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Chiral-symmetry breaking and confinement in Minkowski space

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We propose a model for the quark-antiquark interaction in the framework of the Covariant Spectator Theory (CST). Our interaction kernel in momentum space is the sum of a delta-function potential and a covariant generalization of the linear confining interaction. With a pure vector Lorentz structure for the delta-function and a mixed scalar-pseudoscalar structure for the confining part, the axial-vector Ward-Takahashi identity is preserved. The confining part decouples from the pion CST equation in the chiral limit of vanishing current quark masses, a necessary condition for chiral symmetry to hold. These properties also ensure that the Adler zero in pi-pi scattering is reproduced. Within this model, the dressed quark mass function is calculated and compared to the existing lattice QCD data at negative Minkowski-space momenta-squared. Furthermore, it is used, together with a dressed off-shell quark current that satisfies the vector Ward-Takahashi identity, in the calculation of the pion electromagnetic form factor in the relativistic impulse approximation. Our form factor results are in agreement with experimental data, they exhibit the typical monopole behaviour at high-momentum transfer squared, and they satisfy some remarkable scaling relations.

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