

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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Phys. quantities:

$Q=c$. Let $y = \text{c.m. rapid. of } c$:

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

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

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

Asyms:

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

Results at $\sqrt{s}_{\gamma\gamma} = 10 \text{ GeV}$; also at 40×150 , typical
HERA (pre-proposal).

NOTE: Results for photopr. by real γ ; for leptopr.
at $q^2=0$: Weisz.-Will. involu. $\int \text{over } [\Delta]_{\gamma/e} = \frac{1+(1-z)^2}{z}$
 \Rightarrow asymmetries smaller.

CONCLUSIONS

Det. HOC of $\bar{\gamma}\bar{p} \rightarrow Q(\bar{Q}) + X$ due to domin. subpr.

$\bar{\gamma}\bar{q} \rightarrow Q\bar{Q}$; also resolved γ contribn (small):

(a) K-factors large $z > 0$

(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: $\sqrt{s}_{\gamma\gamma} \sim 40-150 \text{ GeV}$ (preproposal)

COMPARE: COMPASS $\bar{\mu}\bar{p} \rightarrow \mu + c + X$ vs RHIC $\bar{p}\bar{p} \rightarrow \gamma + X$:

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:

$\bar{p}p \rightarrow \gamma(\text{large-}p_T) + X$ Kamal-Mereb-Tkachou-C
domtd by $\bar{q}q \rightarrow \gamma q$. Another: Gordon-Vogelsang

domtd by $\bar{\gamma}p \rightarrow Q(\bar{Q}) + X$
 $\bar{\gamma}q \rightarrow Q\bar{Q}$

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

Pre-proposal: HERA; (SLAC-E156)

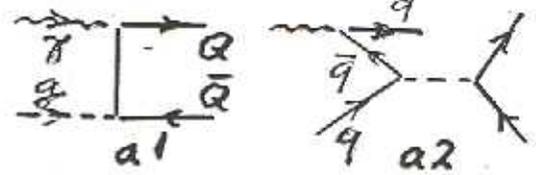
Present HOC for contribtn of subpr. γq to $\bar{\gamma}p$,
present asymms A & discuss possib. to disting.
between various scenarios for Δg ;

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

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

Leading order ($\alpha\alpha_s$)

(a1) Born



(a2) Resolved γ via

$q\bar{q} \rightarrow Q\bar{Q}$
 γ str. fn $\Delta F_{q/\gamma}$

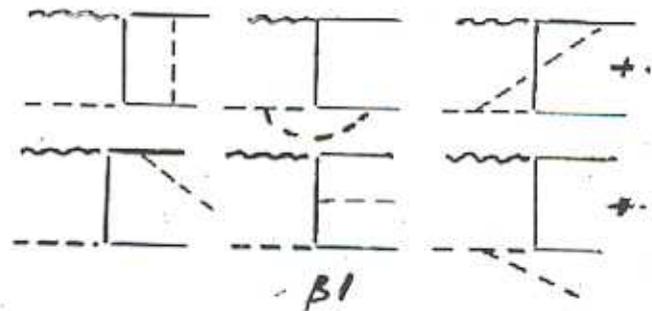
$q\bar{q} \rightarrow Q\bar{Q}$
 $\Delta F_{q/\gamma}$ known only thro.

NLO ($\alpha\alpha_s^2$)

(B1) Loops & Brems

HARDEST part due to $m_Q \neq 0$.

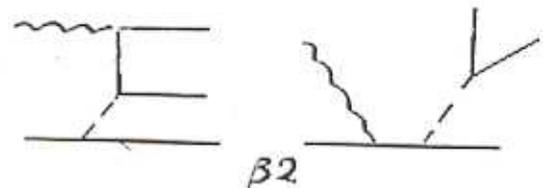
Results for this.



(B2) Subpr.

$\gamma q \rightarrow Q\bar{Q}q$
 no loops

Prelim. results: small



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

Hassan & Pilon

NOTE

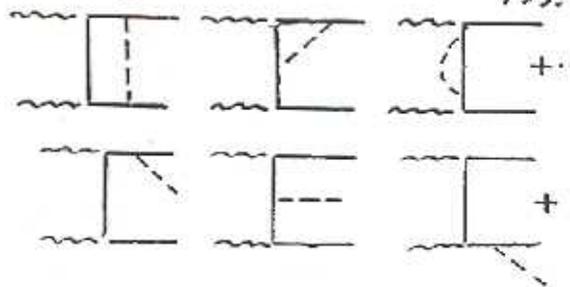
Abelian part of (B1) provides HOC to

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

$\gamma\gamma \rightarrow Q\bar{Q}$

This of interest in itself in Higgs search when

$m_H < 2m_W$



Determinn of HOC:

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

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

$$\gamma^\mu \rightarrow \frac{-q^2}{(4\pi)^2} C_F \left(\frac{q^{\mu\nu}}{q^2} - \frac{q^\mu q^\nu}{q_n^2} \right) \gamma_\nu$$

Renormaliztn: Of heavy Q mass & w-fn: on-shell.
Of charge: In scheme with internal loops of heavy Q
subtracted out (heavy Q decoupled).

