# Remarks on b-quark and c-quark PDFs

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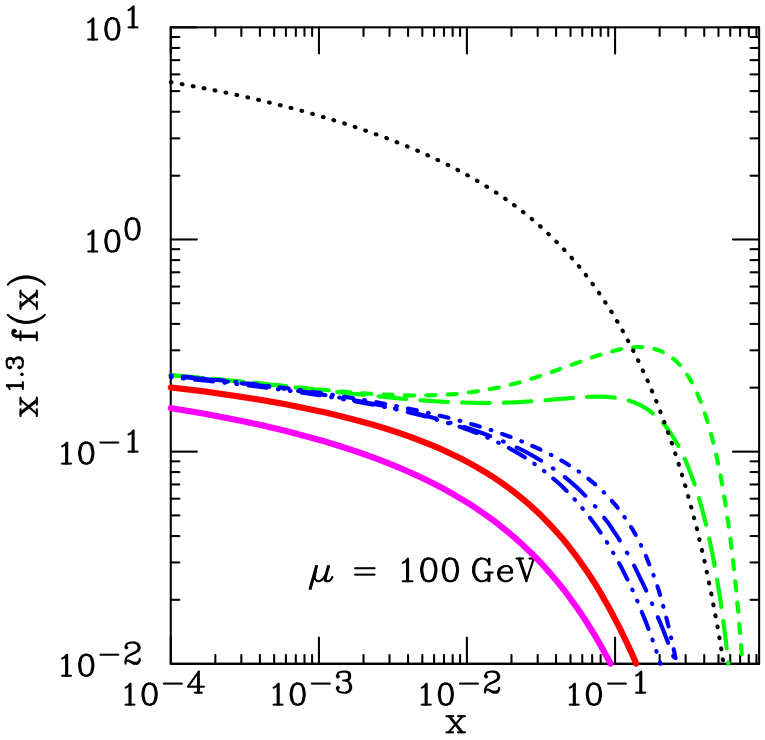
TOP09 Top Quark Institute (CERN 5 June, 2009)

- PDFs at $\mu = 100\,\mathrm{GeV}$
- PDF uncertainties and CT09
- Intrinsic charm and bottom – i.e., charm and bottom that are present in the non-perturbative proton wave function at the initial scale of evolution, as opposed to being generated by gluon splitting.

