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Chromopolis: A complete framework for the pQCD analysis of the structure of the nucleon[☆]

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Abstract

The *Fortran* program ***Chromopolis*** is documented. This is a complete QCD framework for the analysis of the spin-averaged and spin-dependent structure of the nucleon in perturbative quantum chromodynamics (pQCD). The core of Chromopolis consist of an extended and extensible database with world data on polarized and unpolarized high-energy scattering, and the implementation of calculations for the relevant observables; including renormalization-group evolution codes for the strong coupling and the parton distribution functions up to NNLO of QCD. A characteristic of these codes is that they work to a large extent in the space of complex moments known as Mellin space. Chromopolis also contains code for the statistical analysis of the data, including optimization algorithms with different treatments of correlated and uncorrelated uncertainties, and an implementation of the Hessian approach for the propagation of experimental uncertainties. In addition it provides facilities for the graphical representation of the results.

Keywords: perturbative QCD, parton distribution functions, helicity distributions, Mellin space, optimization, Hessian method

1. Introduction

2. Data structures

3. Optimization

4. A complete example

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DATER: from 27698 points 5710 used (lmcount = 6074)
CHISQ: 5710 (from 27698) points used, chi2 (chi2/#points) = 7112 (1.2455)
                25E605_PRD43_DYpCu              136 ( 136),   152 (1.1192)
                26E866_Private_DYpp             138 ( 184),   157 (1.1390)
                27E866_Private_DYpd             159 ( 191),   284 (1.7888)
                55SLAC_PLB282_sigrpCO           594 ( 661),   716 (1.2057)
                60E866_PRD64_DYd2p               39 (  39),    40 (1.0183)
                65SLAC_PLB282_sigrdCO           617 ( 691),   698 (1.1314)
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[☆]Chromopolis is free software released under the GNU General Public License. It can be obtained from the author on request, or directly downloaded from https://users.hepforge.org/~pjimenezdelgado; current version is *Chromopolis 1.0*.

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 81HERA_JHEP0110_sigrCO          647 (  741),   1060 (1.6383)
 82E665_PRD54_F2CO               130 (  182),    186 (1.4271)
 83NMC_NPB483_sigrCO             578 (  584),    931 (1.6100)
 84BCDMS_PLB223_sigrpCO          351 (  351),    410 (1.1674)
 85BCDMS_PLB237_sigrdCO          254 (  254),    291 (1.1447)
 86NMC_NPB487_F2dpCO              211 (  260),    191 (0.9038)
 87H1_EPJC71_F2p                  64 (   64),     69 (1.0829)
 88H1_EPJC71_FLp                  64 (   64),     82 (1.2790)
 90combined_dimuon_sigpl         180 (  180),    105 (0.5848)
 91JLab_PRC80_sigp                91 (  261),    104 (1.1474)
 92JLab_PRC80_sigd                91 (  261),    109 (1.2008)
 93fastNLO_fnh2001                30 (   30),     20 (0.6668)
 94fastNLO_fnh2003                24 (   24),     40 (1.6654)
 95fastNLO_fnt2007                64 (   77),    174 (2.7193)
 96fastNLO_fnt2009                96 (  110),    138 (1.4370)
 97HERA_EPJC73_sigrc               52 (   52),     79 (1.5229)
101SLAC_PRL51_Apap                23 (   35),     12 (0.5361)
102EMC_NPB328_A1p                 10 (   10),      4 (0.3850)
103SMC_PRD58_A1p                  12 (   15),      4 (0.3636)
104SMC_PRD60_A1p                   8 (   15),     11 (1.3645)
105COMPASS_PLB690_A1p              15 (   15),     14 (0.9457)
106SLAC_PRD58_Apap                 85 (  159),     69 (0.8112)
107SLAC_PRD58_Apep                 48 (   50),     44 (0.9105)
108SLAC_PLB553_ApeE155xp          117 (  133),    193 (1.6473)
109HERMES_PRD75_Apap               37 (   45),     14 (0.3895)
111SMC_PRD58_A1d                  12 (   15),     20 (1.6958)
112SMC_PRD60_A1d                   8 (   15),      4 (0.5601)
113COMPASS_PLB647_A1d              15 (   17),      8 (0.5049)
114SLAC_PRD58_Apad                 85 (  156),     88 (1.0347)
115SLAC_PRD58_Aped                 48 (   50),     44 (0.9138)
116SLAC_PLB553_ApeE155xd          117 (  133),     98 (0.8419)
117HERMES_PRD75_Apad               37 (   45),     31 (0.8390)
119SU2_baryon decay                 1 (    1),      0 (0.0053)
120SU3_baryon decay                 1 (    1),      1 (0.9051)
121SLAC_PRD54_A1He                  8 (    8),      6 (0.7220)
122SLAC_PRD54_A2He                  8 (    8),      6 (0.6993)
123SLAC_PRL79_ApaHe                 18 (   18),      8 (0.4170)
124SLAC_PRL79_ApeHe                 18 (   18),     18 (1.0027)
125HERMES_PLB404_A1n                 9 (    9),      3 (0.2946)
126JLabHallA_PRL92_ApaHe            3 (    3),      0 (0.0764)
127JLabHallA_PRL92_ApeHe            3 (    3),      3 (0.8658)
131SLAC_PLB493_Apap                73 (   75),     67 (0.9128)
132SLAC_PLB463_Apad                 73 (   75),     71 (0.9704)
133SLAC_PLB493_Apep                 66 (   71),     63 (0.9576)
134SLAC_PLB463_Aped                 66 (   71),     99 (1.4945)
135HERMES_EPJC72_A2p                20 (   23),     23 (1.1570)
136COMPASS_12116849_pgg              1 (    1),      1 (1.1586)
139DUB_secondmoment                 1 (    1),      2 (1.9929)
140DDB_secondmoment                 1 (    1),      1 (1.1426)
141BCDMS_PRL_F2p                   10 (   10),     17 (1.6853)
142BCDMS_PRL_FLp                   10 (   10),      4 (0.3924)
143SLAC140x_PRL_F2p                  3 (    4),      3 (0.9061)
144SLAC140x_PRL_FLp                  3 (    4),      8 (2.7686)
155PHENIX_PRD79_ALLpi0              5 (    5),      3 (0.5403)
156PHENIX_14026296_ALLpi0           12 (   12),      5 (0.3867)
157STAR_PRD80_ALLpi0                4 (    4),      2 (0.4572)
158STAR_PRD89_ALLpi0                6 (    6),      5 (0.8374)
0D,    0H,    6M,  53S
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5. Conclusions

