the width of absorption and a poor fit in the forward direction. This problem is difficult to cure with reasonable D/F ratios and may indicate some SU3 breaking, or a too low ρ trajectory in $\pi^-p \to \pi^o n$.

4.2 Effective absorption is rather strong

Around an incident momentum of 5 GeV/c, k is approximately equal to 1, showing that the absorption of the s wave is nearly complete**. This is required especially in order to describe the strong break in the differential cross section of hypercharge exchange reactions.

There is also, from our fits, an indication of a decrease of this strength when the energy increases.

4.3 The s-u crossing behaviour of absorption is complicated

Of the two terms 1 and $e^{-i\pi\alpha}$ of the Regge signature factor, the latter is more absorbed around 5 GeV/c than the former. This can be seen from the following tables where we try to abstract typical values of the absorption parameters around 5 GeV/c.

	$e^{-i\pi\alpha}$	1
Strength k	1	.8 - 1.
Width a	3.- 4. GeV^{-2}	1.3 - 2. GeV^{-2}
Phase shift ϕ	4.	.8 - 1.2
Effective "Pomeron"	$-4.e^{-i\frac{\pi}{2}(1+.8t)}e^{4t}$	$-1.5e^{-i\frac{\pi}{2}(1+.8t)}e^{.8t}$

* This is really a prediction since the F/D ratios have been determined from the comparison of Λ and Σ production.

** Conventional models have a k around .55 .

The last line gives the effective "Pomeron" amplitude which correspond to our fitted absorption. It is seen that its "trajectory" is quite steep and that the main difference between the absorption of the two types of amplitudes is the difference of width a which is reflected in the difference of ϕ.

5. DISCUSSION

The phenomenological picture to which we arrive, is quite similar to what has been already described at this meeting by Martin and Michael. In particular our amplitudes are very similar which is not so surprising since we use the same data and have similar phenomenological prejudices! We would like only to comment on the consequences of the s-u crossing behaviour we have found.

5.1 Relative absorption of real and imaginary part of amplitudes

5.1.1 Is real part really less absorbed than imaginary part?

It is often stated that real part of amplitudes behaves in the way predicted by the Regge model while the imaginary part are strongly distorted. This valid statement seems to imply that real part are less absorbed than imaginary part and this last statement is wrong as shown by the polarization $\mathcal{P}$ at small t

$$\mathcal{P} \alpha \text{ Im } ({}^{s}f_{+-} \, {}^{s}f_{++}^{*})$$

Let us consider $\pi^- p \to \pi^o n$ and $\pi^- p \to K^o \Lambda$ (Fig. 5). Absorption ${}^{s}f_{+-}$ and ${}^{s}f_{++}$ are in phase in $\pi^- p \to \pi^o n$ and in $\pi^- p \to K^o \Lambda$. Let us switch on absorption in ${}^{s}f_{++}$ and neglect its effect - anyway small - in ${}^{s}f_{+-}$. In order to have positive polarization, ${}^{s}f_{++}$ should be late in phase with respect to ${}^{s}f_{+-}$. In $\pi^- p \to \pi^o n^-$ since at small $|t|$, the imaginary and real parts of

Regge amplitudes have the same sign-in order to produce this phase delay absorption should be stronger for the imaginary part than for the real part. In $\pi^- p \to K^o \Lambda$ the situation is the opposite: in order to have positive polarization at small $|t|$ the real part should be more strongly absorbed.

5.1.2 Rotating phase Regge amplitudes are more absorbed than real ones

We therefore prefer to speak of a greater absorption of rotating phase Regge amplitudes than real ones. How this leads to the correct results can be shown as follows:

Let us call R_1 a real Regge amplitude and C_1 the associated absorption correction and R_2 a rotating phase amplitude and C_2 the corresponding correction. The situation is schematized in the table below :

Regge amplitude	Total amplitude	Effect of absorption
Real	$R_1 + C_1$	Creates an imaginary part
$e^{-i\pi\alpha}$	$R_2 + C_2$	Real part is more absorbed than imaginary part
$1 - e^{-i\pi\alpha}$	$R_1 - R_2 + C_1 - C_2$	Cancels in Real part Adds in Imaginary part
$1 + e^{-i\pi\alpha}$	$R_1 + R_2 + C_1 + C_2$	Adds in Real part Cancels in Imaginary part

In order to have maximum effects it is important to have a large phase shift of absorption ϕ_1 in the case of real Regge amplitudes. In our model it can be interpretated as a consequence of the smallness of the t slope of the effective Pomeron. In the model presented by Tran Thanh Van[12] at this meeting such a large phase shift is essentially put in by hand.

Note that our model predicts a positive polarization of the baryon in $\pi^- p \to \eta n$ at small t.

5.1.3 Relative position of the cross-over points

Another consequence of our model and especially of a large value of ϕ_1 is that the zeros of the imaginary part of s-channel helicity non-flip amplitudes (cross-over points) do not appear at the same t_c in all charge exchange reactions. This is readily seen from our previous discussion. With ϕ_1 positive and large, Im R_2 is less absorbed than $\mathrm{Im}(R_1 - R_2)$ but more than $\mathrm{Im}(R_1 + R_2)$ and we expect that

$$0 > t_c(\pi^- p \to \pi^0 n) > t_c(K^- p \to K^0 n) > t_c(\pi^- p \to \eta n) \ .$$

Exact calculations substantiate this result. Experimentally around 6 GeV/c it seems that the cross-over point of $\pi^\pm p \to \pi^\pm p$ is at about -0.15 GeV^2 (with large errors) while the one of $K^\pm p \to K^\pm p$ is at -0.2 . This is in qualitative agreement with our prediction, although the cross-over points obtained in our fits are at too high values of $|t|$. In fact with our absorption function it is impossible in $\pi^- p \to \pi^0 n$ to fit at the same time the forward point of the imaginary part of the helicity non-flip amplitude and the position of its zero. This comes obviously from the fact that the mean impact parameter of the amplitude is too low. Simple modifications of the low waves cannot cure the problem. Therefore, higher J components, absent in exchange degenerate Regge poles, are necessary. In that sense we reach the same conclusion as Hōgaasen and Michael[13].

