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The effects of fermions in the complex Langevin simulation of the Lorentzian type IIB matrix model

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The type IIB matrix model was proposed as a nonperturbative formulation of superstring theory. In particular, interesting results such as the emergence of (3+1)D exponentially expanding space-time have been obtained from the Lorentzian version of the model. Recently the complex Langevin simulation of the bosonic model has been performed to avoid the previously used approximation in overcoming the sign problem. In this talk, we include the effects of fermions in this simulation to discuss their impact on the (3+1)D space-time structure.

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