The impact of e+A collisions on nuclear PDFs

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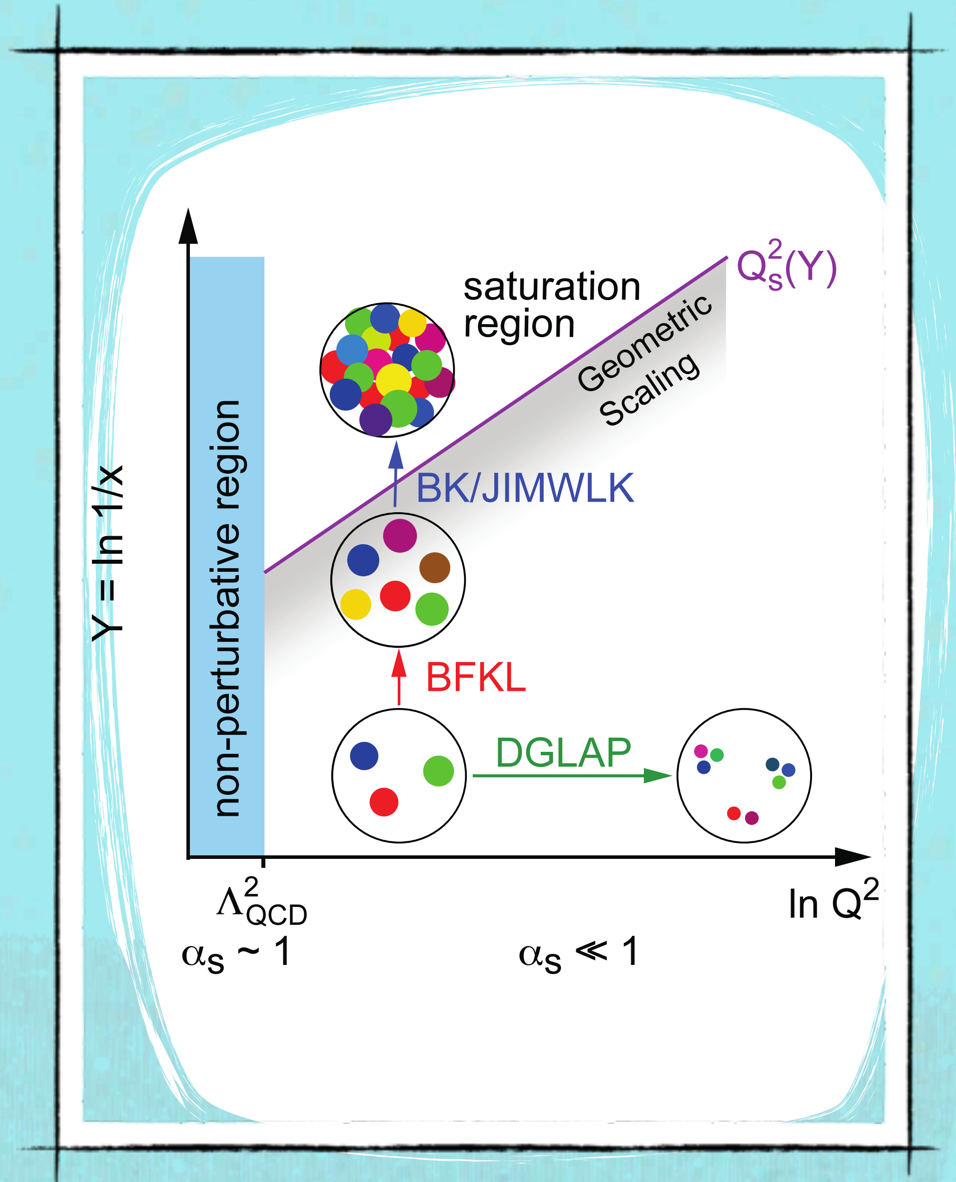
Outline

- Why e+A collisions?
- What do we want to do?
- How do we do it?
- What do we get?
- What do we conclude?

Why e+A collisions?

