DETERMINATIONS OF THE POLARIZED GLUON DISTRIBUTION(+)

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SUMMARY

Photoproduction of heavy quarks in polarized photon-proton collisions, including higher order corrections (HOC), is studied. It is found that the HOC significantly enhance the Born contribution (K-factors well exceeding unit). The resulting asymmetries permit a distinction between various scenarios for the size and shape of the polarized gluon distribution. The results are compared to earlier work on large-p_T direct photon production in polarized proton-proton collisions at RHIC and fixed-target energies.

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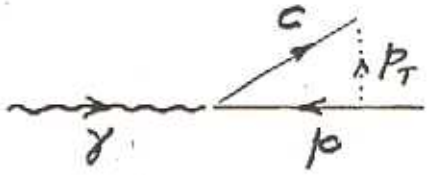
4.

Phys. quantities:

$Q = c$. Let y = c.m. rapid. of c:



$\Delta \frac{d\sigma}{dp_T dy}(s, p_T, y)$, $\Delta \frac{d\sigma}{dp_T}$, $\Delta \frac{d\sigma}{dy}$

K-factors corresp. to $\Delta d\sigma/dp_T = \Delta\sigma$

$$K = \frac{\Delta\sigma_B + \Delta\sigma_{HOC}}{\Delta\sigma_B} \quad vs \quad x_T$$

Asymms:

$$A = \Delta\sigma/\sigma$$

Results at $\sqrt{s_{\gamma p}} = 10$ GeV; also at 40 & 150, typical HERA (pre-proposal).

NOTE: Results for photopr. by <u>real</u> γ; for leptopr. at $q_\gamma^2 = 0$: Weisz.-Will. involv. $\int$ over $[\Delta]P_{\gamma/\ell} = \frac{1 \mp (1-z)^2}{z}$
$\Rightarrow$ asymmetries smaller.

CONCLUSIONS

Det. HOC of $\vec{\gamma}\vec{p} \to Q(\bar{Q}) + X$ due to domin. subpr. $\vec{\gamma}\vec{g} \to Q\bar{Q}$; also resolved γ contribtn (small):

(a) K-factors large & > 0

(b) Asymmetries: COMPASS can disting. set A from B, C; to disting. B from C need good stat. at larger x_T.
Best way disting all A, B, C: $\sqrt{s_{\gamma p}} \sim 40$–$150$ GeV (preproposal)

COMPARE: COMPASS $\vec{\mu}\vec{p} \to \mu + c + X$ vs RHIC $\vec{p}\vec{p} \to \gamma + X$: Better is RHIC

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Central problem of Spin Physics:

Size & shape of polzed gluon distr. Δg

Best way: Study polzd reactions domtd by subprs with initl gluons. One case:

$$\vec{p}\vec{p} \to \gamma(\text{large-}p_T) + X$$ Kamal-Mereb-Tkachov-C Gordon-Vogelsang

domtd by $\vec{q}\vec{g} \to \gamma q$. Another:

$$\vec{\gamma}\vec{p} \to Q(\bar{Q}) + X$$

domtd by

$$\vec{\gamma}\vec{g} \to Q\bar{Q}$$

Expt: COMPASS (CERN) $\sqrt{s_{\gamma p}} \sim 10$ GeV

Pre-proposal: HERA; (SLAC-E156)

Present HOC for contribtn of subpr. γg to $\vec{\gamma}\vec{p}$, present asymms A & discuss possib. to disting. between various scenarios for Δg;

compare with corresp. A of $\vec{p}\vec{p} \to \gamma + X$ (RHIC)

Note: Interested in <u>whole</u> Δg: all moments (not just in 1st mom.)

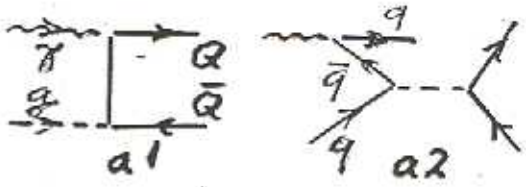
Leading order ($\alpha\alpha_s$)

(a1) Born

(a2) Resolved γ via

$\vec{q}\vec{\bar{q}} \to Q\bar{Q}$ $\quad$ $\vec{g}\vec{g} \to Q\bar{Q}$

γ str. fn $\Delta F_{q/\gamma}$ $\quad$ $\Delta F_{g/\gamma}$ $\quad$ known only theo.

