Pre-constraining Evolution of Parton Distributions in the matrix solution of DGLAP

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[i] Abstract:

- Potential advantages of the 'matrix solution to DGLAP

- Instability of the set of linear decomposition equations obtained from it, when decomposing the structure function data (F_1 or g_1)
- (Proceedings of Spin2002, pp.299-301)

- Here, we precondition or pre-constrain the solutions of the decomposition equations, based on:

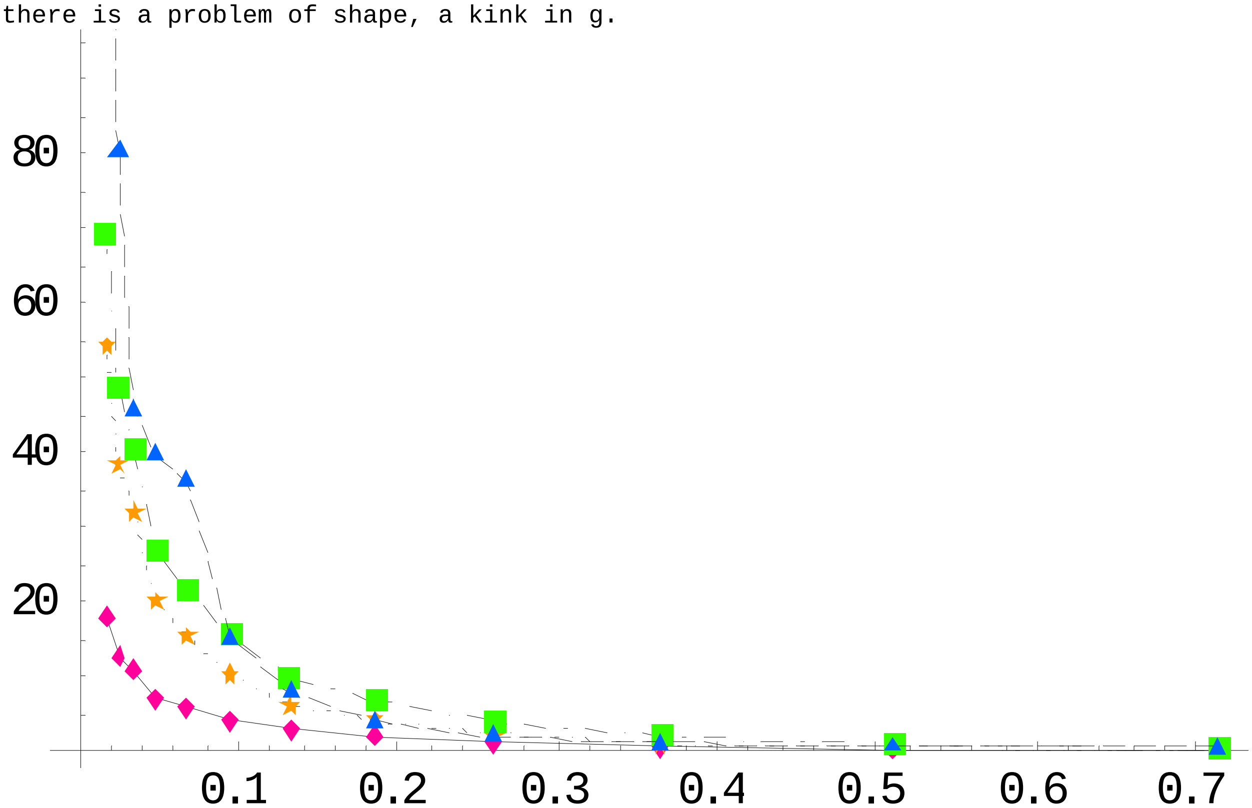
- Principle of positivity of the parton distributions,

 and accepted fact,
increasing nature of the gluons with decreasing values of Bjorken x.

- Data analysis can begin.

Constraints:

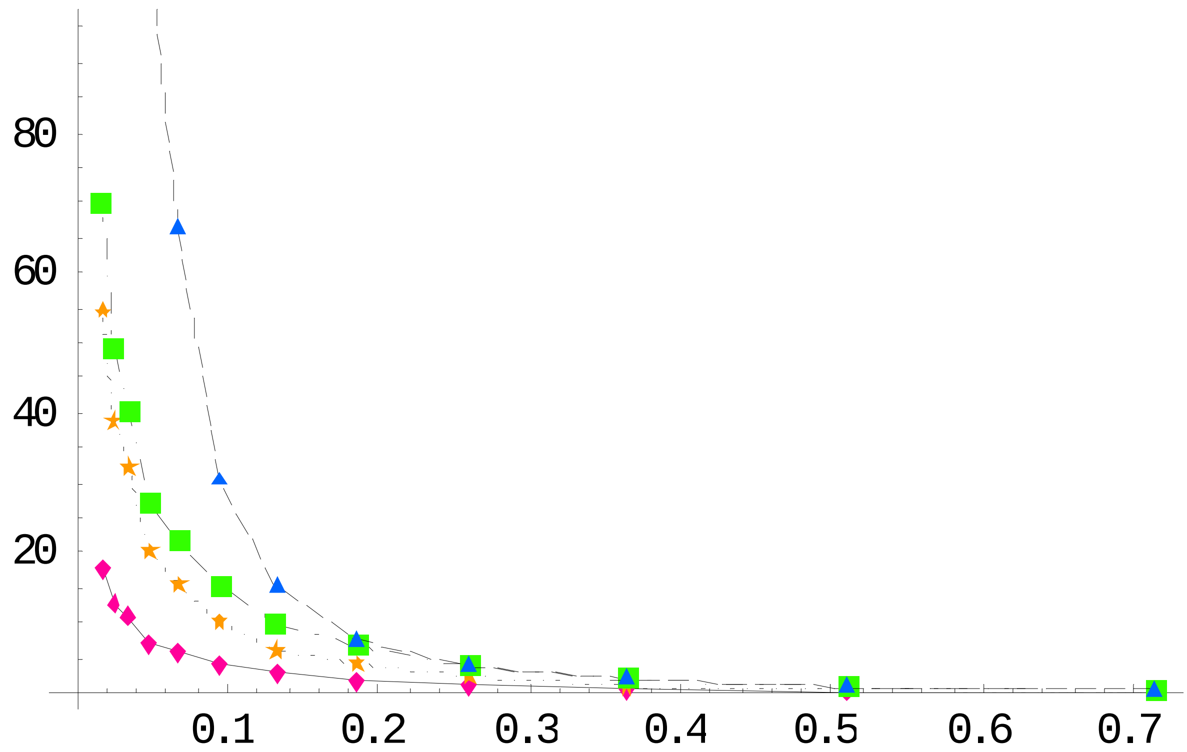
With only positivity constraint on our parton distributions, as the following graph of the solutions of decomposition equations indicate, there is a problem of shape, a kink in g.



