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LARGE P_T CROSS-SECTION DIFFERENCES AS TESTS OF QUARK-GLUON SCATTERING

M. Anselmino^{*)}

Westfield College, London N.W.3

P. Kroll^{**) .}

CERN — Geneva

and

E. Leader

Westfield College, London N.W.3

ABSTRACT

It is shown that certain cross-section differences, such as $d\sigma(p\bar{p} \rightarrow CX) - d\sigma(p\bar{p} \rightarrow \bar{C}X)$ or $d\sigma(pp \rightarrow CX) - d\sigma(pp \rightarrow \bar{C}X)$ provide a more direct and stringent test of the QCD partonic picture than do the individual cross-sections. In particular they are very sensitive to quark-gluon scattering and to the three-gluon vertex. They also provide a severe test of the evolution of the distribution functions into a new régime of Q^2 .

We carry out detailed numerical studies for π and K production, at ISR and collider energies. We find very good agreement with the recent ISR data on $pp \rightarrow \pi^\pm X$. The cross-section differences for $p\bar{p}$ collisions are predicted to be also large and measurable with significant accuracy.

^{*)} Present address: Istituto di Fisica Teorica dell'Università, Torino.
^{**)} On leave of absence from Dept. of Physics, University of Wuppertal.

1. - INTRODUCTION

Perturbative QCD can in principle be tested in large p_T inclusive reactions $AB \rightarrow CX$. In practice, however, the number of different partonic subprocesses contributing, and the uncertainty in our knowledge of the required distribution and fragmentation functions, make it difficult to assess the significance of fits to the data on inclusive cross-sections.

In this paper we show that certain combinations of experimental data, namely

$$d\sigma(p\bar{p} \rightarrow CX) - d\sigma(p\bar{p} \rightarrow \bar{C}X)$$

and

$$d\sigma(pp \rightarrow CX) - d\sigma(pp \rightarrow \bar{C}X)$$

single out particular partonic subprocesses and can, as a consequence, be calculated with greater theoretical reliability. Comparison with this type of data will thus provide a more significant test of the theory.

We show that such combinations are very sensitive to the quark-gluon scattering contribution. They test stringently the existence of a three-gluon coupling and help to determine the form of the gluon distribution function in a hadron. It turns out that the Q^2 values involved in the distribution functions are enormous compared with the values occurring in deep inelastic scattering, so that the QCD formulae for the Q^2 evolution are severely tested.

The inclusive production of a large transverse momentum hadron C , in the collision of two hadrons A and B , is described, in the parton model picture, by the well-known hard scattering formula¹⁾

$$\frac{E_C d^3 G^{AB \rightarrow CX}}{d^3 p_C} = \sum_{a,b,c,d} \int dx_a dx_b dz q_A^a(x_a) q_B^b(x_b) \frac{d\hat{\sigma}^{abcd}}{d\hat{t}} \delta(\hat{s} + \hat{t} + \hat{u}) \frac{\hat{s}}{\pi \hat{t}^2} D_c^C(z) \quad (1)$$

where the sum is over all kinds of elementary constituents a , b , c and d and where, as usual, x_a , x_b and $1/z$ are the fractions of longitudinal

momentum carried by the constituents. The q 's and D 's are respectively the parton distribution and fragmentation functions; $d\hat{\sigma}/d\hat{t}$ is the cross-section for the elementary subprocess and $\hat{s}$, $\hat{t}$ and $\hat{u}$ are the Mandelstam variables for the subprocess.

Equation (1) is thought to be valid also in the leading log approximation in QCD²⁾ provided that the distribution and fragmentation functions are replaced by Q^2 dependent ones, $q(x, Q^2)$ and $D(x, Q^2)$, which obey the evolution equations of the QCD structure functions³⁾.

Particle and jet production, using such a scheme and the QCD elementary interactions, has been studied by many authors⁴⁾⁻⁷⁾, and their results, when a comparison is possible, are in qualitative agreement with the experimental trends⁸⁾.