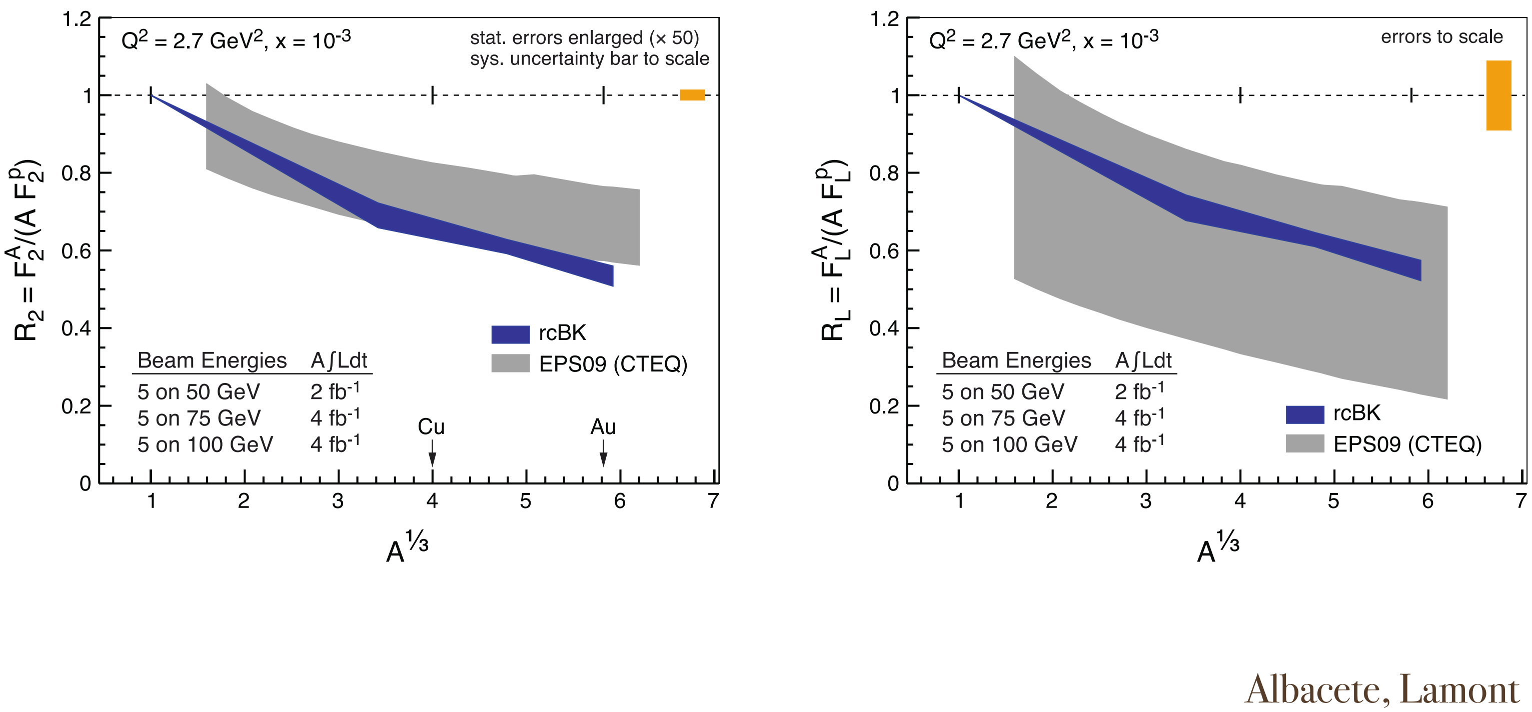
Why e+A collisions?

- At asymptotically small x:
  - Parton saturation.
  - QCD evolution becomes non-linear.



Why e+A collisions?

- e+A can provide:
  - proofs that non-linear QCD evolution is indispensable/ irrelevant.
  - strong evidence of saturation.
  - knowledge about the properties of the saturation regime.
  - data on the impact parameter dependence of the gluon density.



Can NLO DGLAP simultaneously accommodate F_2 and F_L data if saturation sets in according to the current models?

What do we want to do?

What do we want to do?

See the impact of e+A (pseudo)data on the nuclear parton distribution functions.

How do we do it?

How do we do it?

- e+A Deep Inelastic Scattering:
  - Bjorken frame

$$F_2(x, Q^2) = x \sum_q e_q^2 \left(q(x, Q^2) + \bar{q}(x, Q^2)\right)$$

  - Dipole frame

$$F_2(x, Q^2) = \frac{Q^2}{4\pi^2 \alpha_{\mathrm{em}}} (\sigma_T + \sigma_L)$$

- Reweighting

How do we do it?

- How do we generate the pseudodata?
- How do we deal with the pseudodata?

How do we generate the pseudodata?

- e+p collisions

$$\sigma_{T,L}^{\gamma^* h}(x,Q^2) = \sum_q \int_0^1 \mathrm{d}z \int \mathrm{d}^2\mathbf{r} |\Psi_{T,L}^q(e_q, m_q, z, Q^2, \mathbf{r})|^2 \sigma_{dip}^{e+p}(r,x)$$

- Extension to e+A collisions

$$\sigma_{dip}^{e+A}(r,x) = \int \mathrm{d}^2 b \; \sigma_{dip}^{e+A}(r,x,b)$$

$$\sigma_{dip}^{e+A}(r,x,b) = 2\left[1 - \exp\left(-\frac{1}{2} A\, T_A(b) \sigma_{dip}^{e+p}(r,x)\right)\right]$$

Armesto [hep.ph/0206017]
Lappi,Mäntysaari [1309.6963v1]

How do we deal with the pseudodata?

