

# Exact Path Integral for 3D Quantum Gravity

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Three dimensional Euclidean pure gravity with negative cosmological constant can be formulated in terms of the Chern-Simons theory, classically. This theory can be written in a supersymmetric way by introducing auxiliary gauginos and scalars. We calculate the exact partition function of this Chern-Simons theory by using the localization technique. Thus we obtain the quantum gravity partition function, assuming that it can be obtained non-perturbatively by summing over partition functions of Chern-Simons theory on topologically different manifolds. The resultant partition function is modular invariant, and in the case of central charge is expected to be 24, is the J-function, predicted by Witten.