5.2 Peripherality of the helicity non-flip amplitudes

By construction our absorption function increases the peripheralit of the amplitudes. At intermediate energy, the absorption strength k is close to one, and therefore this effect is maximum. However, the exact impact parameter behaviour of the amplitudes is modified as indicated above by the interplay of signs and the presence of phase.

Fig.9 summarizes the expected behaviour of our amplitudes and it is seen that some of them are not peripheral at all. The peripherality of different amplitudes is characterized in the next table :

Regge amplitude	1	$e^{-i\pi\alpha}$	$1 - e^{-i\pi\alpha}$	$1 + e^{-i\pi\alpha}$
Real part	not peripheral	peripheral	not peripheral	--
Imaginary part	not peripheral	--	peripheral	not peripheral

It is interesting to note that for positive signature Regge pole exchange, the imaginary part of the total amplitude has a strong central component. This could explain why in $I_t=0$ $\pi p \to \pi p$ amplitudes no peripheral component[14a] is observed at 6 GeV/c. A dual absorptive model cannot reproduce this behaviour and therefore it is not surprising in that approach that it fails to describe the positive signature component of elastic scattering[14b] - at least with a flat pomeron.

5.3 Energy dependence and interpretation

At energies around 5 GeV/c, it seems therefore true that rotating phase Regge amplitudes should be absorbed more strongly than real ones.

Using the usual assumptions about the analyticity of amplitudes and the Phrägmen-Lindelöf theorem, we may however go a little further[15]: line reversed reaction amplitudes should be equal in modulus at asymptotic energies. Therefore, absorption should become equal for real and rotating phase amplitudes. So from analytical properties our effective absorption is bound to vary with energy. This is indicated by our fits and the more straightforward observation that effective trajectories are higher than expected ones and that the large t tails seem to decrease with increasing energy. There is even an indication of a

decrease of k which may show that the effective absorption is converging towards the traditional absorption at high energy.

The most likely explanation of this energy-dependence, and strengthening of absorption at intermediate energy, is the presence of Regge-Regge cuts. However, their force has to be considerably increased with respect to box diagram calculation.

This suggestion may be supported by the following observation. If we believe in Schmid's interpretation[16] of the rotating phase, we may note that absorption is stronger in channels where resonances exist. The presence of these resonances is related to a higher total cross-section, which itself is explained in Regge model by secondary poles to be added to the Pomeron. The fact that absorption is greater in these channels is therefore conceivable and due in that approach to Regge-Regge cuts.

Reciprocally it is possible to interpret the effective absorption as constructing peripheral resonances in rotating phase amplitudes. It should then be noted that we expect more peripheral resonances in odd-signature amplitudes than even-signature ones. Some central resonances should also be present in s-channel exotic reactions.

6. CONCLUSIONS

From this study it is clear that exchange degenerate SU(3) symmetr Regge poles provide a reasonable first order in the description of simple charge and hypercharge exchange reactions. At intermediate energy, however, rather strong absorption corrections should be included. They are characterized by the maximum strength compatible with unitarity and a very peculiar behaviour under s-u crossing. Around 5 GeV/c, of the two terms 1 and $e^{-i\pi\alpha}$ of the Regge signature factor, the first is less absorbed than the latter. Asymptotically these absorptions have to be equal.

We arrive at the following phenomenological picture: in reactions dominated by s-channel helicity flip, the influence of these absorption corrections is negligible. They are practically unseen on differential cross-sections which agree reasonably well with exchange degeneracy predictions. When helicity non-flip dominates, striking effects appear such as a strong break in $d\sigma/dt$ due to absorption of the low waves. Fig.9 presents a systematic of the effects expected in our approach. Positive and negative signature amplitudes behave differently. It is clear that the picture obtained is certainly more complicated than assumed a priori in the dual absorptive model. The theoretical problem is to generate such effects and here we should confess our ignorance.

On the experimental side, more precise measurements of charge and hypercharge exchange reactions would clarify the situation. From our discussion, we think that the main emphases have to be put on:

a) accurate measurement of $\pi^{\pm}p$ cross-over;

b) precise polarization measurement at small t of $K^-p \to \overline{K^0}n$, $K^+n \to K^0\eta$, and $\pi^-p \to \eta n$;

c) relative normalization of $\pi p \to KY$ and $K^-p \to \pi Y$, at intermediate and high energy;

d) careful measurement of the large $|t|$ tail of hypercharge exchange reactions;

e) measurement of individual helicity amplitudes through A and R parameter measurements up to high $|t|$ especially in hypercharge exchange reactions where it is simpler.

We would like to end this talk with the following speculative remark: If it is really true that absorption is due to some kind of Bremsstrahlung of interacting hadrons it may be useful in order to understand better absorption to measure "two body reactions" with the emission of supplementary pions and study somehow the transition between two body and inclusive reactions. Unfortunately the theoretical tools are nearly inexistent apart, maybe, from the triple Regge limit analysis of inclusive cross sections.

REFERENCES

1. This talk is essentially a summary of two publications:
   - Thesis: "Phénomenologie des réactions d'échange d'hypercharge", submitted on 28 June, 1971 to the Paris-Sud University (Orsay - No 831 série A).
   - "Phenomenological characteristics of absorption in charge and hypercharge exchange reactions", submitted to Nuclear Physics B.

   For details and a more complete list of references we refer the reader to these two works.

2. For the experimental side see especially talks of M. Aguilar-Benitez, H. Videau and D.W. Leith. Some phenomenological discussions have been given by A.D. Martin and C. Michael.