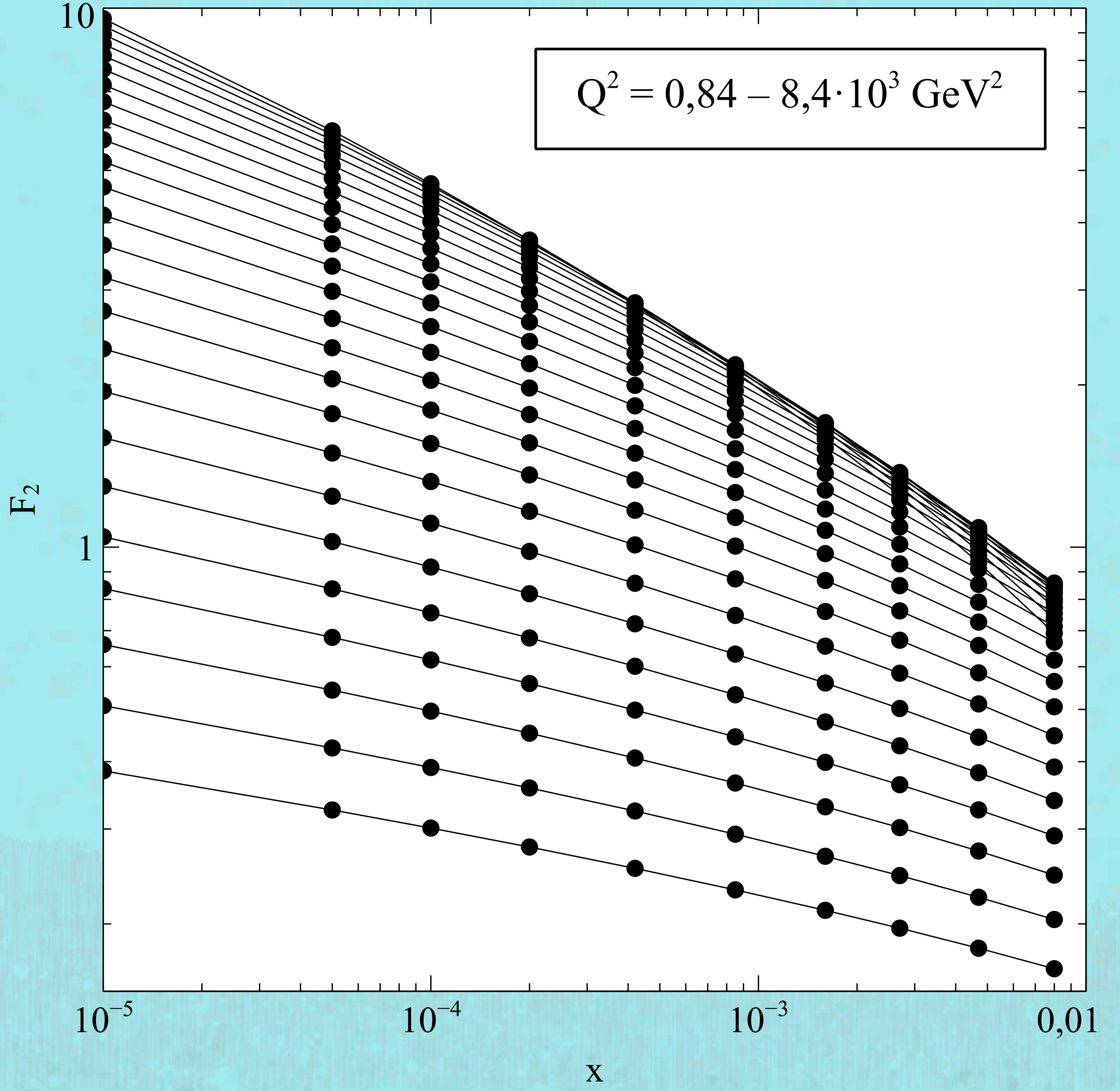
- Hessian reweighting method. Paukkunen, Zurita [hep-ph/1402.6623]
- Technique developed to save time.
- Quantitative estimation of data/theory incompatibility.

How do we deal with the pseudodata?

- Data/theory compatibility estimator (penalty term):
  - If $P \gtrsim \Delta\chi^2$ incompatible: new fit is mandatory.
  - If $P \ll \Delta\chi^2$ compatible: nPDFs get *reweighted* and include the new data.

How do we deal with the pseudodata?