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

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

B: > 0 , " small

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

even for A, signif. \ll old Δg

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

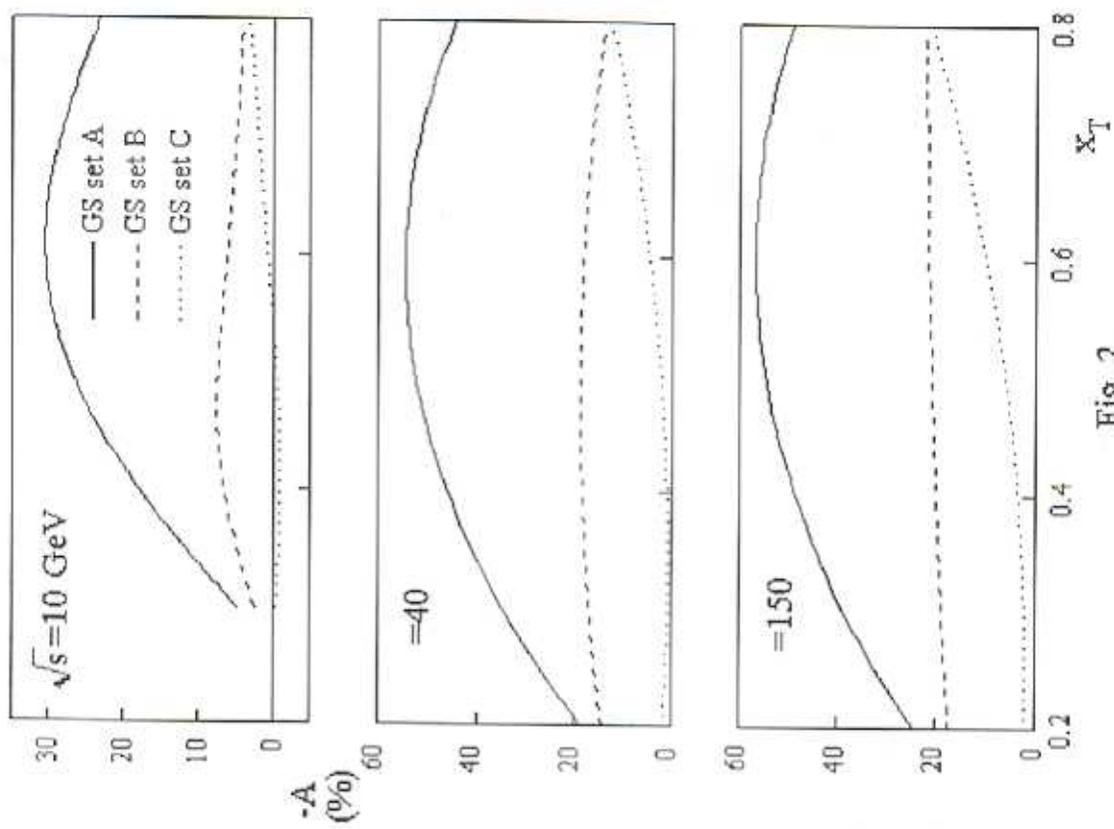


Fig. 2

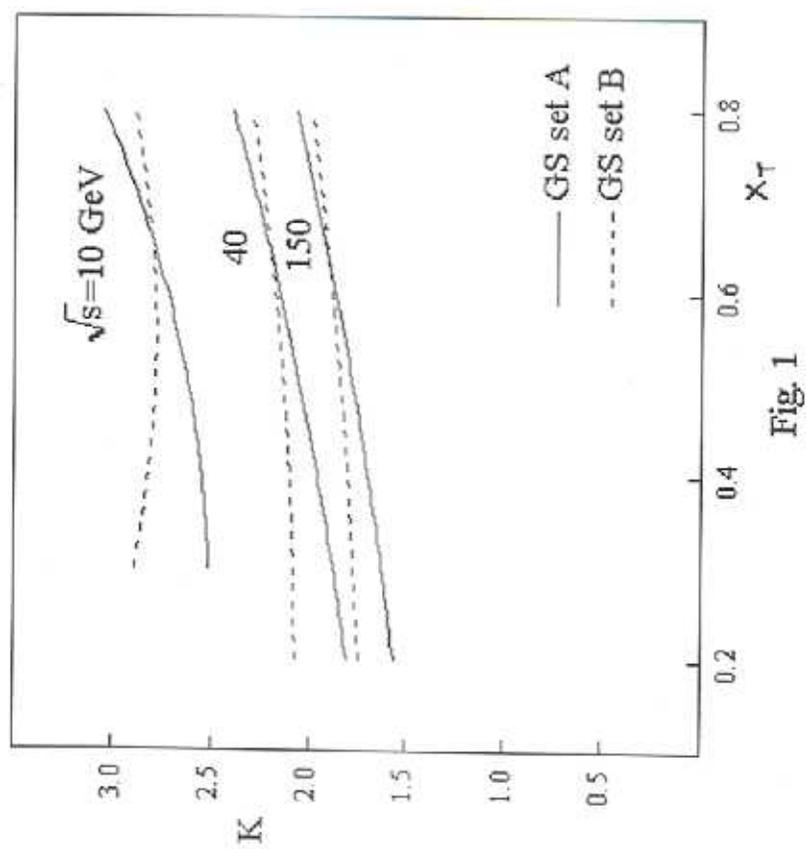


Fig. 1