String Quark Model of Mesons

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A relativistic quantum quark model of mesons is described. The mesons in the model are eigenstates of the quantized Nambu-Goto string with spinning quarks attached to the string ends.

Only those configurations of the string are considered which admit relativistic quantization. Among then, the straight-line string is the simplest one. The quantized string accounts for the main gluon contribution into a meson. The string provides quark confinement and main gluon contribution into energy, momentum and angular momentum of the meson. The short-range nonstring gluon contribution is taken into account by phenomenological constants.

Quarks in the model are current quarks. They are spin 1/2 Dirac particles with current quark masses. The model describes on an equal footing all the mesons, composed by light, strange and heavy quarks.

The parameters of the model are current quark masses, string tension and short-range constants.

The model has been considered in details for the straight-line string. This string configuration describes mesons lying on the leading Regge trajectories which depend on quark masses and P and C-parity. These trajectories are in general nonlinear; practically linear are only trajectories for light-quark mesons with non-zero lowest spins. The model describes well the mass spectrum of mesons, from pion to upsilon, that lie on the leading Regge trajectories (i.e. the lowest radial excitations, in terms of potential models). Comparison with measured meson masses allows one to determine all the model parameters. Many new meson states are predicted.

The relativistic wave functions of the composite mesons obtained in the model allow one to calculate the energy and spin structure of mesons. The meson spin structure is in general different from potential model predictions. This result may be relevant to understanding the "spin crisis" for nucleons.

In perspective, the model should be able to describe, without new parameters, the daughter states of mesons (higher radial excitations) and the electroweak properties of mesons.

Field-theoretic description of meson states ("second quantization") should allow one to introduce an interaction between them, with one independent strong decay constants for all mesons belonging to a Regge trajectory.

The phenomenological short-range constants of the model, at least some of them, may be calculable from the perturbative QCD.

References

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