3. A. Dar - Phys. Letters 7 (1963) 339
   A. Dar, M. Kugler, Y. Dothan, S. Nissmov - Phys. Letters 12 (1964) 82
   A. Dar, W. Tobocman - Phys. Letters 12 (1964) 511

4. N.J. Sopkovitch - Nuovo Cimento 26 (1962) 186
   K. Gottfried, J.D. Jackson - Nuovo Cimento 34 (1964) 735

5. G. Cohen Tannoudji, A. Morel, H. Navelet - Phys. Letters 19 (1965 62
   R.C. Arnold Phys Rev. 140 (1965) B 1022 and 153 (1967) 1506

6. SCRAM: - F. Henyey, G.L. Kane, J. Pumplin, M.H. Ross - Phys. Rev. 182 (1969) 1579
   - M. Ross, F.S. Henyey, G.L. Kane - Nucl. Physics B 23 (1970) 269. Dual absorptive model: H. Harari - Phys. Rev. Letters 26 (1971) 1400

7. Argonne School: - R.C. Arnold and M.L. Blackmon - Phys. Rev. 176 (1968) 2082

and in Europe e.g. - Lovelace - Nucl. Phys. B 12 (1969) 253

- A. Krzywicki, J. Tran Thanh Van - Lettere al Nuovo Cimento 2 (1969) 249 and Phys.letters 30B(1969)185

8. C. Michael - Proceedings of the Ruhenstein meeting on "Low energy hadron interactions and coupling constants" (Springer Tracts in Modern Physics 1970)

9. A.C. Irving, A.D. Martin, C. Michael - Nucl. Physics B 32 (1971) 1

10. F. Halzen, C. Michael - Phys. Letters 36 B (1971) 367

11. V. Barger, R.J.N. Phillips - Phys. Rev. 187 (1969) 2210

12. J. Tran Thanh Van - Talk at this meeting

13. H. Hogaasen, C. Michael - CERN preprint TH 1442 and their talks at this meeting.

14. V. Barger, F. Halzen - (a) "Empirical systematics of πN amplitude" Preprint Wisconsin 1972
(b) "Success and failure of Dual Absorption Models" Preprint Wisconsin 1972

15. A.A. Logunov, Nguyen van Hieu, I.T. Todorov - Annals of Physics 31 (1965) 203

16. C. Schmid - Phys. Rev. letters 20 (1968) 689

FIGURE CAPTIONS

1. Evolution of the idea of absorption

2. s-channel helicity non flip amplitude are more sensitive to absorption than helicity flip

3. Our absorption function

4. Some fits to hypercharge exchange reactions differential cross sectio

5. Prediction of polarization in hypercharge exchange from $\frac{d\sigma}{dt}$ fits.

6. Fit to $\pi^- p \to \pi^0 n$ amplitudes and polarization at 6 GeV/c. We give also the differential cross section (not fitted).

7. Predictions of

   $K^- p \to \bar{K}^0 n$ at 7 GeV/c

   $K^+ n \to K^0 p$ at 5.5 GeV/c

   $\pi^- p \to \eta n$ at 5.9 GeV/c

   $\pi^+ p \to K^+ \Sigma^+$ at 7 GeV/c

   from $\pi^- p \to \pi^0 n$ amplitude fits.