$F_{1p,d}$ data from NMC(1995-7) is used (red is F_{1p} vs x, at x and Q^2 of the experiment, except for the largest x), then parton distributions, q_8(orange), q_0(green) and g(blue) are extracted at the same x and Q^2 via a combination workings of DGLAP and constrained decomposition equations

Expect the kink in g to be corrected via trials of:

1. simple increasing g, which we see below works well (For the moment, never mind the absolute increase in g which is simply correctable by a more proper choice of A-parameter introduced later).

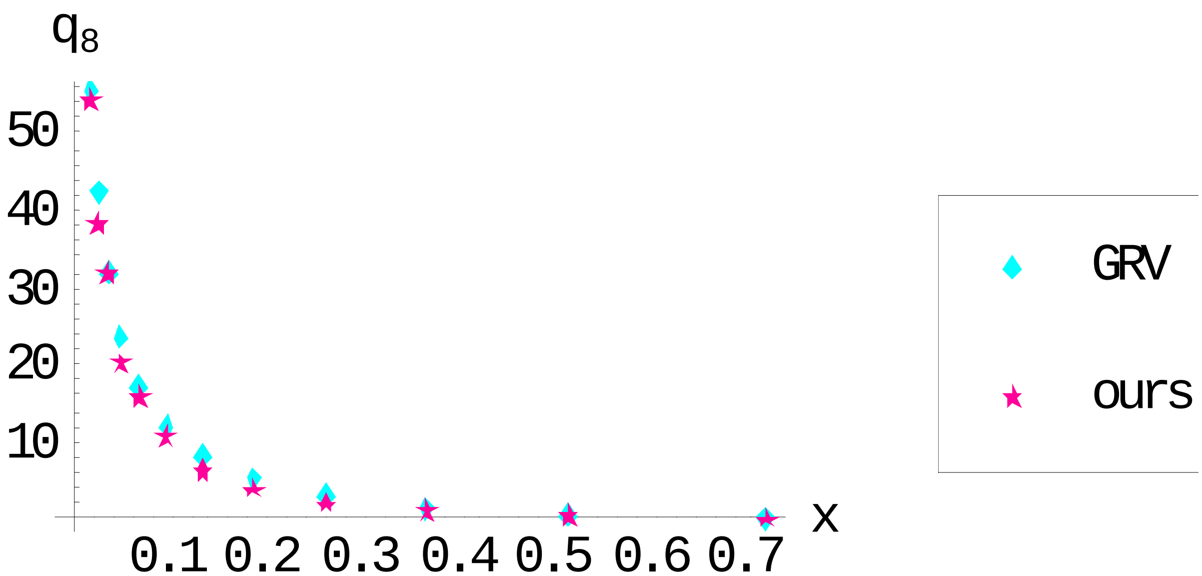


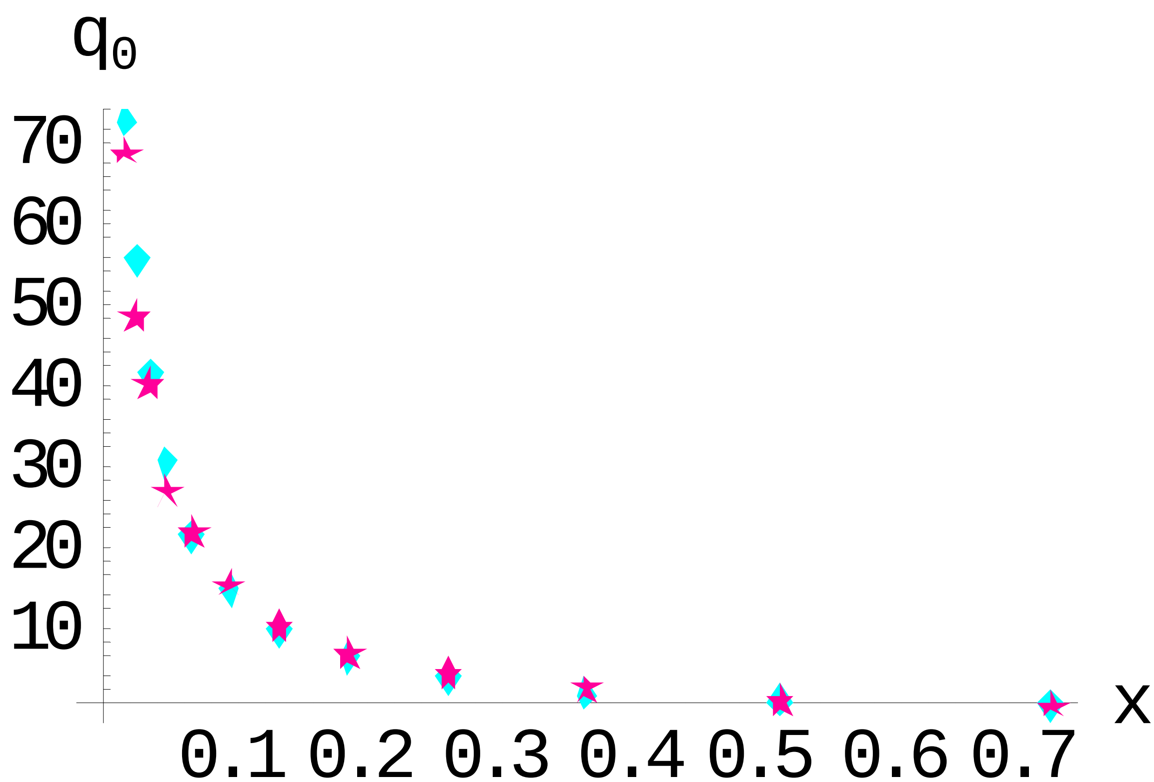
If such a simple constraint had not responded as well we could have made it stronger; e.g,

2. via respecting curvature of g.
If needed, until the solution takes its desired exactness, we may constrain within reasonable limits the shapes of the other parton distributions.
3. The next easy constraint would be on the strange quark distribution which can be obtained here as $(q_0-q_8)/3$, and whose general shape is not very different from the gluon distribution.
Of course, with rather fine numerical results that we are obtaining there is no immediate question of having such extra constraints.

