

Interaction amplitudes of π mesons and nucleons in composite superconformal string model.

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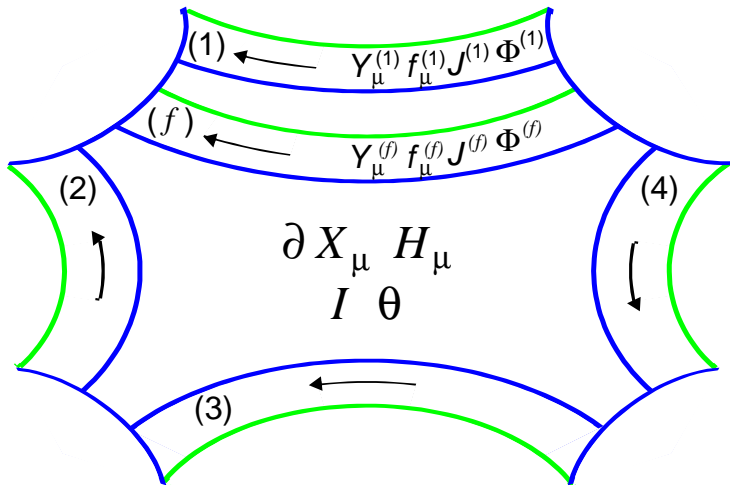
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Introduction

- ▶ Description of meson and baryon spectrum.
- ▶ Construction of interaction amplitude at low and intermediate energies (0,1 - 7 GeV).
- ▶ New type of string model.
 - ▶ Intercept α_0 of leading meson trajectory is equal to $\frac{1}{2}$.
 - ▶ Slope of Regge trajectories α' is about usual hadron scale 1GeV^{-2} .
 - ▶ New topology. Additional two-dimensional surfaces.
 - ▶ Supersymmetry occurs on two-dimensional world surface only. Target space does not have supersymmetry.
 - ▶ The model describes resonances on π, K, ρ, ϕ Regge trajectories.

Direct amplitude



Description of fermions in this model

- ▶ Set of two-dimensional fields on basic world surface: $\partial X_\mu, H_\mu, I, \theta$.
- ▶ Set of two-dimensional fields on additional world surfaces: $Y_\mu^{(i)}, f_\mu^{(i)}, J^{(i)}, \Phi^{(i)}$.
- ▶ Quark spinors λ_i are represented by eigenvectors of zeroth component of field $J^{(i)}$. $J_0^{(i)} \lambda_i = \xi_i \lambda_i$.
- ▶ Additional surface, propagating between two fermions has special property:

$$\xi_f = \xi_f^0 + \xi_f^P P + \xi_f^T T^2.$$

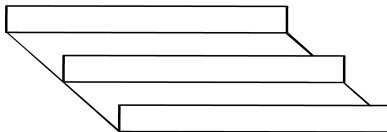
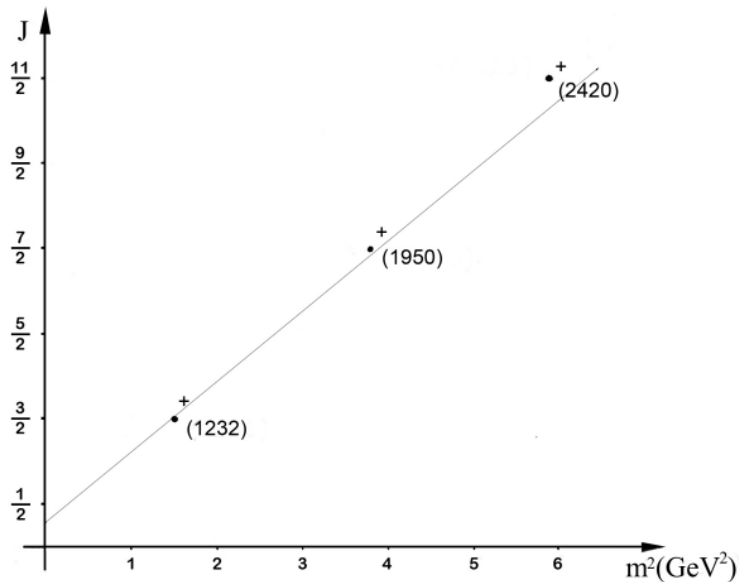


Figure: Composite string for baryons.

