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## The spectrum of open confining strings in the large- $N_c$ limit

We present a comprehensive study of the spectrum of the open confining string (open flux tube) in 3+1 dimensions for several  $SU(N_c)$  gauge groups, with a focus on the large- $N_c$  limit and the possible emergence of world-sheet axion states. Specifically, we analyze the excitation spectra of flux tubes formed between static quark-antiquark pairs for  $N_c = 3, 4, 5$ , and 6. Our study includes a detailed analysis of a wide range of radial excitations and eight irreducible representations, classified by the angular momentum quantum number  $\Lambda$ , charge conjugation and parity  $\eta_{CP}$ , and the reflection symmetry  $\epsilon$  for  $\Lambda = 0$ . To extract the spectrum, we employ an anisotropic lattice action, smearing techniques, a diverse basis of operators, and solve the generalized eigenvalue problem. We compare our results to the predictions of the Nambu-Goto string model to identify potential discrepancies that may signal new physical phenomena. Notably, we observe clear evidence for a massive axion-like excitation on the world-sheet, with a mass matching that of the axion previously identified in the closed flux-tube spectrum. This strongly supports the conjecture that the axion is an intrinsic world-sheet excitation of the QCD string.

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