

The κ Meson in Quenched Approximation

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If the sigma meson exists, it is natural to consider the κ meson as member of the nonet scalar states chiral $SU(3) \times SU(3)$ symmetry. Recently, the κ with $I=1/2$ is reported with mass $m_\kappa \sim 800$ MeV [1]. It is very important to investigate the κ meson by lattice QCD in order to establish the mass spectroscopy of the scalar mesons. Because lattice QCD provides a first principal approach of hadron physics and allows us to study non-perturbative aspects of quark-gluon dynamics.

We perform a quenched QCD calculation using the Wilson fermion, with the plaquette gauge action, on a relatively large lattice, i.e., $20^3 \times 24$. The values of the hopping parameter for the u/d quark are $h_{u/d} = 0.1589, 0.1583$ and 0.1574 , while $h_s = 0.1566$ and 0.1557 for the s quark. By using these hopping parameters except for $h_s = 0.1557$, CP-PACS performed quenched QCD calculation of the light meson spectrum with a larger lattice $32^3 \times 56$ [2], which we refer to for comparison. The gauge configurations are generated by the heat bath algorithm at $\beta = 5.9$. After 20000 thermalization iterations, we start to calculate the meson propagators. On every 2000 configurations, 80 configurations are used for the ensemble average. We have checked that the masses of the π , ρ , K and K^* mesons obtained in our simulation are in good agreement with those on a larger lattice, $32^3 \times 56$ [2]; our results are only within five-percent higher than the latter. The results are summarized in Table 1. Our estimated value of mass of the κ is ~ 1.7 GeV which is larger than twice of the experimental mass ~ 800 MeV. Although more statistics is preferable for reducing error bars, for a definite conclusion for the evaluation of these masses, our lattice study and the quark model analysis seem to suggest that the simple two-body constituent-quark picture of the κ is at odd with the experimentally observed κ , and if its existence with the reported low mass is experimentally established the κ may have interesting structure like $qq\bar{q}\bar{q}$ [3] or $K\pi$ molecular state[4].

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Table 1: The summary results for K , K^* and κ mesons at $h_s = 0.1566$.

$h_{u/d}$	$h_{\text{crit}}^1)$	0.1589	0.1583	0.1574
m_K	0.2829(23)	0.3138(33)	0.3368(30)	0.3677(29)
m_{K^*}	0.4649(69)	0.4821(57)	0.4941(49)	0.5117(42)
m_κ	0.89(29)	0.88(23)	0.81(12)	0.814(81)
CP-PACS [2]				
m_K	—	0.30769(28)	0.32833(26)	—
m_{K^*}	—	0.46724(84)	0.47749(74)	—

¹⁾ $h_{\text{crit}} = 0.1598(1)$.

References

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