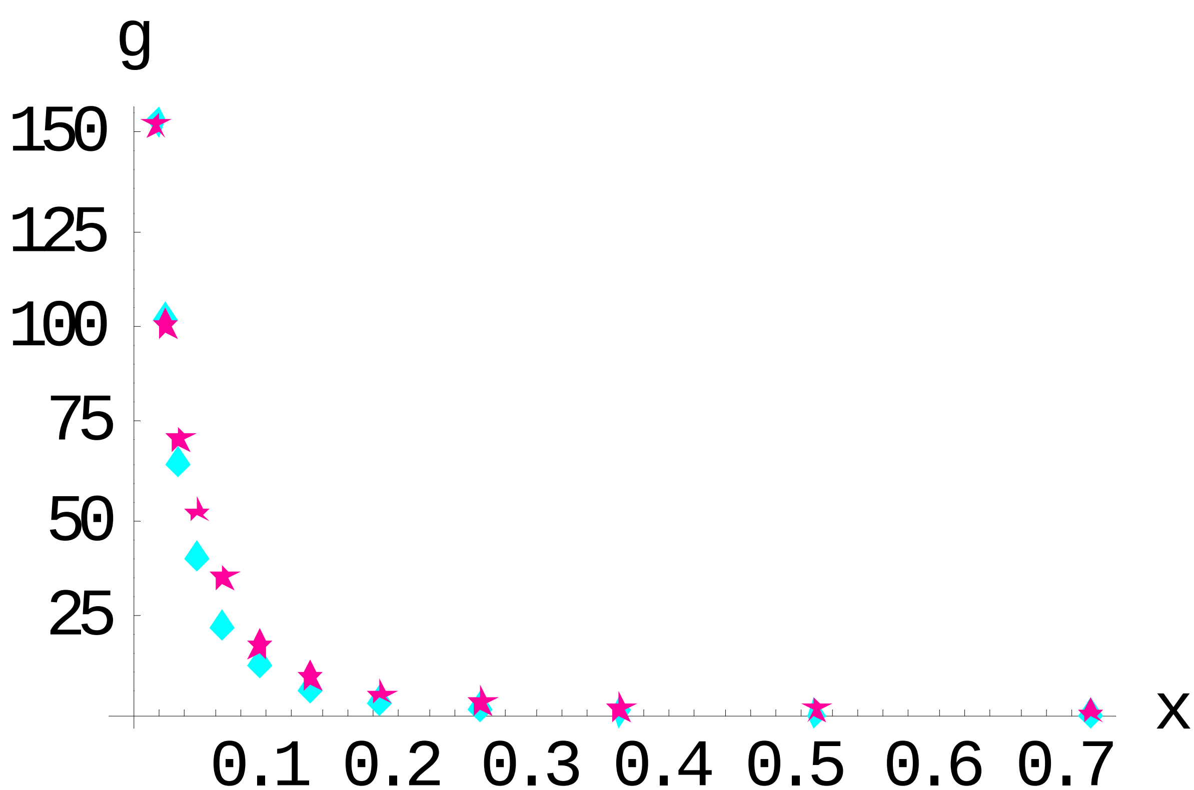
Comparison with GRV:

The graphs below show both x and Q^2 dependences of our decomposed and then evolved $F_{1p,d}$ data and GRV parton distributions and structure function F_{1p} at the experimental values of x and Q^2, using strong constraints which includes a simple increasing g . The closeness (fit) of the two sets of points show the success of the present pre-constraining method to control the instability of the decomposition equations.