# Parton Distributions at $\mu = 100\,\text{GeV}$

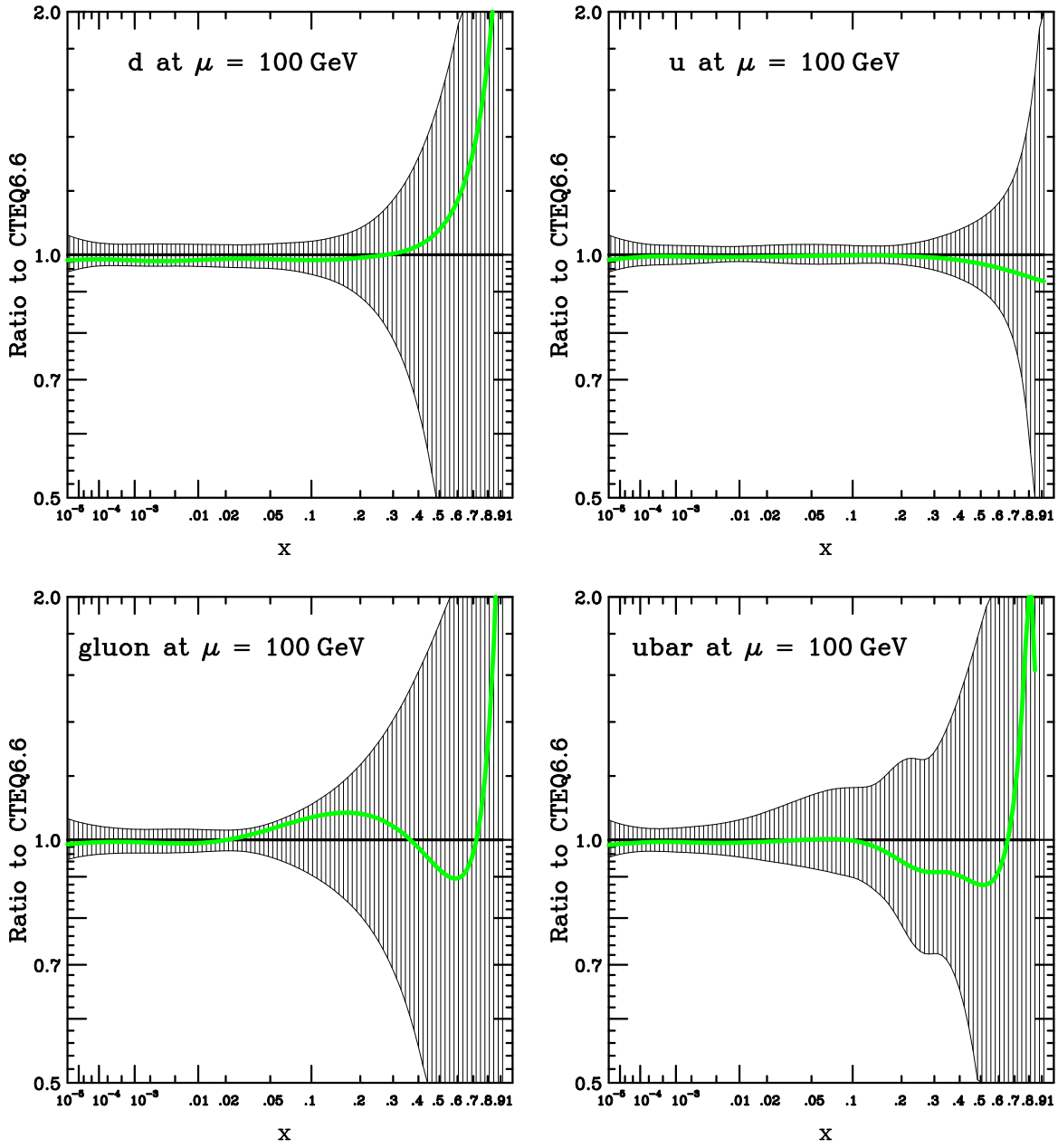



dotted $= g$ dashed $= u,\ d$
dot dashed $= \bar{u},\ \bar{d},\ s = \bar{s}$ solid $= c,\ b$

Straight line behavior at small $x$: Regge theory

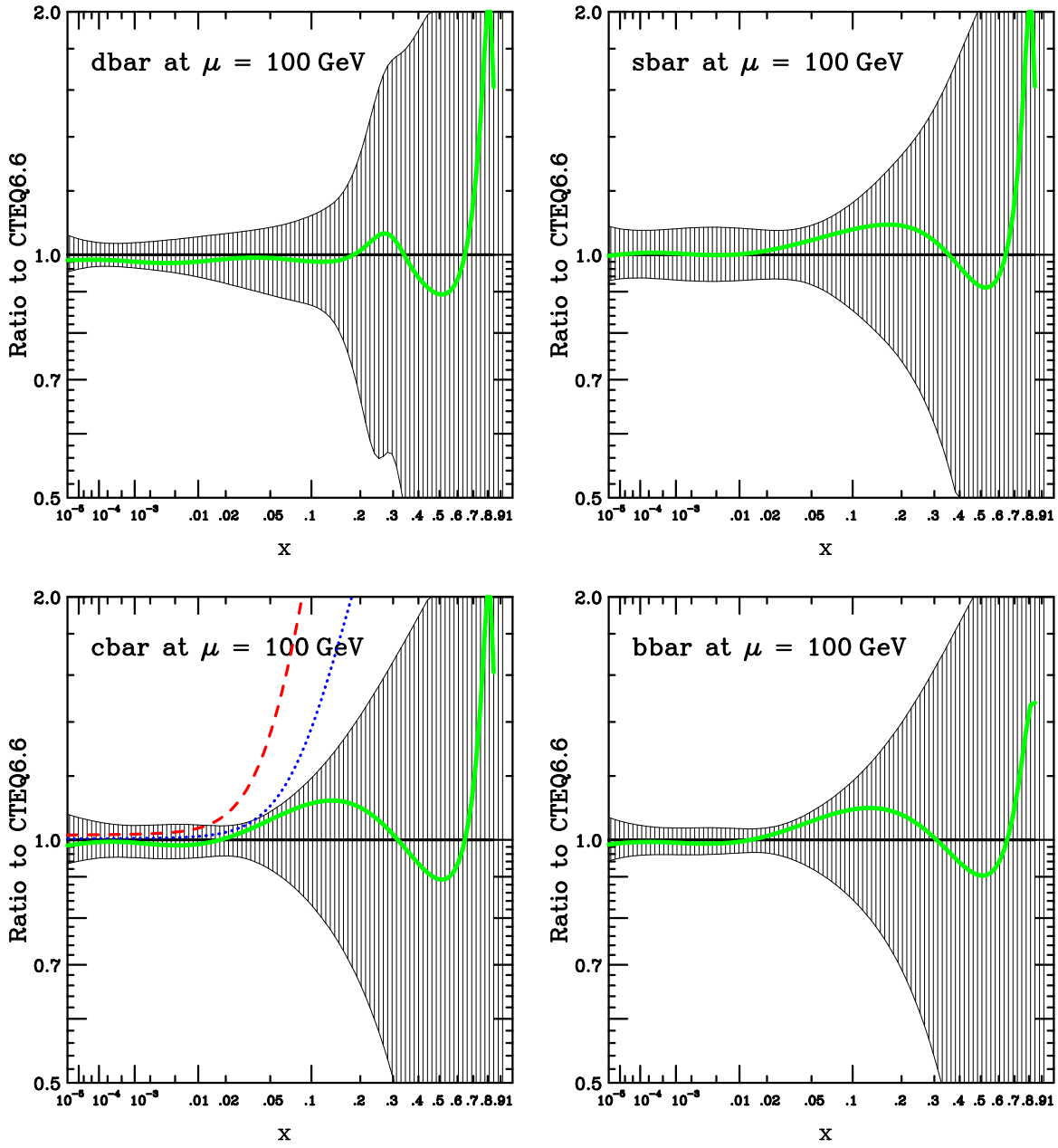
- Gluon dominant at small x
- Valence quarks dominant at large x
- Rapid fall-off at $x \to 1$ – many partons share the total momentum
- $c$ suppressed by less than a factor of 2 compared to light sea quarks.
- $b$ suppressed by a factor $\sim 3$ compared to light sea quarks.

