Experimentelle Elementarteilchenphysik

Ulrich Husemann
Humboldt-Universität zu Berlin
Sommersemester 2009

Zahl der Farbladungen

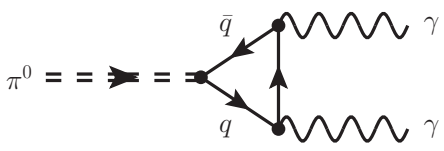
- Verhältnis R:

$$R(s) := \frac{\sigma(e^+e^- \to \text{Hadronen})(s)}{\sigma(e^+e^- \to \mu^+\mu^-)(s)}$$

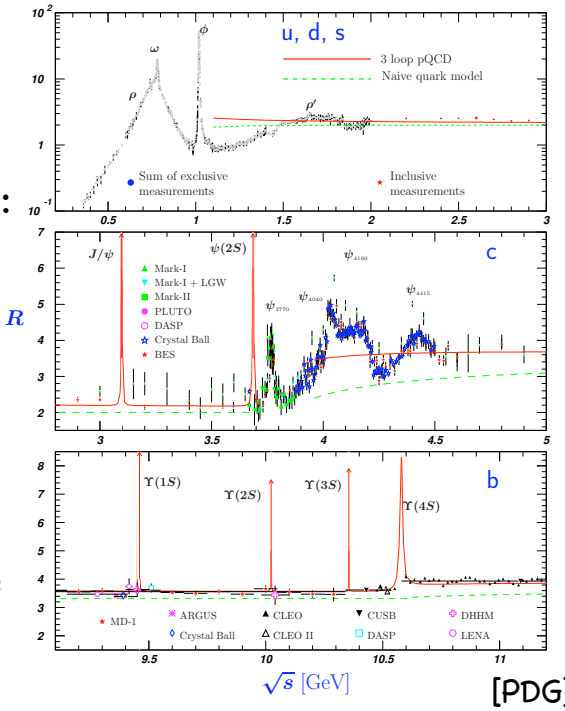
→ im naiven Partonmodell:

$$R = N_c \sum_q q_q^2$$

- Pionzerfall:



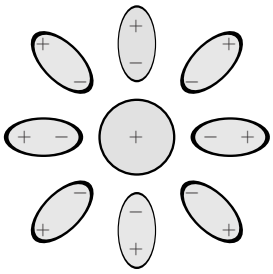
$$\Gamma(\pi^0 \to \gamma\gamma) = \frac{\alpha^2 m_{\pi^0}^3}{64\pi^3 f_\pi^2} N_c^2 \left(q_u^2 + q_d^2\right)^2$$



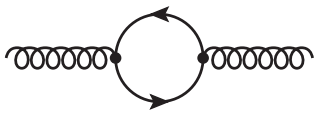
[PDG]

Laufende QCD-Kopplung

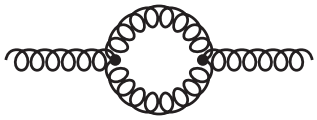
- Abschirmung einer Ladung in der QED:



- Abschirmung und Antiabschirmung in der QCD:



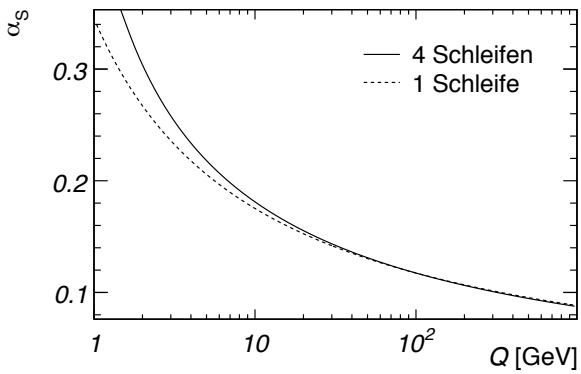
Fermionschleife: Abschirmung



Gluonschleife: Abschirmung

Laufende QCD-Kopplung

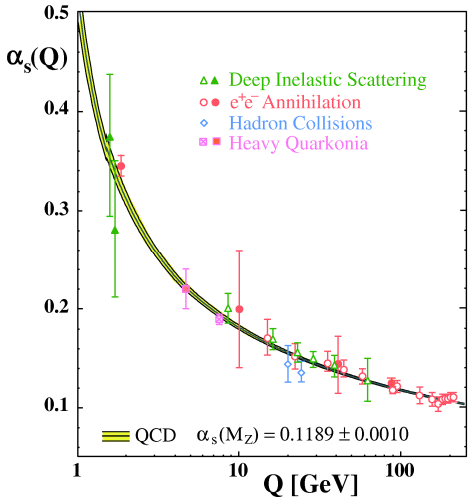
QCD-Vorhersage:



1-Schleifen-Näherung:

