Асимптотические режимы адронных процессов в КХД

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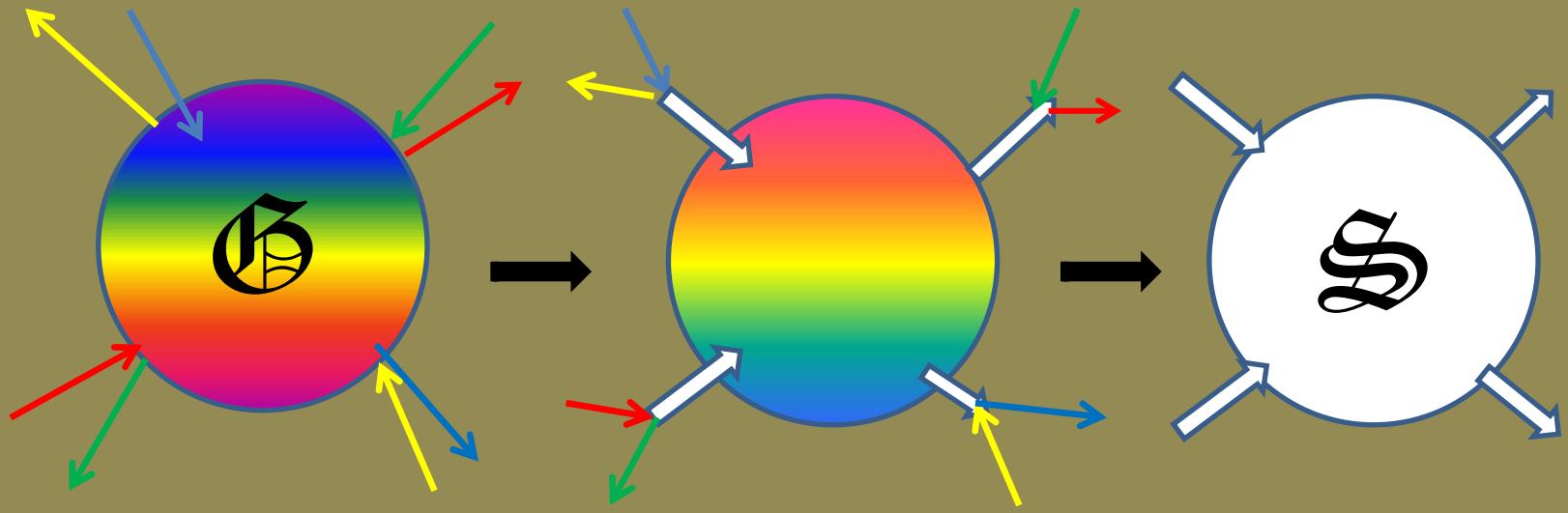
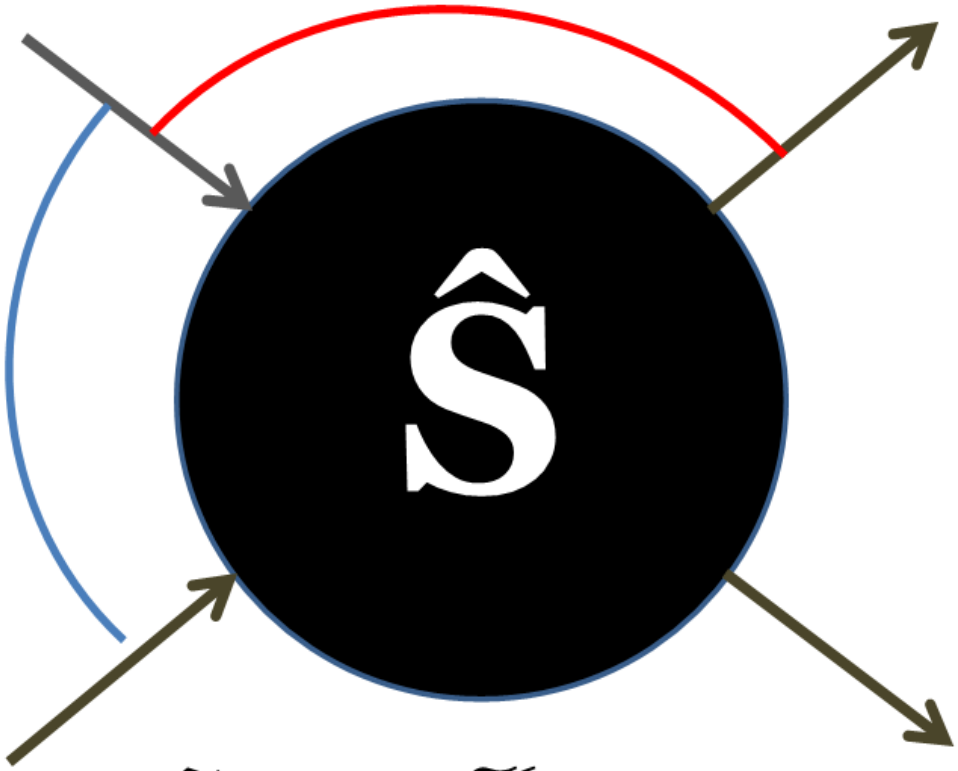
От кварк-глюонных функций Грина к адронной S-матрице



