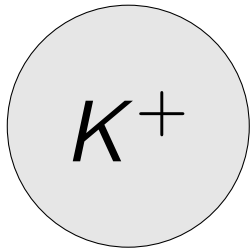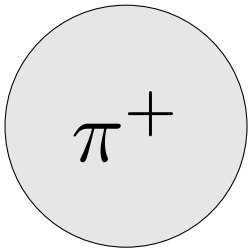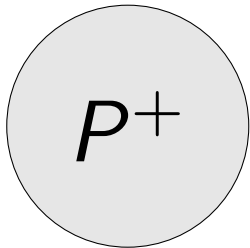# Development of module for fitting distribution functions of quarks and gluons in mesons for xFitter package
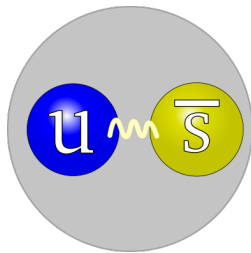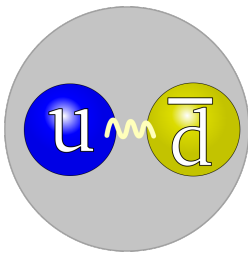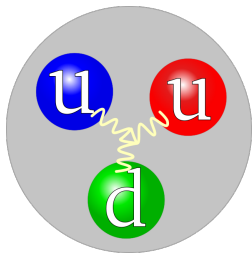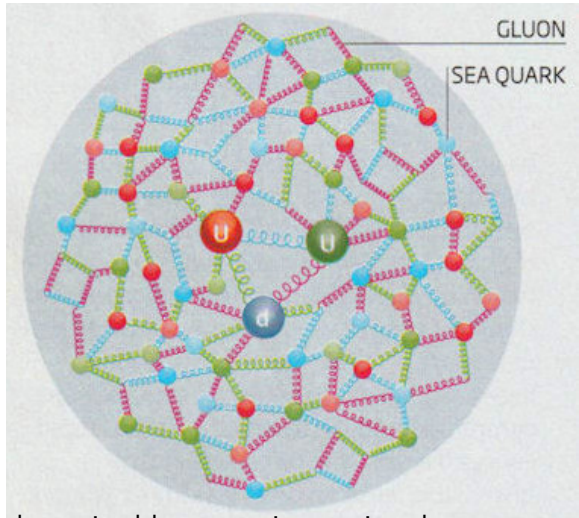
Novikov Ivan
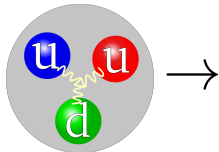
NEOVP LNP JINR

2018-06-14

Which particles constitute these hadrons?

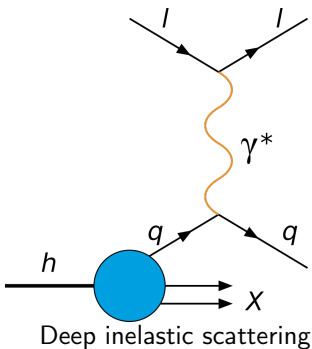# Which particles constitute these hadrons?

The real picture is not as simple

Hadron structure is determined by strong interactions between valence quarks, gluons and sea of quark-antiquark pairs

Parton Distribution Function

Deep inelastic scattering

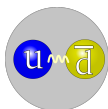$$d\sigma = \sum_{i \in \{u,d,\bar{u},...\}} \int_0^1 dx \; f_i(x, Q^2) \; d\sigma_i(p_h x, p_l, Q^2)$$

PDF

cross-section of scattering on
an individual parton of type i

- $f_i(x, Q^2) \approx$ density of partons of type i with fraction x of hadron's momentum
- Cannot be calculated in perturbative QCD $\implies$ must be extracted from experiment
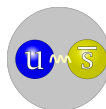- Universal for all reactions with a given hadron type
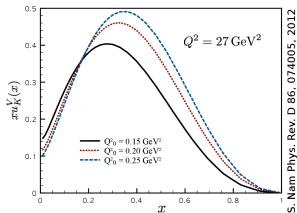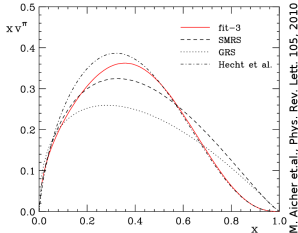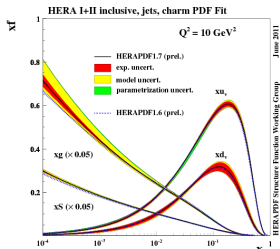
Current status of different PDFs

