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Renormalization in large-N QCD is incompatible with open/closed string duality

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Solving by a string theory the 't Hooft large-N expansion of QCD is a long-standing problem that resisted all the attempts despite the advent of the celebrated gauge/gravity duality in the framework of string theory. We demonstrate that in the canonical string framework such a solution does not actually exist because an inconsistency arises between the renormalization properties of the Yang-Mills (YM) and QCD S matrix at large-N recently worked out in Phys. Rev. D 95, 054010 and the open/closed duality of the would-be canonical string solution.The ultraviolet (UV) finiteness of the large-N YM S matrix is compatible with the universally believed UV finiteness of closed-string diagrams, but open/closed duality turns out to be incompatible with the UV divergence of glueball amplitudes with the insertion of meson loops in large-N QCD. Naively, the inconsistency arises in the would-be canonical string solution because such UV-divergent open-string loop amplitudes are dual to tree closed-string diagrams which are universally believed to be both UV finite – since they are closed-string tree diagrams – and infrared finite because of the glueball mass gap. In fact, the aforementioned incompatibility follows from a low-energy theorem of the Novikov-Shifman-Vainshtein-Zakharov type derived in Phys. Rev. D 95, 054010 that controls the renormalization in QCD-like theories both perturbatively and nonperturbatively in the large-N expansion. The incompatibility extends to the large-N 't Hooft expansion of a vast class of confining asymptotically free QCD-like theories including $\mathcal{N} = 1$ SUSY QCD. We suggest a noncanonical way-out for QCD-like theories based on topological strings on noncommutative twistor space.

Experimental Collaboration

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