As mentioned above, there are several QCD subprocess interactions entering Eq. (1): $q\bar{q}$ scattering, $q\bar{q}$ scattering and annihilation, qg scattering, $g\bar{g}$ scattering; and each of them is convoluted with the corresponding distribution and fragmentation functions (valence quarks, sea quarks, gluons), some of which are very poorly known, especially as regards their Q^2 evolution.

The measurement of one (or two) particle inclusive cross-sections does not seem adequate to disentangle the various elementary subprocesses and their accompanying structure functions and to give a stringent test of the strong interaction dynamics. Other measurements, such as jet angular distributions with the identification of the nature of the jets⁷⁾, would be much more helpful, but they are not yet practicable.

In this paper we identify combinations of cross-sections, the measurement of which is quite straightforward, and which depend on far fewer "unknown" functions than the inclusive cross-sections $d\sigma$. In particular we show that certain angular or particle cross-section differences in $p\bar{p}$ and pp collisions depend only on a limited subset of the elementary interactions. They require a knowledge of only the up and down quark fragmentation functions, yet depend very strongly (almost entirely in certain cases) on the qg scattering. They thus offer the possibility of testing the nature of the QCD qg interaction, including the three-gluon coupling. They also provide a way of learning about the gluon distribution function. On the contrary, cross-section ratios, the measurement of which has been emphasized by Field⁹⁾, are less reliable theoretically than the differences.

2. - CROSS-SECTIONS

We mainly consider the cross-section

$$\frac{E_c d^3 \sigma^{AB \rightarrow CD}}{d\rho_c^3} = \sum_{a,b,c,d} \iint_S dx_a dx_b \frac{\alpha_s^2(Q^2)}{8p^3 p_c x_a x_b [x_a(1-\cos\theta_c) + x_b(1+\cos\theta_c)]} q_A^a(x_a, Q^2) q_B^b(x_b, Q^2) |A^{ab \rightarrow cd}(x_a, x_b, \cos\theta_c)|^2 D_c^C(z_0, Q^2) \quad (2)$$

obtained from Eq. (1) by integrating over z . Here θ_c is the scattering angle of hadron C in the centre of mass of particles A and B and is related to the parton-parton scattering angle θ in the centre of mass of the constituents a and b by

$$\cos\theta = \frac{\cos\theta_c - \beta}{1 - \beta \cos\theta_c} \quad (3)$$

where

$$\beta = \frac{x_a - x_b}{x_a + x_b} \quad (3')$$

In Eq. (2) we have written

$$\frac{d\hat{\sigma}}{d\hat{t}}(\cos\theta) = \frac{\pi \alpha_s^2(Q^2)}{\hat{s}^2} |A(\cos\theta)|^2 \quad (4)$$

and z_0 is given by

$$z_0 = \frac{\bar{x}_c [x_a(1-\cos\theta_c) + x_b(1+\cos\theta_c)]}{x_a x_b} \quad (5)$$

where

$$\bar{x}_c = \frac{p_c}{2p}, \quad p = |\vec{p}_A| = |\vec{p}_B| = \sqrt{s}/2, \quad p_c = |\vec{p}_c|$$

The subprocess Mandelstam variables $\hat{s}$, $\hat{t}$ and $\hat{u}$ are related to the over-all ones by

$$\begin{aligned} \hat{s} &= x_a x_b s \\ \hat{t} &= \frac{x_a}{z_0} t = - \frac{x_a \bar{x}_c}{z_0} s (1 - \cos\theta_c) \\ \hat{u} &= \frac{x_b}{z_0} u = - \frac{x_b \bar{x}_c}{z_0} s (1 + \cos\theta_c) \end{aligned} \quad (6)$$