Proton

Pion

Kaon

- Best-studied hadron
- High precision for all flavors

- Poorly constrained
- First moments calculated on lattice

- Almost unknown
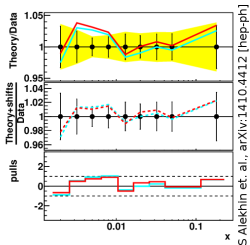- Multiple theoretical approaches (e.g. NJL model)
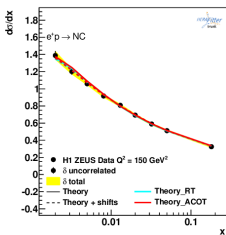
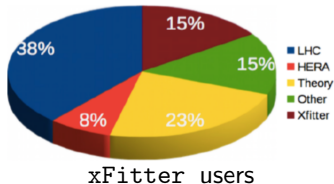Expect progress from COMPASS III (2020+) and Electron-Ion Collider (JLab/BNL) (~2022+)

xFitter project

former HERAFitter

S Alekhin et. al., arXiv:1410.4412 [hep-ph]

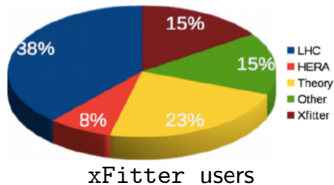Example of plots obtained with `xFitter`

xFitter users

- Mature feature-rich Open-Source QCD fit framework
- >60 published results
- Can estimate PDF sensitivity to new data
- Multiple theoretical schemes

xFitter project

former HERAFitter

Example of plots obtained with xFitter

S Alekhin et al., arXiv:1410.4412 [hep-ph]

xFitter users
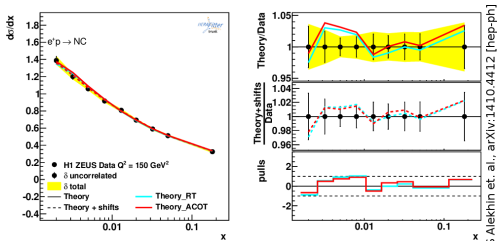
But!

No support for meson PDFs

And it is my job to fix that

Thank you for your attention!

Any questions?
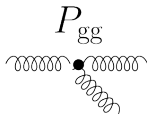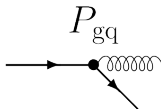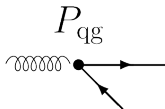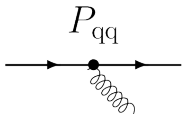
Do I have time for a few backup slides?

DGLAP PDF evolution

Dokshitzer-Gribov-Lipatov-Altarelli-Parisi Equations

$$\frac{\partial f_i(x, Q^2)}{\partial \ln(Q^2)} = \sum_{j \in \{q, \bar{q}, g\}} \int_x^1 \frac{dz}{z} P_{ij}\left(\frac{x}{z}, Q^2\right) f_j(z, Q^2)$$

- Evolve $f(x, Q_0^2) \rightarrow f(x, Q_1^2)$
- Splitting functions P_{ij} are derived in perturbative QCD

Fitting cycle

Parametrisation
$f_i(x, Q_0^2) = Ax^B(1 - x)^C(1 + Dx + Ex^2)$
+sum rules

Fitted parameters
$A_u, B_u, A_d, B_d, ...$

Evolution
Numerical solution of DGLAP equations
QCDNUM,APFEL

χ^2 minimisation
MINUIT

Cross-section calculation
fastNLO,APPLgrid

χ^2 calculation

Theory modules

Experimental data

Correlated uncertainties