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ON THE STRANGE QUARK SUPPRESSION FACTOR IN HIGH ENERGY COLLISIONS

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The strange quark suppression factor λ has been determined by a direct comparison of the number of produced strange and non-strange quark-antiquark pairs. The results are compared with those found by other methods.

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1. Introduction

According to the current understanding of particle production in high energy collisions the secondary hadrons are made up in the hadronization process from $q\bar{q}$ pairs formed in the chromoelectric flux tube stretched out between separating color systems. The $q\bar{q}$ pairs can be of different flavors (u, d, s, c, ...). However in hadron-hadron collisions at energies $\sqrt{s} \lesssim 60$ GeV one can safely assume that only u, d and s flavors are produced with probabilities $u\bar{u} : d\bar{d} : s\bar{s} = 1 : 1 : \lambda$ (see below for the $c\bar{c}$ suppression). The strange quark suppression factor λ has been determined by many authors (see Ref. [1] and [2] for recent reviews) from measurements of the ratios K/π, K^*/ρ, ϕ/ρ etc. and found to be in the range from 0.1 to 0.4.

In the present paper λ is determined by another method which consists of a direct comparison of the number of strange ($s\bar{s}$) and non-strange ($u\bar{u}$, $d\bar{d}$) quark-antiquark pairs formed in the initial prehadronization stage. We consider here only those $q\bar{q}$ pairs which then provide valence quarks in the observed hadrons.

The average number of created $q\bar{q}$ pairs $\langle N_{q\bar{q}} \rangle$ is estimated here from $\langle N_{tot} \rangle$, the average number of charged and neutral particles, by accounting for the multiplication of hadrons due to resonance decays. Here we consider as particles all hadrons stable with respect to strong interaction. Because of experimental problems however we treat η and Σ^0 as resonances.

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Since $\langle N_{q\bar{q}}\rangle = \langle N_{u\bar{u}}\rangle + \langle N_{d\bar{d}}\rangle + \langle N_{s\bar{s}}\rangle = 2\langle N_{u\bar{u}}\rangle + \langle N_{s\bar{s}}\rangle$ the strange quark suppression factor λ is given by

$$\lambda = \frac{\langle N_{s\bar{s}}\rangle}{(\langle N_{q\bar{q}}\rangle - \langle N_{s\bar{s}}\rangle)}. \tag{1}$$

Thus, in order to determine λ, one has to know separately $\langle N_{q\bar{q}}\rangle$ and $\langle N_{s\bar{s}}\rangle$. The latter quantity can be obtained from the data on the production of strange particles and those non-strange mesons which contain the $s\bar{s}$ component (e.g. η).

This method of determining λ has been proposed in 1982 [3] and has been successfully applied since to calculate $\langle N_{q\bar{q}}\rangle$ and the strange quark suppression at the SPS Collider [4]. The present paper is a revised and enlarged version of Ref. [3].

2. *Determination of* $\langle N_{tot}\rangle$

The average number of all particles in hadron-hadron collisions can be written as

$$\langle N_{tot}\rangle = \langle N_{ch}\rangle + \langle N_{\Lambda}\rangle + \langle N_{K^n}\rangle + \langle N_{\pi^0}\rangle + \langle N_{n}\rangle + \langle N_{\bar{n}}\rangle + \langle N_{\bar{\Lambda}}\rangle, \tag{2}$$

where $\Lambda(\bar{\Lambda})$ stands for $\Lambda/\Sigma^0(\bar{\Lambda}/\Sigma^0)$, K^n for $K^0/\bar{K}^0$ and subscripts π^0, n and $\bar{n}$ refer to neutral pions, neutrons and antineutrons, respectively. The average number of charged particles $\langle N_{ch}\rangle$ is well known from experimental data (see [5] for a recent review). In many experiments the average number of lambdas, neutral kaons, neutral pions and antilambdas also has been determined, so that the only two unknowns in the right-hand-side of Eq. (2) are $\langle N_n\rangle$ and $\langle N_{\bar{n}}\rangle$. These two numbers can be estimated by using baryon number conservation which requires

$$(\langle N_p\rangle - \langle N_{\bar{p}}\rangle) + (\langle N_n\rangle - \langle N_{\bar{n}}\rangle) + (\langle N_Y\rangle - \langle N_{\bar{Y}}\rangle) = B, \tag{3}$$

where $B = 2$, 1 and 0 for proton-proton, meson-proton and antiproton-proton interactions, respectively. We now make the following assumptions:

$$\begin{aligned} &1)\ \langle N_{\bar{p}}\rangle = \langle N_{\bar{n}}\rangle, \\ &2)\ \langle N_{Y^\pm}\rangle = (0.6\pm0.1)\,\langle N_{\Lambda}\rangle, \\ &3)\ \langle N_{\bar{Y}^\pm}\rangle = (0.6\pm0.1)\,\langle N_{\bar{\Lambda}}\rangle. \end{aligned} \tag{4}$$

Assumption 1) seems to be reasonable because the $\bar{p}$ and $\bar{n}$ masses are almost equal. Assumption 2) is based on experimental data in the range 6 GeV/c < P_{LAB} < 28 GeV/c [6] shown in Fig. 1. However the $\Sigma^{\pm}/\Lambda$ ratio[1] assumed in this paper is in agreement with a recent result at 240 GeV/c [7]. Assumption 3) is made by analogy with assumption 2) (the production of antihyperons is very small anyway). All three assumptions are taken to hold at all incident energies.

