STRING MECHANISM OF CONFINMENT AND HADRON STRUCTURE

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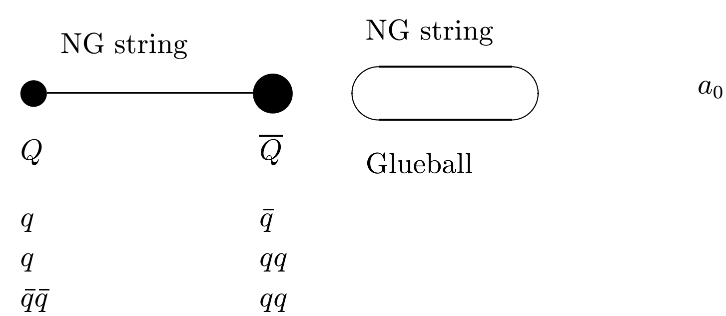
1. **The model of hadrons.**
2. **$q\bar{q}$-mesons.**
3. **Glueballs and the Pomeron trajectory.**

The Model



- Relativistic quantum model of hadrons with universal string-tension parameter and current quark masses.
- String contributes to mass and spin of hadrons (current quarks).
- Hadrons lies on Regge trajectories, which depend on universal string tension and current quark (diquark) masses. For light quarks (diquarks) the slope of trajectories is universal.
- Light quarks are relativistic: average quarks spins (in polarized hadrons) are twice as small as for nonrelativistic quarks.

$$\mathcal{L} = -a \int_0^{\pi(2\pi)} \sqrt{(\dot{x}x')^2 - \dot{x}^2 x'^2} d\sigma +$$

$$+ \sum_{i=1}^{2} \mathcal{L}_i(\dot{x}_i, \xi_i, \lambda_i, m_i) + \mathcal{L}_{ss};$$

$$x(\sigma, \tau) = r(\tau) + q(\tau) cos\sigma;$$

$$(x(\sigma, \tau) = r(\tau) + q_1(\tau) cos\sigma + q_2(\tau) sin\sigma).$$

Constraints
Independent variables ζ_i

$$\mathcal{L} = \frac{1}{2} f_{ij}\zeta_i\dot{\zeta}_j - \sum c_k\varphi_k(\zeta),$$

$\varphi_k(\zeta)$ are concidered

$$\{\zeta_i, \zeta_j\} = f_{ij}^{-1},$$
$$\varphi_k(\zeta) = 0.$$

Stability
Quantization $\zeta \to \hat{\zeta}$ $\quad \{\, ,\, \} \to -i[\, ,\,]_{\mp}$

$$\varphi_k(\hat{\zeta})\Psi = 0,$$
$$\varphi_1 = \sqrt{\vec{J}^2} - K(m^2, m_i^2, a) \to$$
$$\to \varphi_1 - a_{0n}(m_i, \vec{J}^2, P, C)P_n.$$

$q\bar{q}$-mesons

$$(\sqrt{\vec{J}^2} - K - \sum_{n=1}^{4} a_{0n}P_n)\Psi = 0,$$
$$(p_{1\mu}\gamma^\mu - m_1)\Psi = 0,$$
$$\Psi(p_{2\mu}\gamma^\mu + m_2) = 0;$$

$$\Psi \equiv \Psi_n = (\Psi_{jMlS}(\vec{n}))_{\alpha\beta},$$

$$\sqrt{j(j+1)} = K + a_{0n},$$

$$a = 0.176 \pm 0.002\; GeV^2,$$

$$m_s = 224 \pm 7\; MeV,\; m_c = 1440 \pm 10\; MeV,$$

$$m_b = 4715 \pm 20\; MeV,$$

$$m_u/m_d = 0.55, \;\; m_s/m_d = 20.1,$$

$$m_u = 6.2 \pm 0.2\; MeV,\; m_d = 11.1 \pm 0.4\; MeV,$$

$$a_{0n}.$$

Glueballs and the Pomeron trajectory

$$\vec{J} = \vec{L}_1 + \vec{L}_2,$$

$$(\sqrt{\vec{L}_1^2} + \sqrt{\vec{L}_2^2} - \frac{1}{4\pi a} m^2 - a_0)\Psi = 0,$$
$$(\sqrt{\vec{L}_1^2} - \sqrt{\vec{L}_2^2})\Psi = 0.$$

$$\Psi_{jMl}(\vec{n}_1, \vec{n}_2) = \sum C(jM, lm_1, lm_2) Y_{lm_1}(\vec{n}_1) Y_{lm_2}(\vec{n}_2),$$
$$l = 1, 2, 3, ...,$$
$$j = 0, ..., 2l,$$
$$I^G j^{PC} = 0^+ j^{++}.$$

$$f_0(1500), \quad 0^+0^{++}, \quad m = 1500 \pm 10\ MeV,$$
$$f_1(1510), \quad 0^+1^{++}, \quad m = 1518 \pm 5\ \ MeV,$$
$$f_2(1565), \quad 0^+2^{++}, \quad m = 1542 \pm 22\ MeV.$$

$$m_1 = 1500 \pm 20 MeV,$$
$$a_0 = 1.81 \pm 0.04,$$

$$0^{++}, 1^{++}, 2^{++}, 3^{++}, 4^{++}; \quad m_2 = 2610 \pm 20\ MeV.$$
$$0^{++}, 1^{++}, ..., 5^{++}, 6^{++}; \quad m_3 = 3360 \pm 25\ MeV.$$

$$j = 2l - k,$$
$$\sqrt{(j+k)(j+k+2)} = \frac{1}{4\pi a} m^2 + a_0.$$

The Pomeron trajectory $k = 0$

$$j(m^2) = \sqrt{\left(a_0 + \frac{1}{4\pi a} m^2\right)^2 + 1} - 1,$$

$$j(0) = 1.07 \pm 0.03.$$

$\Psi_k(\xi)$ are concidered

$$\xi_i, \xi_j = f_{ij}^{-1},$$
$$\varphi_k(\xi) = 0,$$

Quantization $\xi \to \hat{\xi}$
$\{ \ \} \to -i[]_{\mp}$

$$\Phi_k(\hat{\xi})\Psi = 0,$$

$$\varphi_1 = \sqrt{\vec{J}^2} - K(m^2, m_i^2, a) \to \varphi_1 - a - 0(m_i, \vec{J}^2, P, C)P_n).$$

<u>$q\bar{q}$-mesons</u>

$$(\sqrt{\vec{J}^2} - K - \sum_{n=1}^{4} a_{0n} P_n)\Psi = 0,$$

$$(p_{1\mu} - \gamma^{\mu} - m_1)\Psi = 0,$$

$$\Psi(p_{2\mu} + m_2) = 0,$$

$$\Psi \equiv \Psi_n = (\Psi_{jMls}(\vec{n}))_{\alpha\beta},$$

$$\sqrt{j(j+1)} = K + a_{0n},$$

$$a = 0.176 \pm 0.002 \ (GeV^2),$$

$$m_s = 224 \pm 7 \ MeV, \ m_c = 1440 \pm 10 \ MeV,$$

$$m_b = 4715 \pm 20 \ MeV,$$

$$m_u/m_b = 0.55, \ \ m_s/m_d = 20.1,$$

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