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Transverse-Momentum-Dependent Wave Functions of Pion from Lattice QCD

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We present a first lattice QCD calculation of the transverse-momentum-dependent wave functions (TMDWFs) of the pion using large-momentum effective theory. Numerical simulations are based on one ensemble with 2+1+1 flavors of highly improved staggered quarks action with lattice spacing a = 0.121 fm from the MILC Collaboration, and one with 2 +1 flavor clover fermions and tree-level Symanzik gauge action generated by the CLS Collaboration with a = 0.098 fm. As a key ingredient, the soft function is first obtained by incorporating the one-loop perturbative contributions and a proper normalization. Based on this and the equal-time quasi-TMDWFs simulated on the lattice, we extract the light-cone TMDWFs. The results are comparable between the two lattice ensembles and a comparison with phenomenological parametrization is made. Our studies provide a first attempt of ab initio calculation of TMDWFs which will eventually lead to crucial theory inputs for making predictions for exclusive processes under QCD factorization.

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