The x_a , x_b integration region S in Eq. (2) is defined by the condition $z_0 \leq 1$. The indices a , b , c and d run over all kinds of QCD constituents (valence and sea quarks and antiquarks, gluons) and $\alpha_s(Q^2)$ is the usual QCD effective coupling constant $[\alpha_s(Q^2) = 12\pi/25 \ln(Q^2/\lambda^2)]$. The choice of Q^2 is not unique. We follow most authors and take

$$Q^2 = \frac{2\hat{s}\hat{t}\hat{u}}{\hat{s}^2 + \hat{t}^2 + \hat{u}^2} \quad (7)$$

Equation (2) gives the cross-section for the inclusive production of particles C at angle θ_C in the over-all c.m. system and with momentum p_C . We have neglected the parton transverse momenta inside the hadrons, which is reasonable for large angle production at large p_C . That is the region in which the hard scattering model is supposed to be valid.

It is important to note that, as x_a and x_b vary in the integration region S , the range of Q^2 given by Eq. (7) is

$$\frac{\bar{x}_c^2(1 - \cos^2\theta_c)}{1 - \bar{x}_c(1 \pm \cos\theta_c) + \bar{x}_c^2(1 \pm \cos\theta_c)^2} s \leq Q^2 \leq \frac{1 - \cos^2\theta_c}{3 + \cos^2\theta_c} s \quad (8)$$

(one has to take the $-$ sign in the denominator of the lower limit when $\theta_C < \pi/2$ and the $+$ sign when $\theta_C > \pi/2$), and that, at the collider energy, $s = (540)^2 \text{ GeV}^2$, the value of Q^2 is always very large. For example at $\theta_C = \pi/2$, fixing $p_C = 27 \text{ GeV}/c$ at $p = 270 \text{ GeV}/c$, we have $767 \leq Q^2 \leq 97,200 \text{ GeV}^2/c^2$ and at $\theta_C = 30^\circ$, $183 \leq Q^2 \leq 19,440 \text{ GeV}^2/c^2$.

3. - CROSS-SECTION DIFFERENCES

The combination of cross-sections that we shall concentrate on is

$$\Delta_{AB}^C(p_c, \theta_c) = E_C \frac{d^3 \sigma^{AB \rightarrow CX}}{d p_c^3}(p_c, \theta_c) - E_C \frac{d^3 \sigma^{AB \rightarrow \bar{C}X}}{d p_c^3}(p_c, \theta_c) \quad (9)$$

with $AB = p\bar{p}$ or pp . By charge-conjugation invariance one can show that for $p\bar{p}$ collisions (9) is the same as the angular asymmetry about 90° , i.e.

$$\Delta_{p\bar{p}}^C(p_c, \theta_c) = E_C \frac{d^3 \sigma^{p\bar{p} \rightarrow CX}}{d p_c^3}(p_c, \theta_c) - E_C \frac{d^3 \sigma^{p\bar{p} \rightarrow CX}}{d p_c^3}(p_c, \pi - \theta_c) \quad (10)$$

but presumably Eq. (9) can be measured with less danger of systematic errors.

From Eq. (2) we get (dropping the Q^2 variable)

$$\Delta_{p\bar{p}}^C(p_c, \theta_c) = \frac{1}{8p^3 p_c} \sum_{a,b,c,d} \iint dx_a dx_b \frac{\alpha_s^2}{x_a x_b [x_a (1 - \cos \theta_c) + x_b (1 + \cos \theta_c)]} \left\{ q_p^a(x_a) q_{\bar{p}}^b(x_b) |A^{ab \rightarrow cd}(x_a, x_b, \theta_c)|^2 - q_p^a(x_b) q_{\bar{p}}^b(x_a) |A^{ab \rightarrow cd}(x_b, x_a, \pi - \theta_c)|^2 \right\} D_c^C(z_0) \quad (11)$$

where the order in which the variables appear should be noted.

Notice that Eq. (11) contains a difference of terms, the first involving $A(x_a, x_b, \theta_c)$ and the second $A(x_b, x_a, \pi - \theta_c)$. From Eqs. (3) and (3') we see that they correspond respectively to $A(\theta)$ and $A(\pi - \theta)$, θ being the constituent-constituent c.m. scattering angle. Thus the cross-section difference Eq. (9) or (10) directly reflects the elementary asymmetries, that is the asymmetry about 90° of the elementary QCD scatterings.

