

Theta-dependence of the spectrum of SU(N) gauge theories

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Abstract: We study the θ dependence of the spectrum of four-dimensional SU(N) gauge theories, where θ is the coefficient of the topological term in the Lagrangian, for $N \geq 3$ and in the large- N limit. We compute the $O(\theta^2)$ terms of the expansions around $\theta = 0$ of the string tension and the lowest glueball mass, respectively $\sigma(\theta) = \sigma(1 + s_2\theta^2 + \dots)$ and $M(\theta) = M(1 + g_2\theta^2 + \dots)$, where σ and M are the values at $\theta = 0$. For this purpose we use numerical simulations of the Wilson lattice formulation of SU(N) gauge theories for $N = 3, 4, 6$. The $O(\theta^2)$ coefficients turn out to be very small for all $N \geq 3$. For example, $s_2 = -0.08(1)$ and $g_2 = -0.06(2)$ for $N = 3$. Their absolute values decrease with increasing N . Our results are suggestive of a scenario in which the θ dependence in the string and glueball spectrum vanishes in the large- N limit, at least for sufficiently small values of $|\theta|$. They support the general large- N scaling arguments that indicate $\bar{\theta} \equiv \theta/N$ as the relevant Lagrangian parameter in the large- N expansion.