Global Analysis

… of short-distance processes
using perturbative QCD (NLO)

The challenge of Global Analysis is to construct a set of PDF's with good agreement between data and theory, for many disparate experiments.

Perfect agreement for all experiments simultaneously will not be possible because of systematic errors – both experimental and theoretical.

Our philosophy is

- to make compromises between different experiments that are not perfectly compatible;
- to get satisfactory* agreement with every data set.

The problem of balance. How much weight should be given to each of two competing experiments?

* which needs to be defined

The program of Global Analysis is not a routine statistical analysis, because of systematic differences between experiments.

We must sometimes use *physics judgement* in this complex real-world problem.

Parametrization

At low Q_0 , of order 1 GeV,

$$f(x,Q_0) = a_0\ x^{a_1}\ (1-x)^{a_2}\ P(x)$$

P(x) has a few more parameters for increased flexibility.

~ 20 free *shape parameters*

Q dependence of *f(x,Q)* is obtained by solving the QCD evolution equations (DGLAP).

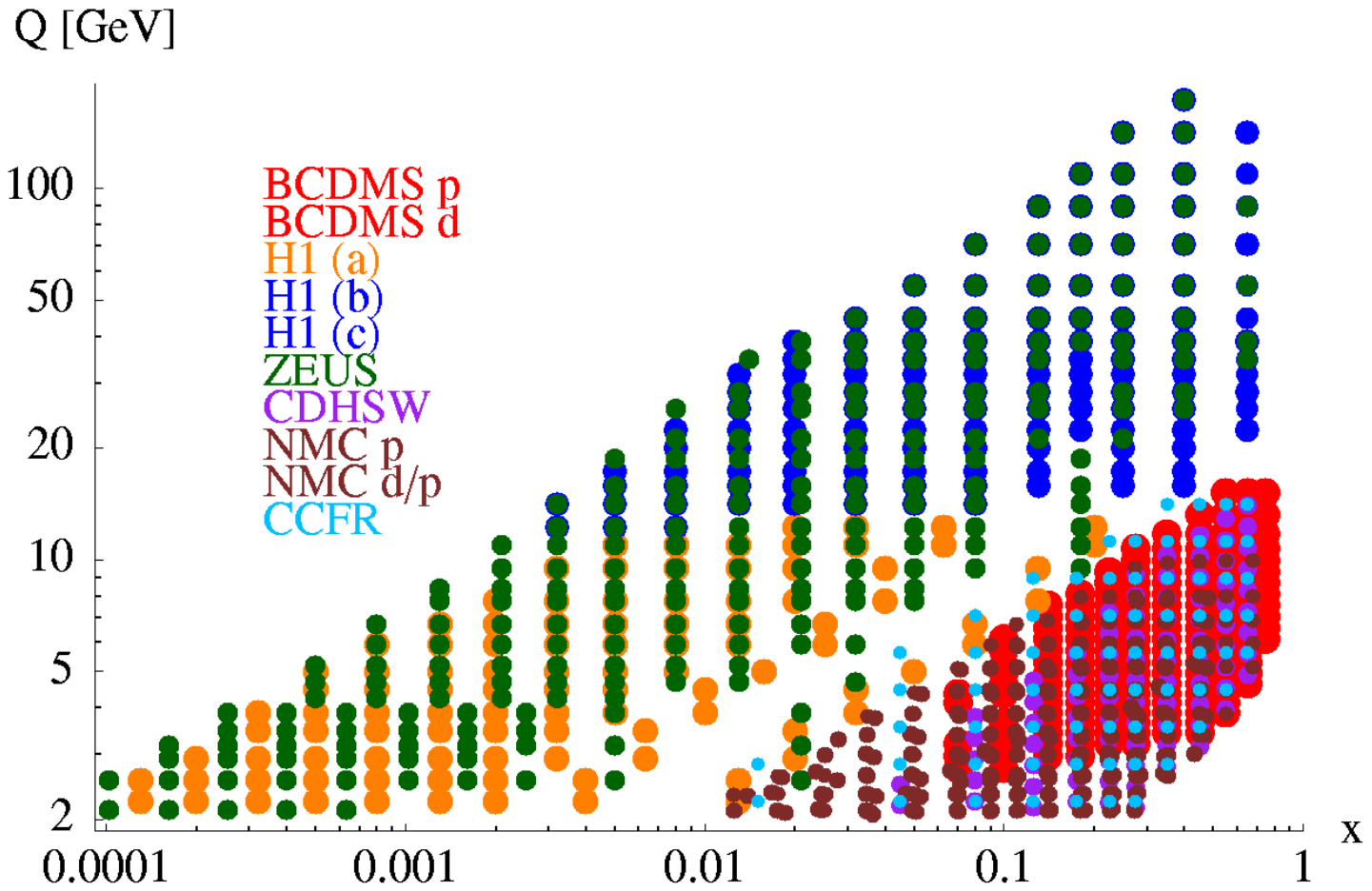
CTEQ6 -- Table of experimental data sets

