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The glueball spectrum with $N_f = 4$ light fermions

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We investigate the glueball spectrum for $N_f = 4$ fermions corresponding to low pion masses of $m_\pi \sim$ 260MeV. We do so by making use of configurations produced with maximally twisted fermions within the framework of the Extended Twisted Mass Collaboration (ETMC). We extract states that belong to irreducible representations of the octagonal group of rotations R in combination with the quantum numbers of charge conjugation C and parity P, i.e. R^{PC}. We implement the Generalized Eigenvalue Problem (GEVP) using a basis consisting only of gluonic operators. The purpose of this work is to investigate the effect of light dynamical quarks on the glueball spectrum and how this compares to the statistically more accurate spectrum of pure gauge theory. We employed large ensembles of the order of $\sim calO(10\mathrm{K})$ configurations each for three different lattice spacings. Our results demonstrate that in the scalar channel A_1^{++} we obtain an additional state due to inclusion of the dynamical quarks while the mass of the tensor glueball $J^{PC} = 2^{++}$ appears to be insensitive to the inclusion of sea quarks. In addition we perform an investigation of the low lying spectrum of the representation A_1^{++} for $N_f = 2 + 1 + 1$ twisted mass quarks with low masses and demonstrate that the lowest mass depends strongly on the pion mass. This suggests that the ground state of the scalar glueball has a quark content.

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