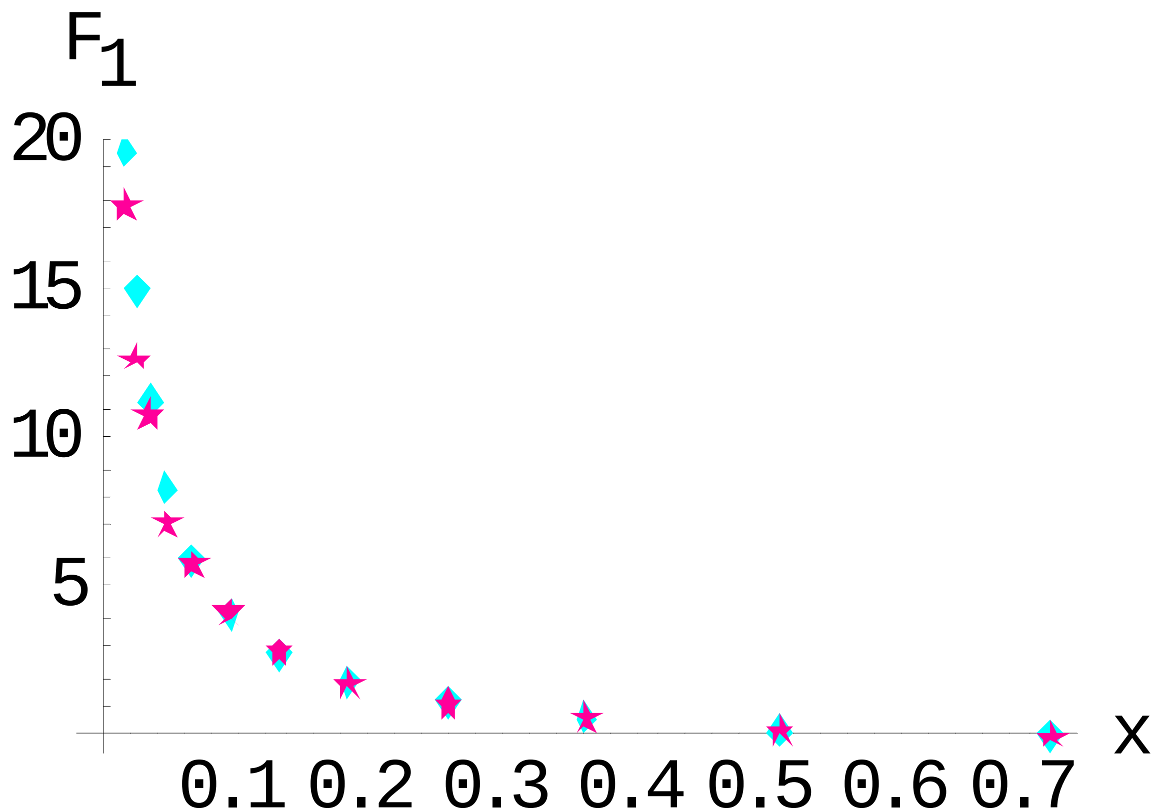




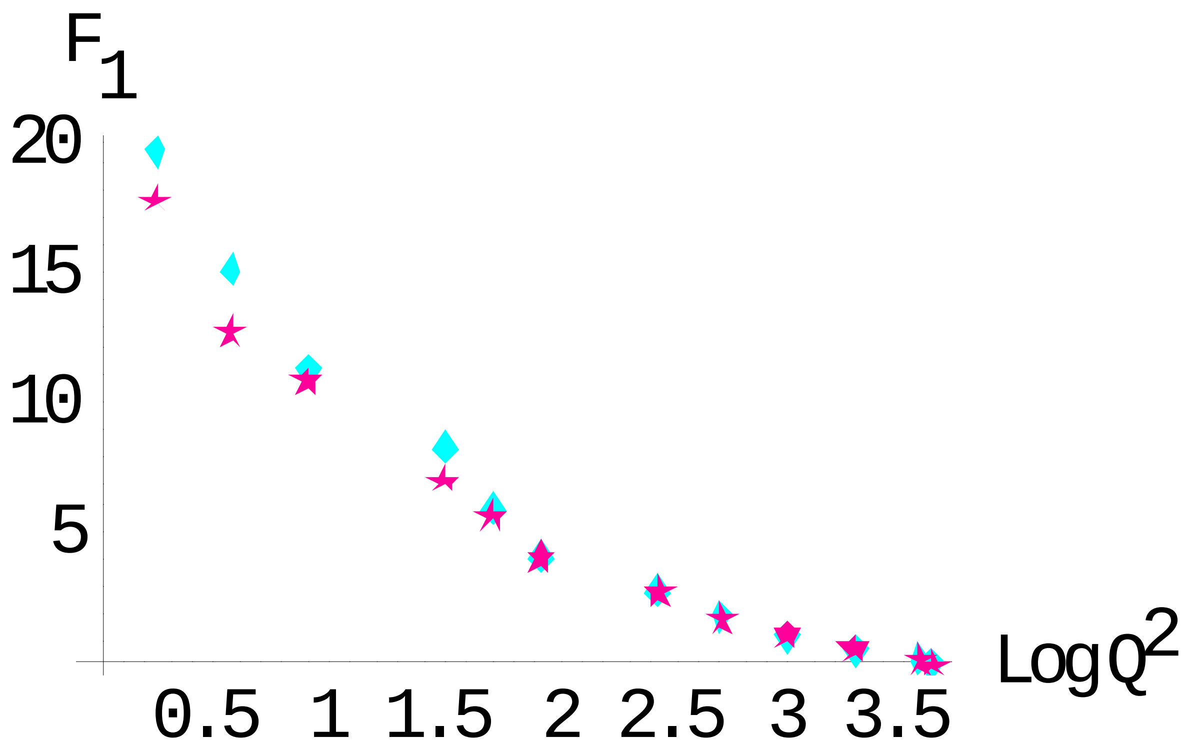
q_0
70
60
50
40
30
20
10
0.1 0.2 0.3 0.4 0.5 0.6 0.7
x



g
150
125
100
75
50
25
0.1 0.2 0.3 0.4 0.5 0.6 0.7
x



F1
20
15
10
5
x
0.1
0.2
0.3
0.4
0.5
0.6
0.7



F_1
20
15
10
5
0.5 1 1.5 2 2.5 3 3.5
$\mathrm{Log}\,Q^2$

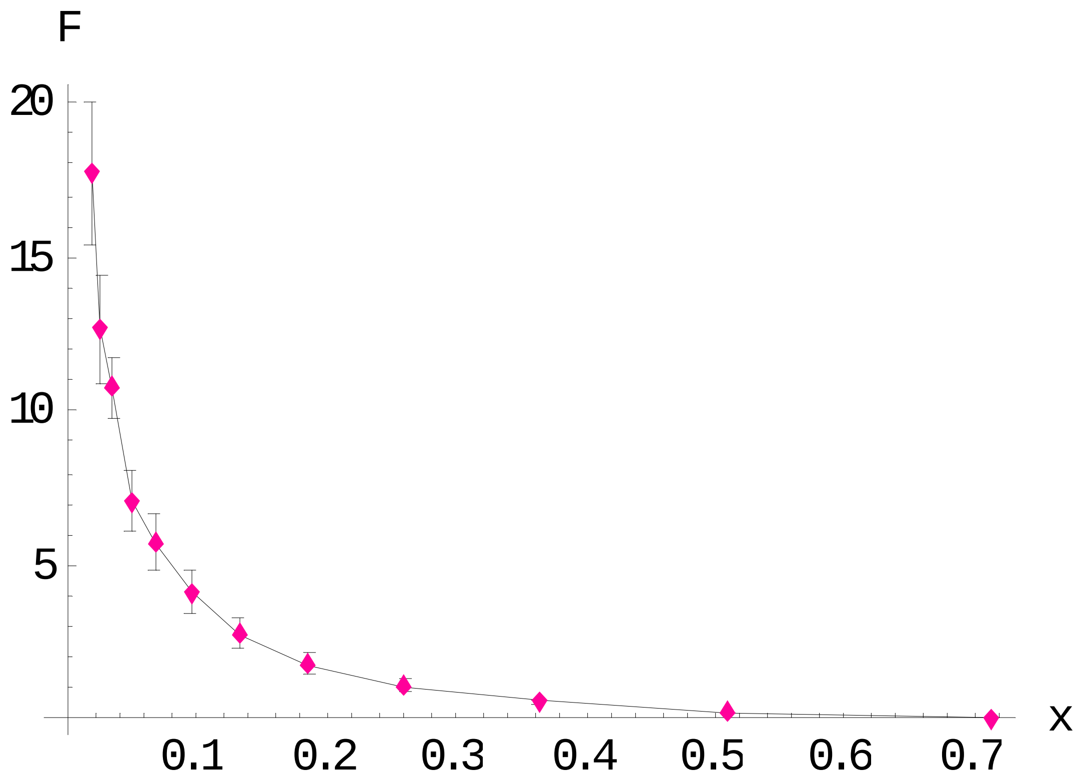
Implementation of the Constraints

In two ways, we thought of implementing the constraints. We introduced a parameter in each evolved F_{1p} within the equations of decompose.
In the first method, we tried to determine the parameter by satisfying the constraints via conditional minimization of the distance of the parameterized F_{1p} from the corresponding actual data point F_{1p}. There are some problems with jumps and discontinuities that make programming for dependable numerical solutions a bit hard.