Scattering Regimes



Hard:

$s \gg m^2; \frac{s}{t} fixed$

"Short distances"

Semi-Hard

$m^2 \ll -t \ll s$

Soft:

$s \gg m^2;\ 0 \leq -t \ll s$

"Large distances"

Amplitude

Massless QCD

$$T(s+i0,t) = F(s,t;\Lambda^2,\{c_h\}) \qquad c_h = \frac{M_h^2}{\Lambda^2}$$

$$\Lambda^2 = \mu^2 \exp\left(-\int^{g^2} \frac{dx}{\beta(x)}\right)$$

$$\Lambda^2|_{g^2\to 0} \sim e^{-1/(\beta_0 g^2)}$$

Boundary Condition

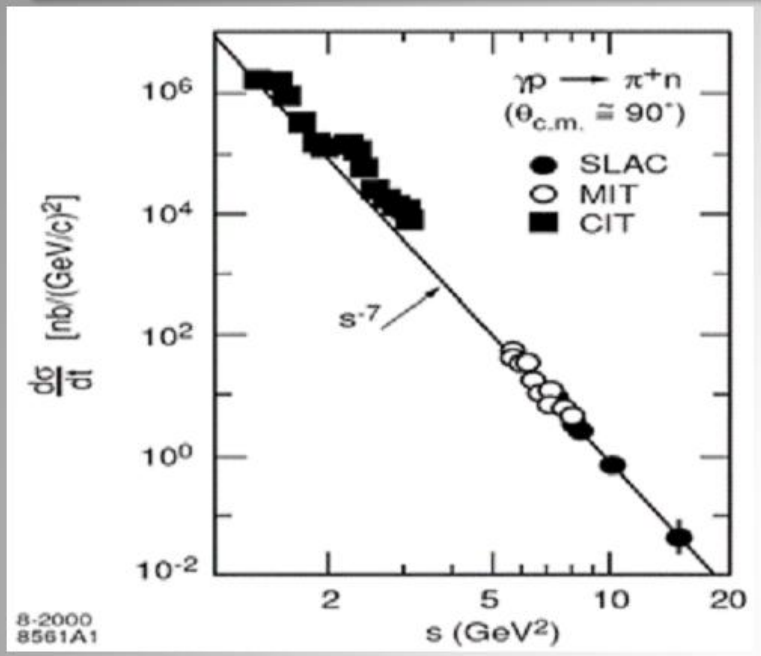
$$\hat{S}|_{g^2\to 0} \to \hat{1} \qquad T|_{g^2\to 0} \to 0$$

