Phase Shift Analysis of $I=2$ Two-Pion System with Attention to Interaction Range

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For an estimation of the scattering phase shift on a lattice, the interaction range between two particles is required to be smaller than the spatial size of lattice. Therefore, the interaction range must be traced for a reliable analysis. In this work, we study the $I = 2$ two-pion wave functions with two energy eigenvalues and estimate the interaction ranges from this quantities. A simulation is performed with a plaquette gauge action for gluons and a clover-improved Wilson action for quarks at $a^{-1} = 1.63$ GeV on $32^3 \times 120$ lattice in quenched approximation. The employed parameters correspond to the quark-mass region of $m_{\pi}^2 = 0.176 - 0.345$ GeV$^2$. We conclude that in the scattering energy of $k^2 \leq 0.026$ GeV$^2$, it is not necessary to worry the rapid increase of the interaction range with increasing $k^2$. Moreover, we estimate the phase shift from the two-pion wave functions. This method provides a smaller statistical error than that from the conventional analysis with the two-pion time correlators.