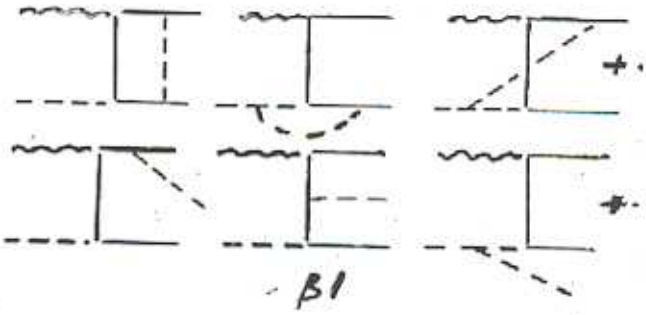


NLO ($\alpha\alpha_s^2$)

(β1) Loops & Brems

HARDEST part due to $m_Q \neq 0$.

Results for this.

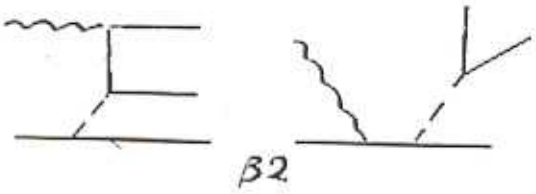


(β2) Subpr.

$\vec{\gamma}\vec{q} \to Q\bar{Q}q$

no loops

Prelim. results : small



Reg. (a2): Using theoret. $\Delta F_{q/\gamma}$, $\Delta F_{g/\gamma}$ contribtns small in $\overline{MS}$ & phys. scales. Hassan & Pilkin

NOTE

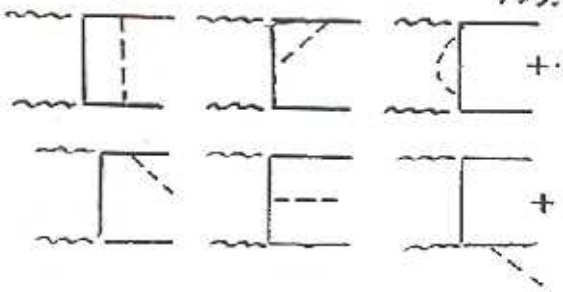
Abelian part of (β1) provides HOC to

$\vec{\gamma}\vec{\gamma} \to Q\bar{Q}$

This of interest in itself in Higgs search when

$m_H < 2m_W$

Kamal-Hereb.-C Phys. Rev. D51, 4802 199.



· Determintn of HOC: 3

Loops via **Passarino-Veltman**, Brems integrals via Gottfr.-Jackson frame of final $g+\bar{Q}$.

Eliminatn of singuls ($1/\epsilon^2$ & $1/\epsilon$): Dimnl reduction; to satisfy **Ward's id** add **finite** vertex cterterm

$$\gamma^\mu \to \frac{-g^2}{(4\pi)^2} C_F (g^{\mu\nu} - g_n^{\mu\nu}) \gamma_\nu$$

· Renormaliztn: Of heavy Q mass & w-fn: on-shell.

Of charge: In scheme with internal loops of heavy Q subtracted out (heavy Q decoupled).

· Polzd parton distrs: **2-loop** split fns: several groups, use distrs of **one** group, 3 sets **Gehrm.-Stirl.**

set A: $\Delta g(x) > 0$, reltvly large

B: > 0, " small

C: $\Delta g(x)$ changes sign; for $x > .1$ $\Delta g < 0$;

even for A, signif. < old Δg

These parton distrs in modif. t'Hooft-Veltman ($\sim \overline{MS}$) since our HOC in dimnl redctn: **conversion terms**.