Acknowledgements

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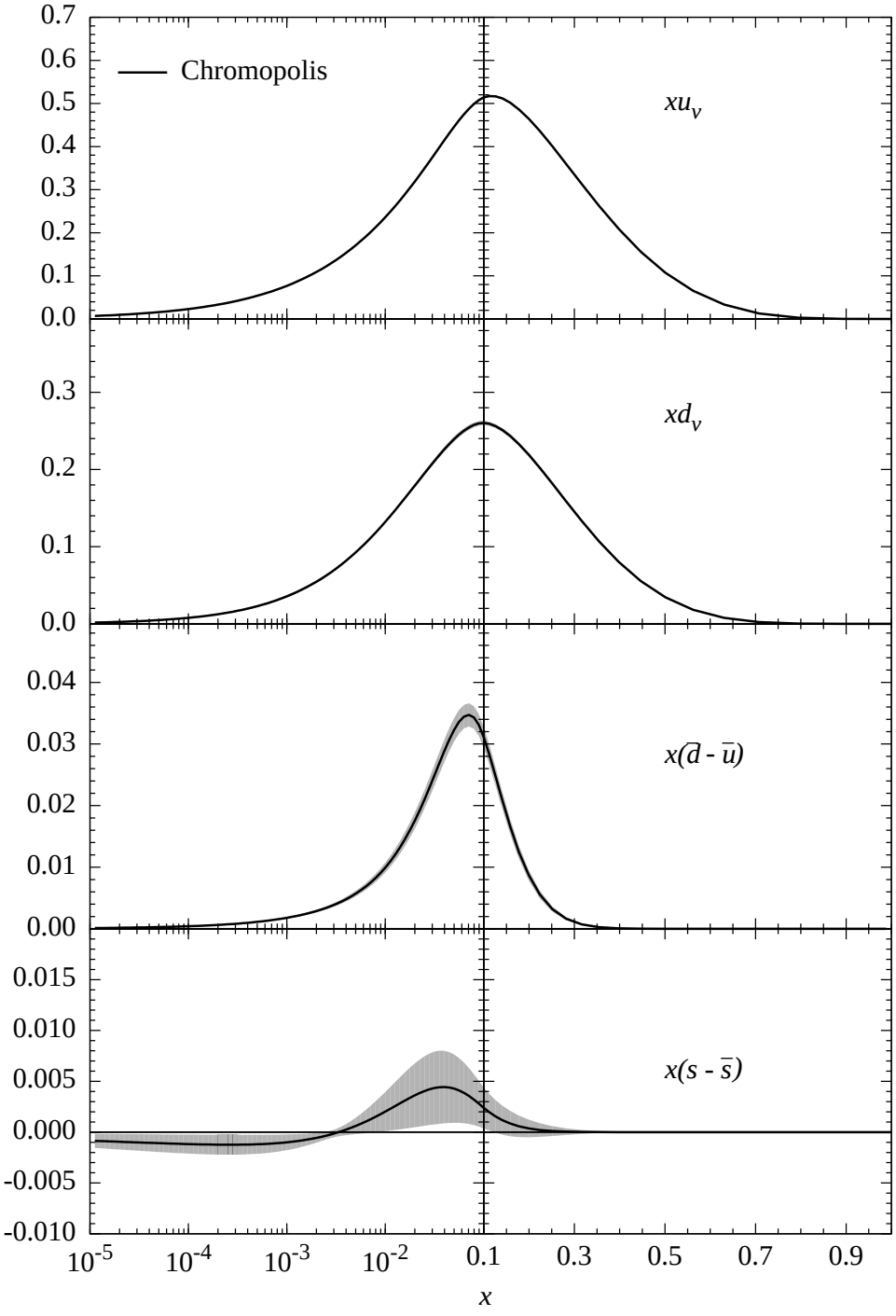