F_2 pseudodata for Au-197



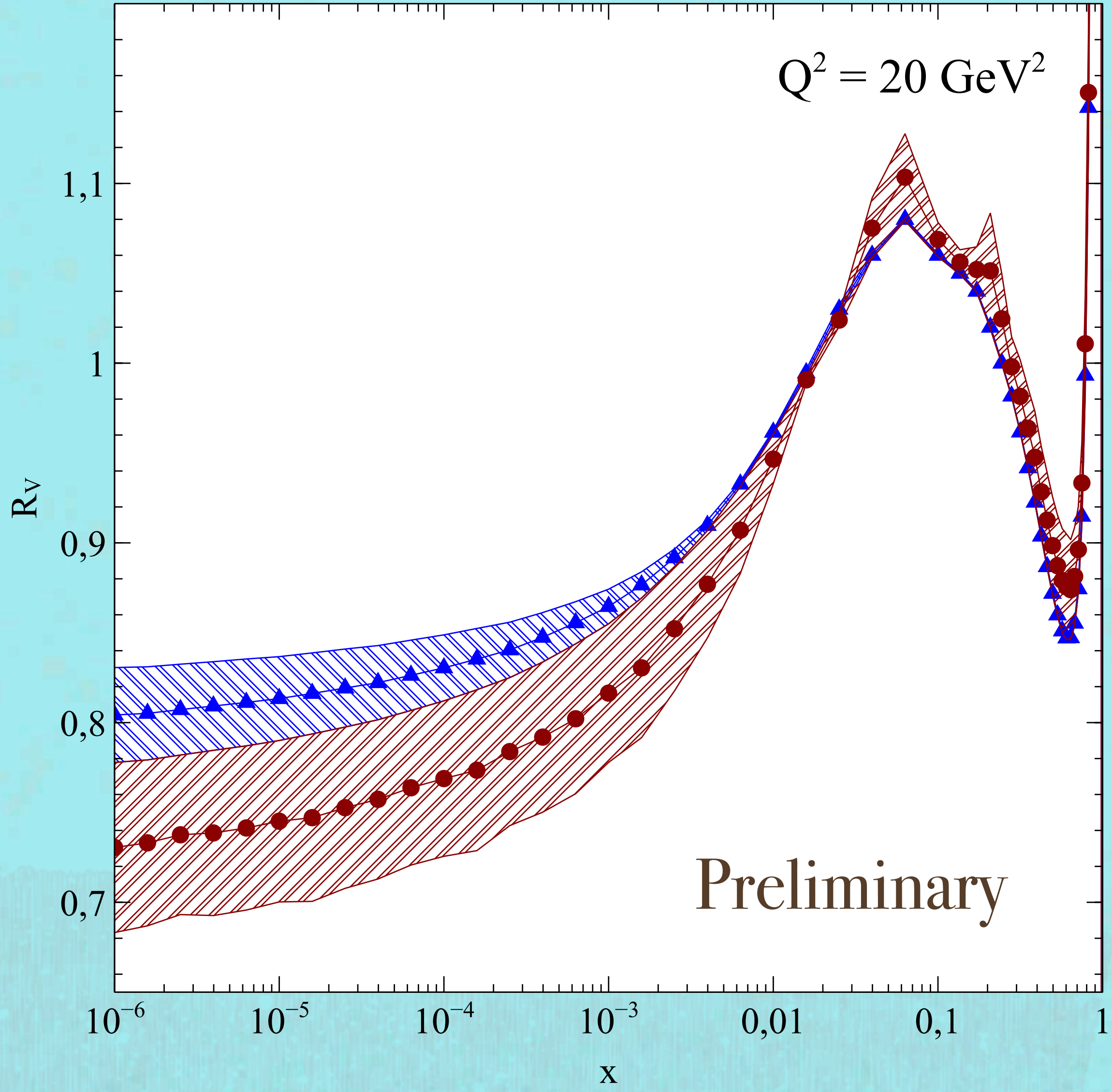
Reweighting time!

What do we get?

What do we get?