8. Polarization build up in charge and hypercharge exchange reactions.

9. Summary of expected behaviour.

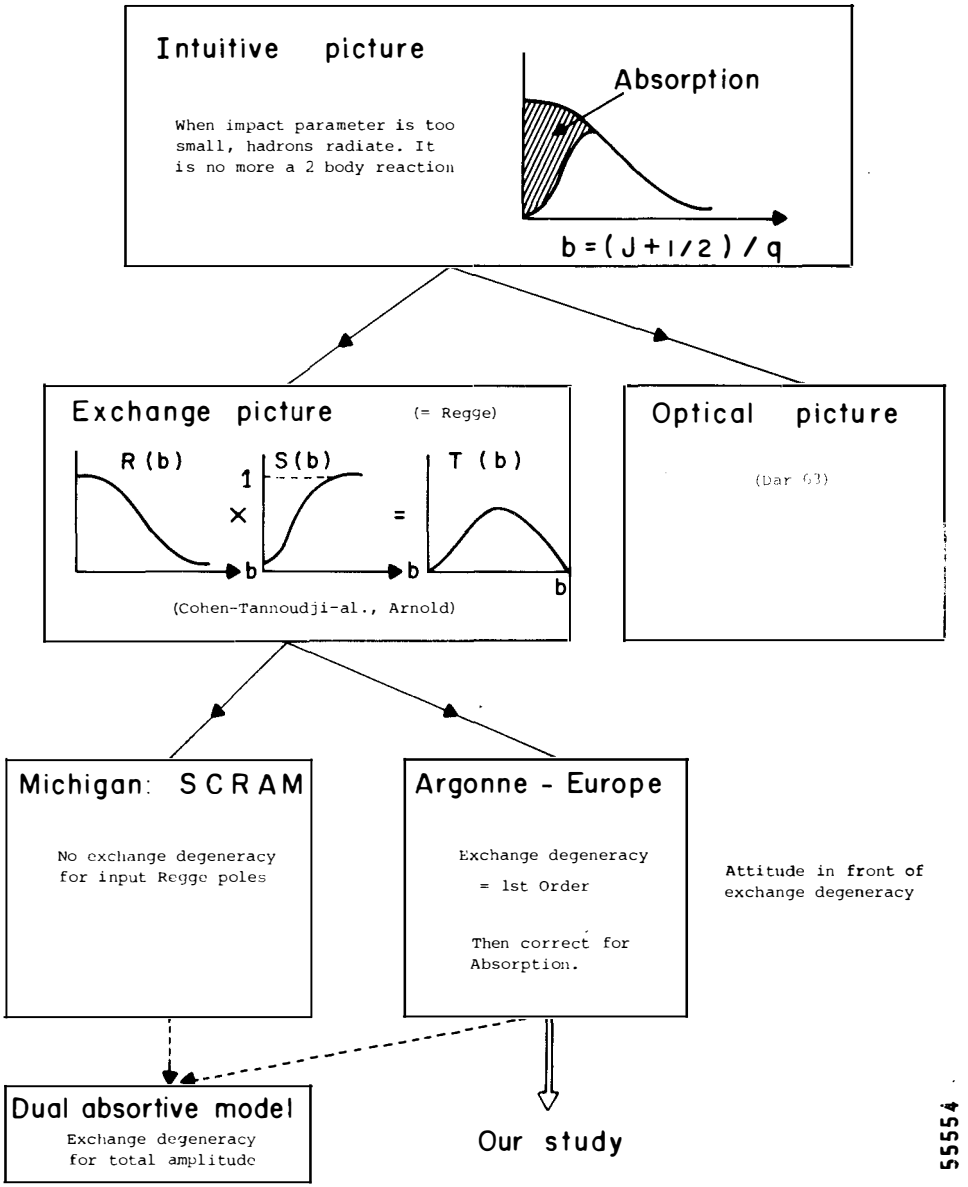

Intuitive picture
When impact parameter is too small, hadrons radiate. It is no more a 2 body reaction
Absorption
b = (J + 1/2) / q
Exchange picture
(= Regge)
R (b)
S(b)
T (b)
1
×
=
b
b
b
(Cohen-Tannoudji-al., Arnold)
Optical picture
(Dar 63)
Michigan: SCRAM
No exchange degeneracy for input Regge poles
Argonne - Europe
Exchange degeneracy
= 1st Order
Then correct for Absorption.
Attitude in front of exchange degeneracy
Dual absortive model
Exchange degeneracy for total amplitude
Our study
55554

Fig. 1

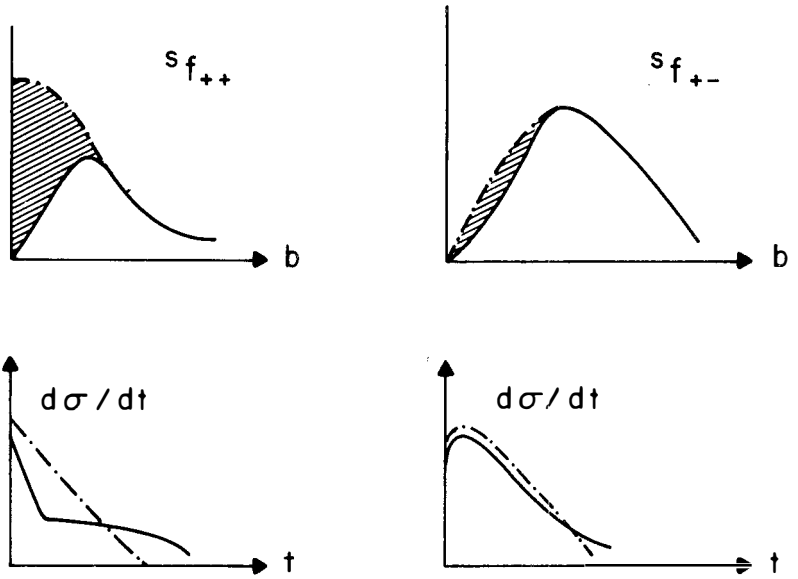
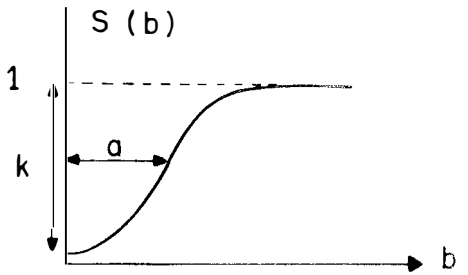


