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Infrared renormalon in the supersymmetric $\mathbb{C}P^{N-1}$ model on $\mathbb{R} \times S^1$

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In the leading order of the large N approximation, we study the renormalon ambiguity in the gluon (or more appropriately, photon) condensate in the two-dimensional supersymmetric $\mathbb{C}P^{N-1}$ model on $\mathbb{R} \times S^1$ with the $\mathbb{Z}_N$ twisted boundary conditions. In our large N limit, the combination ΛR, where Λ is the dynamical scale and R is the S^1 radius, is kept fixed (we set $\Lambda R \ll 1$ so that the perturbative expansion with respect to the coupling constant at the mass scale $1/R$ is meaningful). We extract the perturbative part from the large N expression of the gluon condensate and obtain the corresponding Borel transform $B(u)$. For $\mathbb{R} \times S^1$, we find that the Borel singularity at $u = 2$, which exists in the system on the un-compactified $\mathbb{R}^2$ and corresponds to twice the minimal bion action, disappears. Instead, an unfamiliar renormalon singularity emerges at $u = 3/2$ for the compactified space $\mathbb{R} \times S^1$. The semi-classical interpretation of this peculiar singularity is not clear because $u = 3/2$ is not dividable by the minimal bion action. It appears that our observation for the system on $\mathbb{R} \times S^1$ prompts reconsideration on the semi-classical bion picture of the infrared renormalon.

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