Valence quark

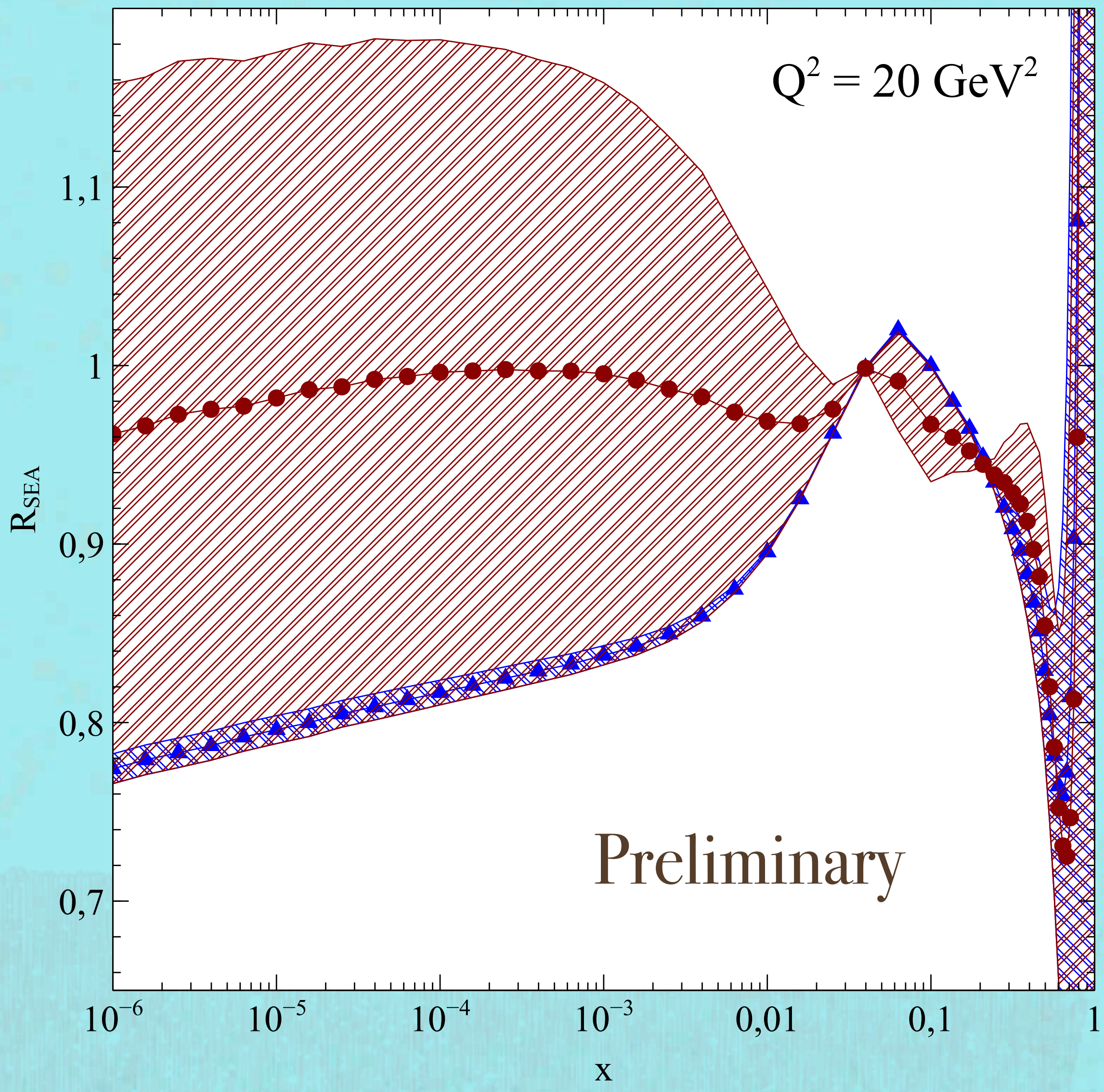
Blue: EPS09
Red: EPS09 reweighted



What do we get?