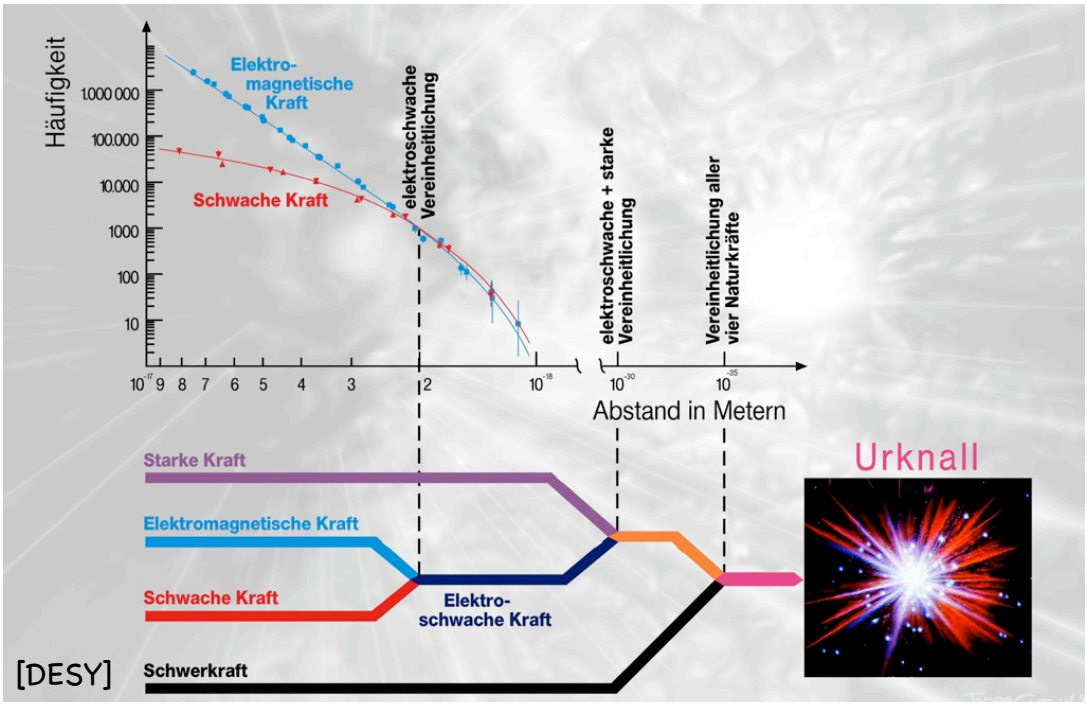
$$\alpha_S(Q^2) = \frac{1}{\beta_0 \ln \frac{Q^2}{\Lambda^2}} = \frac{12\pi}{(-2N_f + 33) \ln \frac{Q^2}{\Lambda^2}}$$

Experimentell:

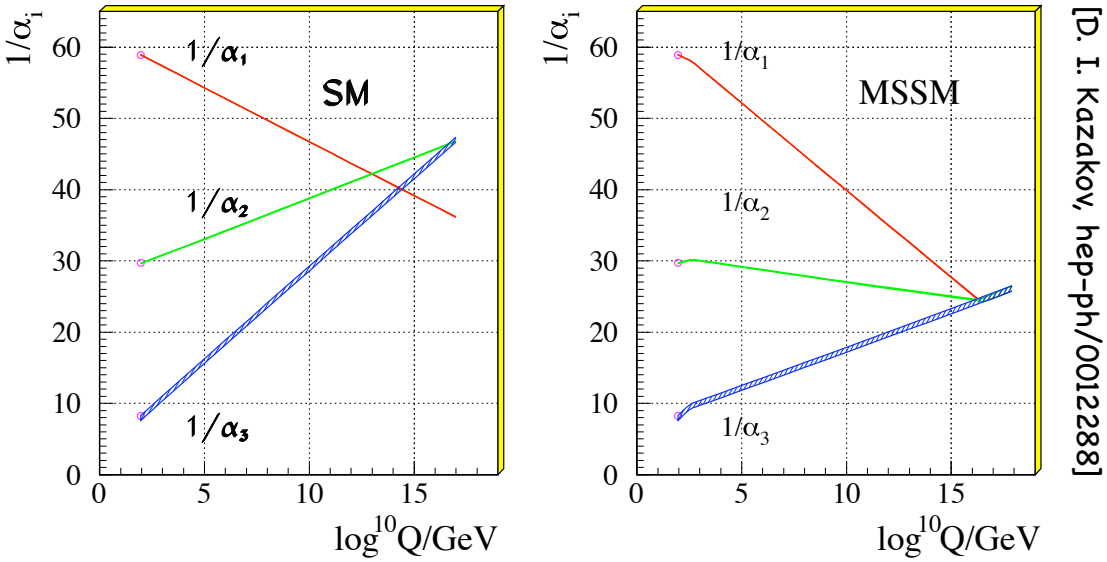


[S. Bethke, Prog. Part. Nucl. Phys. **58** (2007), 351]