Using (3) and (4) one can rewrite (2) for pp collisions as

$$\langle N_{tot}\rangle = \langle N_{ch}\rangle + 2 - \langle N_p\rangle + 3\langle N_{\bar{p}}\rangle - 0.6\langle N_{\Lambda}\rangle + 2.6\langle N_{\bar{\Lambda}}\rangle + \langle N_{\pi^0}\rangle + \langle N_{K^n}\rangle. \tag{5}$$

[1] The production of Ξ^- is very small and can be neglected.

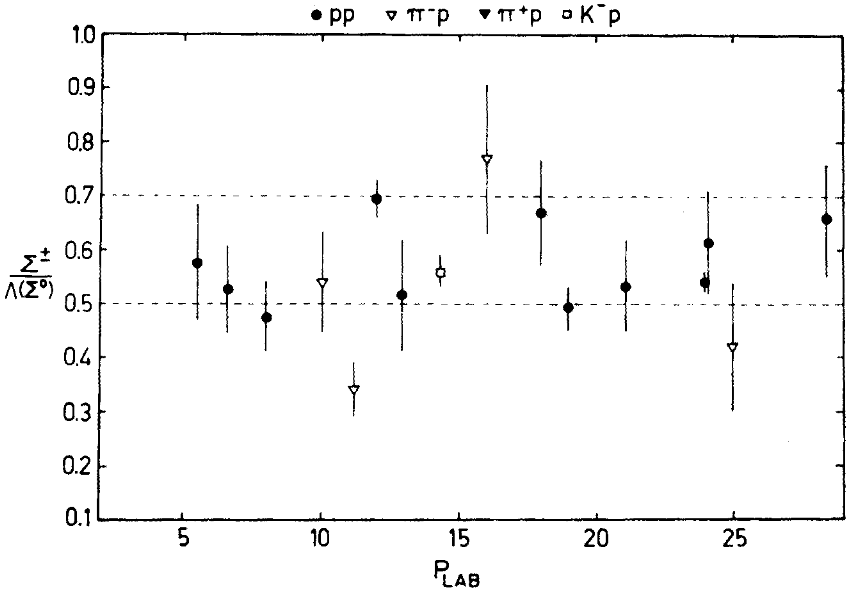

Fig. 1. The ratio of inclusive cross sections for $\Sigma^{\pm}$ and $\Lambda(\Sigma^0)$ production. Experimental data were taken from Ref. [6], [20e] and [26]

Since $\langle N_{\mathrm{p}}\rangle$ and $\langle N_{\bar{\mathrm{p}}}\rangle$ are known relatively well from counter measurements [8], $\langle N_{\mathrm{tot}}\rangle$ can be estimated quite accurately. As an example, for pp collisions at 69 GeV/c one has: $\langle N_{\mathrm{ch}}\rangle = 5.85 \pm 0.04$ [9a]; $\langle N_{\pi^0}\rangle = 2.35 \pm 0.05$ [9b]; $\langle N_{\mathrm{K}^0}\rangle = 0.218 \pm 0.014$ [9c]; $\langle N_{\Lambda}\rangle = 0.109 \pm 0.006$ [9c]; $\langle N_{\bar{\Lambda}}\rangle = 0.005 \pm 0.001$ [9c] and $\langle N_{\mathrm{p}}\rangle = 1.24 \pm 0.02$ [9d] from which one finds using (5); $\langle N_{\mathrm{n}}\rangle = 0.642 \pm 0.024$ and $\langle N_{\mathrm{tot}}\rangle = 9.17 \pm 0.10$.

The values of $\langle N_{\mathrm{tot}}\rangle$ have been calculated using data for pp collisions at 12 [6b, 11], 19 [10], 24 [11], 69 [9], 100 [12], 147 [13], 205 [14], 303 [15], 405 [16] and 1500 GeV/c [17, 22a].

3. *Determination of* $\langle N_{\mathrm{q}\bar{\mathrm{q}}}\rangle$

In order to calculate $\langle N_{\mathrm{q}\bar{\mathrm{q}}}\rangle$ from the average number of produced particles, which is $\langle N_{\mathrm{tot}}\rangle - 2$, one has to account for the multiplication of hadrons due to the decay of resonances.

In this paper the following assumptions concerning resonance production have been made:

A. Meson resonances

(1) For neutral ρ production in pp collisions [18, 22a] the following fit has been used:

$$\langle N_{\varrho^0}\rangle = (0.127 \pm 0.008) + (-0.078 \pm 0.005) \ln s + (0.0182 \pm 0.0009) \ln^2 s.$$

This fit gives $\chi^2/\mathrm{NDF} = 7.2/11$ (see Fig. 2).

