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Theory: Noncommutative Correction to Black Hole Entropy

Noncommutative geometry is an established potential candidate for including quantum phenomena in gravitation. We outline the formalism of Hopf algebras and its connection to the algebra of infinitesimal diffeomorphisms. Using a Drinfeld twist we deform spacetime symmetries, algebra of vector fields and differential forms leading to a formulation of noncommutative Einstein equations. We study a concrete example of charged BTZ and RN spacetime and deformations steaming from the so called angular twist. The entropy of the noncommutative black hole is obtained using the brick-wall method. We provide the method to calculate corrections to the Bekenstein-Hawking entropy in higher orders in WKB, but we present the final result in the lowest WKB order. The result is that even in the lowest order in WKB, the entropy, in general, contains higher powers in $\hbar$, and it has logarithmic corrections. In contrast, such logarithmic corrections in the commutative setup appear only after the quantum effects are included through higher order WKB corrections or through higher loop effects. Our analysis thus provides further evidence towards the hypothesis that the noncommutative framework is capable of encoding quantum effects in curved spacetime.

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