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Nonextensive Black Hole Thermodynamics from Generalized Euclidean Path Integral and Wick's Rotation

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We extends the Euclidean path integral formalism to account for nonextensive thermodynamics. Concretely, we introduce a generalized Wick's rotation from real time t to imaginary time τ such that, $t \to -if_\alpha(\tau)$, where f_α a differentiable function and α is a parameter related to nonextensivity. The standard extensive formalism is recovered in the limit $\alpha \to 0$ and $f_0(\tau) = \tau$. Furthermore, we apply this generalized Euclidean path integral to black hole thermodynamics and derive the generalized Wick's rotations given the nonextensive statistics. The proposed formulation enables the treatment of nonextensive statistics on the same footing as extensive Boltzmann-Gibbs statistics. Moreover, we define a universal measure, η, for the nonextensivity character of statistics. Lastly, based on the present formalism, we strengthen the equivalence between the AdS-Schwarzschild black hole in Boltzmann-Gibbs statistics and the flat-Schwarzschild black hole within R\'enyi statistics and suggest a potential reformulation of the AdS_5/CFT_4 duality.

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