(2) It is assumed that $\langle N_{\rho^\pm} \rangle = (2 \pm 1) \langle N_{\rho^0} \rangle$ which is consistent with the results of the only work [19] in which a comparison was made of the inclusive production of charged and neutral ρ mesons.

(3) It is assumed that $\langle N_\eta \rangle = \langle N_\omega \rangle = (1.0 \pm 0.5) \langle N_{\rho^0} \rangle$. The data on inclusive η and ω production are scarce [9b, 20] but consistent with the above assumption

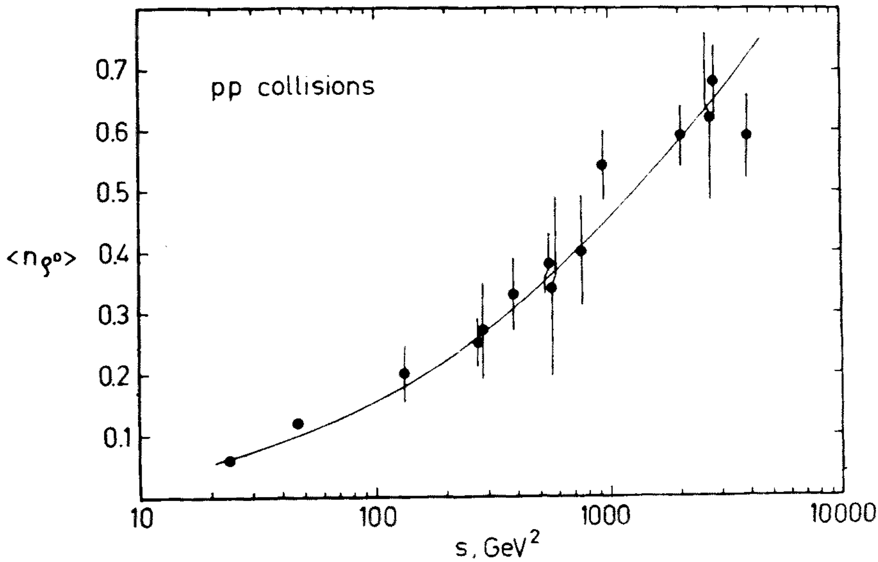

Fig. 2. Average number of neutral rho mesons per event in proton-proton collisions [18, 22a]. The line shows the fit used in this paper

TABLE I

Available data for ratios of inclusive cross sections

Reaction	ω/ρ^0	η/ρ^0	η/ω	Ref.
pp 12 GeV/c	1.0 ± 0.2	$\lesssim 0.8$		20a
pp 24 GeV/c	1.1 ± 0.2			20a
pp 69 GeV/c		< 0.9		9b
pp 300 GeV/c	2.6 ± 1.4	2.1 ± 1.7	0.8 ± 0.6	20b
$\bar{p}$p 32 GeV/c	~ 0.7	0.8 ± 0.3	~ 1.1	20c
K^-p 10 GeV/c			0.5 ± 0.1	20d
K^-p 14 GeV/c		1.6 ± 0.7		20e
K^-p 16 GeV/c			0.4 ± 0.1	20d
K^-p 32 GeV/c	0.9 ± 0.4	1.4 ± 0.5	1.6 ± 0.8	20f
K^+p 32 GeV/c		1.2 ± 0.8		20g
K^+p 70 GeV/c		< 0.9		20h
π^+p 4 GeV/c			0.8 ± 0.4	20i
π^+p 16 GeV/c	0.9 ± 0.1		0.4 ± 0.1	20d
π^-p 16 GeV/c	1.1 ± 0.2		0.5 ± 0.1	20d
π^-p 70 GeV/c		0.5 ± 0.3		20j

(see Table I). The ρ and ω have similar masses and belong to the same SU_3 multiplet so that their inclusive production is expected to be the same. For the η the situation is less clear. In the present work it was also taken into account that both η and ω contribute to the inclusive gamma cross section.

(4) $\langle N_{K^*_{890}} \rangle$ has been estimated by using the measured cross sections for K^0_s and the

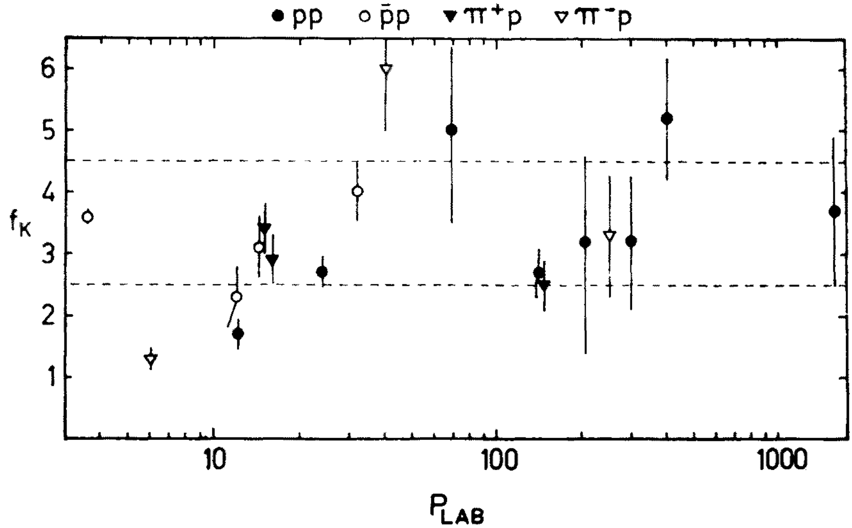

Fig. 3. The fraction f_K of neutral kaons coming from the decay of K*(890) [15d, 16d, 18d, 21, 22a]. The dashed lines indicate limits for f_K accepted in this paper

