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Lattice calculation of K->l nu l' l' decay width

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We develop a methodology for the computation of the $K \to \ell\nu_\ell\ell'^+\ell'^-$ decay width using lattice QCD and present an exploratory study. We use a scalar function method to account for the momentum dependence of the decay amplitude. We adopt infinite volume reconstruction (IVR) method to solve temporal truncation effects and general finite-volume effects in a systematic way. To be specifically, general finite-volume effect comes from using arbitrary momentum instead of lattice discrete momentum in phase space integration. Temporal truncation effects can either come from slowly converging exponential factor associated with soft photon region of $K \to K\ell'^+\ell'^- \to \ell\nu_\ell\ell'^+\ell'^-$ contribution, or from exponentially growing term in $K \to \pi\pi\ell\nu_\ell \to \ell\nu_\ell\ell'^+\ell'^-$ contribution. We then perform a four-body phase-space integral to obtain the decay width. Using the developed methods mentioned above, we calculate the branching ratios for four channels of $K \to \ell\nu_\ell\ell'^+\ell'^-$ in ensembles at physical pion mass generated by RBC/UKQCD collaborations. The results close to the experimental measurements and ChPT predictions are obtained. Our work demonstrates the capability of lattice QCD to improve Standard Model prediction in $K \to \ell\nu_\ell\ell'^+\ell'^-$ decay width.

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