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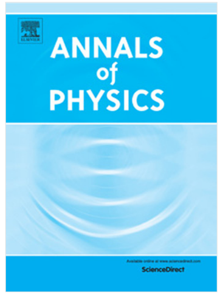

On entropic uncertainty relations in the presence of a minimal length

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On entropic uncertainty relations in the presence of a minimal length

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Abstract

Entropic uncertainty relations for the position and momentum within the generalized uncertainty principle are examined. Studies of this principle are motivated by the existence of a minimal observable length. Then the position and momentum operators satisfy the modified commutation relation, for which more than one algebraic representation is known. One of them is described by auxiliary momentum so that the momentum and coordinate wave functions are connected by the Fourier transform. However, the probability density functions of the physically true and auxiliary momenta are different. As the corresponding entropies differ, known entropic uncertainty relations are changed. Using differential Shannon entropies, we give a state-dependent formulation with correction term. State-independent uncertainty relations are obtained in terms of the Rényi entropies and the Tsallis entropies with binning. Such relations allow one to take into account a finiteness of measurement resolution.

Keywords:
generalized uncertainty principle, minimal observable length, Rényi entropy, Tsallis entropy

1. Introduction

One of fundamental problems of modern physics is to describe the gravitation at the quantum level [1]. Today, theoretical efforts are focused on unifying all fundamental interactions into a single theoretical framework. The existence of a minimal observable length has long been suggested due to such studies [2, 3]. It should lead to an effective cutoff in the ultraviolet [4]. String-theoretic arguments also maintain a minimal length effectively in the form of a minimal position uncertainty. The are proposals to investigate observable effects of the minimal length, including astronomical observations [5, 6] and experimental schemes feasible within current technology [7, 8]. The authors of [9, 10, 11] discussed measurements in which we may be able to probe effects of quantum gravity. The role of quantum decoherence in modern particle experiments is emphasized in [12].