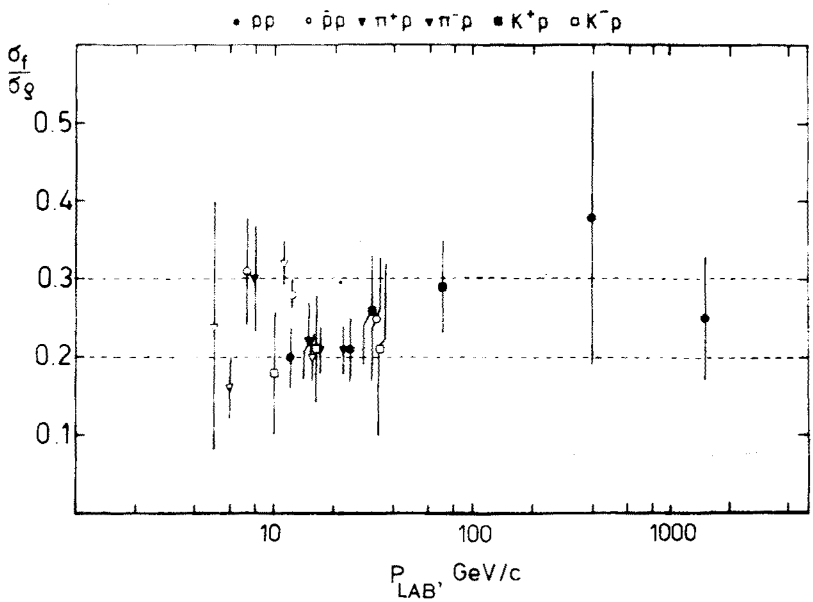

Fig. 4. The ratio of inclusive cross sections for f^0 and ρ^0 production [18a, 22, 20c, 20e]. The dashed lines indicate limits for the f^0/ρ^0 ratio accepted in this paper

constant value of 0.35 ± 0.10 for $f_K = (\sigma(K^{*+}) + \sigma(K^{*-}))/(\sigma(K^0) + \sigma(\overline{K}^0))$ as shown in Fig. 3 [15d, 16d, 18d, 21, 22a].

(5) Meson resonances of higher masses are produced with smaller inclusive cross sections. This has been found is several experiments and recently demonstrated in a convincing way by D. Drijard et al. [22a]. Experimental data are consistent [22] with the following assumptions used in the present paper:

$\langle N_{f^0} \rangle = (0.25 \pm 0.05) \langle N_{\varrho^0} \rangle$ (see Fig. 4),

$\langle N_{A_2} \rangle = (0.2 \pm 0.1) \langle N_{\varrho^0} \rangle$,

$\langle N_{g^0} \rangle = (0.25 \pm 0.10) \langle N_{f^0} \rangle$,

$\langle N_{K^*_{1410}} \rangle = (0.2 \pm 0.05) \langle N_{K^*_{890}} \rangle$.

(6) $\langle N_\phi \rangle$ has been taken according to the fit in [23].

(7) The production of other resonances with higher masses has been neglected in agreement with the lack of experimental evidence for their production.

B. Baryon resonances

The only baryon resonances produced with an appreciable cross section are Δ_{1240} and Σ_{1385}. Good data exist on Δ^{++}_{1240} production [24] but little is known about other charged states of this resonance[2] and about the production of other baryon resonances of the Δ and N* series. In this paper it is therefore assumed that the total contribution of all nucleon resonances equals $(3 \pm 1.5) \langle N^{++}_{1240} \rangle$.