Figure 1: The nonsinglet unpolarized parton distributions at a scale $Q^2 = 10^4$ GeV^2 as obtained in the NLO example fit. The band indicates the $\pm 1\sigma$ uncertainties ($\Delta\chi^2 = 1$).

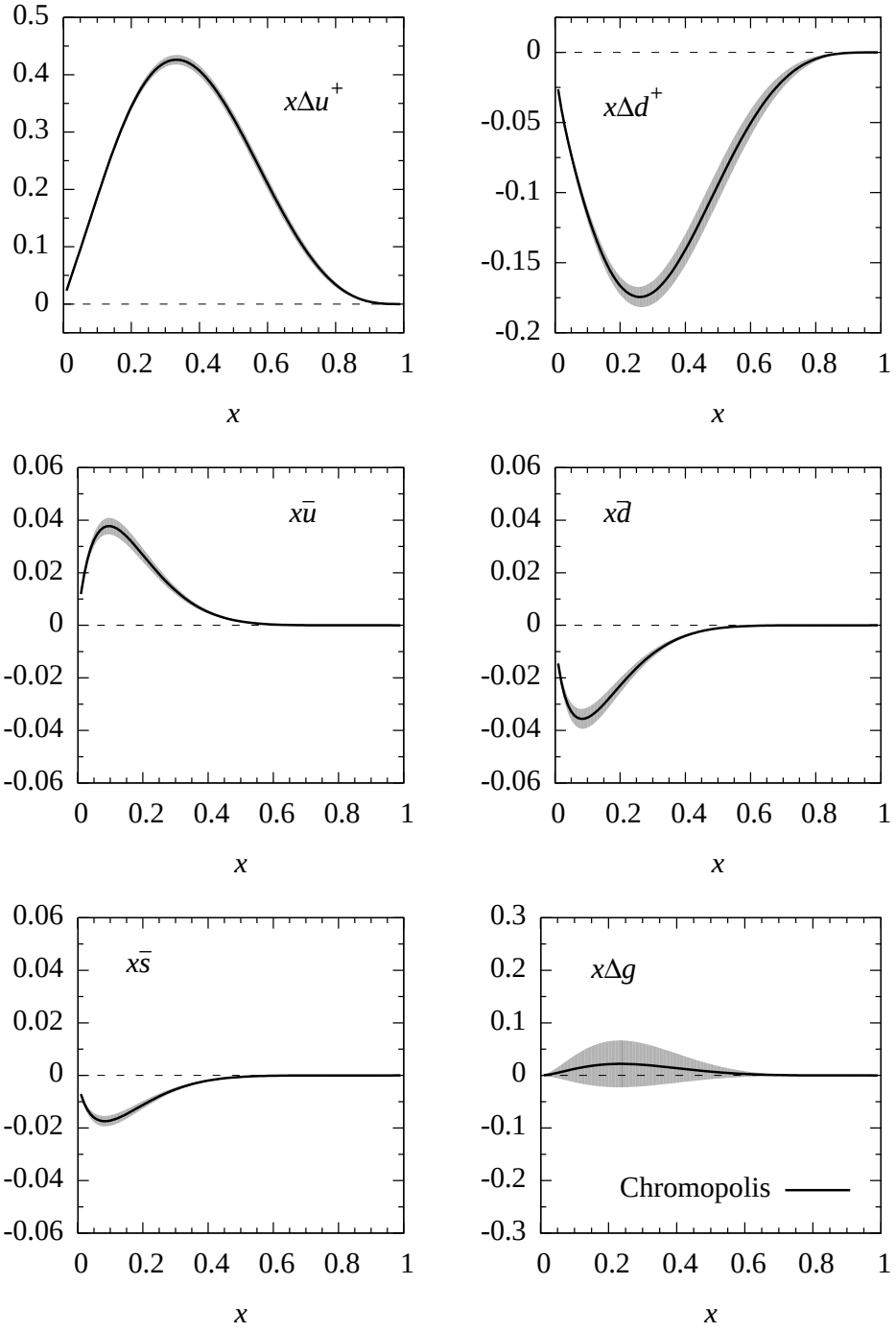

Figure 2: The polarized input distributions at a scale $Q_0^2 = 1$ GeV^2 as obtained in the NLO example fit. The band indicates the $\pm 1\sigma$ uncertainties ($\Delta\chi^2 = 1$).

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