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Numerical study of complex instantons in the Gross-Witten U(N) matrix model

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It is known that the 1/N expansion in the Gross-Witten U(N) matrix model is divergent and leading divergence in the weak coupling regime is governed by instanton which is associated with eigenvalue tunneling. However, it was not known what triggers divergences in the strong coupling phase where instantons disappear. To address this problem, we numerically study structure of saddle points in the Gross-Witten model with complexified degrees of freedom. These complex saddle points can be considered as complex instantons. In the strong coupling phase we identify complex instanton which governs leading divergence in the 1/N expansion. Also we find, that in the limit of large N in the strong coupling regime action of the perturbative vacuum has one flat direction. We present an evidence that in the vicinity of the transition point all complex instantons might give a significant contribution to the partition function, which might be important observation for Hybrid Monte-Carlo simulations based on integration on a Lefschetz thimbles.

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