Roshan Raj

Research Transcript

Upto Dec., 2023

Research Experience

[11]
Tentative Date of completion: May 2024
Date of pre-print/publication: -
Thesis Title: `Quantum and Classical Applications of Relativistic Relationship of Kinetic Energy and Momentum`
Guide: Dr Vikash K Ojha, SVNIT-Surat
Co-Guide:-
Type: Master's Dissertation (Final)
DOI:-
URL:-
Abstract Draft: To compile the Part I and Part II work on relativistic quantum mechanics. To extend the work by finding the eigenvalues of the relativistic anharmonic oscillator by algebraic methods (creation-annihilation operators). To apply the alternate kinetic energy expression (relativistic) and the Kinetic Energy and Momentum relationship in classical theory. Finally, all non-relativistic results (irrespective of classical or quantum theory) can be deduced by substituting the Lorentz factor $\gamma = 1$.

[10]
Tentative Date of completion: Last week of Feb 2024
Date of pre-print/publication: -
Title: `On the novel approach to Relativistic Quantum Mechanics-II`
Guide: Dr Vikash K Ojha, SVNIT-Surat
Co-Guide:-
Type: Master's Dissertation-Mid-Semester (Part II)
DOI:-
URL:-
Abstract: Einstein's energy-momentum relationship provides the relation between total energy and momentum for a relativistic system. However, there is no definite relation between kinetic energy and momentum for a relativistic system. The relativistic system's kinetic energy is the difference between total and rest mass energy. A better relativistic relationship can be obtained [Roshan, RQM Part-I, 2023] and used to formulate a quantum wave equation. *The formulation is solved for the harmonic oscillator.* It is noticed that the applications of the relativistic Schrodinger's equation result in predicting compression of Energy levels with increasing velocity, the increasing probability density for the with value of velocity and, in addition, the decrease in the electronic radius of the H-atom as the speed of the electron increases. *An effort is also made to obtain the Lorentz covariance form, which is empirically discussed along with the conservation of particle number.* The modification in the de-Broglie wavelength

relation and Pauli's equation is also noticed, providing an expression of the relativistic magnetic moment of the electron. Finally, one can obtain non-relativistic results by substituting Lorentz factor $\gamma = 1$ for all required cases.

[9]
Date of completion: 04 Dec 2023
Date of pre-print/publication:-
Title: `On the novel approach to Relativistic Quantum Mechanics-I`
Guide: Dr Vikash K Ojha, SVNIT-Surat
Co-Guide:-
Type: Master's Dissertation-Preliminary (part I/A)
DOI:-
URL:
Abstract: A connection between the kinetic energy and momentum for a relativistic system is derived along with an alternate expression of relativistic kinetic energy and finally used in quantum mechanical problems to demonstrate that it can formulate a consistent relativistic quantum mechanical Hamiltonian. The work seems essential as it shows a compressible interpretation of probability density. It is noticed that the applications of the *relativistic Schrodinger's equation result in predicting compression of Energy levels with increasing velocity* and increased probability density for the increasing value of velocity in ideal systems such as one-dimensional quantum mechanical problems. *The work seems vital as it resolves Klein's paradox.* Finally, one can obtain non-relativistic results by substituting the Lorentz factor $\gamma = 1$ for all required cases.

[8]
Date of completion: 05 Jul 2023
Date of pre-print/publication: 30 Oct 2023: OSF Preprints
Title: `Obtaining the Klein-Gordon wave equation without using the quantum operators`
Guide:-
Type: Article
DOI: **10.31219/osf.io/6hmyf**
Abstract: A derivation of the Klein-Gordon wave equation without substituting the corresponding quantum mechanical energy and momentum operators in Einstein's relativistic energy-momentum relationship is presented. An additional discussion is made to motivate readers to understand the distinction between the quantum wave equation and the governing law in the context of quantum mechanical formalisms. A resemblance of mathematical structure between the Maxwell wave equation and the deduced Klein-Gordan equation is shown. It is also noted that the wave velocity of the matter wave becomes equal to photon velocity for massless cases. This can be useful to explain why light equally shows matter and particle behaviour.

