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A.Mihul, T.Angelescu

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A.Mihul[1], T.Angelescu[2]

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[1] On leave from the University of Bucharest, Romania.

[2] Now at the University of Bucharest, Romania.

Recently Chou and Yang [1] and Quigg and Thomas [2] in analysing the transfer of the electric charge in high energy interactions pointed out that similar conclusions must be valid for the exchange of any additive conserving quantum number, namely the baryon number and strangeness. Similar to the electric charge the quantum number transfer Δq will be determined for each interaction by:

$$\Delta q = \sum_f q_f - q_i ,$$

where q_f is the value of the respective quantum number (baryon, strangeness) of the particles in the final state in the forward (projectile) hemisphere and q_i is the value of the same quantum number for the projectile. The average value of the quantum number transfer will be given by:

$$\langle \Delta q \rangle = \frac{1}{\sigma_t} \sum_k \left(\sum_f q_f - q_i \right)_k \sigma_k ,$$

where σ_t is the total inelastic cross section and the sum is done over all k interactions.

Different authors tried to compare the experimental data with the predictions of theoretical models for electric charge exchange, but no attempt was made to compare the theoretical predictions with the experimental results for other quantum numbers as baryonic number or strangeness. This is mainly due to the difficulties to detect neutrons and to identify high momentum protons and to the impossibility of differentiating between K^0 and $\bar{K}^0$.

In the present paper we try to compare the average value for the strangeness transfer obtained from the existing experimental data with the theoretical predictions. The simplest case is the K^+p interaction if we neglect the reactions in which we know that a supplementary pair of strange particles is produced. In the available energy range the amount of neglected events is not higher than 5% /3/ and the error introduced by this approach will not change dramatically the result. So we have only one strange particle in the final state and ΔS will be either 0 or -1. The most complete set of data available to us for the K^+p high energy interactions was from the 16 GeV/c collaboration /4,6/. For the inclusive distributions for K^o, K^+ and $\tilde{\Lambda}$ the asymmetry coefficient:

$$a = (F-B)/(F+B)$$

(where F is the number of forward going strange particles and B is the number of backward going strange particles) was computed. The corresponding values are $a(K^+) = .38 \mp .01$; $a(\tilde{\Lambda}) = .54 \mp .01$; $a(K^o) = .58 \mp .01$. The smaller value obtained for K^+ is probably due to the difficulties in the identification of K^+. Taking into account the error in the K^+ distribution due to the bad identification of 10% per bin we have to consider an error of .04 in the coefficient $a(K^+)$.

With the values of the asymmetry coefficients $a(j)$ and the corresponding inclusive cross sections (σ_j) for the particle j, we can compute the average strangeness transfer:

$$\langle \Delta S \rangle = [(\sum_j a(j)\sigma_j \; / \sum_j \sigma_j) - 1] q_i \; /2 .$$

The sum have to be done on all strange particles in the final state. In such a way we get an average value for the strangeness tr.nsfer of:

$$\langle \Delta S \rangle_{K^+p(16)} = -.26 \mp .0.5 .$$

Another experiment was done at 12.7 GeV/c /5/. In this experiment the distributions for K^o and $\tilde{\Lambda}$ have been published but no data about the K^+ distribution is available in the literature. To approximate the value for $\langle\Delta S\rangle$ at this energy we have to use a rather rough hypothesis, namely, that the asymmetry coefficient of the K^+ distribution is the same at 12.7 as at 16 GeV/c. The support for this assumption is the fact that in a more wide momentum range (5÷16 GeV/c) the asymmetry coefficient for K^o distribution does not change as one can conclude from the distributions published in /5,6,7/. From the given distributions the asymmetry coefficient for K^o at 5, 8.2, 12.7 and 16 GeV/c are respectively: $a(K^o)_5 = .54 \mp .02$; $a(K^o)_{8.2} = .60 \mp .02$; $a(K^o)_{12.7} = .60 \mp .02$; $a(K^o)_{16} = .58 \mp .01$. With such assumption we obtain for the average strangeness transfer at 12.7 GeV/c the value:

$$\langle \Delta S \rangle_{K^+ p\,(12.7)} = -.28 \mp .05 .$$

For these two energies the percentage of events with $\Delta S = 0$ and $\Delta S = -1$ will be respectively $74 \mp 5\%$ and $26 \mp 5\%$ at 16 GeV/c and $72 \mp 5\%$ and $28 \mp 5\%$ at 12.7 GeV/c.

