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The charmonium states $X(3872)(1^{++})$ and $Z_c(3900)(1^{+-})$ on HISQ lattices

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We present preliminary simulation results for the $I = 0$ charmonium state $X(3872)(1^{++})$ and the $I = 1$ charmonium state $Z_c(3900)(1^{+-})$. The study is performed on $(2+1+1)$ -flavor highly improved staggered quark (HISQ) lattices with clover (Fermilab interpretation) charm quarks and HISQ light quarks. Since the $X(3872)$ lies very close to the open charm $D\text{-bar-}D$ threshold, we use a combination of $c\text{-bar-}c$ and $D\text{-bar-}D$ interpolating operators. For the $Z_c(3900)$ we use a combination of $J/\psi\text{-}\pi$ and $D\text{-bar-}D^*$ channels.

This is the first such study with HISQ light valence quarks. To this end, we describe a variational method for treating staggered quarks that provides for both oscillating and non-oscillating components.

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