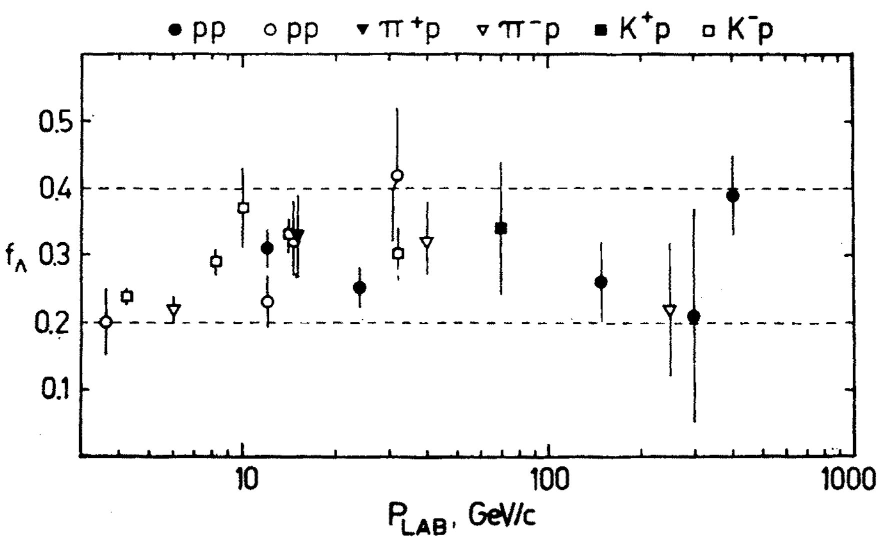

Fig. 5. The fraction f_Λ of lambda hyperons coming from the decay of $\Sigma(1385)$ [15d, 16d, 20e, 21a–e, 22c, 25]. The dashed lines indicate limits for f_Λ accepted in this paper

[2] The inclusive cross section for Δ^0 seems to be about one-fourth of that of Δ^{++} [16c, 18d, 24a].

TABLE II

Reaction	$\langle N_{tot}\rangle$*	$\langle N_{q\bar{q}}\rangle$	$\langle N_{s\bar{s}}\rangle$	λ
pp 12 GeV/c	5.39±0.05	2.3±0.3	0.11±0.02	0.10±0.02
pp 19 GeV/c	6.05±0.07	2.8±0.3	0.18±0.03	0.14±0.025
pp 24 GeV/c	6.70±0.06	3.4±0.3	0.22±0.03	0.13±0.02
pp 69 GeV/c	9.17±0.10	5.3±0.4	0.46±0.05	0.19±0.03
pp 100 GeV/c	10.04±0.12	6.1±0.5	0.53±0.06	0.19±0.03
pp 147 GeV/c	11.19±0.20	7.2±0.5	0.64±0.07	0.20±0.03
pp 205 GeV/c	12.00±0.27	7.4±0.6	0.67±0.08	0.20±0.03
pp 303 GeV/c	13.77±0.19	8.7±0.7	0.78±0.10	0.20±0.03
pp 405 GeV/c	14.63±0.18	9.3±0.8	0.83±0.11	0.20±0.03
pp 1473 GeV/c	19.37±0.32	12.0±1.3	1.14±0.12	0.21±0.03
π^+p 16 GeV/c	6.80±0.10	3.2±0.2	0.24±0.03	0.16±0.03
K$^-$p 14 GeV/c	6.24±0.12	2.5±0.3	0.23±0.05	0.21±0.05
$\bar{p}$p 32 GeV/c	7.84±0.05	3.6±0.2	0.33±0.07	0.20±0.05
$\bar{p}$p $\sqrt{s}$ = 540 GeV		28.5±0.9	4.5±0.8	0.38±0.7**

* Includes pions from η decay.
** From Ref. [4].

The production of Σ_{1385} is taken into account in a way similar to that of K^*_{890}, that is by taking the data on inclusive Λ production and assuming a constant value of 0.3 ± 0.1 for $f_\Lambda = \sigma(\Sigma^\pm_{1385})/\sigma(\Lambda)$ as shown in Fig. 5 [15d, 16d, 20e, 21a–d, 22c, 25]. It was assumed that $[\sigma(\Lambda_{1405}+\Lambda_{1520})]/\sigma(\Sigma^\pm) = 0.5$.

The values of $\langle N_{q\bar{q}}\rangle$ calculated[3] using the above assumptions vary between 2.3 at 12 GeV/c and 12.0 at 1500 GeV/c (see Table II).

4. *Determination of* $\langle N_{s\bar{s}}\rangle$

In collisions of non-strange hadrons $\langle N_{s\bar{s}}\rangle$ can be calculated most simply by counting all particles which have an s valence quark, or alternatively these which contain an $\bar{s}$ antiquark. Therefore

$$\langle N_{s\bar{s}}\rangle = \langle N_\Lambda\rangle + \langle N_\Sigma\rangle + \langle N_{K^-}\rangle + \langle N_{\bar{K}^0}\rangle + \langle N_{ns}\rangle + \delta$$

$$= \langle N_{K^+}\rangle + \langle N_{K^0}\rangle + \langle N_{ns}\rangle + \bar{\delta} \tag{6}$$

where $\delta(\bar{\delta})$ are the (small) contributions from other hyperons (antihyperons)[4], and $\langle N_{ns}\rangle$ is the contribution from non-strange mesons which contain strange quarks (antiquarks). The most important contribution to $\langle N_{ns}\rangle$ comes from $|\eta\rangle \sim (u\bar{u}+d\bar{d}-2s\bar{s})$. The production of η' is very small ($\langle N_{\eta'}\rangle \lesssim 0.1\langle N_\eta\rangle$) and can be neglected. It is also not necessary

[3] It also has been taken into account that three $q\bar{q}$ pairs are needed to form one baryon-antibaryon pair. In this approach possible production of diquark-diantiquark pairs is neglected.