Sea quark

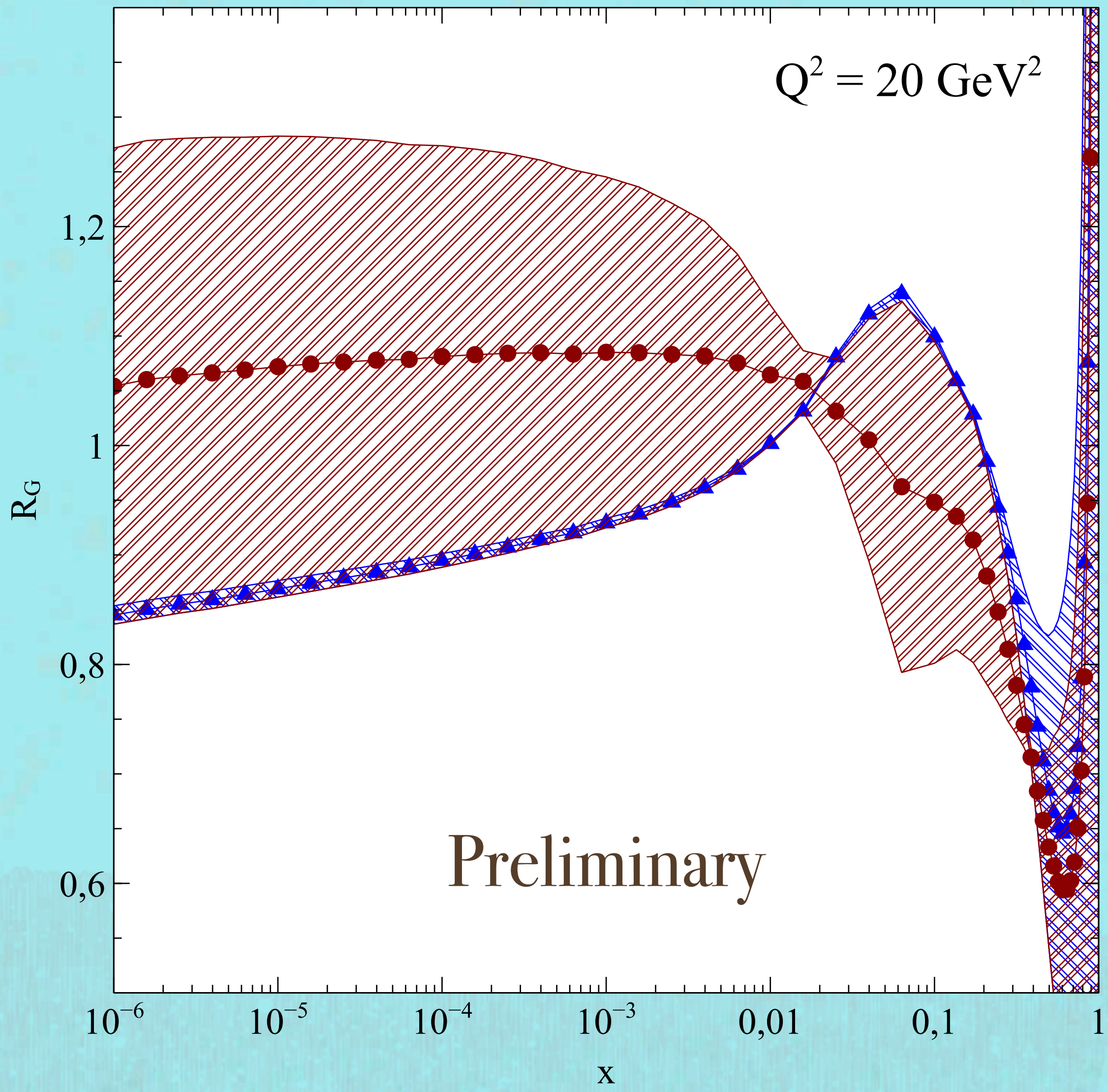
Blue: EPS09
Red: EPS09 reweighted



What do we get?

