# Kaon light cone wave function from the QCD instanton vacuum

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We invetigate the meson light-cone wave function (LCWF) [1] considering the explicit $SU(3)_{\rm flavor}$ symmetry breaking with the the modified improved action (MIA) [2, 3]. The MIA is based on the chiral quark soliton model (CQSM) and contains the effects of the overlapping instatons. In the action via the MIA the current quark mass of quarks appears in the quark propagator explicitly. In order to consider the momentum-dependent non-local quark mass (dynamical quark mass), which plays the role of a natural UV regulator in the calculations, we employ the simple-pole type form factor with the power of $n = 1$ and $n = 2$ used. The cutoff ($\sim$ the inverse of average instanton size) is determined by the normalization condition of the meson LCWF with the experimental pion and kaon decay constants. We also consider the resumation of the QCD loops which presents the correction to the dynamical quark mass with the current quark mass of different flavors (Pobylitsa's correction) [4]. Since the kaon is heavier than the pion, we take into account the on-shell meson mass as $P^2 = m^2_{\pi,K}$ [5]. Our calculations are done separately for the different approaches which are DP, MIA-1 and MIA-2. Most differences are due to the consideration of the current quark mass. the pion LCWF show negligible differences for the different approaches. The shape of the pion LCWF is rather close to that of the asymptotic one as indicate in the coefficients of the Gegenbauer polynomial expansion. As for the kaon LCWF, we had quite different curves for the approaches. Interstingly, as we choose more realistic approach (DP$\rightarrow$MIA-1$\rightarrow$MIA-2), the curves become more symmetric (Fig. 1). The reason for this behavior can be understood by that the QCD loop correction reduces the dynamical quark mass $M_{0,f}$ by about 50% for the strangeness quark. Therefore, the sum of the current and dynamical quark masses ($m_s + M_s(q^2)$) in the strange quark propagator becomes similar to those of $u$ and $d$–quarks. However, we observe that the Gegenbauer coefficients shows relatively larger deviation of the kaon LCWF from the asymtotic one than those of the pion LCWF. The intgration quantity $I$ which appears in the meson form-factor gives the values of $3 \sim 3.4$ for the pion whereas $3 \sim 3.6$ for the kaon. These values are rather similar to that of the asymptotic one ($I = 3$) for the pion. However, as for the kaon, they were slightly larger than those of the pion. The transverse momentum distributions $\langle k_T^2 \rangle$ and $\langle k_T^4 \rangle$ are also studied. They are related to the quark-gluon condensate. We obtain quite sizable and unsaturated values of $\langle k_T^2 \rangle$ for the kaon. The most important consequence in the present work must be that the kaon LCWF became nearly symmetric when we apply most sophisticated MIA-2 approach though there are also obviously differences. If there is a experiment for the kaon exclusive production in the high energy scattering, the present work will be of great importance to understand the physics there and to verify the validity of the MIA approach.

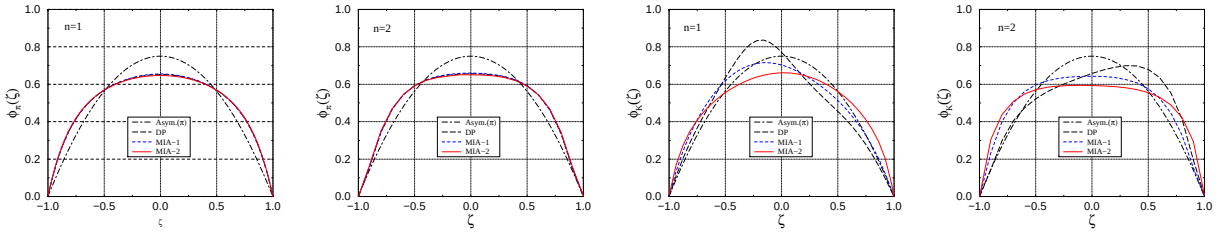


FIG. 1: The pion (left two panels) and kaon (right two panels) LCWF for $n = 1$ and 2.

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