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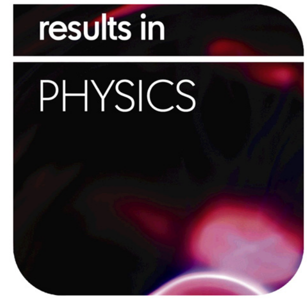

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PII: S2211-3797(18)31005-2
DOI: https://doi.org/10.1016/j.rinp.2018.06.037
Reference: RINP 1526

To appear in: *Results in Physics*

Received Date: 24 April 2018
Revised Date: 24 May 2018
Accepted Date: 14 June 2018

Please cite this article as: Onate, C.A., Okoro, J.O., Adbimpe, O., Lukman, A.F., Eigen solutions of the Schrödinger equation and the thermodynamic stability of the black hole temperature, *Results in Physics* (2018), doi: https://doi.org/10.1016/j.rinp.2018.06.037

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Eigen solutions of the Schrödinger equation and the thermodynamic stability of the black hole temperature.

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Abstract:
The approximate analytical solutions of the Schrödinger equation for Eckart potential is obtained via supersymmetry shape invariance approach. The energy equation and the corresponding wave function are obtained in a closed and compact form. The wave function was used to calculate the Rényi entropy. The results of the Rényi entropy was used to study the mass energy parameter, temperature and heat capacity of the black hole. From the results obtained, the temperature of the black hole becomes stable as the two Eckart potential parameters increases respectively.

Keywords: Eigensolutions; Wave equation; Schrödinger Equation; Rényi entropy; Black hole temperature.

1. Introduction

In the recent years, a lot of articles have focused on the analytical and approximate solutions of the non-relativistic Schrödinger equation and the relativistic Klein-Gordon and Dirac equations. The most singular reason is the fact that the solutions of these wave equations contain all the necessary information for the quantum system under consideration. The non-relativistic Schrödinger equation has been used to study the spinless particles while the relativistic Klein-Gordon equation and Dirac equation have been used to study spin 0 and spin -1/2 particles respectively. The wave equations in the presence of various potential function have been studied extensively using different techniques such as asymptotic iteration method (AIM) [1-6], exact/proper quantization rule [7-10], conventional and parametric Nikiforov-Uvarov method [11-20], supersymmetric approach [21-27], factorization method [28], ansatz approaches [29-31], Formula method [32] and others.

The investigation of the non-relativistic Schrödinger equation for a particle in a strong potential field gives the complete description of such particle in the non-relativistic quantum mechanics. However, it is clearly observed that each potential model has its own advantages and failures. For example, some potentials such as Yukawa, Hellmann, Frost-Musulin, do not admit exact solutions due to the centrifugal barrier. Thus, to obtain the solutions of any wave equation with such potential model, the use of approximation scheme is high significant. The choice of approximation scheme depends on the nature of potential under consideration. In this study, we considered Eckart potential. The Eckart potential was introduced in 1930 [33] and is widely used in physics [34] and chemical physics [35, 36]. The Eckart potential under consideration is of the form

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