Gluons

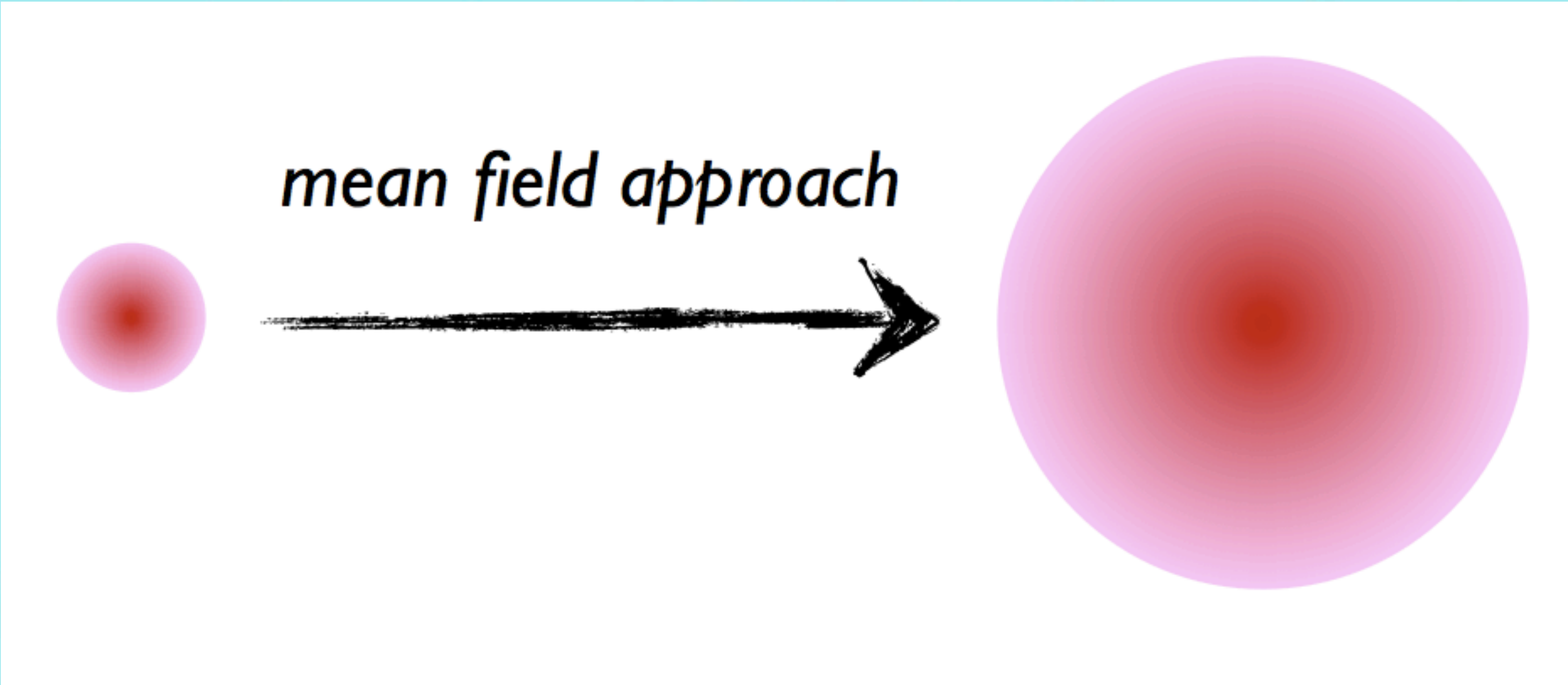
Blue: EPS09
Red: EPS09 reweighted



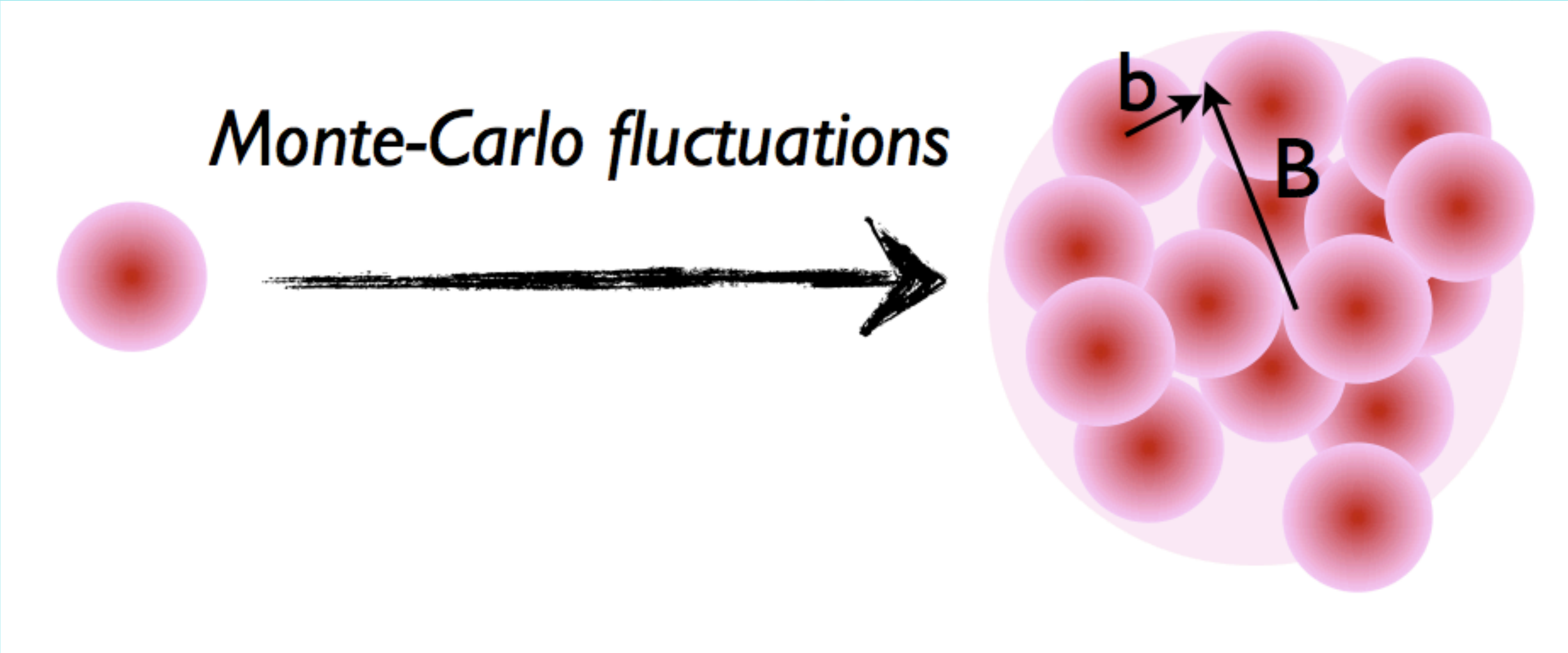
What do we get?