Fig. 2



55558

Fig. 3

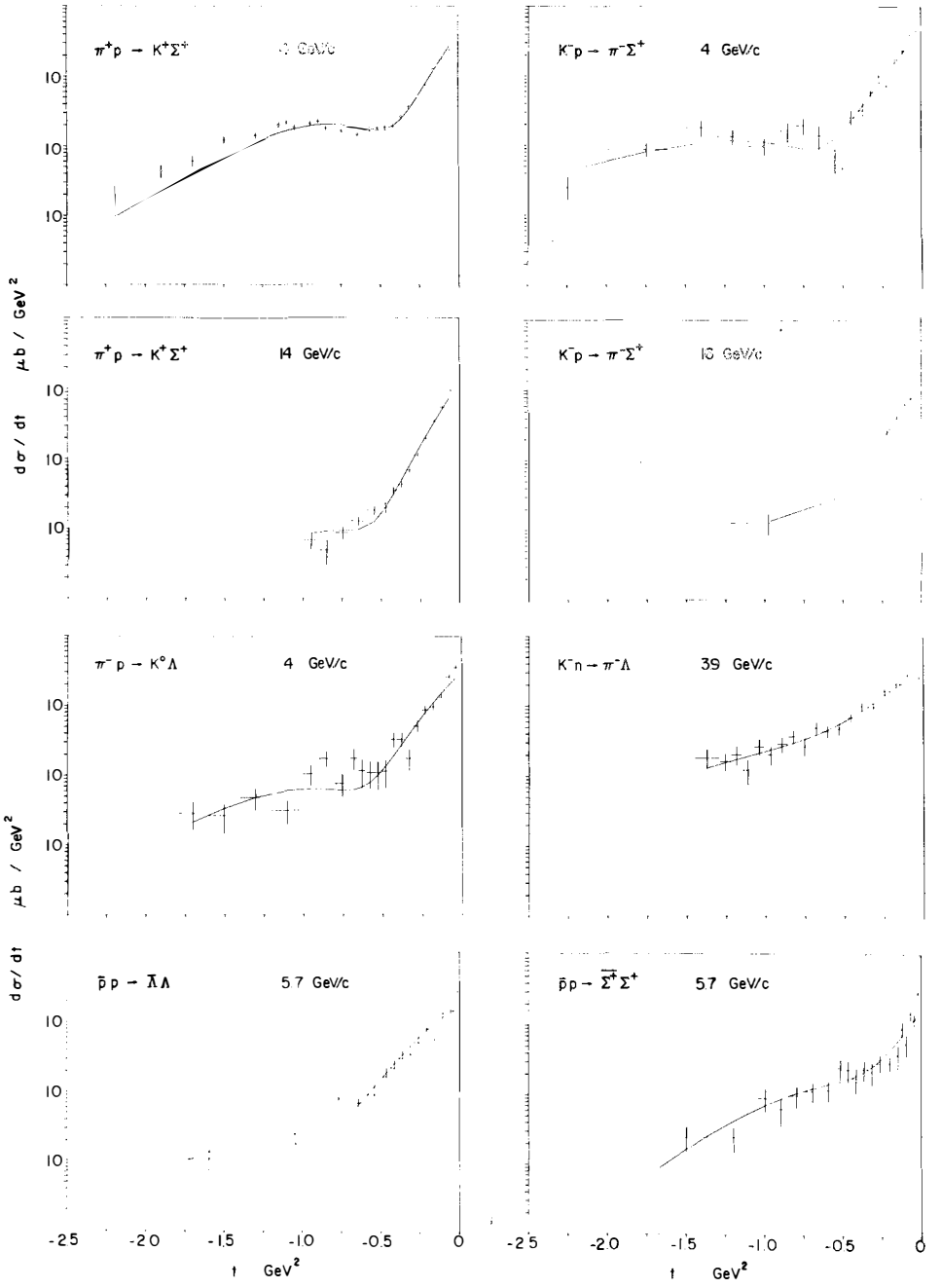
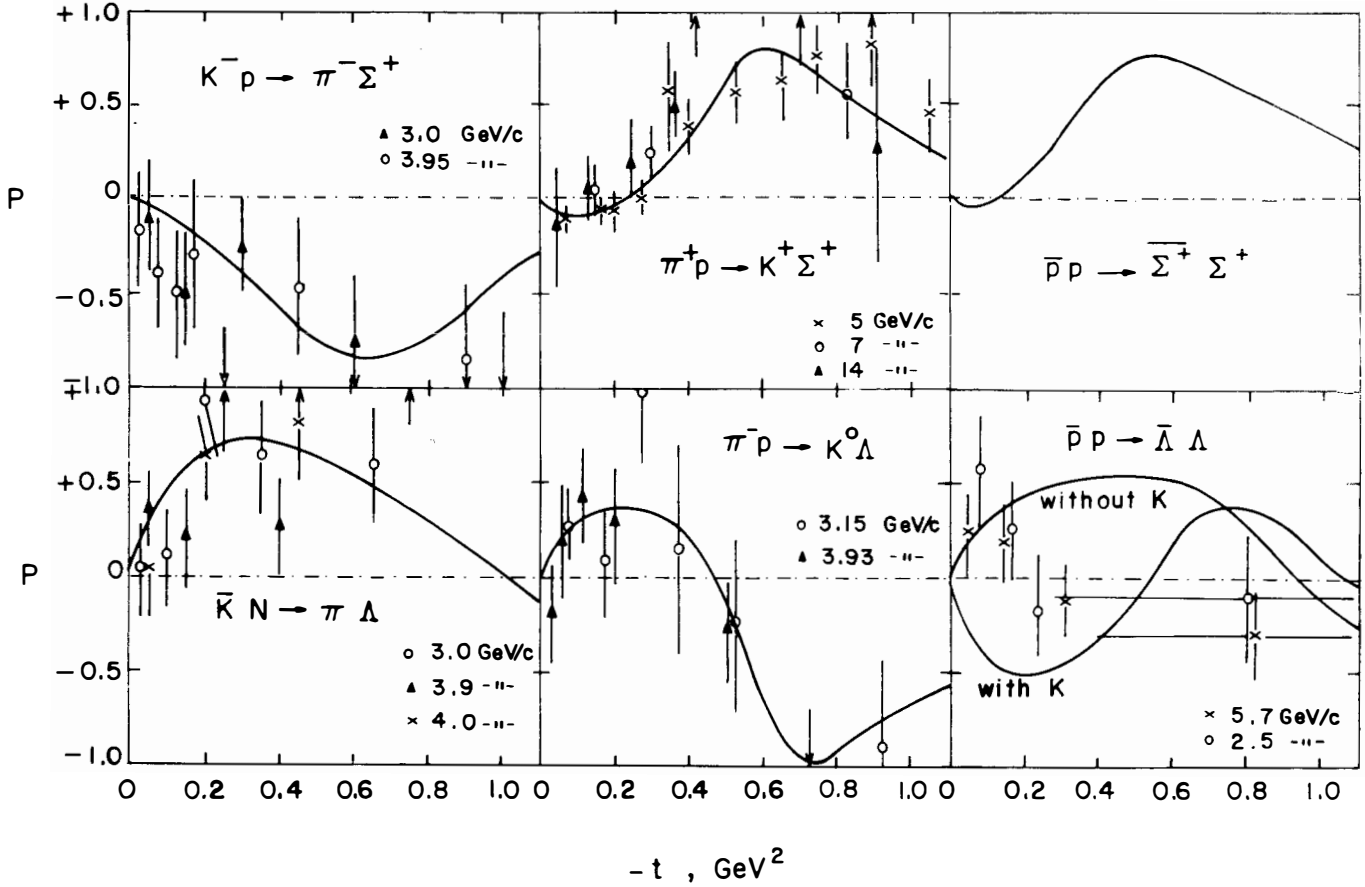