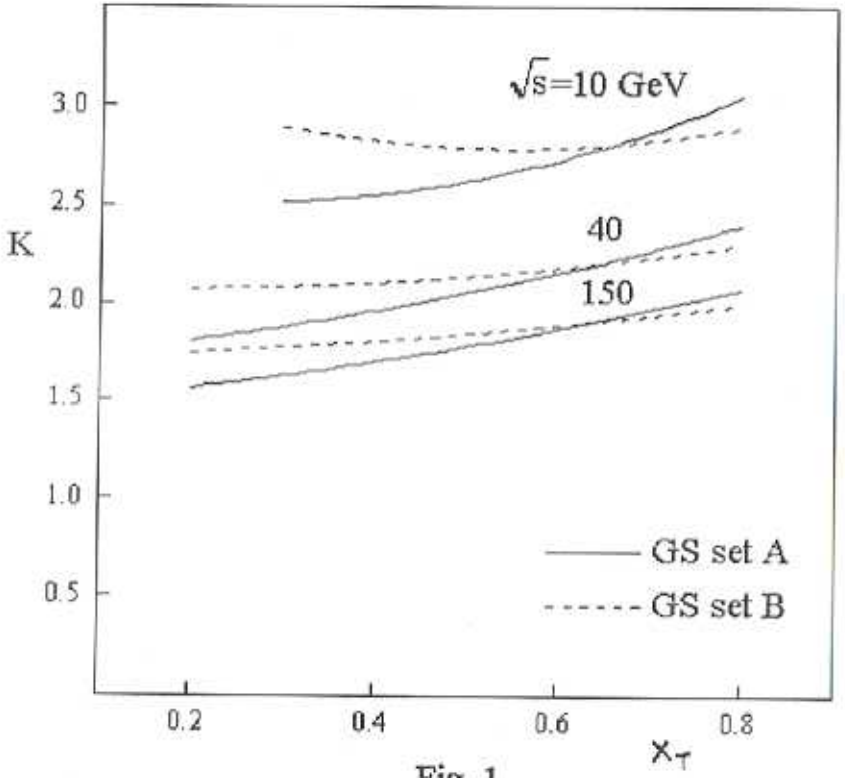

√s=10 GeV
40
150
K
3.0
2.5
2.0
1.5
1.0
0.5
GS set A
GS set B
0.2
0.4
0.6
0.8
x_T

Fig. 1

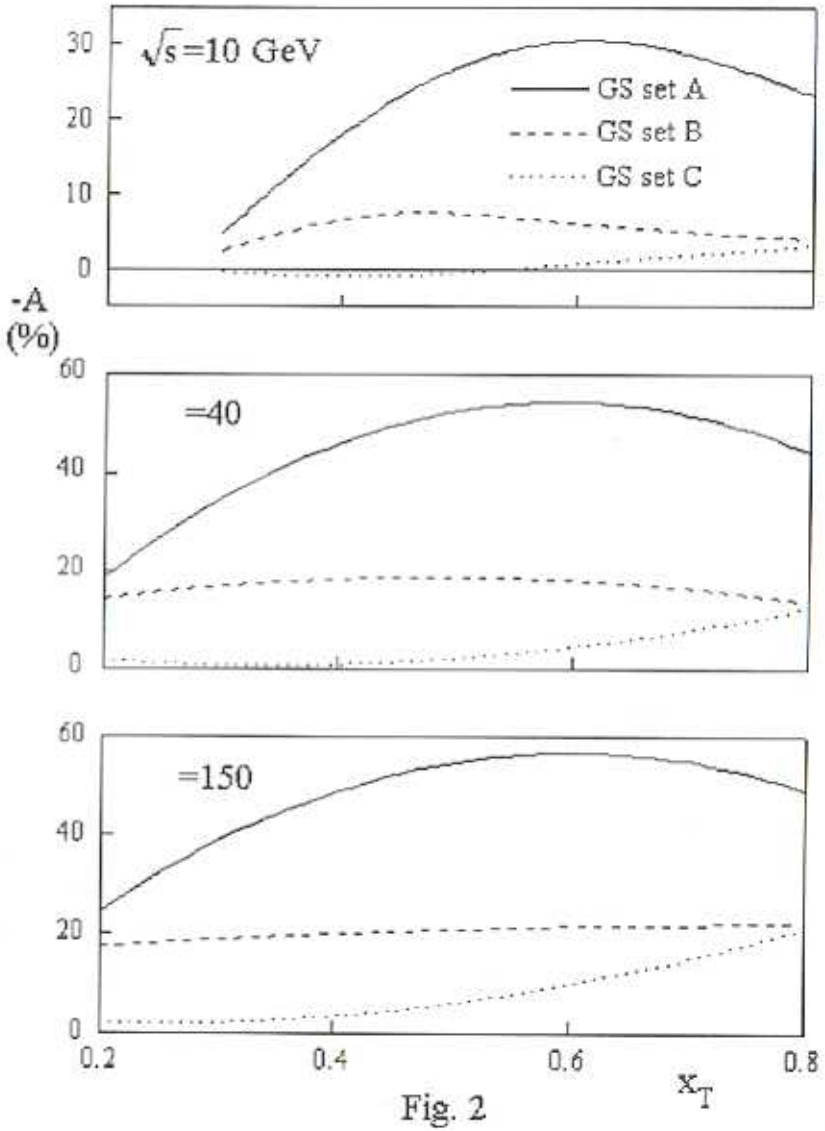

√s=10 GeV
GS set A
GS set B
GS set C
-A
(%)
30
20
10
0
=40
60
40
20
0
=150
60
40
20
0
0.2
0.4
0.6
0.8
x_T

Fig. 2