For the primary momentum of 8.2 and 5 GeV/c we were not able to find the K^+ distributions. The fraction of the inelastic cross section associated with K^o production is practically constant (~40%) in this momentum region /6,10/. The K^+ production cross section is slightly decreasing and the production of $\tilde{\Lambda}$ is negligible. So it is straightforward to suppose that if there are no drastic changes in the K^+ asymmetry coefficient the average strangeness transfer will remain negative and of the same order of magnitude as for 16 GeV/c.

The analysis of K^-p interactions is more difficult due to the lack of information about the distributions of charged hyperons. The only possible approach is to suppose that the distribution of charged hyperons ($\Sigma^\mp$) will be such that the asymmetry coefficient for these hyperons taken together will not be different of the asymmetry coefficient of Λ distribution. In this way we hope not to introduce an error larger than 10% in the value of the asymmetry coefficient. In the case of K^-p interactions as for K^+p we neglect the production of a supplementary pair of strange particles in order to have only $\Delta S = 1$; 0 values possible. The omission of these events will affect only slightly the inclusive distributions, the percentage of the excluded events being about 8% [8] at 10 and 16 GeV/c. So, from the invariant x distributions given in [8] and using a constant value for the $\langle P_T \rangle$ of each particle we can obtain the asymmetry coefficients for $\bar{K}^\circ$, K^- and Λ at 10 and 16 GeV/c. The error introduced by this procedure is not larger than 10%. This fact can be seen from the comparison of the asymmetry coefficients obtained by this method and that computed straightforward from $d\sigma/dx$ distribution for Λ or $\bar{K}^\circ$ given in [9,10]. We obtain from the invariant x distribution $a(\Lambda)_{10} = -.19 \mp .01$ and from the $d\sigma/dx$ distribution $a(\Lambda)_{10} = -.20 \mp .01$. Finally we obtain for the average strangeness transfer the values:

$$\langle \Delta S \rangle_{K^- p(10)} = .26 \mp .08, \quad \langle \Delta S \rangle_{K^- p(16)} = .24 \mp .08.$$

Some inclusive distributions are available for $\bar{K}^\circ$ and Λ at 4.2 GeV/c [10]. The corresponding asymmetry coefficients differ only slightly from those for 10 GeV/c.

If we assume that the same is happening for K^- distributions then the only fact which changes the $\langle \Delta S \rangle$ value will be the change in the corresponding partial cross sections. So we obtain for 4.2 GeV/c a value of:

$$\langle \Delta S \rangle_{K^- p(4.2)} = .28 \mp .08$$

The amount of events with $\Delta S = 0$ and $\Delta S = 1$ will be respectively $72 \mp 8\%$ and $28 \mp 8\%$ at 4.2 GeV/c, $74 \mp 8\%$ and $26 \mp 8\%$ at 10 GeV/c and $76 \mp 8\%$ and $24 \mp 8\%$ at 16 GeV/c.

The first conclusion which we can draw from the previous data is that for K^+p and K^-p interactions in the region of primary momentum from 4 to 16 GeV/c the average strangeness transfer does not change appreciably being negative for K^+p and positive for K^-p.

To enable a comparison with the electric charge transfer we show on the same graph (fig. 1) the average value for strangeness and electric charge transfer [11]. We note that the values for the average transfer of both quantum numbers are of the same order of magnitude. This fact seems strange because the two kinds of reactions are different from the point of view of the amount of secondary particles produced with the respective quantum numbers. If the electrical charge is produced abundantly, the average number of charged particles varying between 5 ÷ 10, for the strange particles this number is ~ 1.3.