To simplify notation we drop the subscripts A, B and write for the valence quark distributions in a proton, $u_V(x)$ and $d_V(x)$ respectively, and for the non-charmed sea $\Lambda(x)$ (assumed, for simplicity, to be the same for all types of non-charmed sea quarks). The charmed sea is denoted by $\Lambda_c(x)$ and the gluon distribution by $g(x)$. We naturally take $q_{\bar{p}}^u(x) = q_p^u(x)$, etc.

Writing out the curly bracket terms in Eq. (11) in detail, we get, with $q' \neq q$

$$\sum_{a,b,c,d} \left\{ \right\}_{p\bar{p}}^C D_c^C(z_0) = \left\{ \left[|A^{q\bar{q} \rightarrow q\bar{q}}(\theta)|^2 - |A^{q\bar{q} \rightarrow q\bar{q}}(\pi - \theta)|^2 \right] \right. \\ \left. (u_V(x_a)u_V(x_b) + \Lambda(x_a)u_V(x_b) + u_V(x_a)\Lambda(x_b)) \right. \\ \left. + |A^{q\bar{q} \rightarrow q\bar{q}}(\theta)|^2 (u_V(x_a)\Lambda(x_b) - \Lambda(x_a)u_V(x_b)) \right. \\ \left. + |A^{q\bar{q}' \rightarrow q\bar{q}'}(\theta)|^2 u_V(x_a)(d_V(x_b) + 4\Lambda(x_b) + 2\Lambda_c(x_b)) \right. \\ \left. - |A^{q\bar{q}' \rightarrow q\bar{q}'}(\pi - \theta)|^2 (d_V(x_a) + 4\Lambda(x_a) + 2\Lambda_c(x_a)) u_V(x_b) \right. \\ \left. + |A^{qg \rightarrow qg}(\theta)|^2 u_V(x_a)g(x_b) - |A^{qg \rightarrow qg}(\pi - \theta)|^2 g(x_a)u_V(x_b) \right\} \quad (12) \\ [D_u^C(z_0) - D_{\bar{u}}^C(z_0)] + u \longleftrightarrow d$$

where θ is given in terms of x_a, x_b and θ_c by Eqs. (3).

For pp collisions Δ_{pp}^C is obtained from Eqs. (11) and (12) by interchanging the distributions multiplying the qq and $q\bar{q}$ contributions and changing the signs in front of $|A^{qq \rightarrow qq'}(\pi-\theta)|^2$ and $|A^{qg \rightarrow qg}(\pi-\theta)|^2$.

Several aspects of Eq. (12) are noteworthy.

- i) Δ_{AB}^C contains only the up and down quark and antiquark fragmentation functions, which are the best known from deep inelastic scattering and e^+e^- annihilation. We thus avoid the uncertainties in the gluon and strange or charm quark fragmentation functions.
- ii) Only four of the several elementary interactions play a rôle, and they include the dominant qg mode for which one has

$$|A^{qg \rightarrow qg}(\theta)|^2 = -\frac{4}{9} \frac{\hat{u}^2 + \hat{s}^2}{\hat{u}\hat{s}} + \frac{\hat{u}^2 + \hat{s}^2}{\hat{t}^2} \quad (13)$$

The last term, arising from the three-gluon diagram in Fig. 1, dominates this cross-section in the forward hemisphere.

Therefore, Δ_{AB}^C is very sensitive to the existence of the three-gluon coupling. For angles less than about 60° Δ_{pp}^C will be almost as large as Δ_{pp}^C as a consequence of this highly asymmetric three gluon contribution^{*)}.

- iii) The least well known quantity in Eq. (12) is the gluon distribution function $g(x)$ (all other distribution functions can be measured in other processes) and therefore Δ_{AB}^C can be used to learn about it.
- iv) It can be shown that with some fairly obvious generalizations Eq. (12) holds to higher orders in QCD. It is crucial from our point of view, that only the same combinations of parton distribution functions as above appear and that there is still no contribution from the gluon fragmentation.