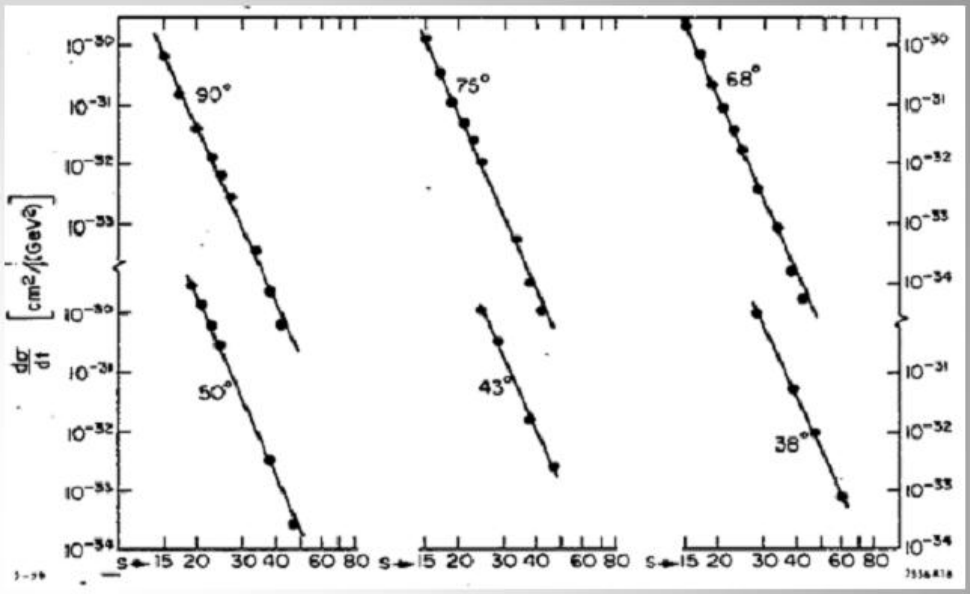
Hard Scattering

$$\lim_{(s\to\infty,\ \frac{t}{s}fix)} T(s,t) = \lim_{(s\to\infty,\ \frac{t}{s}fix)} F\left(\frac{s}{\Lambda^2}, \frac{t}{s}\right) = F\left(\infty, \frac{t}{s}\right)$$

$$\lim_{(g^2\to 0)} T(s,t) = \lim_{(\Lambda^2\to 0,\ \frac{t}{s}fix)} F\left(\frac{s}{\Lambda^2}, \frac{t}{s}\right) = F\left(\infty, \frac{t}{s}\right) = 0$$