[4] The ratio Ξ^-/Λ in pp collisions increases from 0.016 ± 0.011 at 19 GeV/c [10] to 0.06 ± 0.02 at 2100 GeV/c ($\sqrt{s}$ = 63 GeV) [27].

to include the ϕ meson in $\langle N_{ns}\rangle$ since its $s\bar{s}$ pair is accounted for (in 85%) in the contribution from the kaons.

Using $\langle N_{K^0}\rangle+\langle N_{\bar{K}^0}\rangle = 2\langle N_{K^0_S}\rangle$ and (4) one can rewrite (6) in the form

$$\langle N_{s\bar{s}}\rangle = 0.8\langle N_{\Lambda}\rangle+0.5(\langle N_{K^-}\rangle+\langle N_{K^+}\rangle)+\langle N_{K^0_S}\rangle+0.8\langle N_{\bar{\Lambda}}\rangle+\langle N_{ns}\rangle. \quad (7)$$

The data on the inclusive production of charged kaons have been taken from [8], the data on neutral strange particles from [9–16, 22a]. The contribution to $\langle N_{s\bar{s}}\rangle$ from non-strange mesons has been taken as $\langle N_{ns}\rangle = \langle N_{\eta}\rangle/2$. The values of $\langle N_{s\bar{s}}\rangle$ in pp collisions calculated from (7) vary between 0.11 at 12 GeV/c to 1.14 at 1500 GeV/c (see Table II).

5. *Results and discussion*

The values of the strange quark suppression factor in pp collisions calculated from formula (1) are presented in Table II and Fig. 6 together with the value of λ calculated for $\bar{p}p$ collisions at the SPS Collider [4].

In addition λ has been calculated for π^+p at 16 GeV/c [19, 21a, 28], K^-p at 14 GeV/c [20e, 22m] and $\bar{p}p$ at 32 GeV/c [20c, 21h, 29]. In these experiments data were obtained on inclusive production of very many resonances. These data were used directly (i.e. without using many of the assumptions discussed above) to calculate λ from formula (1). The results shown in Table II and Fig. 6 compare well with those calculated for pp collisions.

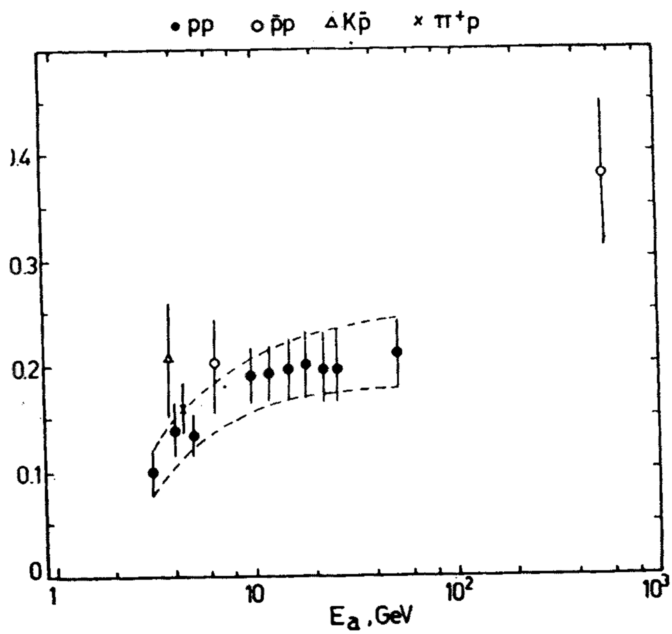

Fig. 6. The values of the strange quark suppression factor λ calculated from formula (1) as a function of the available energy $E_a = \sqrt{s}-m_{beam}-m_{target}$. Included is the UA5 result obtained in Ref. [4] for non single-diffractive events. The hand-drawn dashed lines indicate approximate limits of λ in pp collisions between 12 and 1500 GeV/c

Fig. 7 shows the values of λ in hadron-hadron collisions calculated in a traditional way by using the additive quark model predictions [30]. The results agree well with those presented in Fig. 6, except for the region of very high E_a, in which the energy dependence of λ determined in this paper seems to be weaker than that found in other papers. The present experimental evidence does not allow one to draw definitive conclusion on this point. One has to remember, however, that some of the assumptions used in this paper may no longer be independent of energy for high E_a.

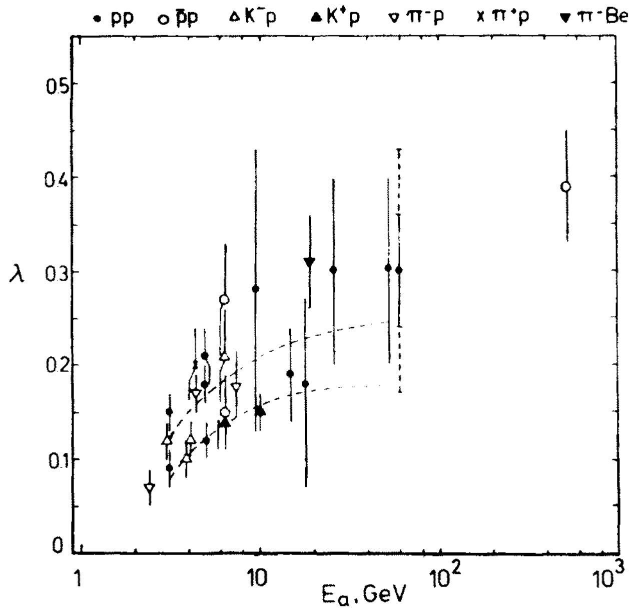

Fig. 7. The values of the strange quark suppression factor λ in hadron-hadron collisions calculated by using the additive quark model predictions. The data were taken from [16d, 18d, e, 20c, e, f, g, 21g, j, 22a, f, 31]. The dashed lines are the same as in Fig. 6