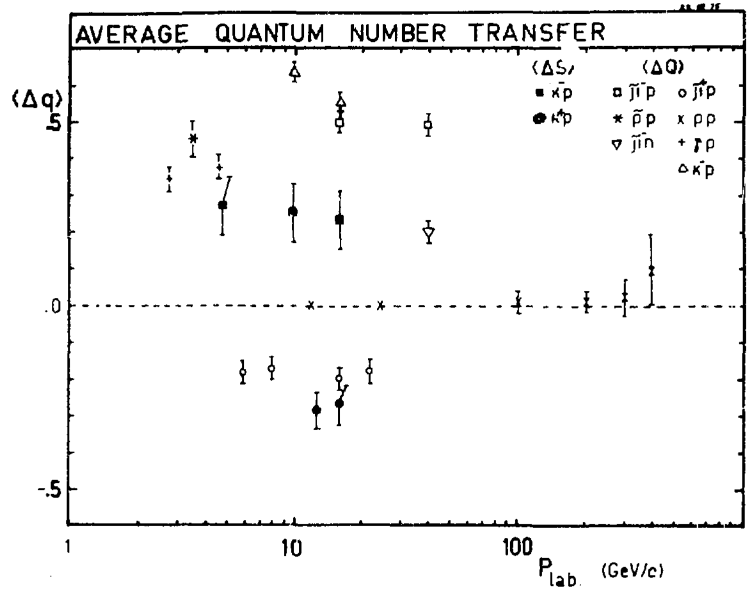

Fig. 1. Average quantum number transfer as function of the primary momentum. Strangeness transfer $\langle\Delta S\rangle$ *for* K^+p *and* K^-p *interactions. Electrical charge transfer* $\langle\Delta Q\rangle$ *from* /11/.

Other similitude between the two phenomena, charge and strangeness transfer, is that the $\langle\Delta q\rangle$ plot seems to be symmetrical in respect to $\langle\Delta q\rangle = 0$ against an T_3 (for charge) or S (for strangeness) conjugation.

A more difficult problem is to discuss the squared dispersion D^2 of the strangeness transfer since an important role in the value of D^2 have the reactions with more than one strange particle in the final state.

If we assume that two supplementary strange particles are produced in 10% of the events and that all these events contribute equally to the highest possible ΔS ,namely, -2; +1 for K^+p and +2; -1 for the K^-p interactions then the value of D^2 can raise from $D^2 \cong .18 \div .20$ to $D^2 = .45 \div .50$. Comparing these values with the corresponding values of D^2 for charge transfer (fig. 2)/11/

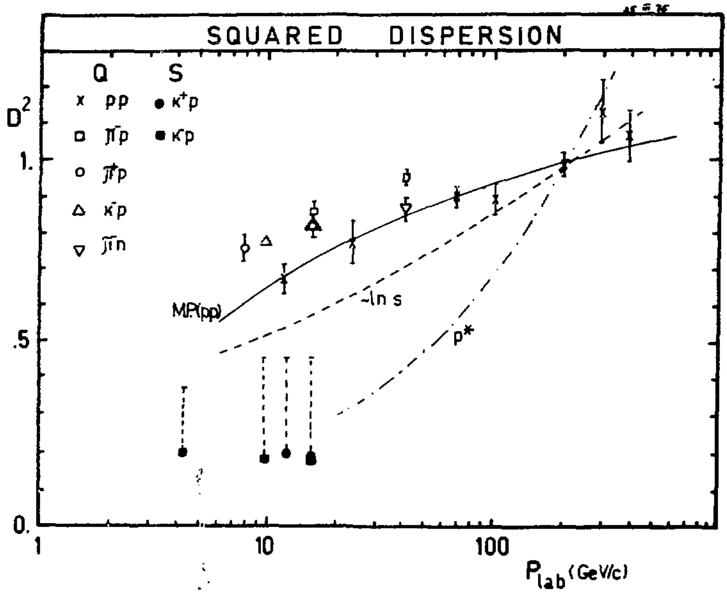

Fig. 2. Quantum number transfer squared dispersion as function of the primary momentum. For strangeness S from K^+p and K^-p interactions. For electrical charge Q from /11/. The curves are explained in /11/.

we see that D^2 value for strangeness transfer is appreciable smaller than the corresponding values for the electric charge.

Finally we have to point out that our conclusions can be false only if some of our assumptions are badly wrong.

References

1. T.T.Chou and C.N.Yang. Phys.Rev., D7, p. 1425 (1973).
2. C.Quigg and C.H.Thomas. Phys.Rev., D7, p. 2752 (1973).
3. E.Bracci et al. CERN/HERA/ 72-2 (1972).
4. Y.Goldschmidt-Clermont. Private communication.
5. S.Stone et al. Phys.Rev., D5, p.1621 (1973).
6. J.V.Beaupre et al. Nucl.Phys., B30, p. 381 (1971).
7. P.V.Chliapnicov et al. Preprint CERN/D.Ph. II/Phys. 74-45 (1974).
8. P.Bosetti et al. Nucl.Phys., B60, p. 307 (1973).
9. J.Bartsch et al. Nucl.Phys., B40, p. 103 (1972).
10. M.Deutschman. Many Particle Reaction. Rapporteur's talk at the Amsterdam International Conference on Elementary Particles, Amsterdam 1971, p. 153 (North-Holland).
11. A.Mihul and T.Angelescu. Preprint JINR, E1-8654, Dubna, 1975.

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