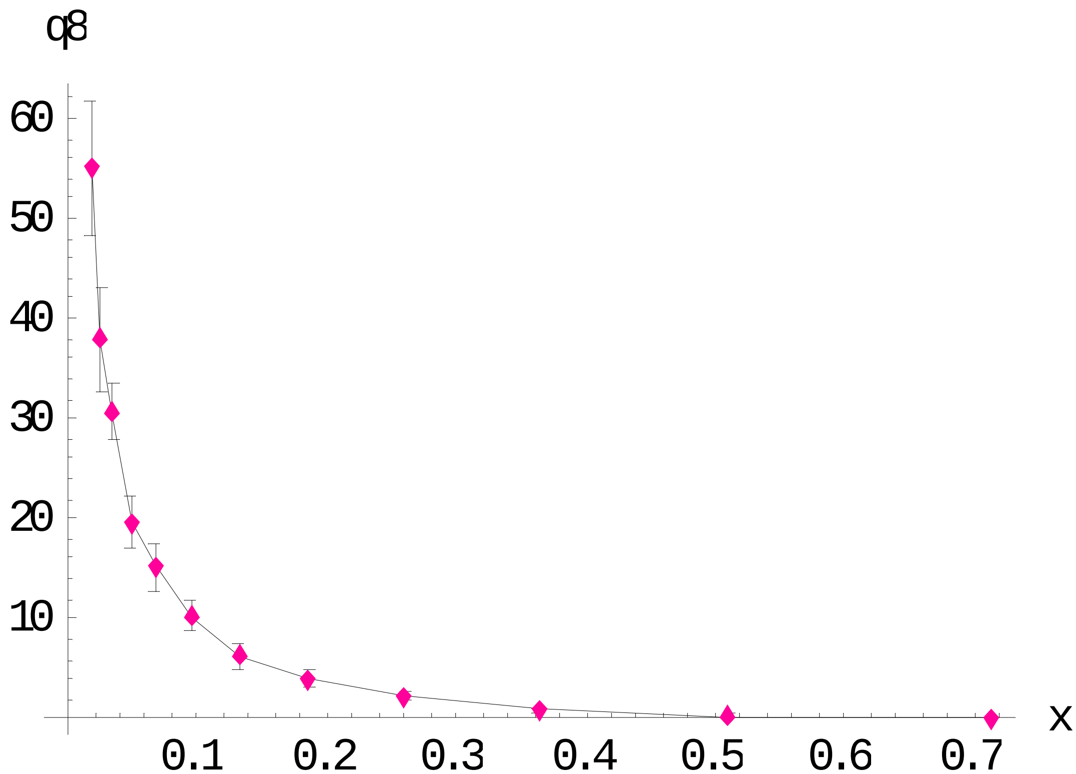
In the second method, we tried to solve the inequalities of the constraints for the parameters and then, within the range of the solutions, via a suitable function, we moved continuously towards those values of the parameters which give distributions with the desired exactness.
In this process, we chose F_{1p} itself as the 1st parameter discussed, and for guiding our choice in the continuous motion we adjusted only two parameter by hand: A and B in the following functions :$1/x^A$ added to the first evolved F_{1p}(in the 2nd equation), and $x^B/(x^B+1)$ multiplied by the second evolved F_{1p}(3rd decomposition equation).
Continuous change of A, and B can guide the continuous motion to the desired exactness. Choice of A=2.1 and B=.4 is shown in the graphs above

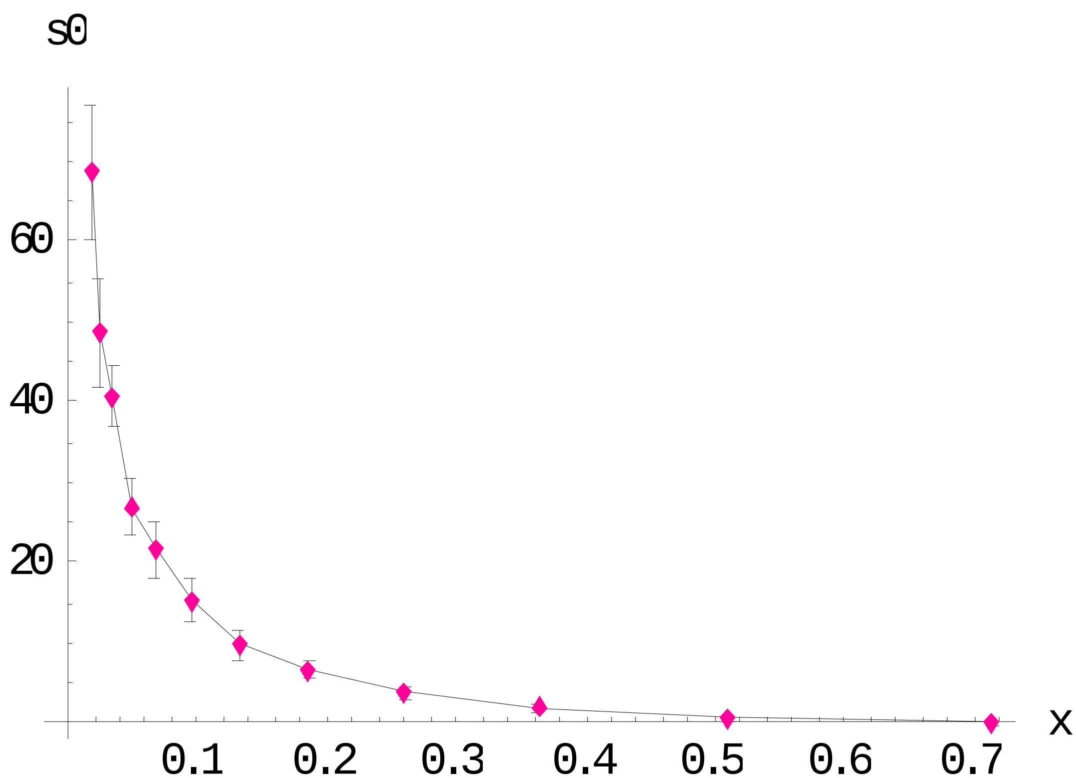
(for the strong constraints). The functions are chosen among a set of continuous functions that give a good feeling for the continuous motion mentioned. In this particular form change of A selectively effects rate of rise of g, and change of B has a selective effect on q_8.