CTEQ6						
	process	data set	CorrMat	N	χ^2	χ^2/N
1	μ DIS	BCDMS F2p	Y	339	378	1.11
2	μ DIS	BCDMS F2d	Y	251	280	1.11
3	$\overline{e}$ DIS	H1 (a)	Y	104	98.6	0.95
4	e DIS	H1 (b)	Y	126	129	1.02
5	$\overline{e}$ DIS	ZEUS	Y	229	263	1.15
6	μ DIS	NMC F2p	Y	201	305	1.52
7	μ DIS	NMC d/p	Y	123	112	0.91
8	$p\overline{p} \to$ jet	D0	Y	90	69	0.77
9	$p\overline{p} \to$ jet	CDF	Y	33	49	1.47
10	$\nu(\overline{\nu})$ DIS	CCFR F2 + F3	Y/N	156	150	0.96
11	Drell-Yan	E605	N	119	95	0.80
12	Drell-Yan	E866 d/p	N	15	6	0.40
13	$p\overline{p} \to W$	CDF (Lasy)	N	11	10	0.91

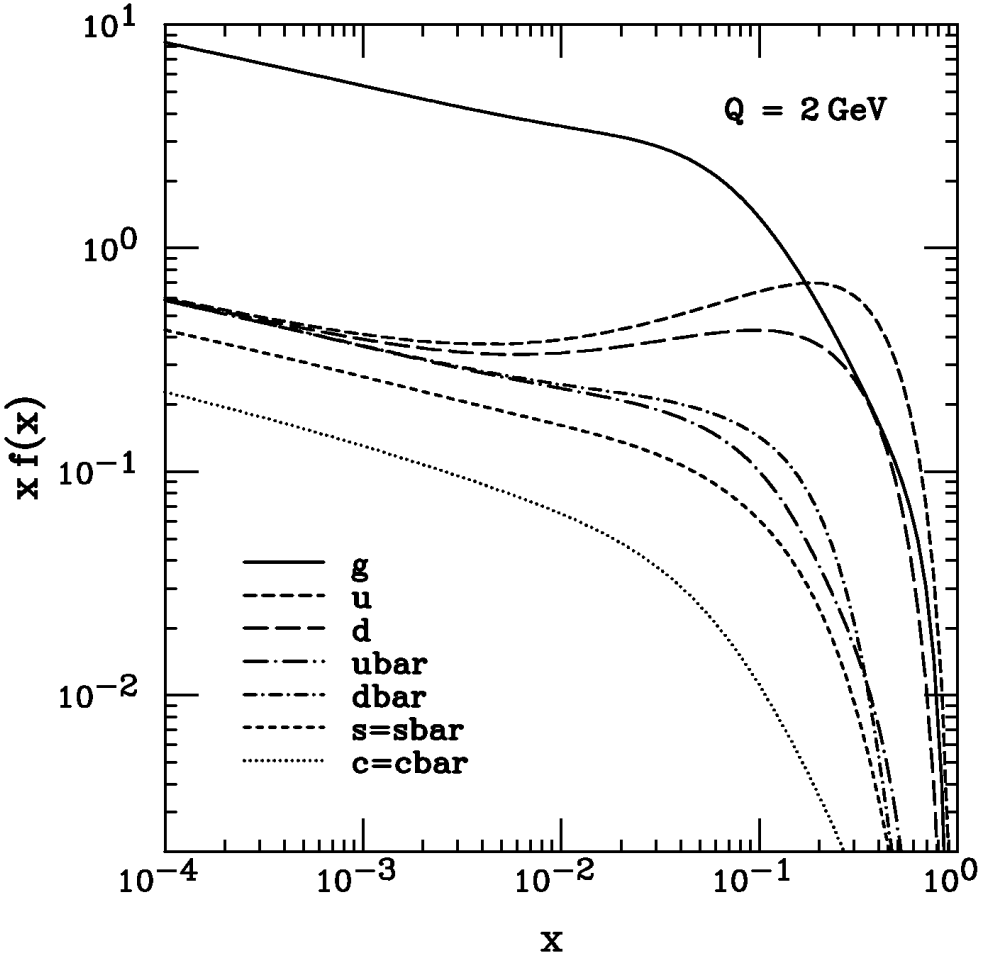
H1 (a) 96/97 low-x e+p data
H1 (b) 98/99 high-Q e-p data
ZEUS 96/97 e+p data
D0 : $d^2\sigma/d\eta\, dpT$