Hard Scattering: Data





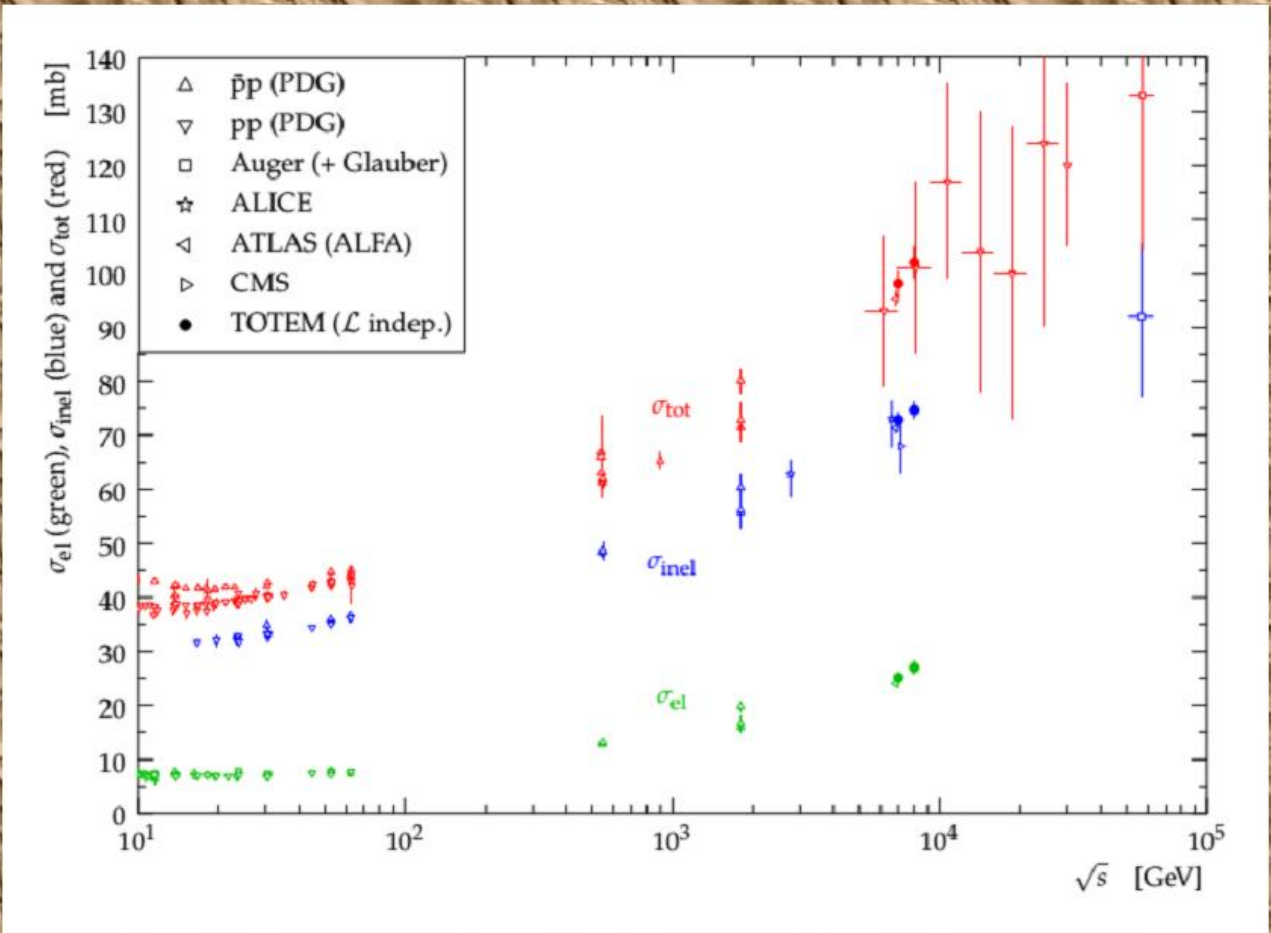
Constituent Counting Rule

Matveev V.A., Muradyan R.M., Tavkhelidze A.N. ***Lett. Nuovo Cimento 7,719 (1973);***

Brodsky S., Farrar G. ***Phys. Rev. Lett. 31,1153 (1973)***

$$T(s,t)\big|_{(s\to\infty;\,\frac{t}{s}\,fix)} \approx \left(\frac{\Lambda^2}{s}\right)^N f\left(\frac{t}{s}\right)$$

Soft Scattering: Data



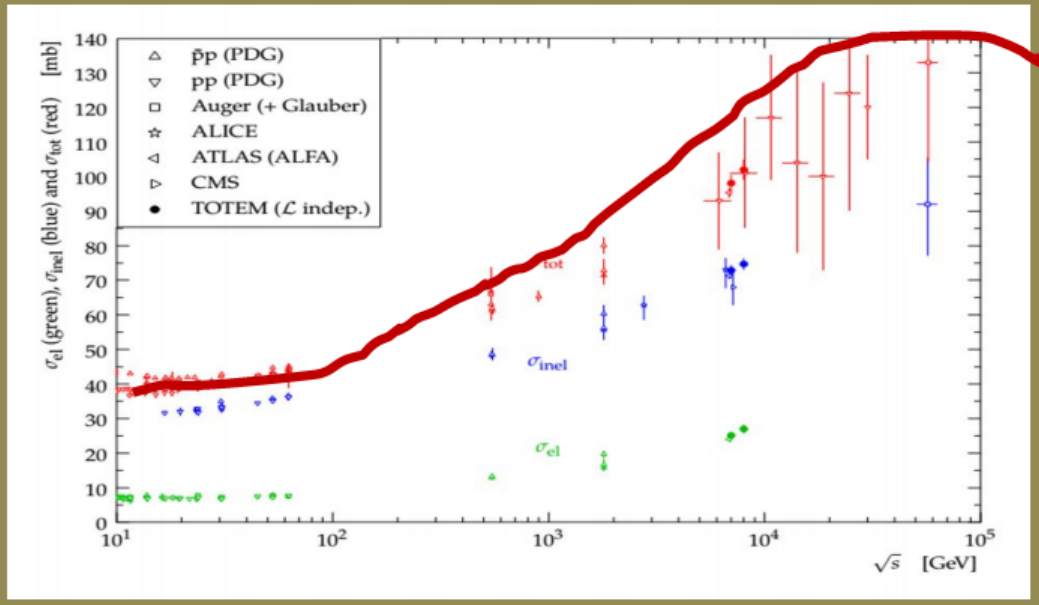
$$\sigma_{tot}(s) = \lim_{t \to 0} \frac{T(s + i0, t) - T(s - i0, t)}{2is}$$

Soft Scattering

$$T(s,0)|_{g^2 \to 0} \to 0$$

$$\lim_{g^2 \to 0} T(s,0) = \lim_{\Lambda^2 \to 0} F(s/\Lambda^2) = \lim_{s \to \infty} F(s/\Lambda^2) = 0$$

$$\lim_{s \to \infty} \sigma_{tot}(s) = 0$$



?

Adding mass

$$Let\ \exists i, i \in (1, 2, \dots, N_f): m_{qi} \neq 0$$

2nd mass scale

$$M^2 = m_i^2 exp(L(g^2))$$

$$\frac{dL}{dg^2} = -\frac{\gamma_m}{\beta} = \frac{\gamma_{m0} g^2 + \cdots}{\beta_0 g^4 + \cdots}$$

$$\gamma_m = -\frac{\mu^2}{m^2}\frac{dm^2}{d\mu^2} \qquad M^2 \sim \frac{1}{(g^2)^{\gamma_{m0}/\beta_0}}$$

Quark Mass to Open the Way to Infinity ?