# PDF uncertainties in CTEQ6.6 at $\mu = 100\,\mathrm{GeV}$




solid = CT09 (most recent fit)

# PDF uncertainties in CTEQ6.6 at $\mu = 100\,\mathrm{GeV}$

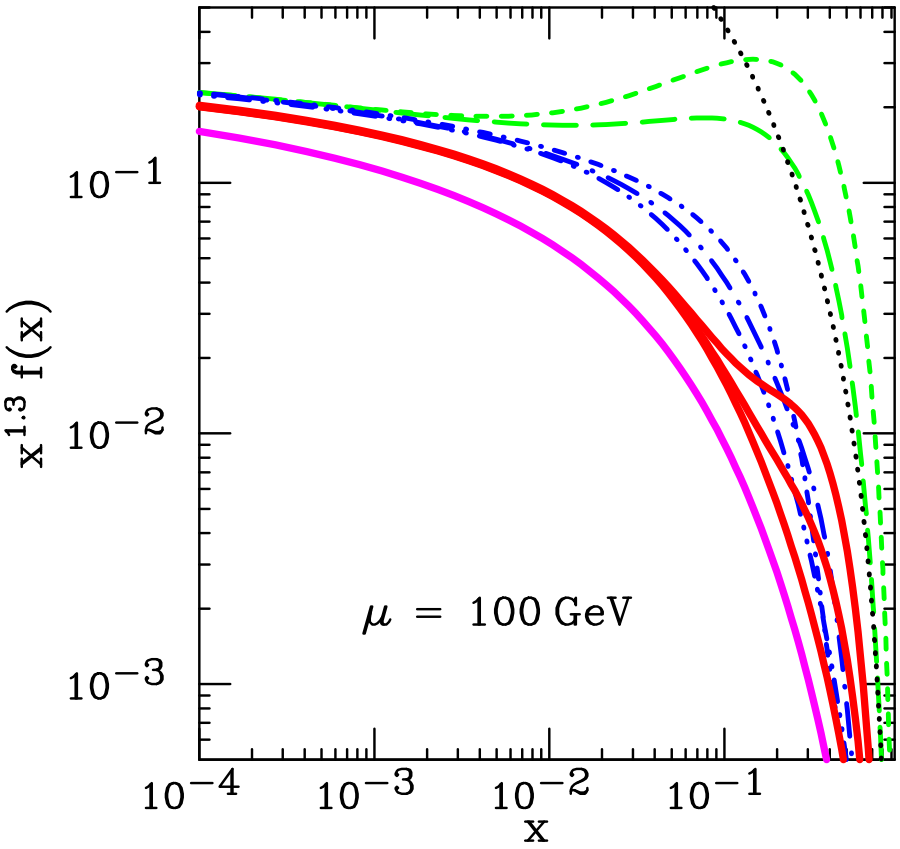



solid = CT09 (most recent fit)

dotted = CTEQ6.6 with 1% Intrinsic Charm (consistent with estimates)

dashed = CTEQ6.6 with 3.5% Intrinsic Charm (consistent with known constraints)