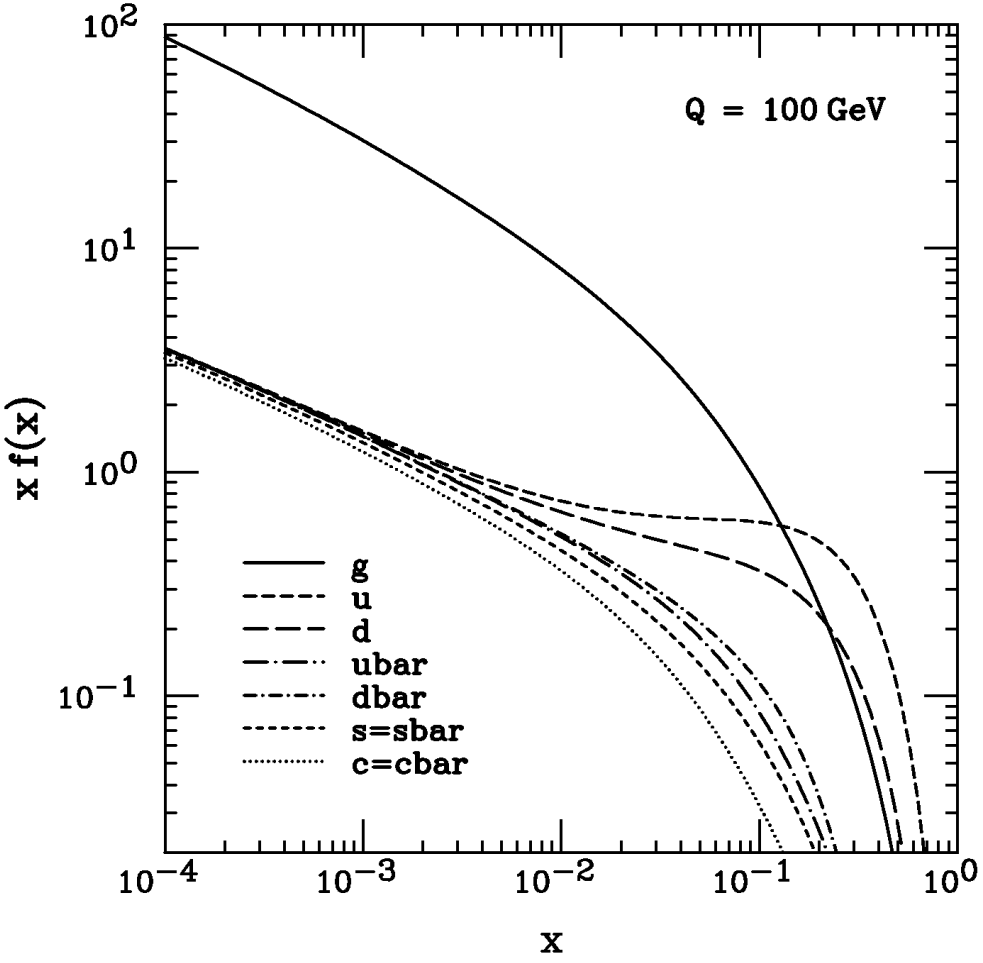
Global Analysis

data from many disparate experiments



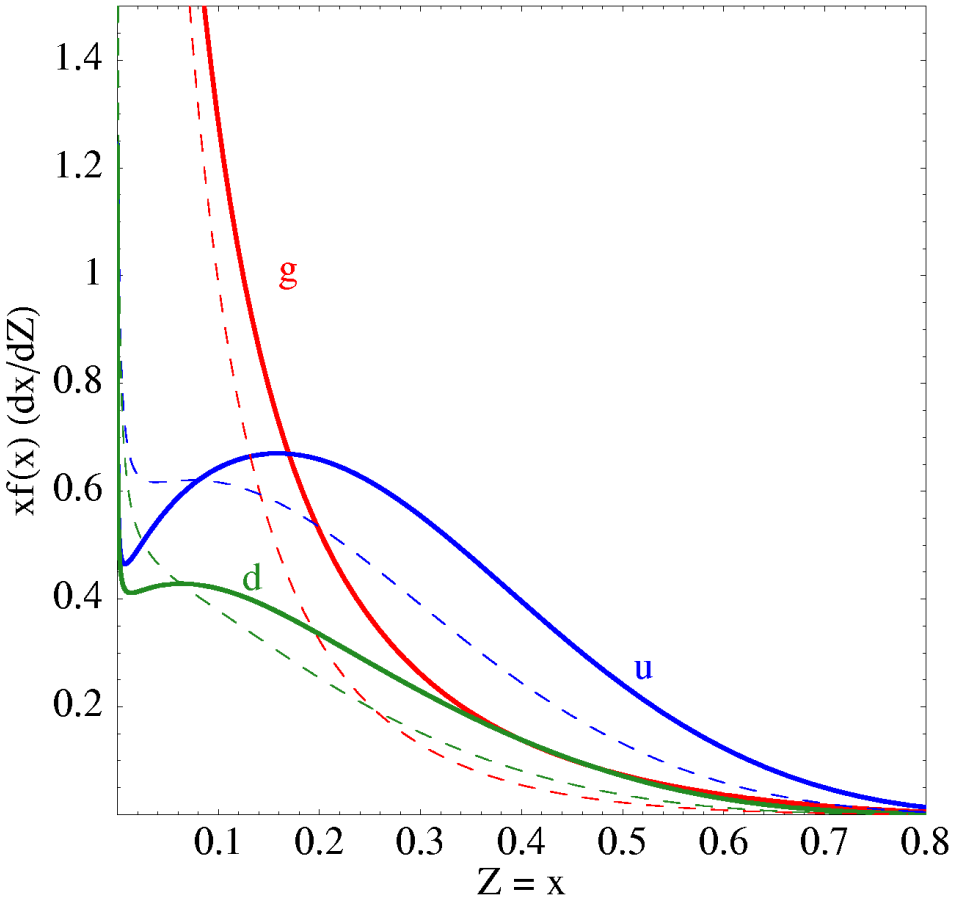
