We present our recent study of $I=1/2$ scalar meson ($\kappa$ meson) by the lattice QCD simulation.

1 Introduction

The $I=0$ scalar meson ($\sigma$) and $I=1/2$ meson ($\kappa$) are still a source of debated. The $\sigma$ meson is now listed in the table of the Particle Data Group (PDG) [1]. Recent experimental candidates for the neutral $\kappa$ are reported to have a mass about 800 MeV [2, 3]. Moreover the charged $\kappa$ is observed to be about 800 MeV by BES II collaboration [4, 5]. However, the $\kappa$ meson is not currently included in the table of the PDG summary [1]. These mesons can not be usual $q\bar{q}$ mesons as described in the non-relativistic constituent quark model since in such a quark model, $J^{PC}=0^{++}$ meson is realized in the $^3P_0$ state, which implies that the mass of the these mesons must be as high as $1.2 \sim 1.6$ GeV. Several approaches based on QCD have been performed the understanding of the structure of these mesons have not been settled yet [6–8].

There have been several attempts at lattice study of $I=1/2$ scalar meson. The first such calculation was carried out our (Scalar) collaboration [9]. All the lattice results for $I=1/2$ scalar meson with the used $\bar{s}q$ (where $q$ is $u$ and $d$) operator are consistent with mass of the $K_0^\ast$, but inconsistent the $\kappa$ meson [9, 10, 12–14]. Recently, Prelovsek et al. presented the $I=1/2$ light scalar meson using the tetra quark type interpolating operators with the dynamical simulations and quenched simulations [15]. However they omitted the disconnected contributions.

2 Method and simulation

We perform dynamical simulations on $I=1/2$ scalar meson with much higher statistics and larger lattice volume than the previous simulations. We report the current status of our new data.

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1motoo@kokushikan.ac.jp
We use gauge configurations from CP-PACS collaboration [16]. These configurations were generated with renormalization group improved gauge action and the Wilson-clover quark action. Our calculation is based upon the variational method. This method is to use several interpolating operators. The following interpolating operators were adopted the $s_i \Gamma q_j$, ($i,\ j = p, n, w$). These operators are constructed from Jacobi smeared quarks of Gaussian type sources and sinks [11]. The subscript $p$ denotes the point source. And the subscripts $n, w$ denote the type of smearing used. $\Gamma$ is gamma matrix.

We use 70 gauge configurations for our analysis of $I=1$ channel. We work on $16^3 \times 32$ lattice at $\beta=1.95$ and $C_{sw}=1.5300$ with $a=0.1555(17)$ fm. The vale of the hopping parameter for $h_{u/d}$ for $u/d$ quark is $h_{u/d}=0.1390$. Our mass ratio for $m_\pi/m_\rho = 0.741(5)$ is consistent with $m_\pi/m_\rho =0.752(1)$ by CP-PACS with hopping parameter $h=0.1390$.

![Graph](image)

**Figure 1:** Effective mass of $a_0$ ($I=1$) and $\kappa$ ($I=1/2$).

For our analysis of $I=1/2$ channel, we use 50 gauge configurations. We work on $16^3 \times 32$ lattice at $\beta=1.95$ and $C_{sw}=1.5300$ with $a=0.1555(17)$ fm. The value of the hopping parameter for $h_{u/d}$ for $u/d$ quark is $h_{u/d}=0.1390$ and the value of hopping parameter for $s$ quark is $h_s=0.1375$. The $s$ quark is valence approximation. Figure 1 shows the results for the effective mass $a_0$ ($I=1$) and $\kappa$ meson. We have presented tentative results for mass ratio $m_{a_0}/m_\rho=1.30(6)$ and $m_\kappa/m_\rho=1.29(5)$.

## 3 Summary

Our simulations are the preliminary stage. The mass for scalar meson is more noisy than for $\pi$ meson and $\rho$ meson. It is necessary to generate much more gauge configurations and improve the statistical precision of the estimation of the $\kappa$ meson.

The calculation was carried out on SX-9 at RCNP, Osaka University.
References