	$\Delta\chi^2$	Penalty
EPS09	50	817

- $P \gg \Delta\chi^2$. Pseudodata seems to be incompatible with theory.
- Should the collinear factorization for e+A be improved?



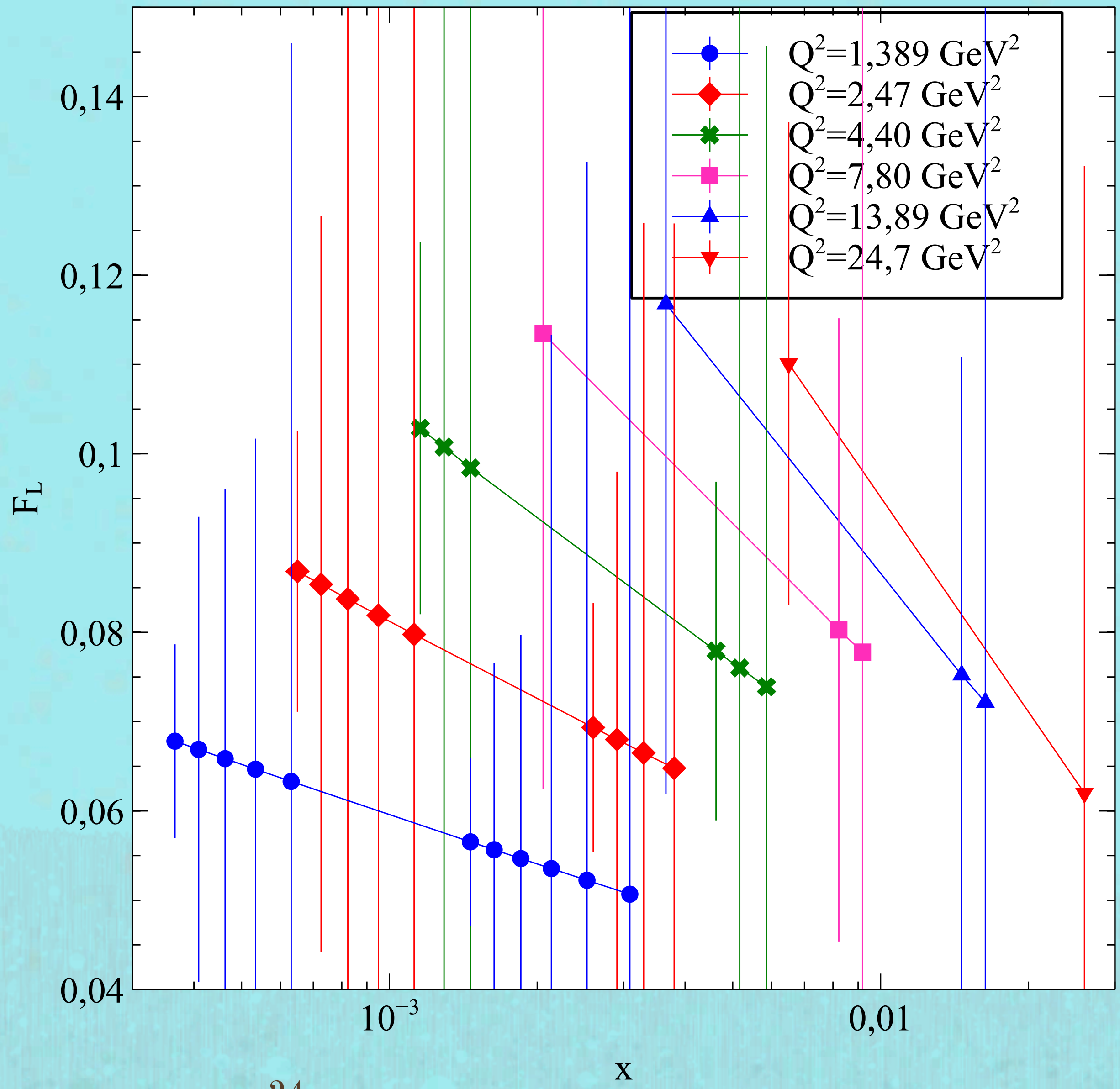
Albacete, Marquet [1401.4866v1]



Albacete, Marquet [1401.4866v1]

How do we deal with the pseudodata?

F_L pseudodata for Au-197



NaN

What do we conclude?

- e+A collisions can give us a lot of useful information on topics such as saturation.
- We have seen how to constrain nPDFs with e+A (pseudo)data.
- Reweighting methods are helpful to treat data in a fast way.
- Preliminary results show incompatibility of the pseudodata with the nPDFs.
- Collinear factorization for e+A is not correct? More realistic models are needed.