There is another combination of data which also has a simple theoretical interpretation, namely

$$d\sigma(p\bar{p} \rightarrow CX) + d\sigma(p\bar{p} \rightarrow \bar{C}X) - d\sigma(pp \rightarrow CX) - d\sigma(pp \rightarrow \bar{C}X) \quad (14)$$

^{*)} Actually, if all the elementary interactions were such that $|A(\theta)|^2 = |A(\pi-\theta)|^2$, Δ_{pp}^C would still be non-zero, but very small.

With the same assumptions as above one can show that this combination receives contributions only from the interaction of valence quarks of the same flavour. The combination (14) provides a tool to study gluon fragmentation. However, Eq. (14) is hard to measure with sufficient accuracy since it is a difference of almost equal terms.

4. - QUANTITATIVE RESULTS

4.1 The Input Functions

To compute the cross-section (9) one needs a set of distribution and fragmentation functions. As mentioned earlier, some of them are rather well known from other processes, like deep inelastic scattering or e^+e^- annihilation, while others are very poorly known.

We have tried two different sets of distribution functions:

- i) For one set of distribution functions (hereafter called I) we adopted the parametrization used by the CDHS group¹⁰⁾. In particular, for the gluon distribution, which is the least well known, we used

$$x g(x, Q^2) = c_g x^{\eta_1} (1-x)^{\eta_2} (1 + 3.5x) \quad (15)$$

with

$$c_g = 2.63 (1 - 1.18 \bar{s} + \bar{s}^2)$$

$$\eta_1 = -0.56 \bar{s} + 0.24 \bar{s}^2, \quad \eta_2 = 5.9 + 0.81 \bar{s}$$

where

$$\bar{s} \equiv \ln \left\{ \ln(Q^2/\Lambda^2) / \ln(Q_0^2/\Lambda^2) \right\}$$

and

$$\Lambda = 0.3 \text{ GeV}/c, \quad Q_0^2 = 5 (6 \text{ GeV}/c)^2$$

- ii) For the second set of distribution functions (hereafter called II) we took the parametrization given by Glueck et al.¹¹⁾, modified to give an SU(3) symmetric sea. For the gluon distribution we have

$$xg(x, Q^2) = c_g (1 + bx + cx^2)(1-x)^2 + de^{-ex} \quad (16)$$

with

$$c_g = 0.9243 + 2.51 \bar{s}^{0.5}$$

$$b = 8.558 - 9.227 \bar{s}^{0.3} - 0.655 \bar{s}^{1.5}$$

$$c = 53.57 - 68.78 \bar{s}^{0.3} + 19.3 \bar{s}$$

$$\eta = 6 + 1454 \bar{s}, \quad d = 11.29 \bar{s}^2, \quad e = 41.24 + 50.71 \bar{s}$$

and

$$\lambda = 0.4 \text{ GeV}/c, \quad Q_0^2 = 4 (\text{GeV}/c)^2$$

The two gluon distribution functions, (15) and (16), differ drastically from each other at large Q^2 (see Fig. 2).

For the fragmentation functions for pions and kaons we used a parametrization similar to that given by Baier et al.⁵⁾ altered, however, to give better agreement with the new deep inelastic data of the EMC group¹²⁾. Thus, we take for the quark fragmentation functions, the only ones appearing in Eq. (12),

$$\begin{aligned} D_u^{\pi^+} &= 3.3 D_u^{K^+} = \frac{1+z}{z} D(z) \\ D_d^{\pi^+} &= 3.3 D_d^{K^+} = \frac{1-z}{z} D(z) \end{aligned} \quad (17)$$

with

$$D(z) = \int_2 z^{\alpha_1} (1-z)^{\alpha_2}$$

and

$$f_2 = 0.5 - 0.07 \bar{s} + 0.03 \bar{s}^2$$

$$\alpha_1 = -0.29 \bar{s} + 0.06 \bar{s}^2, \quad \alpha_2 = 1.0 + 0.59 \bar{s} + 0.05 \bar{s}^2$$

$Q_0^2 = 25(\text{GeV}/C)^2$; λ is chosen according to the parametrization used for the distribution functions.