$\pi^+ p \to K^+ \Sigma^+$
$K^- p \to \pi^- \Sigma^+$
4 GeV/c
$\pi^+ p \to K^+ \Sigma^+$
14 GeV/c
$K^- p \to \pi^- \Sigma^+$
10 GeV/c
$\pi^- p \to K^0 \Lambda$
4 GeV/c
$K^- n \to \pi^- \Lambda$
3.9 GeV/c
$\bar{p} p \to \bar{\Lambda} \Lambda$
5.7 GeV/c
$\bar{p} p \to \bar{\Sigma}^+ \Sigma^+$
5.7 GeV/c
$d\sigma / dt$ $\mu b / GeV^2$
t GeV^2
-2.5
-2.0
-1.5
-1.0
-0.5
0

Fig. 4

55566


+1.0
+0.5
0
−0.5
−1.0
P
$K^- p \to \pi^- \Sigma^+$
▲ 3.0 GeV/c
○ 3.95 -"-
$\pi^+ p \to K^+ \Sigma^+$
× 5 GeV/c
○ 7 -"-
▲ 14 -"-
$\bar{p} p \to \overline{\Sigma^+}\, \Sigma^+$
$\bar{K} N \to \pi \Lambda$
○ 3.0 GeV/c
▲ 3.9 -"-
× 4.0 -"-
$\pi^- p \to K^0 \Lambda$
○ 3.15 GeV/c
▲ 3.93 -"-
$\bar{p} p \to \bar{\Lambda} \Lambda$
without K
with K
× 5.7 GeV/c
○ 2.5 -"-
0 0.2 0.4 0.6 0.8 1.0
$-t$, GeV^2

55561

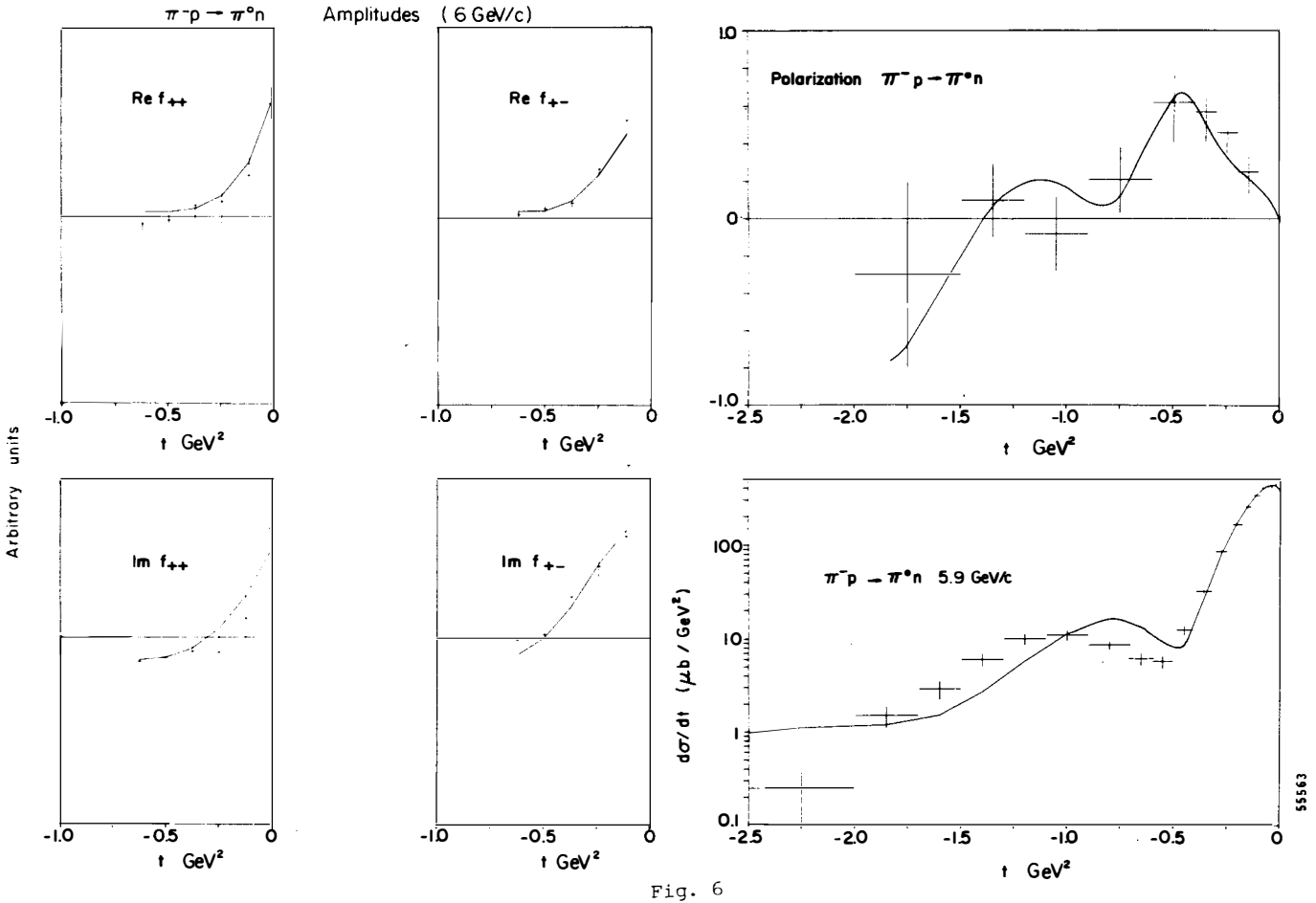

π⁻p → π°n Amplitudes (6 GeV/c)
Re f++
Re f+-
Polarization π⁻p → π°n
Im f++
Im f+-
π⁻p → π°n 5.9 GeV/c
Arbitrary units
dσ/dt (μb / GeV²)
t GeV²
55563