The Parton Distribution Functions

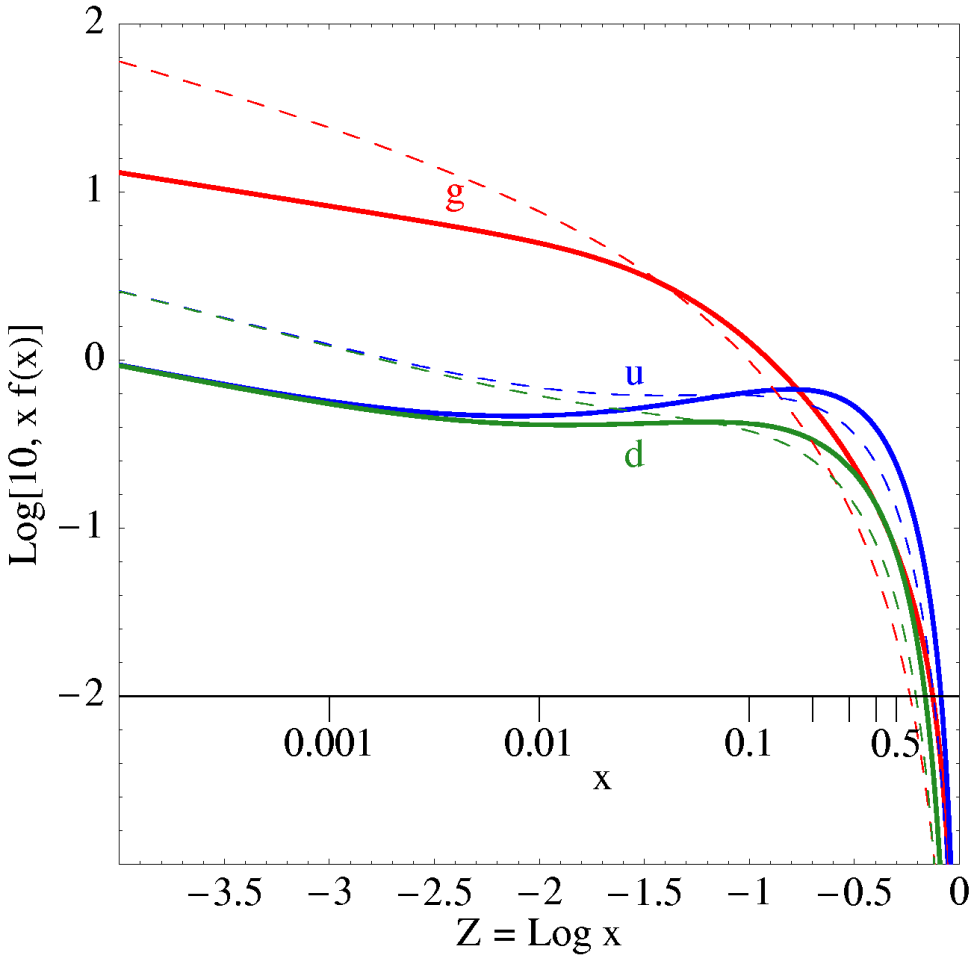




Different ways to plot