By using the method proposed in the present paper it is possible to reduce fluctuations arising from the different procedures used in fitting mass spectra by different authors. It is also worth pointing out that the method which exploits the ratios K/π, K*/ρ, ϕ/K* etc. may yield less reliable results; for example the products of resonance decays may contribute differently to the numerator and the denominator of the above ratios. Another source of ambiguity may be the choice of kinematic region used for calculating the above ratios[5]. The method proposed in this paper is free from such uncertainties. Of course the results presented here depend strongly on the validity of the assumptions explained in the previous sections. However the limits of error for values used in this paper have been set rather generously which makes the final results credible. It also should be pointed out that the

[5] For example the values of λ determined for pp collisions at 24 GeV/c vary between 0.12 ± 0.02 and 0.21 ± 0.03 [31d, g] and in $\bar{p}p$ interactions at 32 GeV/c between 0.15 ± 0.04 and 0.27 ± 0.06 [20c].

neglect of high mass resonances has little effect on the final value of λ. For example, to change λ at 200 GeV/c from 0.20 to 0.25 one would need to include about 43 mb of inclusive cross section of resonances not taken into account in this analysis (this would mean about 1.35 new resonances per inelastic event; it is to be compared with $\langle N_{\varrho^0} \rangle = 0.3$ at this energy).

The neglect of $c\bar{c}$ production has negligible effect on the determination of λ up to the ISR energies. The recent measurement [32] yielded $c\bar{c}/s\bar{s} \approx 0.003$ for pp interactions at 360 GeV/c (E_a = 26 GeV). If the total charm cross section at the ISR (E_a = 60 GeV)

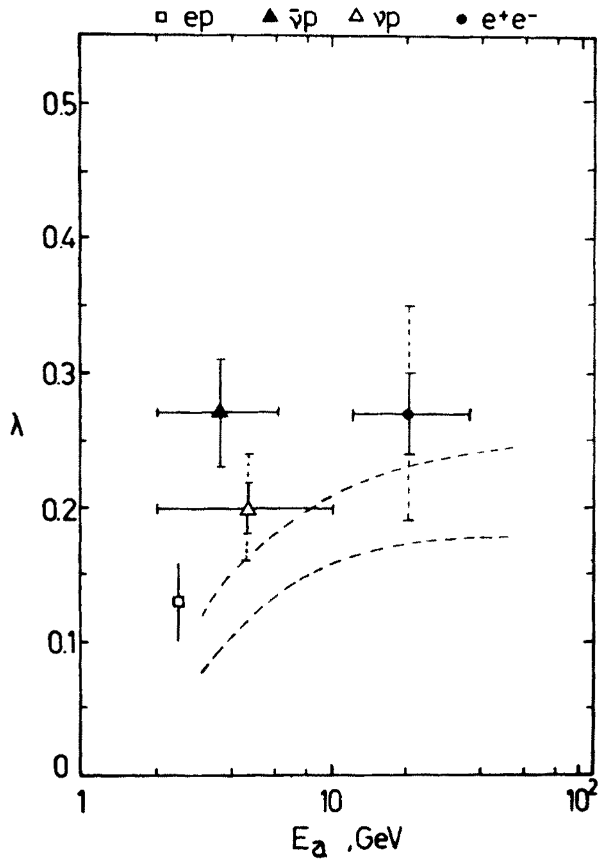

Fig. 8. The values of the strange quark suppression factor λ in lepton-hadron interactions [36] and e^+e^- annihilations [37]. The dashed lines are the same as in Fig. 6

is 1 mb [33], then $c\bar{c}/s\bar{s} \approx 0.05$. The situation at the SPS Collider energy of 540 GeV is less clear in view of the recent finding of copious D* production by the UA1 Collaboration [34]. Taking the results for $\langle N_{q\bar{q}} \rangle$ from [4] and branching ratios for decays of charmed particles one may estimate that at this energy $\Delta\lambda \approx -0.06\langle N_{c\bar{c}} \rangle$. Thus, if $\langle N_{c\bar{c}} \rangle \approx 0.6$, i.e. $c\bar{c}/s\bar{s} \approx 0.15$, the value of λ determined in [4] should be decreased to about 0.35 (i.e. by one half of its present error).

The results shown in Fig. 6 and 7 indicate a slow increase of λ with the energy available for particle production. This increase can be interpreted as reflection of decreasing importance of the mass difference between strange and nonstrange $q\bar{q}$ pairs.

