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Glueball spectrum from $N_f = 2$ lattice QCD study on anisotropic lattices

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The glueball spectrum is investigated through a $N_f = 2$ lattice QCD study. The gauge configurations are generated with two degenerate flavors of quarks on anisotropic lattices. At two pion masses, say, $m_\pi = 580$ MeV and 920 MeV, we obtain the masses of the scalar, the tensor glueballs, which are in agreement with the results from the previous quenched and unquenched lattice QCD studies. For the pseudoscalar channel, we can get a state of mass roughly 2.4-2.5 GeV by the use of the gluonic lattice operators whose continuum counterparts are $\epsilon_{ijk}B_i^a(D_jB_k)^a$. This state is compatible with the pseudoscalar glueball from the previous quenched lattice QCD studies. We do not observe a clear quark mass dependence of the masses of these states. We also calculate the correlation functions of the topological charge density adopting the gradiant flow smearing scheme. We can seemingly observe a state with a mass around 1 GeV, but fail to obtain a definite result owing to our coarse and small lattices. This state might be the isoscalar $q\bar{q}$ pseudoscalar meson, the $SU(2)$ counterpart of the $SU(3)$ flavor singlet η'.

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