the parton distributions

Linear

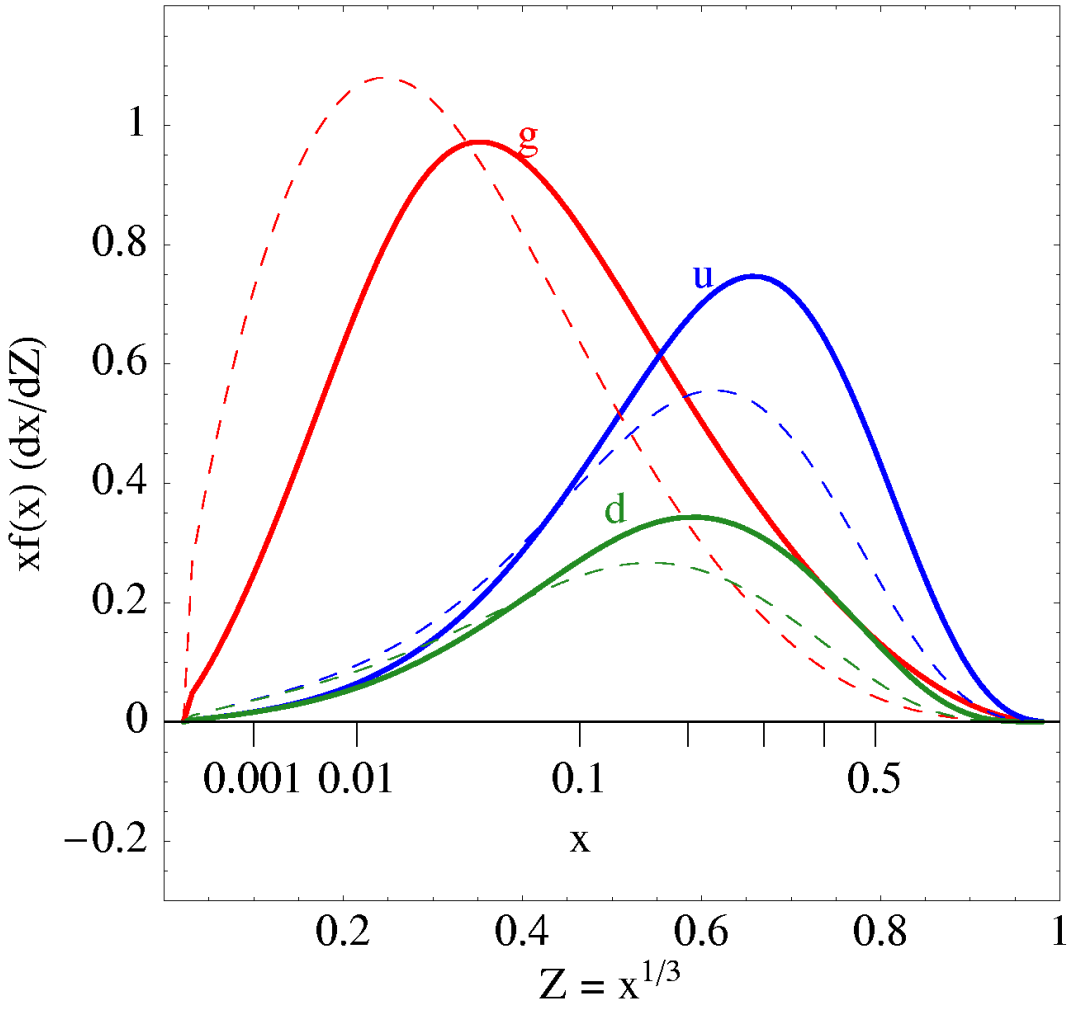


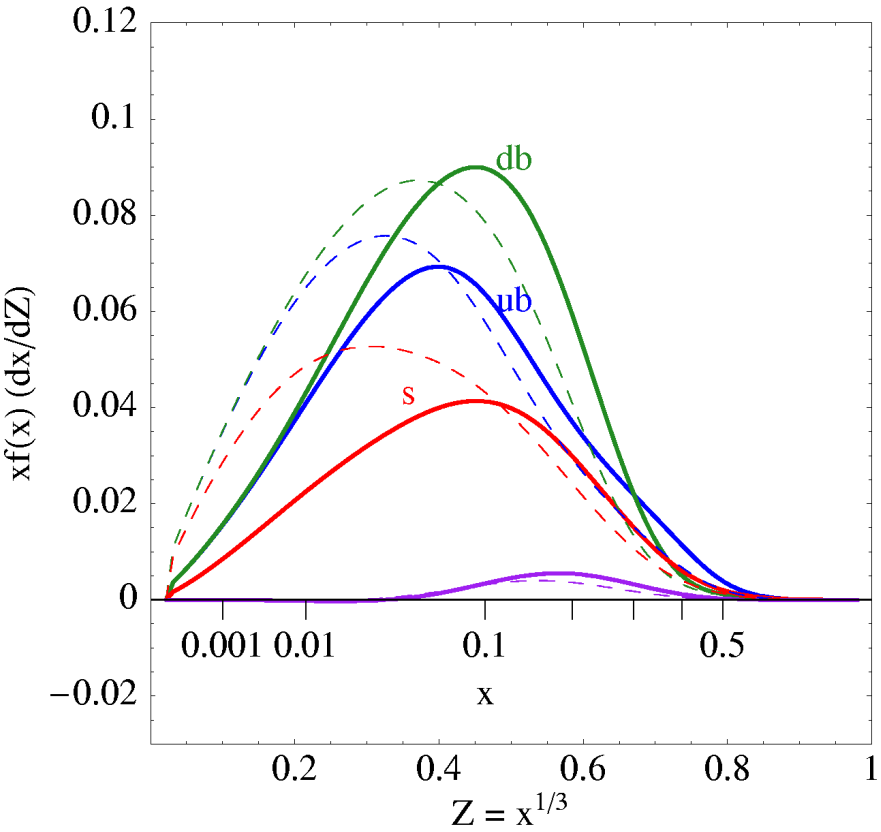