Δ Regge trajectory (PDG data)



Parity separation

- ▶ Projectors on parity $P = +1$ and $P = -1$:

$$(\hat{q} + \sqrt{q^2})/2\sqrt{q^2} = \Pi_+, \quad (-\hat{q} + \sqrt{q^2})/2\sqrt{q^2} = \Pi_-.$$

- ▶ To remove a singularity in the scattering amplitude for $q^2 = 0$ we require for trajectories:

$$\alpha^+(q) = \alpha^-(-q)$$

and for residues of Regge poles:

$$\Gamma^+(q) = \Gamma^-(-q).$$

- ▶ Fermion Regge trajectories:

$$\alpha = \alpha_0 + b \frac{\hat{q}}{q} + \alpha' q^2 = \alpha_0 + bP + \alpha' q^2.$$

For different parities $P = +1$ and $P = -1$ we have:

$$\alpha^+ = \alpha_0 + b + \alpha' q^2, \quad \alpha^- = \alpha_0 - b + \alpha' q^2.$$

Vertex operator

- ▶ Two-dimensional superconformal symmetry.

Quantum super Virasoro algebra:

$$[L_n, L_m] = (n - m)L_{n+m} + \delta_{n,-m}c_1 n(n^2 - 1),$$

$$\{G_r, G_s\} = 2L_{r+s} + c_2 (r^2 - 1/4) \delta_{r,-s},$$

$$[L_n, G_r] = (n/2 - r) G_{n+r}.$$

- ▶ We formulate vertex operator \hat{V} of ground state emission which satisfies superconformal symmetry:

$$\hat{V}(z_i) = z_i^{-L_0} [G_r, \hat{W}] z_i^{L_0}, \quad \hat{W} \sim: e^{-ikX} : .$$

- ▶ We use formalism of vertex operator with conformal spin $J = 1$.

$$[L_n, \hat{V}_{J=1}] = \frac{d}{d\tau} z^n \hat{V}_{J=1}, \quad z = e^{i\tau}$$

- ▶ Additional supercurrent conditions to eliminate all negative norms from physical state spectrum.

$$[k_i Y_n^{(i)}, \hat{W}_{i,i+1}] = [\hat{W}_{i,i+1}, k_{i+1} Y_n^{(i+1)}] = 0.$$

Interaction amplitude of π meson and nucleon

Interaction amplitude of πN with negativ G-parity:

$$A_{\pi N} = -g^2 \bar{u} \left(\frac{p_{1N} + m_N}{2m_N} \right) \langle 0 | \lambda_f^- \times \\ \times \left\{ \Pi_+ \frac{\Gamma(-\alpha^+) \Gamma(1 - \alpha_t^\rho)}{\Gamma(-\alpha^+ - \alpha_t^\rho)} + \Pi_- \frac{\Gamma(-\alpha^-) \Gamma(1 - \alpha_t^\rho)}{\Gamma(-\alpha^- - \alpha_t^\rho)} \right\} \times \\ \times (\vec{T}_{34} \vec{T}_{45}) \lambda_f^+ | 0 \rangle \left(\frac{p_{2N} + m_N}{2m_N} \right) v,$$

where $\alpha^\pm = \frac{1}{2} - \frac{t}{2} - \frac{m_N^2}{2} + \frac{(\xi_f^0 \pm \xi_f^\rho + \xi_f^T T^2)^2}{2}$ and $\alpha_t^\rho = \frac{1}{2} + \frac{s}{2}$.

Conclusions

- ▶ It is a new type of hadron string model.
- ▶ The leading meson trajectory has the intercept $1/2$.
- ▶ Supersymmetry conditions are satisfied on the two-dimensional sheet only.
- ▶ Physical spectrum of states is free from ghosts.
- ▶ The model gives nondegenerate in parity fermion Regge trajectories.

Thank you