Fig. 6

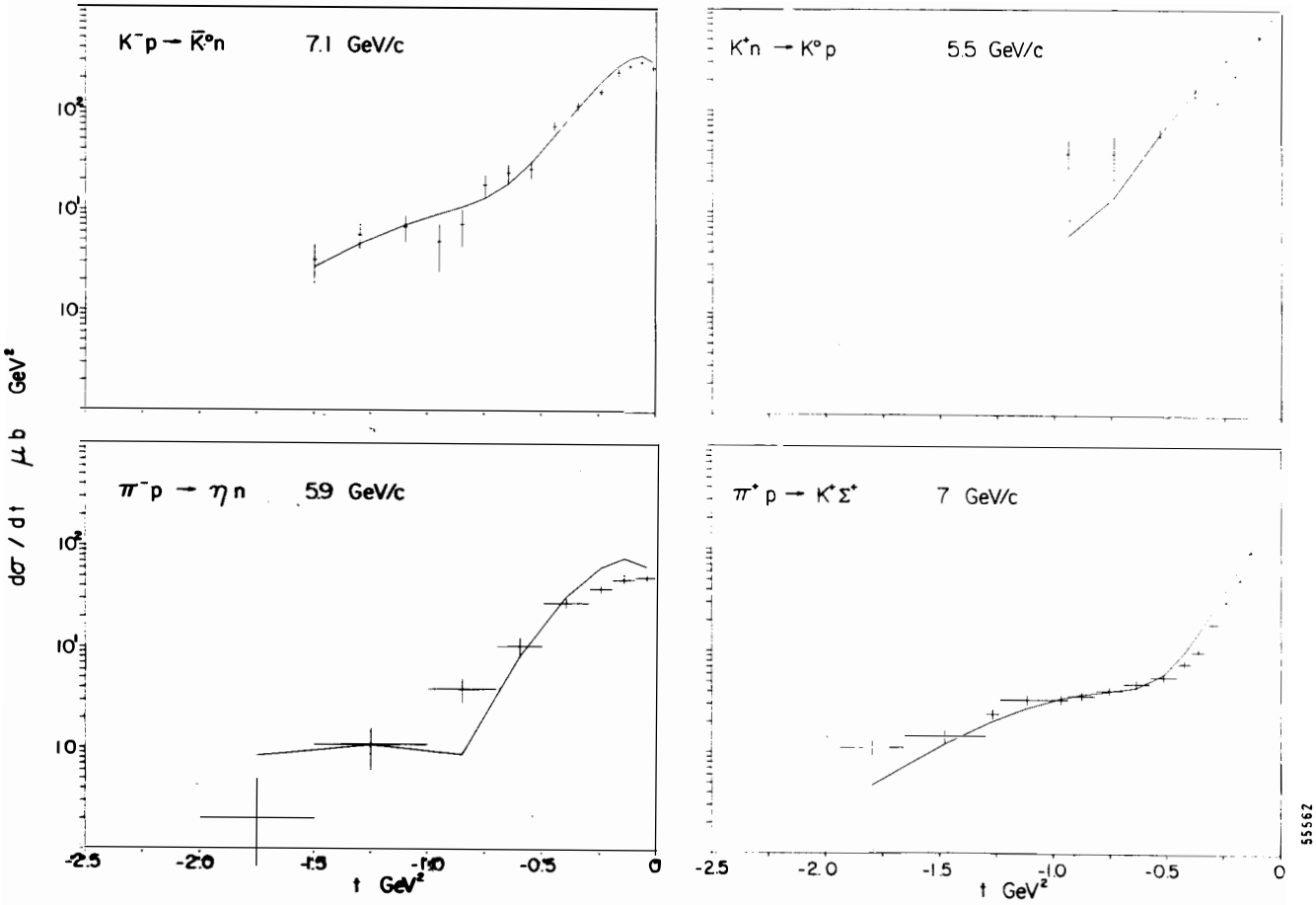

K⁻p → K̄°n 7.1 GeV/c
K⁺n → K°p 5.5 GeV/c
π⁻p → ηn 5.9 GeV/c
π⁺p → K⁺Σ⁺ 7 GeV/c
dσ / dt μb GeV⁻²
t GeV²
-2.5
-2.0
-1.5
-1.0
-0.5
0
55562