Logarithmic

$Q^2 = 10$ (solid) and 1000 (dashed) GeV^2

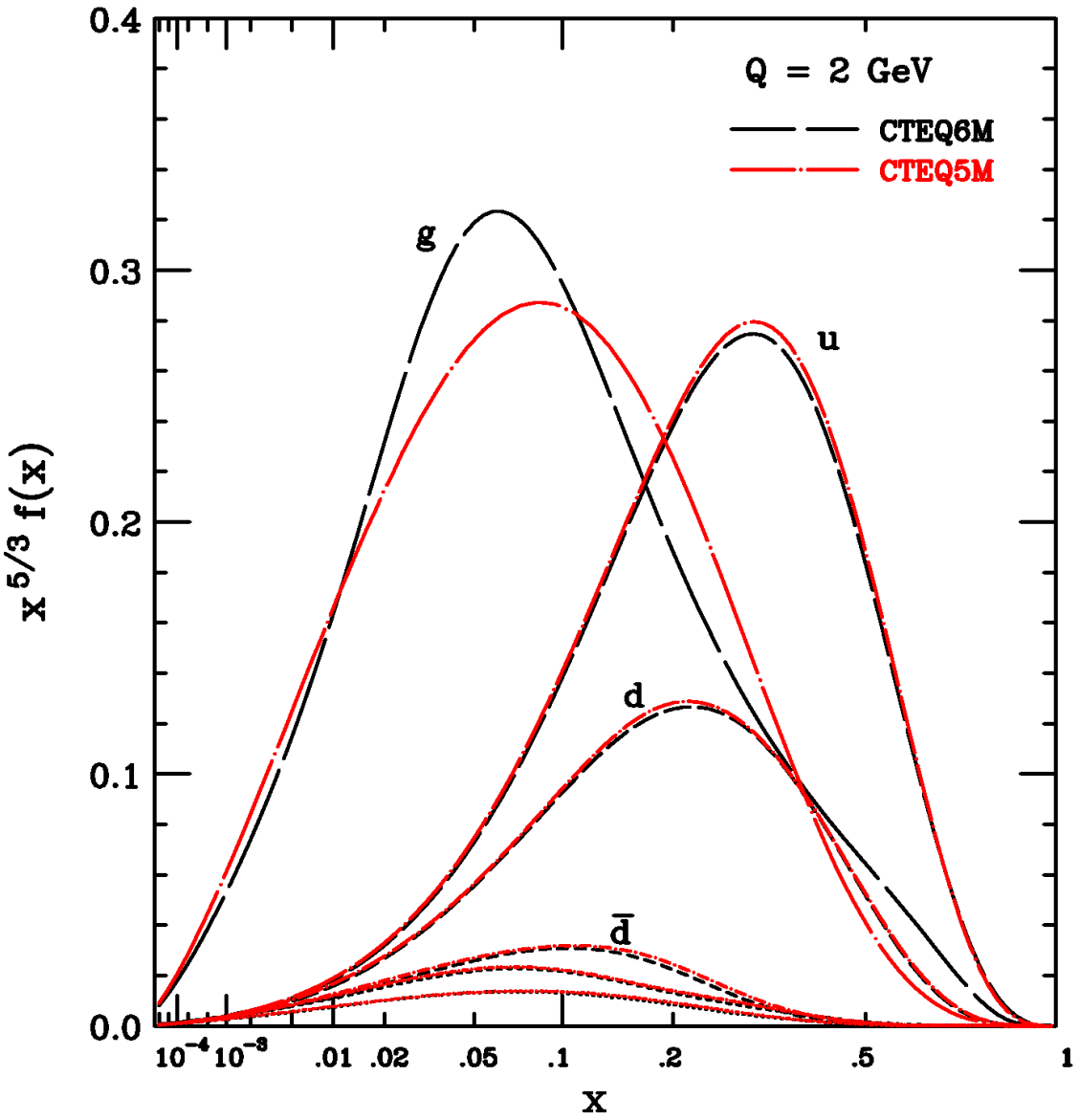
In order to show the large and small x regions simultaneously, we plot $3x^{5/3} f(x)$ versus $x^{1/3}$. {Integral = momentum fraction}