# Intrinsic Charm models at $\mu = 100\,\mathrm{GeV}$




dotted $= g$

dashed $= u,\ d$

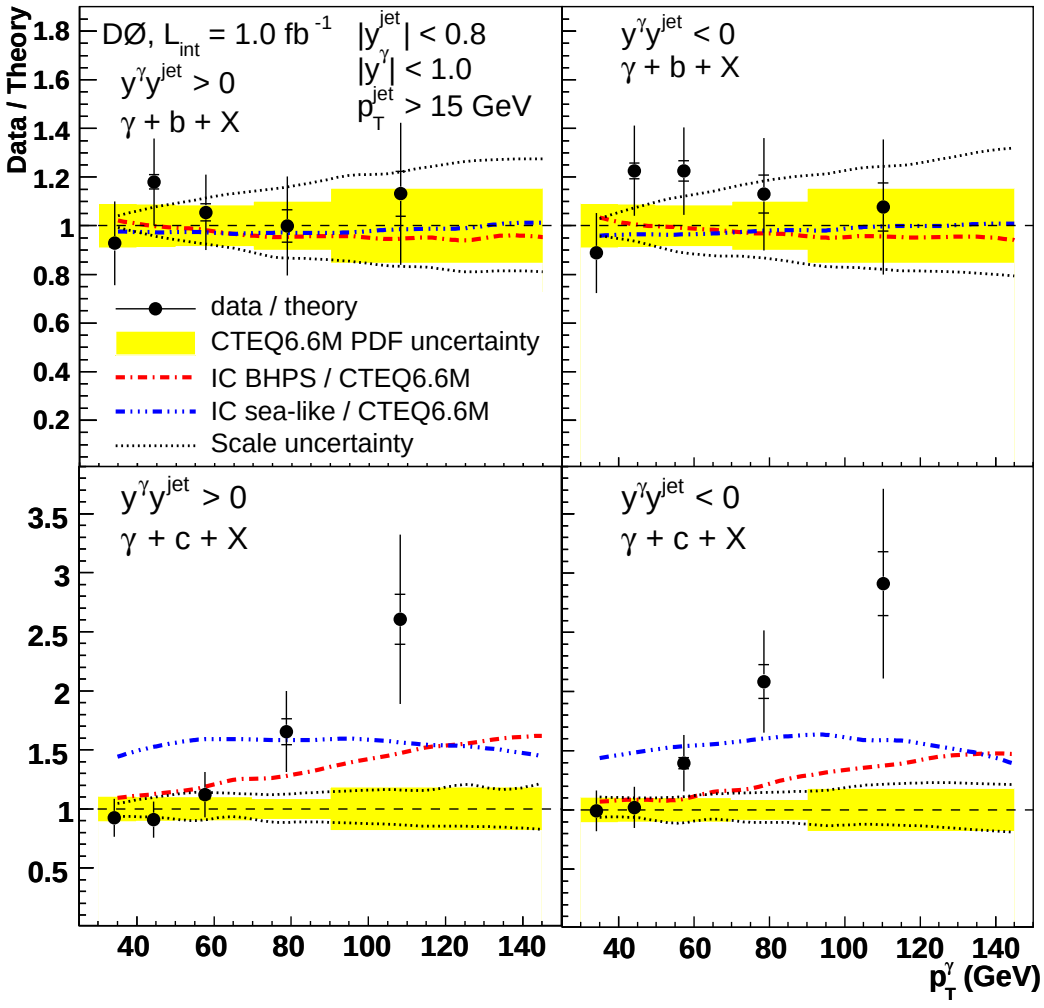
dot dashed $= \bar{u},\ \bar{d},\ s = \bar{s}$

solid $= c$ (including 0, 1%, 3.5% IC from CTEQ6.6)

solid $= b$

In principle, intrinsic $b$ is also possible. But it is supposed to be suppressed at least by $m_c/m_b$, so the absence of compelling evidence for large intrinsic charm probably means intrinsic $b$ is not important.

# Recent D0 measurements of $\gamma + b$–jet and $\gamma + c$–jet




- Agreement with theory is good for $\gamma + b$, so the current PDFs have the $b$-distribution about right.

- Data lies above theory for $\gamma + c$ at large $p_T$ — possible evidence for non-perturbative ("intrinsic") charm.

The evidence for IC is not overwhelming here; but some systematic errors must cancel in the ratio $\frac{\gamma+b}{\gamma+c}$