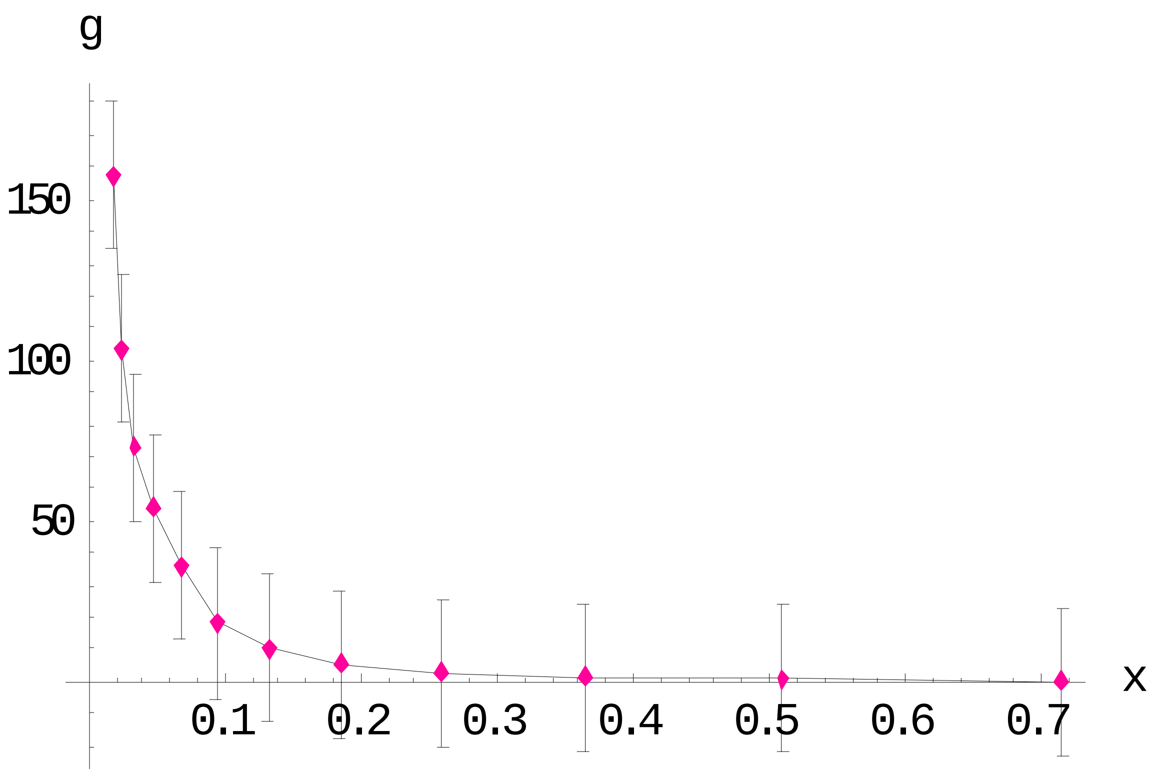
Propagation of errors

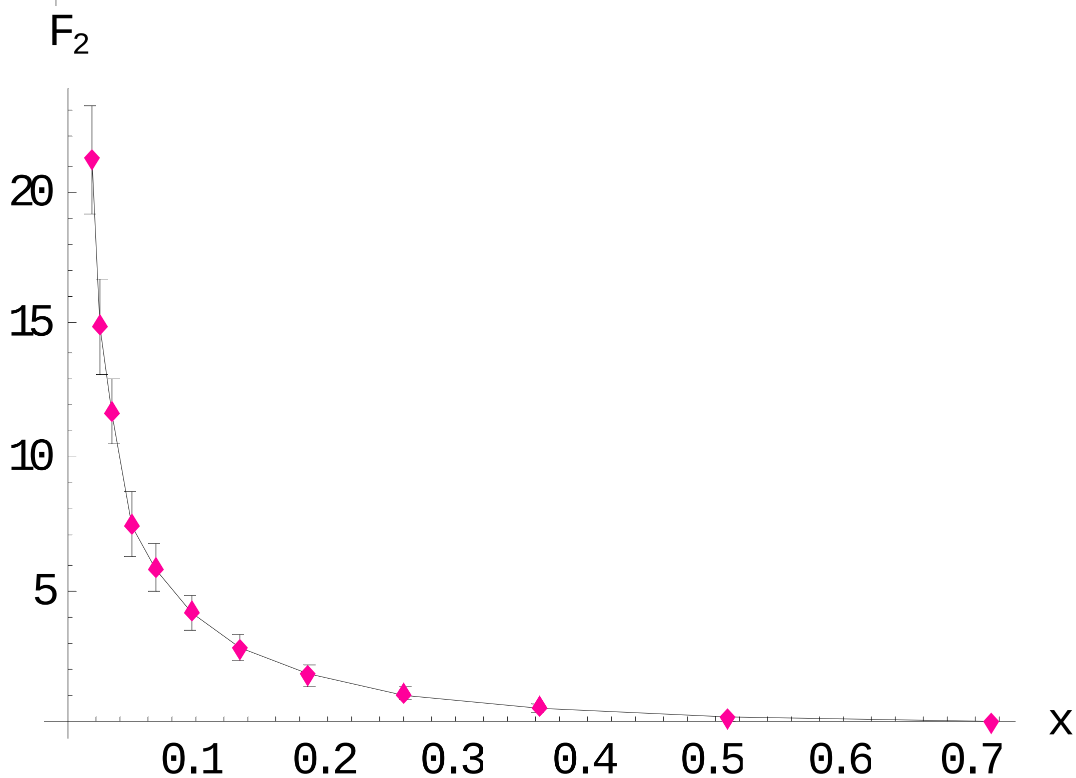


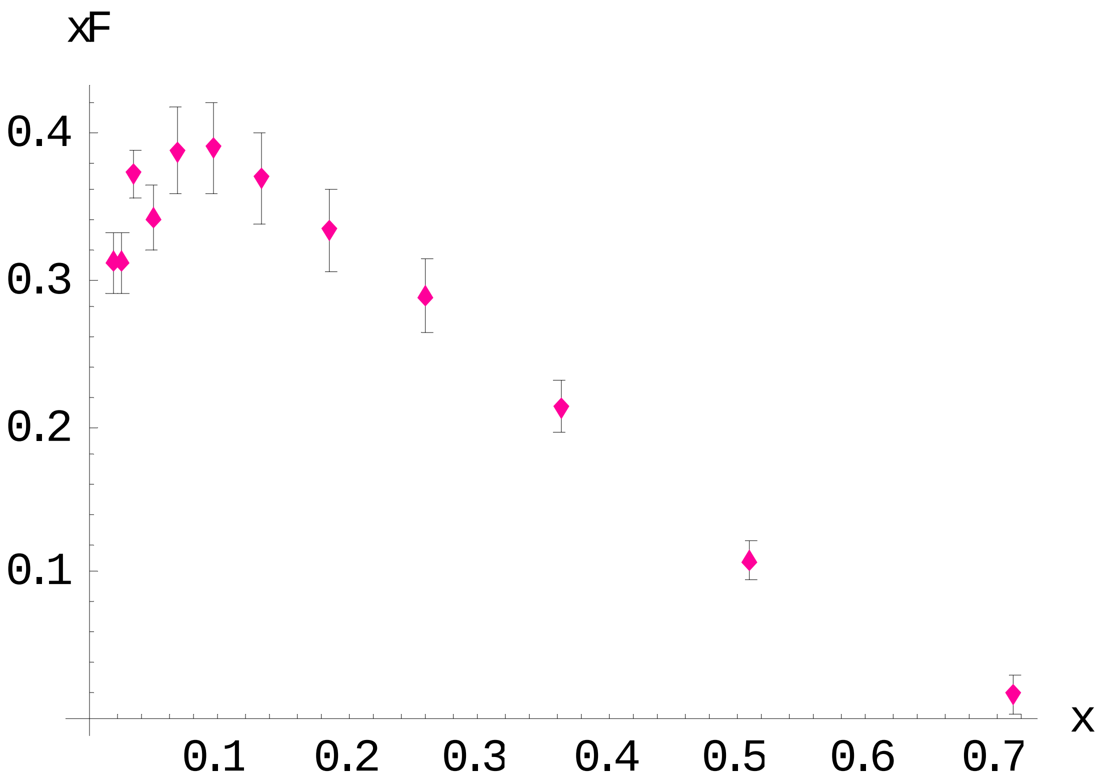
To be conservative for the study of propagation of errors, the actual data errors are multiplied by a factor of 6 (enlargened), Maximum of a 100 runs with random numbers within the enlarged error interval is shown as error of the output parton distributions and evolved F1p.