Recently Breakstone et al. [35] have obtained $\lambda = 0.55 \pm 0.05$ from the K^+/π^+ ratio in high p_T jets at $\sqrt{s} = 62$ GeV. This value however pertains to the kinematic region in which the observed meson carries about 80 percent of the parton's momentum. It is difficult to compare this result with the results shown in Fig. 6 and 7 since the latter refer to an average hadron-hadron collision for which the evaluation of the effective energy ε_{eff} for subprocesses at the parton level is model dependent.

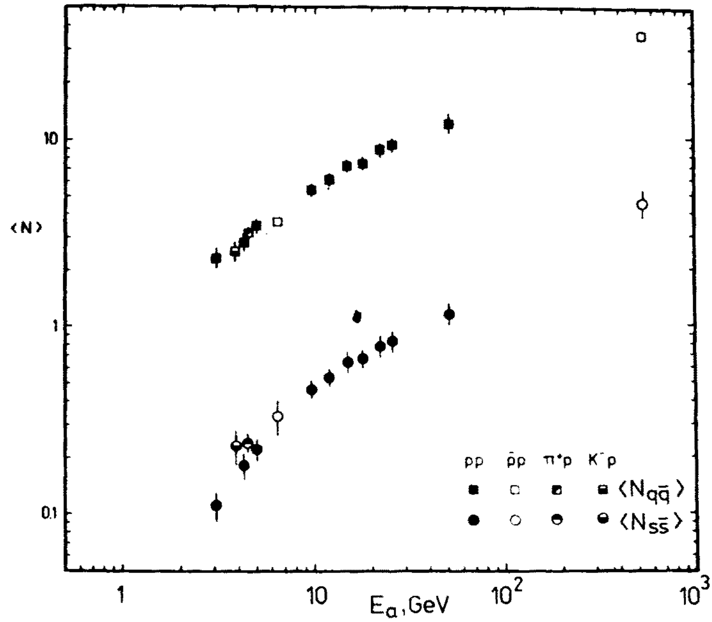

Fig. 9. Energy dependence of the number of primary $q\bar{q}$ pairs. The results at the SPS Collider energy are taken from [4]

Malhotra and Orava [1] assumed that the effective energy ε_{eff} is given by the average energy of the valence quark in the beam particle interacting with the valence quark in the target; they used $\varepsilon_{eff} = (\langle x_1 \rangle \langle x_2 \rangle)\sqrt{s}$, where $\langle x_1 \rangle$ and $\langle x_2 \rangle$ are the average momentum fractions of valence quarks in the beam and in the target, and with a reasonable choice of the valence quark distribution function obtained ε_{eff} (pp) $= 0.11\sqrt{s}$ and ε_{eff} (πp) $= 0.15\sqrt{s}$. Their assumption is questionable because the values of ε_{eff} are quite low[6]. Their prescription gives $\varepsilon_{eff} \approx 60$ GeV for interactions at the SPS Collider; this value is an upper limit for the energy in parton-parton interactions giving rise to high p_T jets at the ISR analyzed in [35]. Nevertheless the value of λ obtained in [35] is considerably higher than that determined in [4].

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[6] Average multiplicities of particles produced in hadron-hadron, lepton-hadron and lepton-lepton interactions at a given $\sqrt{s}$ differ rather little (see [2] for a recent review) which means that the fraction of the total available energy spent for the production of particles is not very different in the three cases.

The values of λ found in lepton-hadron interactions [36] and e^+e^- annihilations [37] seem to be systematically higher than those for pp interactions at the same E_a determined in this paper (see Fig. 8). The results for $\bar{\nu}$p and νp interactions [36a, b] and e^+e^- annihilations [37] were obtained by yet another method based on the use of fragmentation models (Lund, Field-Feynman). Because of that and of the results presented in Fig. 7 it is probably premature to conclude on the different energy dependence of λ in various interactions.

Finally, Fig. 9 shows the energy dependence of $\langle N_{q\bar{q}} \rangle$ and $\langle N_{s\bar{s}} \rangle$ determined in this paper for hadron-hadron interactions. In e^+e^- annihilations at 34 GeV $\langle N_{q\bar{q}} \rangle$ is about 8 to 9 [38], not much different from what one finds for hadron-hadron interactions. However, the average multiplicity of hadrons in e^+e^- annihilations is larger than in hadron-hadron interactions at the same energy.

One of the reasons for that difference is certainly the presence of heavy quark-antiquark pairs produced in the first instant[7] from the virtual photon. The fragmentation of these heavy pairs ($c\bar{c}$, $b\bar{b}$) leads to more hadrons than that of light pairs ($u\bar{u}$, $d\bar{d}$).

6. Conclusions

The strange quark suppression factor λ in hadron-hadron collisions has been calculated by a new method which consists of a direct comparison of the number of created strange and non-strange quark-antiquark pairs. The results agree well with those obtained by other methods. Malhotra and Orava [1] have concluded that λ is a universal and essentially energy independent constant equal to 0.29 ± 0.02. The results of the analysis in the present paper do not agree with this conclusion.

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