$I = 1/2$ scalar meson in lattice QCD

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

1 Introduction

The I=0 scalar meson (σ) and I=1/2 meson (κ) are still a source of debated. The σ meson is now listed in the table of the Particle Data Group (PDG) [1]. Recent experimental candidates for the neutral κ are reported to have a mass about 800 MeV [2,3]. Moreover the charged κ is observed to be about 800 MeV by BES II collaboration [4,5]. However, the κ 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 costituent 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 approches based on QCD have been performed the understanding of the structure of these mesons have not been setled 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^*, but inconsistent the κ 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 lager lattice volume than the previous simulations. We report the current status of our new data.

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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 $\bar{s}_i\Gamma q_j$, (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. Γ is gamma matrix.

We use 70 gauge configurations for our analysis of I=1 channel. We work on $16^3 \times 32$ lattice at β=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 form_π/m_ρ = 0.741(5) is consistent with m_π/m_ρ =0.752(1) by CP-PACS with hopping parameter h=0 .1390.

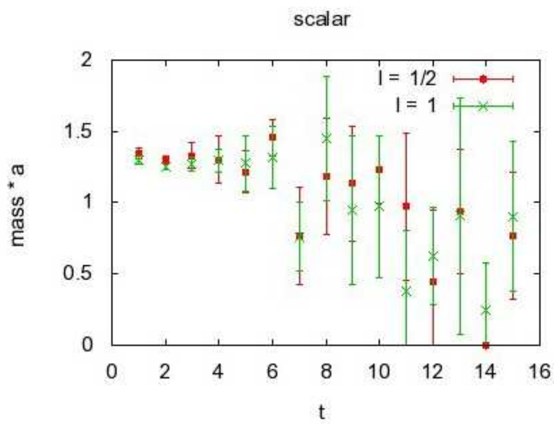

Figure 1: Effective mass of a_0 (I=1) and κ (I=1/2).

For our analysis of I=1/2 channel, we use 50 gauge configurations. We work on $16^3 \times 32$ lattice at β=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 κ meson. We have presented tentative results for mass ratio m_{a_0}/m_ρ=1.30(6) and m_κ/m_ρ=1.29(5).

3 Summary

Our simulations are the preliminary stage. The mass for scalar meson is more noisy than for π meson and ρ meson. It is necessary to generate much more gauge configurations and improve the statistical precision of the estimation of the κ meson.

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

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