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Testing the Witten–Veneziano mechanism with the Yang–Mills gradient flow on the lattice

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We present a precise computation of the topological charge distribution in the SU(3) Yang–Mills theory. It is carried out on the lattice with high statistics Monte Carlo simulations by employing the clover discretization of the field strength tensor combined with the Yang–Mills gradient flow. The flow equations are integrated numerically by a fourth-order structure-preserving Runge–Kutta method. We have performed simulations at four lattice spacings and several lattice sizes to remove with confidence the systematic errors in the second (topological suceptibility χ) and the fourth cumulant of the distribution. In the continuum we obtain $\chi=185(5)$ MeV and the ratio between the fourth and the second cumulant $R=0.233(45)$. Our results disfavour the θ-behaviour of the vacuum energy predicted by dilute instanton models, while they are compatible with the expectation from the large-N expansion.

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