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Long-distance contribution to neutrinoless double beta decays in pion sector

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Neutrinoless double beta decay, if detected, would prove that neutrinos are Majorana fermions and provide the direct evidence for lepton number violation. If such decay would exist in nature, then π−π− ⟶ ee and π− ⟶ π+ee (or equivalently π−e+ ⟶ π+e−) are the two simplest processes accessible via first-principle lattice QCD calculations. In this work, we calculate the long-distance contributions to the π − ⟶ π+ee transition amplitude using four ensembles at the physical pion mass with various volumes and lattice spacings. We adopt the infinite-volume reconstruction method to control the finite-volume effects arising from the (almost) massless neutrino. Providing the lattice QCD inputs for chiral perturbation theory, we obtain the low energy constant gππν(mρ) =−10.89(28)stat(74)sys, which is close to gππν(mρ) = −11.96(31)stat determined from the crossed channel π−π− ⟶ ee decay.

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