NC und CC bei HERA



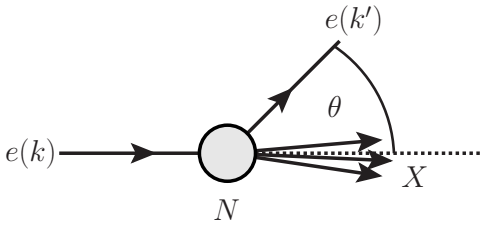
Vereinheitlichung der Kräfte

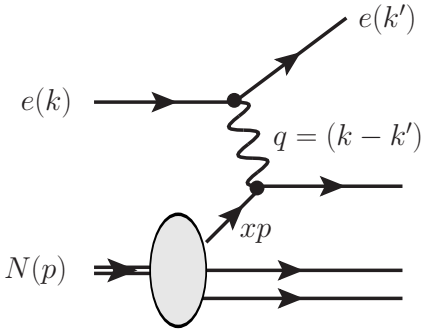


$$\alpha_1 := \frac{5}{3}\frac{g'^2}{4\pi} = \frac{5}{3}\frac{\alpha}{\cos^2\theta_W}, \quad \alpha_2 := \frac{g^2}{4\pi} = \frac{\alpha}{\sin^2\theta_W}, \quad \alpha_3 := \frac{g_S^2}{4\pi} = \alpha_S$$

Tiefinelastische Streuung

- Kinematik:

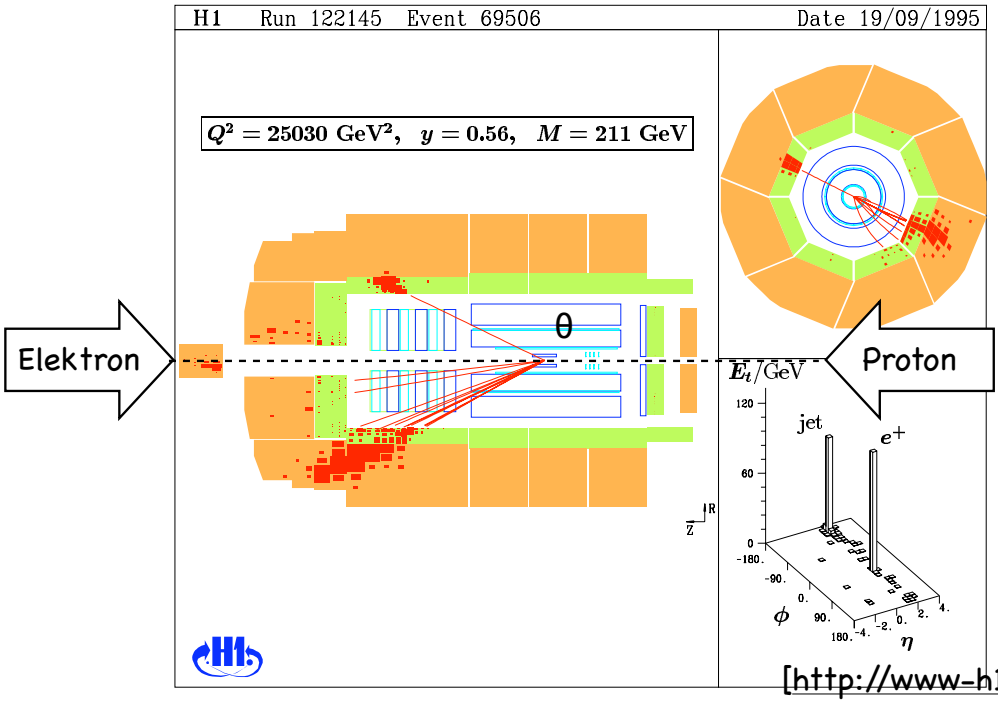




$$Q^2 := -q^2 = -(k - k')^2 \qquad y := \frac{p \cdot q}{p \cdot k}$$

$$\nu := \frac{p \cdot q}{m_N} \qquad x_{\mathrm{Bj}} := \frac{Q^2}{2m_N\nu} = \frac{Q^2}{2pq}$$

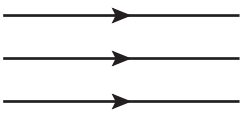
H1-Ereignis: DIS NC

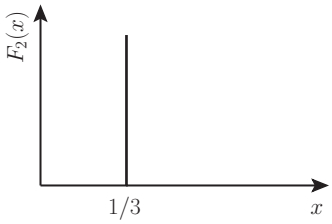


[http://www-h1.desy.de]

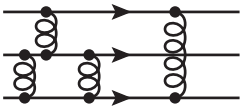
Proton-Strukturfunktion F_2

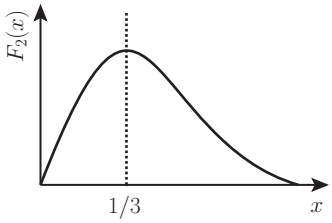
Drei Valenzquarks





Drei Valenzquarks
mit Bindung





Drei Valenzquarks
mit Bindung und
Gluonabstrahlung