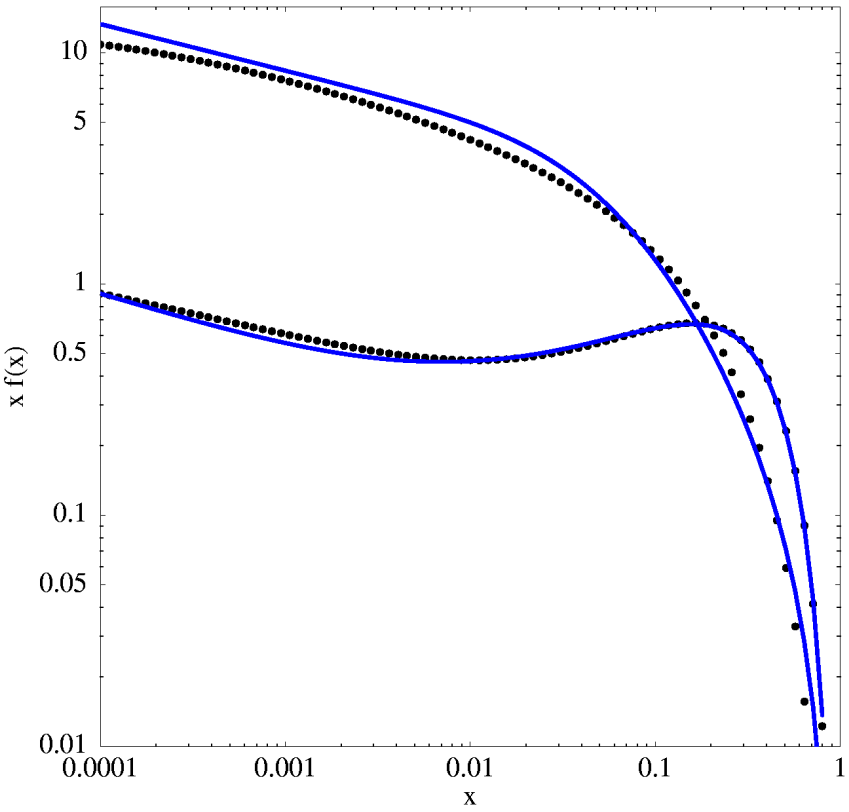


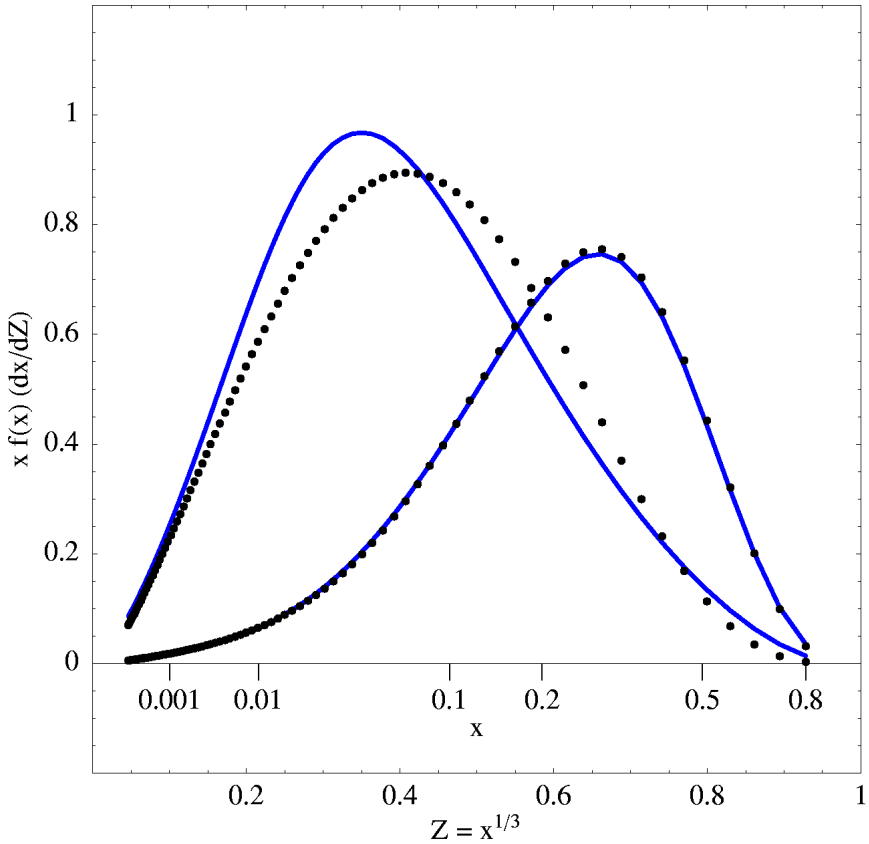
Comparison of CTEQ5 and CTEQ6

Adding new data and applying new methods of analysis — how much change results in the final PDF's?



Comparison of CTEQ6 and MRST2002





blue curves : CTEQ6M
black dots : MRTS2002

gluon and u quark at
$Q^2 = 10\ GeV^2$