Quantum Chromodynamics (QCD)

1. *Asymptotic freedom* ($\alpha_s \to 0$ at short distances)

   pQCD (perturbative technique)

2. *Factorization*

$$P_1 = f_i \quad x_1 P_1$$

$$\boxed{\hat{\sigma}_{ij}(Q^2)}$$

$$P_2 = f_j \quad x_2 P_2$$

$$\sigma = f_i \overbrace{\otimes \hat{\sigma}_{ij} \otimes}^{\text{pQCD}} f_j$$

f_l is a non perturbative part

3. QCD *evolution* (DGLAP)

- NLO $\overline{\mathrm{MS}}$:

$$\frac{1}{x} F_2(x, Q^2) = \sum_{i=1}^{n_f} e_i^2 C_i \otimes (q_i + \bar{q}_i) + C_g \otimes g$$

- evolution of parton densities:

$$g(x, Q^2)$$

$$q^S(x, Q^2) = \sum (q_i + \bar{q}_i)$$

$$q^{NS}(x, Q^2) = \sum (q_i - \bar{q}_i)$$

$$\frac{\partial}{\partial lnQ^2} \begin{pmatrix} q^S \\ g \end{pmatrix} = \frac{\alpha_s(Q^2)}{2\pi} \begin{bmatrix} P_{qq}^S P_{qg} \\ P_{gq} P_{gg} \end{bmatrix} \otimes \begin{pmatrix} q^S \\ g \end{pmatrix}$$

$$\frac{\partial}{\partial lnQ^2} q^{NS} = \frac{\alpha_s(Q^2)}{2\pi} P_{qq}^{NS} \otimes q^{NS}$$

Coefficient and Splitting Functions C_i and P_{ij} known to NLO

- Q^2 *dependence predicted by* pQCD
- x *dependence parameterised at* Q_o^2 (*from a* QCD *fit*)