It should be stressed that the above distribution and fragmentation functions have been tested for Q^2 roughly in the range $\leq 100(\text{GeV}/C)^2$. In utilizing these functions for the $p\bar{p}$ collider we are testing their Q^2 evolution over a gigantic range, typically $200 \leq Q^2 \leq 100,000(\text{GeV}/C)^2$!

4.2 The Results

To begin with we plot Δ_{pp}^C at $\sqrt{s} = 62.4$ and 540 GeV as a function of p_C for various θ_C in Figs. 3 - 6. The angular dependence is presented in Fig. 7. The plots are given for π^+ and K^+ and using both sets of distribution functions. The individual contribution of qg scattering is also shown (for parametrization I only) to illustrate its importance. It must be stressed once more that the experimental confirmation of these predictions would be of crucial importance.

There exists ISR data¹³⁾ on $pp \rightarrow \pi^+ X$ albeit at not quite the same angle ($\theta_C = 49^\circ$ for π^+ , $\theta_C = 53^\circ$ for π^-) and we have tested our approach by comparing our calculations with the cross-section difference

$$E \frac{d^3 \sigma_{pp \rightarrow \pi^+ X}}{d\rho^3} (49^\circ) - E \frac{d^3 \sigma_{pp \rightarrow \pi^- X}}{d\rho^3} (53^\circ) \approx \Delta_{pp}^{\pi^+}$$

It is seen from Fig. 8 that remarkably good agreement is achieved when using parametrization I^{*)}. Again, as for $p\bar{p}$ collisions, the contribution from qg scattering is shown separately. Moreover, we also show what the contribution of qg scattering would be if we neglected the three-gluon coupling [i.e. neglecting the second term in Eq. (13)]. In this case the calculation fails dramatically which suggests that this cross-section difference yields evidence for the three-gluon coupling.

In Ref. 13) data are also presented for undifferentiated charged hadron production from which, if we neglect the small contribution from baryons at large p_T , we can extract the cross-section difference Δ_{pp}^{K+} . The data obtained in this way are compared to our calculations in Fig. 9. Again, we find agreement although not as good as for $\Delta_{pp}^{\pi+}$. The reason for this deterioration probably results from uncertainties in the EMC kaon data which we used to fix the factor between the π and K fragmentation functions [cf., Eq. (17)].

*) It is interesting to note that when we attempt to calculate the individual π^+ or π^- cross-sections we fail by about a factor of 1.5.

Thus, for example, a factor 2.5 instead of the value of 3.3 we used, would improve the agreement between data and prediction.

From the successful fit to both $\Delta_{pp}^{\pi^+}$ and $\Delta_{pp}^{K^+}$ we conclude that the set I of distribution functions together with the fragmentation functions we used seem to have the correct Q^2 evolution up to about 1200 (GeV/C)^2 . This leads us to hope that our predictions for collider energies are reliable.

5. - CONCLUSIONS

We have demonstrated that certain cross-section differences, like $d\sigma(p\bar{p} \rightarrow CX) - d\sigma(p\bar{p} \rightarrow \bar{C}X)$ or $d\sigma(pp \rightarrow CX) - d\sigma(pp \rightarrow \bar{C}X)$, have a much simpler theoretical structure than do the individual cross-sections. They depend on fewer "unknown" input distribution and fragmentation functions and therefore provide a tighter test of the underlying basic QCD mechanisms. Moreover, they depend strongly on the qg interaction and its angular dependence and provide therefore an experimental test of the three-gluon coupling. The cross-section differences thus provide an excellent relatively direct test for the fundamental QCD partonic picture. On the other hand, the differences also give the opportunity to check the phenomenological input functions, in particular the gluon distribution, and their Q^2 evolution.