$$\lim_{g^2 \to 0} T(s,0) = \lim_{\Lambda^2 \to 0} \mathrm{F}\left(\frac{s}{\Lambda^2}, \frac{M^2}{\Lambda^2}\right) = \mathrm{F}(\infty, \infty) = 0$$

$$\lim_{s \to \infty} T(s,0) = \lim_{s \to \infty} F\left(\frac{s}{\Lambda^2}, \frac{\mathrm{M}^2}{\Lambda^2}\right) = F\left(\infty, \frac{\mathrm{M}^2}{\Lambda^2}\right)$$

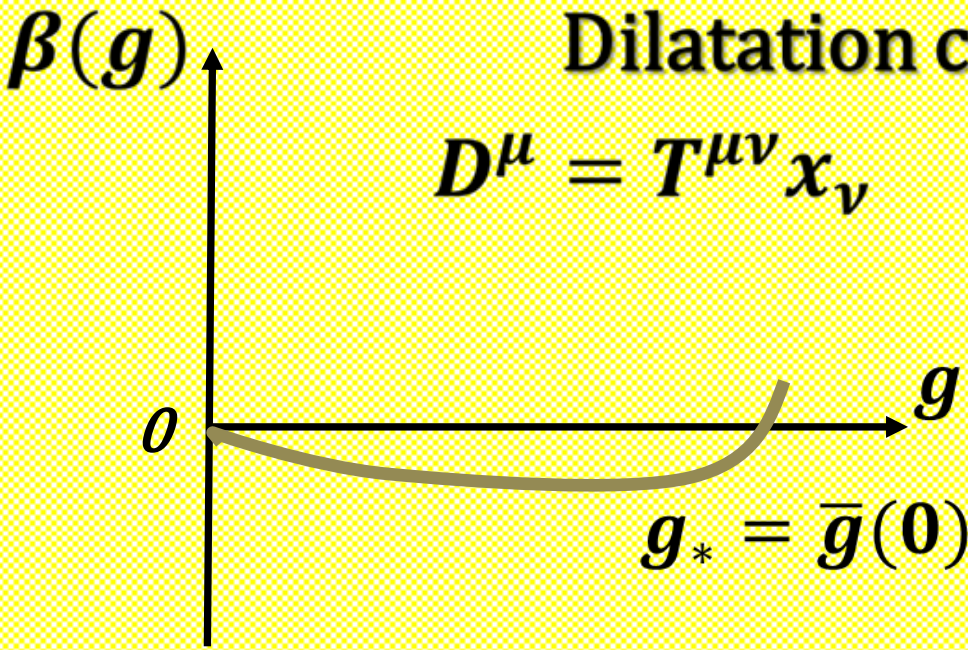
A Toy Model

$$\nu > 1$$

$$Im\, T(s,0) = \left(\frac{\Lambda^2}{M^2}\right)^{\nu} \frac{s}{\Lambda^2} ln^2\left(\frac{s}{\Lambda^2}\right)$$

$$\sigma_{tot}(s) = \frac{1}{\Lambda^2}\left(\frac{\Lambda^2}{M^2}\right)^{\nu} ln^2\left(\frac{s}{\Lambda^2}\right)$$

Infrared fixed point



Dilatation current :

$$D^{\mu} = T^{\mu\nu} x_{\nu} \qquad \partial_{\mu} D^{\mu} = T$$

$$T = g_{\mu\nu} T^{\mu\nu} = \frac{\beta(g)}{g} F^2$$

$$g_* = \bar{g}(0) \qquad \partial_{\mu} D^{\mu}|_{g=g_*} = 0$$

Scale invariance?

$$\Lambda^2|_{g \uparrow g_*} \approx (g_* - g)^{-1/\beta'_*} \quad \text{RG:} \quad \mathfrak{D}(q^2)|_{q^2 \to 0} \sim \frac{1}{q^2} \left(\frac{\Lambda^2}{q^2}\right)^{\gamma_A(g_*)}$$

$$F(s,t)|_{g=g_*} = F(0,0) = const$$

ЗАКЛЮЧЕНІЕ

- ВЪ ЧИСТОЙ ГЛЮОДИНАМИКѢ НЕОГРАНИЧЕННЫЙ РОСТЪ СВѢТНІЙ ГЛЮБОЛОВЪ НЕВОЗМОЖЕНЪ.

- ВЪ КХД СЪ ХОТЯ БЫ ОДНИМЪ МАССИВНЫМЪ КВАРКОМЪ, ИНДУЦИРОВАННЫМЪ ВЗАИМОДѢЙСТВІЕМЪ С ПОЛЕМЪ ХИГГСА, ТАКОЙ РОСТЪ НЕ ЗАПРЕЩЕНЪ.