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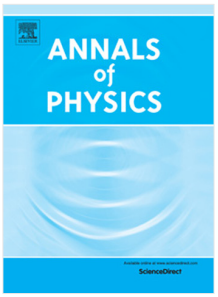


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# Effect of minimal length uncertainty on the mass-radius relation of white dwarfs

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**Abstract**

Generalized uncertainty relation that carries the imprint of quantum gravity introduces a minimal length scale into the description of space-time. It effectively changes the invariant measure of the phase space through a factor $(1+\beta\mathbf{p}^2)^{-3}$ so that the equation of state for an electron gas undergoes a significant modification from the ideal case. It has been shown in the literature (Rashidi 2016) that the ideal Chandrasekhar limit ceases to exist when the modified equation of state due to the generalized uncertainty is taken into account. To assess the situation in a more complete fashion, we analyze in detail the mass-radius relation of Newtonian white dwarfs whose hydrostatic equilibria are governed by the equation of state of the degenerate relativistic electron gas subjected to the generalized uncertainty principle. As the constraint of minimal length imposes a severe restriction on the availability of high momentum states, it is speculated that the central Fermi momentum cannot have values arbitrarily higher than $p_{\max} \sim \beta^{-1/2}$. When this restriction is imposed, it is found that the system approaches limiting mass values higher than the Chandrasekhar mass upon decreasing the parameter $\beta$ to a value given by a legitimate upper bound. Instead, when the more realistic restriction due to inverse $\beta$-decay is considered, it is found that the mass and radius approach the values 1.4518 $M_\odot$ and 601.18 km near the legitimate upper bound for the parameter $\beta$.

*Keywords:* Generalized uncertainty principle, Equation of state, White dwarfs, Chandrasekhar limit, Mass limit due to neutronization, Lane-Emden equation

## 1. Introduction

In recent years we find in the literature a contrasting perspective on the Heisenberg principle of uncertainty. Quantum theories of gravity, namely, string theory [1, 2], black hole physics [3, 4, 5], path-integral quantum gravity [6, 7,

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