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Lattice QCD study of Z_b and Z_c

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We present two lattice studies: The $\bar{b}b\bar{q}q$ systems with various quantum numbers using static bottom quarks and $\bar{c}c\bar{q}q$ systems with $I(J^{PC}) = 1(1^{+\pm})$.
Only one set of quantum numbers that couples to Z_b and $\Upsilon\ \pi$ was explored on the lattice before; these studies found an attractive potential between B and $\bar{B}^*$ resulting in a bound state below the threshold. The first study ($\bar{b}b\bar{q}q$) considers the other three sets of quantum numbers. Eigen-energies are extracted as a function of separation between b and $\bar{b}$. The resulting eigen-energies do not show any sizable deviation from noninteracting energies of the systems $\bar{b}b + \bar{q}q$ and $\bar{b}q + \bar{q}b$, so no significant attraction or repulsion is found.
Our second study ($\bar{c}c\bar{q}q$) is the first study for four-quark states with $I(J^{PC}) = 1(1^{+\pm})$, a non-zero total momentum and two different lattice volumes. Our preliminary lattice results show that the energy shifts for eigenstates dominated by $D\bar{D}^*$ are very small in the 1^{++} channel and consistent with zero in the 1^{+-} channel. Our future plan is to determine the scattering amplitude for the coupled $J/\psi\pi - D\bar{D}^*$ scattering close to the $D\bar{D}^*$ threshold that reproduces experimental results and lattice spectra.

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