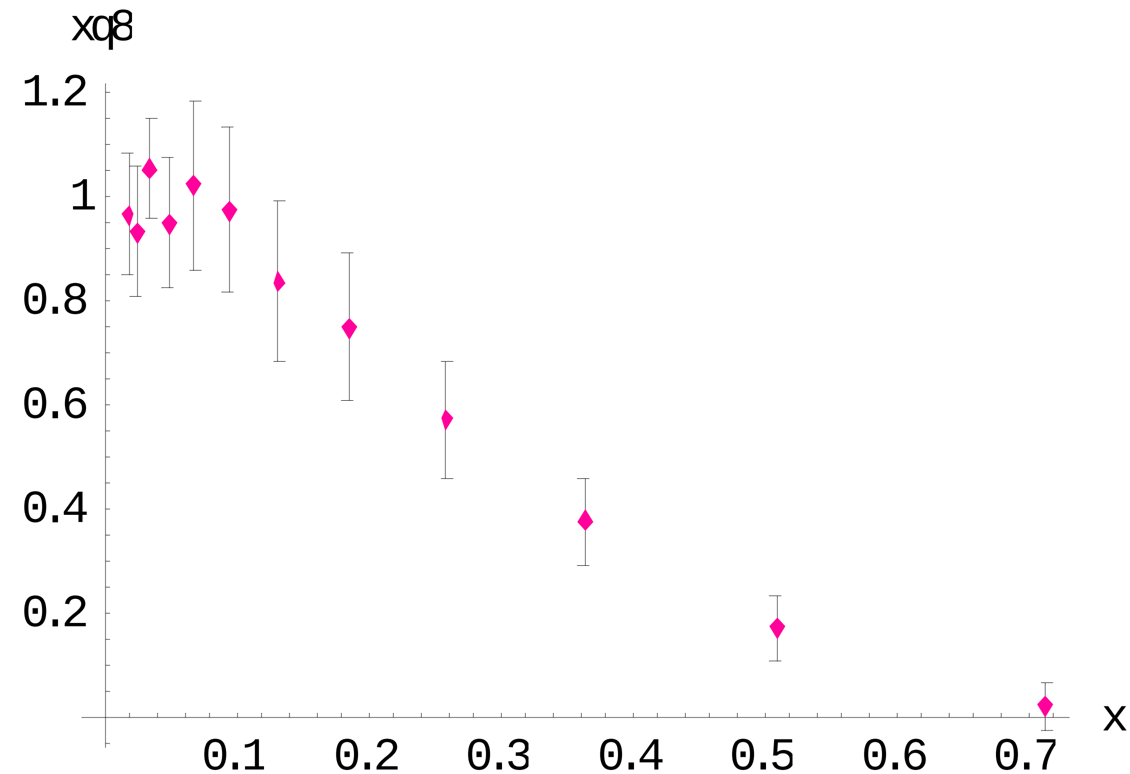

q8
60
50
40
30
20
10
x
0.1
0.2
0.3
0.4
0.5
0.6
0.7

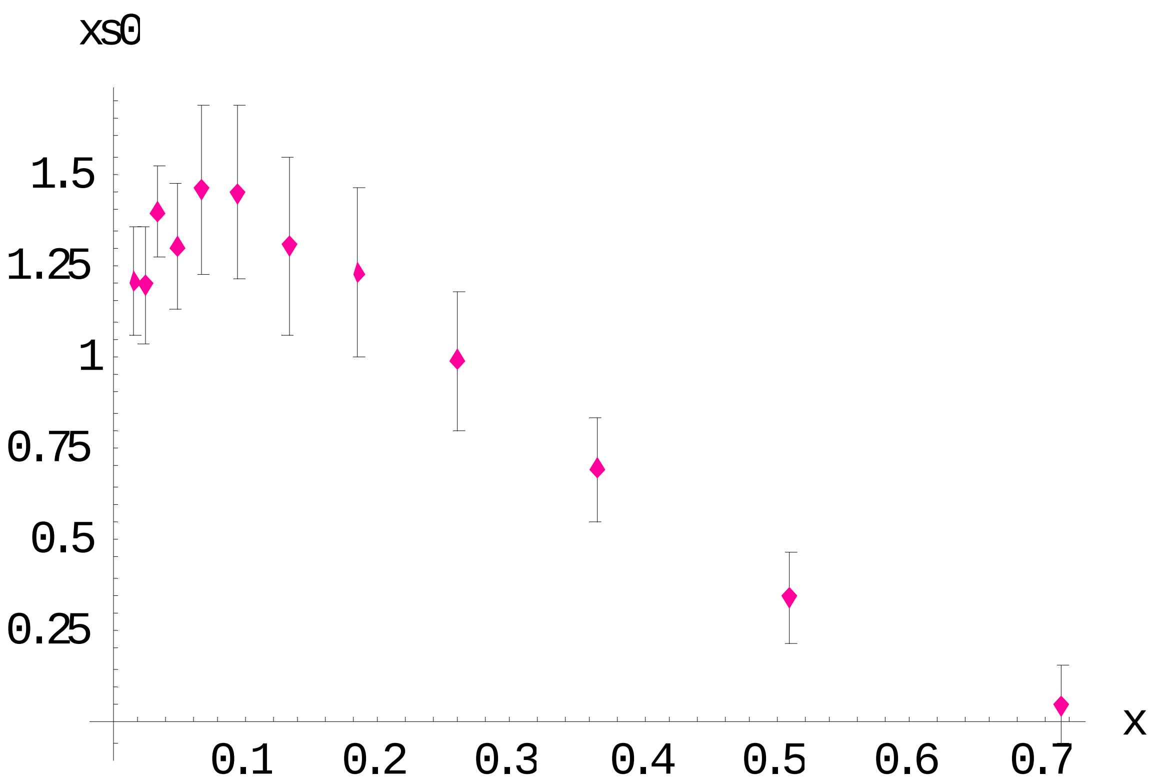

s0
60
40
20
x
0.1
0.2
0.3
0.4
0.5
0.6
0.7

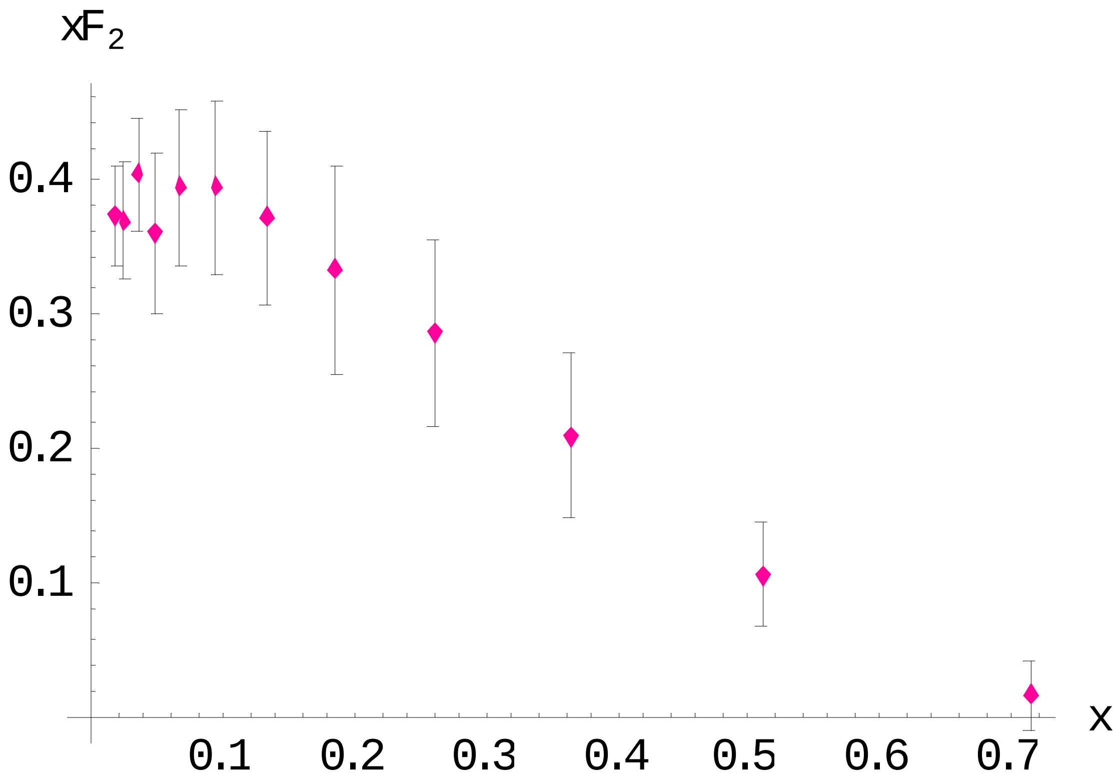

g
150
100
50
0.1
0.2
0.3
0.4
0.5
0.6
0.7
x


F_2
20
15
10
5
0.1
0.2
0.3
0.4
0.5
0.6
0.7
x


xF
0.4
0.3
0.2
0.1
0.1
0.2
0.3
0.4
0.5
0.6
0.7
x


xq8
1.2
1
0.8
0.6
0.4
0.2
0.1 0.2 0.3 0.4 0.5 0.6 0.7
x


xs0
1.5
1.25
1
0.75
0.5
0.25
0.1 0.2 0.3 0.4 0.5 0.6 0.7
x



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sigma={0.00434,0.00434,0.00622,0.00806,0.00957,0.01038,0.01029,0.01003,0.00767,0.00574,0.00722,0.00686}

Q1={37.509999999999988,35.510000000000015,26.670000000000025,19.86,14.970,11.38,6.80,5.47,4.45,2.45,1.76,1.27,1.24,0.8};

Q2={48.630000000000043,46.630000000000025,35.420000000000025,26.7399999999999993,19.859999999999994,14.970000000000006,8.939999999999995,6.8200000000000028,6.890,5.46,4.54,3.34,2.73,1.13};

```
Q3={64.3400000000000105,62.3400000000000176,61.2100000000000044,59.7900000000000009,46.5700000000000002,45.7500000000000017,35.2000000000000046,26.3700000000000045,11.890,9.00,8.890,7.09,4.52,3.47};

F2={0.02439223190472229`,0.2079695310519316`,0.5751103565796685`,1.0969655319834166`,1.789824988141314`,2.790846064702782`,4.1543001462916775`,5.80884677597734`,7.451045052630539`,11.687405627420393`,14.971258600051064`,21.18322768984664`};
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