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Comparing different definitions of the topological charge

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We perform a numerical comparison of different lattice definitions of the topological charge by investigating the correlation coefficient between different definitions as well as the topological susceptibility. We use small-volume ensembles with 2 flavours of dynamical twisted mass fermions. We investigate the following definitions of the topological charge: index of the overlap Dirac operator, spectral flow of the Hermitian Wilson-Dirac operator, spectral projectors and field theoretic extracted with the smoothing schemes of APE, stout and HYP smearing schemes as well as cooling and the recently introduced gradient flow. Furthermore, we carry out a (tree-level) perturbative comparison between the smoothing procedures of the gradient flow, cooling as well as APE and stout smearing. We demonstrate both analytically and numerically that the above smoothing schemes are equivalent if the smoothing scales (flow time, number of cooling or smearing steps) are rescaled properly. Moreover, we demonstrate that HYP smearing is numerically equivalent with all the above smoothers. We show that the generally high correlation between different definitions increases towards the continuum limit.

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