

A new approach to the flowed quark field renormalization constant Z_χ using quark bilinears

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The field renormalization constant of flowed quark fields, denoted as Z_χ , is a critical component in the non-perturbative renormalization of fermion operators within the gradient flow framework. While the conventional “ringed” scheme based on the fermion kinetic term provides a theoretically robust definition, its practical implementation on the lattice is hampered by significant statistical noise arising from disconnected contributions. In this work, we propose a novel approach to determine Z_χ using quark bilinears. To validate our approach, we use the extracted Z_χ to reconstruct the renormalized bilinear matrix elements O^R for the pseudoscalar, scalar, axial-vector, and tensor channels in the continuum limit. Our results demonstrate excellent consistency between the gradient flow and RI/MOM frameworks, confirming that the bilinear-based Z_χ provides a reliable and computationally efficient alternative for high-precision lattice QCD calculations.

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