For the pp case we have found that, using the set I of distribution functions, we get excellent agreement with the present ISR data. This suggests that the underlying QCD dynamics, in particular the quark-gluon interaction, is correct. Of course, our results depend not only on the qg cross-section, but also on the assumed form for the distribution functions. Since the Q^2 evolution of the latter is fixed it will be most interesting to have data for cross-section differences at the $p\bar{p}$ collider where an entirely new régime of Q^2 is encountered. It is also interesting to note that single hard photon production is also sensitive to the gluon distribution so that these measurements provide an additional test.

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REFERENCES

- 1) D. Sivers, R. Blankenbecler and S.J. Brodsky, Phys. Reports 23 (1976) 1;
S.D. Ellis and R. Stroynowski, Rev. Mod. Phys. 49 (1977) 753.
- 2) C. Sachrajda, Phys. Lett. 76B (1978) 100.
- 3) G. Altarelli and G. Parisi, Nucl. Phys. B126 (1977) 298.
- 4) B.L. Combridge, J. Kripfganz and J. Ranft, Phys. Lett. 70B (1977) 234.
- 5) R. Baier, J. Engels and B. Petersson, Z. Physik C2 (1979) 265.
- 6) R. Horgan and M. Jacob, Nucl. Phys. B179 (1981) 441.
- 7) K.O. Mikaelian, K. Mita and M.A. Samuel, Phys. Rev. D23 (1981) 1960.
- 8) See, for example, N. McCubbin, Rutherford Laboratory Report RL-81-041;
also Drijard et al. CERN preprint EP82-70 and talks at the XXI International Conference on High Energy Physics, July 1982, Paris;
A.L.S. Angelis et al., talk at the same Conference.
- 9) R.D. Field, University of Florida preprint, Gainesville (1982).
- 10) J.G.H. de Groot et al., Phys. Lett. 82B (1979) 456;
F. Eisele, Proceedings of the IV Symposium on Elementary Particle Physics,
Kazimierz (1981).
- 11) M. Glueck, E. Hoffmann and E. Reya, preprint DO-TH 80/13, Dortmund (1980).
- 12) M. Henckes, Dissertation WU-B81-14, Wuppertal (1981).
- 13) D. Drijard et al., preprint CERN/EP 82-70 (1982).

FIGURE CAPTIONS

- Fig. 1 Feynman diagrams for $qg \rightarrow qg$.
- Fig. 2 The gluon distribution function $xg(x)$ according to parametrization I (II).
Solid (dash-dotted) line for $Q^2 = 100(\text{GeV}/C)^2$.
Dashed (dotted) line for $100,000(\text{GeV}/C)^2$.
- Fig. 3 The cross-section difference Δ_{pp}^C for pions and kaons versus p_C for $\theta_C = 30^\circ$ at ISR energy.
Solid (dashed) lines correspond to parametrization I (II).
The dash-dotted lines represent the qg contribution for parametrization I.
- Fig. 4 Same as Fig. 3 but at collider energy.
- Fig. 5 Same as Fig. 3 but for $\theta_C = 60^\circ$ at ISR energy.
- Fig. 6 Same as Fig. 3 but for $\theta_C = 60^\circ$ at collider energy.
- Fig. 7 The cross-section difference Δ_{pp}^C versus θ_C for several values of p_C at collider energy.
- Fig. 8 The cross-section difference $\Delta_{pp}^{\pi^+}$ versus p_T at ISR energies. Data taken from Ref. 13.
The dotted line represents the qg contribution for parametrization I assuming the three-gluon coupling to be zero. Other curves as in Fig. 3.
- Fig. 9 The cross-section difference $\Delta_{pp}^{K^+}$ versus p_T at ISR energies as calculated from parametrization I. Data taken from Ref. 13).

FIG. 1

FIG. 2

FIG. 3

FIG. 4

FIG. 5

FIG. 6

FIG. 7

FIG. 8

FIG. 9