Fig. 7

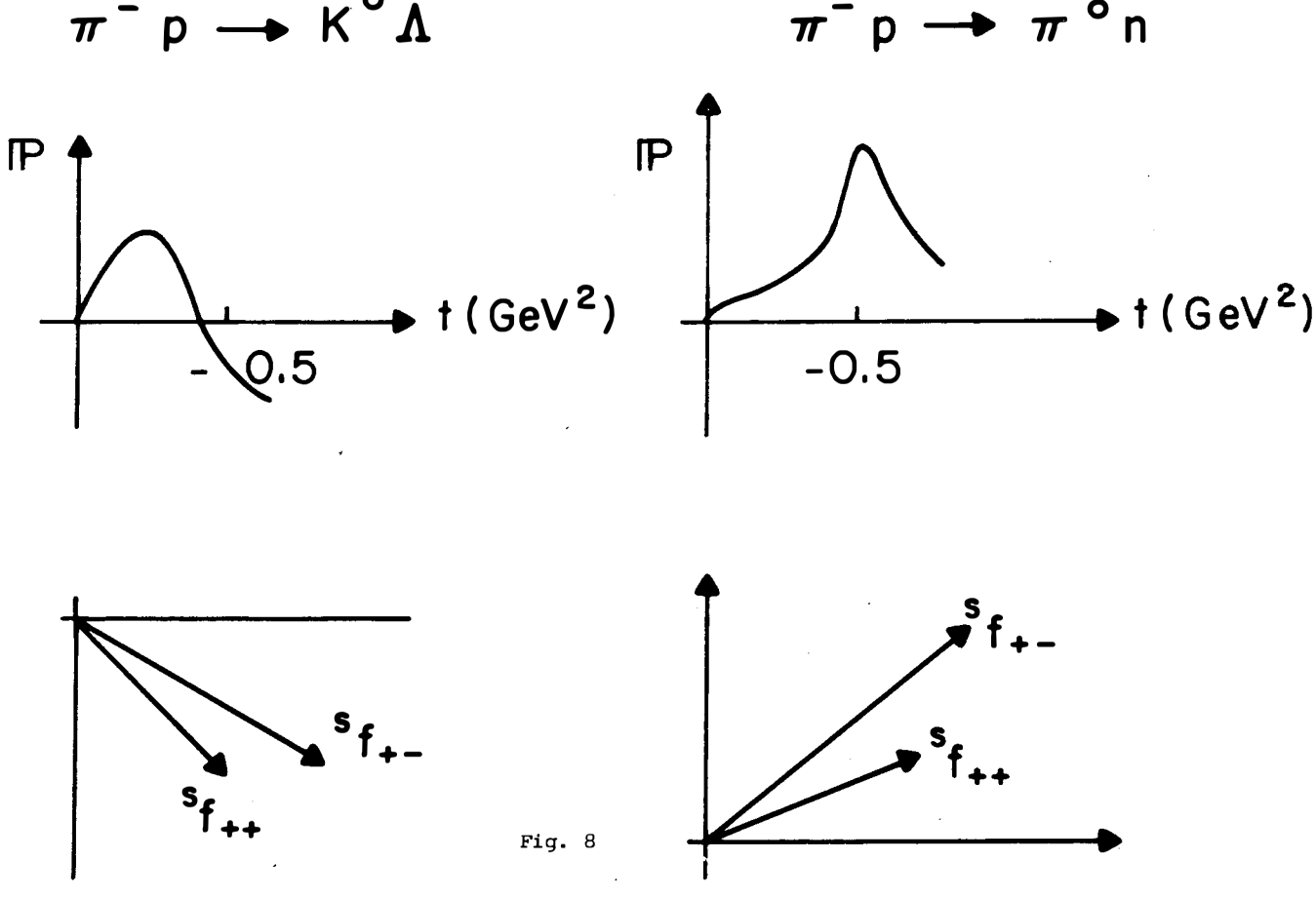

$\pi^- p \rightarrow K^\circ \Lambda$
$\pi^- p \rightarrow \pi^\circ n$
IP
t (GeV^2)
-0.5
$^s f_{+-}$
$^s f_{++}$

Fig. 8

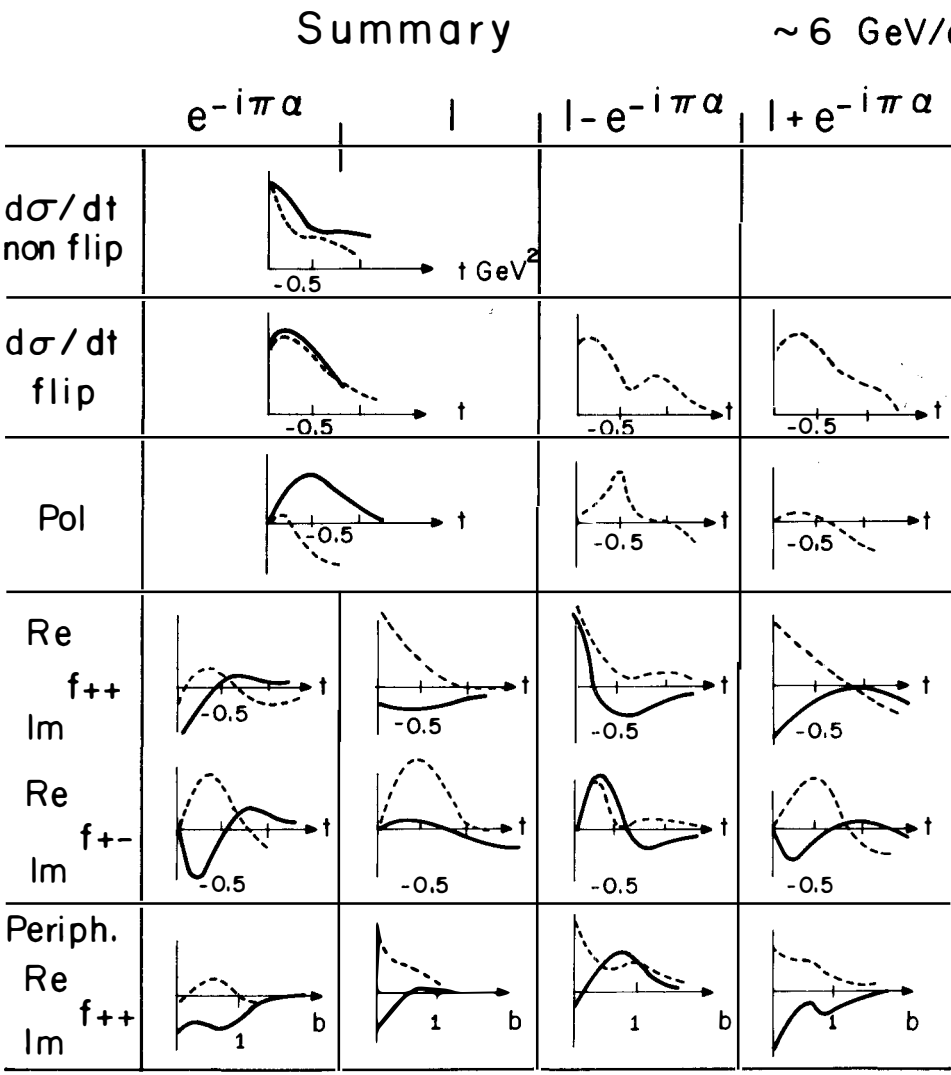

Summary
~6 GeV/
e^{-iπα} | 1 | 1 - e^{-iπα} | 1 + e^{-iπα}
dσ/dt non flip
dσ/dt flip
Pol
Re f++ Im
Re f+- Im
Periph. Re f++ Im
-0.5
t GeV²
t
b
1

Fig. 9