Pair term in the electromagnetic current for a pion-like system and light-form dynamics

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A covariant model for a pion-like spin-zero composite system of two fermions is analysed within the Light Front, to study the frame and scale dependence of the contribution to the electromagnetic form factor on the term which describes the production of pairs from the incoming photon [1]. The dynamical scale of the model is set by the masses of the constituents and by mass and size of the composite system. The electromagnetic current is taken in one-loop approximation and is conserved in our covariant model. In previous analyses, a pion $q\bar{q}$ vertex function, non symmetric in the four momentum of the quarks, was adopted [2] or a non-local photon vertex, together with a constant $q\bar{q}$ vertex, was introduced to regulate the fermion loop [3]. In the present contribution for the first time a nonconstant, symmetric ansatz for the Bethe-Salpeter amplitude is used. By adopting the constituent quark mass $m = 0.220\ GeV$, suggested from meson spectroscopy, and by choosing a regulator mass able to fit the experimental pion decay constant, $f_\pi^{exp} = 92.4$ MeV, the form factor of our covariant model reproduces the experimental charge radius of the pion and nicely agrees with the most recent data for the pion form factor. The probability of the valence component in the pion results to be $\eta = 0.77$.
The frame dependence of the pair term contribution is analyzed in different Breit frames, by allowing a nonvanishing plus component of the momentum transfer. A transverse momentum distribution, associated with the Bethe-Salpeter amplitude, is introduced, which allows to define strongly and weakly relativistic systems by a proper change of the dynamical scale of the model. In particular, for strongly relativistic systems the pair term vanishes for the Drell-Yan condition, while is dominant for momentum transfer along the light-front direction. For a weakly relativistic system, fitted to the deuteron scale, the pair term is negligible up to momentum transfers of 1 $(GeV/c)^2$. A comparison with the results obtained within the Front-Form Hamiltonian dynamics with a fixed number of constituents is also presented.

References

[1] J.P.B.C. de Melo, T. Frederico, E. Pace and G. Salme', nucl-th/0205010, to appear in Nucl. Phys. A.
[2] J.P.B.C. de Melo, H.W. Naus and T. Frederico, Phys. Rev. **C59** (1999) 2278.
[3] B.L.G. Bakker, H.-M. Choi and C.-R. Ji, Phys. Rev. **D63** (2001) 074014.