I=1/2 Scalar and Axial Vector Mesons in Lattice QCD

T. Kunihiro[1], S. Muroya[2], A. Nakamura[3], C. Nonaka[4], M. Sekiguchi[5] and H. Wada[6]
(SCALAR Collaboration)
[1] *YITP Kyoto University, Kyoto 606-8502, Japan*
[2] *Tokuyama University, Tokuyama 745-8511, Japan*
[3] *RIISE, Hiroshima University, Higashi-Hiroshima ,739-8521, Japan*
[4] *School of Physics and Astronomy, University of Minnesota, Minneapolis, MN 55455, USA*
[5] *Faculty of Engineering, Kokushikan University, Tokyo 154-8515, Japan*
[6] *Faculty of Political Science and Economics, Kokushikan University, Tokyo 154-8515, Japan*

Recently, there has been interest in the structure of the scalar mesons in the hadron physics. In particular the existence of the σ meson (I=0, J^{PC}=0^{++}) was obscure for many years. The confidence level of the σ meson has been increasing. There have been accumulation of experimental evidence of the σ with a low mass 500 $\sim$ 600 MeV [1]. In the non-relativistic constituent quark model, J^{PC}=0^{++} meson is realized as $^3P_0$ state, which implies that the mass of the σ should be in 1.2 $\sim$ 1.6GeV region. Therefore some mechanism is needed to down the mass. Many suggestions are discussed in the literature [2].

We have presented a lattice calculation of the σ meson, by full lattice QCD simulation on the $8^3 \times 16$ lattice using the plaquette action and Wilson fermions. We have observed that the disconnected diagram makes the σ mass very light [6]. The connected diagram alone gives heavy mass.

If the σ meson exists, it is natural to consider the κ meson as member of the nonet scalar states chiral SU(3)XSU(3) symmetry. Recently, the κ with I=1/2 is reported with mass $m_\kappa \sim$ 800 MeV[4, 5]. 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. In the previous paper[6, 7], we have treated the s quark as a valence, while u and d quarks dynamical. And Prelosek[8] have presented a rough estimate by extrapolating the mass of κ obtained from the dynamical simulation. They assumed that the u, d and s quarks are degenerate. In our previous simulation, the cutoff was not sufficiently high to accommodate large masses $m_\kappa a > 1$, where a is the lattice spacing. Hence, we present a quench simulation at weaker couplings on a lager lattice. We have reported our preliminary results on the κ and K_1 meson propagator. We see that the κ and K_1mass are almost twice as havey as the K^* meson. Our preliminary result of κ meson does not agree with recent experimental values. It is necessary to generate much more gauge configurations and improve the statistical precision of the estimation of κ and K_1 propagators. And we also mention that our simulation suggests the existence of I=1/2 J^{PC}=1^{++} axial vector (K_1) meson.

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