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Supersymmetric QCD on the lattice: Fine-tuning and counterterms for the Yukawa and quartic couplings

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In this study, we determine the fine-tuning of parameters in $\mathcal{N} = 1$ Supersymmetric QCD, discretized on a Euclidean lattice. Our focus is on the renormalization of Yukawa (gluino-quark-squark interactions) and quartic (four-squark interactions) couplings. Given that SUSY is broken on the lattice, non-supersymmetric counterterms must be added to the discretized Lagrangian, with coefficients which must be appropriately fine-tuned in order to recover SUSY in the continuum limit. To deduce the renormalization factors and the coefficients of the counterterms, we compute the relevant three-point (for the Yukawa couplings) and four-point Green's functions (for the quartic couplings) perturbatively to one-loop and to the lowest order in lattice spacing. Both dimensional and lattice regularizations are used to implement the Modified Minimal Subtraction scheme. Our lattice formulation employs the Wilson discretization for gluino and quark fields, the Wilson gauge action for gluons, and naive discretization for squark fields. The sheer difficulties of this study lie in the fact that different components of squark fields mix among themselves at the quantum level. Consequently, for an appropriate fine-tuning of the aforementioned couplings, these mixings must be taken into account in the renormalization conditions. All Green's functions and renormalization factors are analytic expressions depending on the number of colors, N_c, the number of flavors, N_f, and the gauge parameter, α, which are left unspecified. This work follows previous investigations on SQCD and finalizes the one-loop fine-tuning of the SQCD action on the lattice, paving the way for numerical simulations of SQCD.

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