[7]
Date of completion: 19 Nov 2022
Date of pre-print/publication:-
Title: `New light on the concepts of Observable and indeterminacy in the quantum realm`
Guide: Dr Vikash K Ojha, SVNIT-Surat
Type: UG Project III, [Jul-Dec, 2022]
DOI:-
URL: **Click to See**

Abstract: The work deals with the two objectives of studying (a) providing insights into observable-unobservable correspondence and (b) presenting that there exists a complement form of the Born-Jordan quantum condition. Complement form can be derived if the mathematical structure of an observable is considered slightly different from Heisenberg's quantum theoretical quantities. While obtaining the complement form, it was realised that the imaginary factor (say, $i = \sqrt{-1}$) seemingly acted as an operator and appeared to transform conventionally accepted observables into non-observables and vice versa. One of the significant findings introduces a similar uncertainty principle that exists with the Heisenberg uncertainty principle.

[6]
Date of completion: 19 Nov 2022
Date of pre-print/publication: 08 Oct 2023: OSF Preprints
Title: `An open-ended story on quantization`
Guide:-
Type: Article
DOI: **10.31219/osf.io/92bvp**
Abstract: To provide a write-up, impressing on the evolutionary track of quantization of physical quantities such as Energy, momentum, and angular momentum. In addition, to question which fundamental quantity is responsible for making these derived quantities quantized.

[5]
Date of completion: 17 Sep 2022
Date of pre-print/publication: 10 Oct 2023: OSF Preprints
Title: `Reviewing Observables in Classical and Quantum Mechanics`
Guide: Dr Vikash K Ojha, SVNIT-Surat
Type: Article
DOI: **10.31219/osf.io/p2ufx**
Abstract: It presents the evolution of the quantum observables from their classical counterpart and distinctly analyses the meaning of observable in context to both the classical and the quantum realms, with an emphasis on W. Heisenberg's realization of observable and unobservable [1925]. It is stated that quantum observables are, in the first place, indeed distinctive to classical observables since each appears unobservable to the other; however, to associate physical essence as possessed by the latter, the expectation value of the former is determined. Further, the possibility of mapping quantum information to the classical ones through the action of the operator may be realized after re-interpreting analogies between the quantum commutator and Poisson brackets.

[4]
Date of completion: 17 Jul 2022
Date of pre-print/publication:-
Title: `The pictures of quantum dynamics` [*Pramatrik Gatiki ke Chitra*]
Guide: Dr Vikash K Ojha, SVNIT-Surat
Type: Internship report [May-Jul, 2022]
URL: **Request Book Chapter**
Abstract: An academic report has been created by researching and compiling three quantum dynamical methods, with the essential inclusion of formulations from classical physics, quantum mechanics, and philosophical notions. That work has been expanded and given the appearance of an academic book chapter through a creative effort. It was originally composed in Hindi so that those who are interested

in learning more about the science of quantum dynamics and the background to its development could find it useful. Public education about science is one of its other goals.

[3]
Date of completion: 09 May 2022
Date of pre-print/publication: 21 Sep 2022: arXiv Preprints
Title: `On the investigation of two non-neutral static bodies`
Guide: Dr Sharad K Yadav, SVNIT-Surat
Type: UG Project II, [Jan-May, 2022]
DOI: **10.48550/arXiv.2209.10641**
Abstract: In this work, we have considered statics of two non-neutral bodies unaffected by external force fields. We have tried to calculate the value of θ at which net field strength becomes zero however under given boundary condition, we get no solution. Thereafter, We define a function $Y(A, \theta)$, it can be found that the function Y mathematically resembles to Semi-mass empirical function $\mathrm{M}(Z, A)$ that exists in nuclear model. Further investigations on Y has shown that *the nature gives double preference to a system, which is having heavier object at center of positive charge over another negative charged body.* Meanwhile, we come across another expression which depicts about the geometry of ellipse in complex plane under certain conditions, Whose physical significance is yet to be get realized. Lastly, we have investigated a case associated with non-zero net field. As a result of it, we define a new quantity as *quintessence*, which behaves analogous to the electric potential, and it is mathematically turned out to be a generating function for Legendre polynomials, which also highlights the previous statement about nature's selective behaviour. We have tried to verify the constancy of a factor χ which runs throughout the various expressions in this study of statics, it is indeed found to be almost constant but highly sensitive to scale or order of size of the subject under study.

[2]
Date of completion: 20 Feb 2022
Date of pre-print/publication: 02 Oct 2023: OSF Preprints
Title: `The Coronal Heating Problem`
Guide:-
Type: Review Article
DOI: **10.31219/osf.io/63cag**
Abstract: An overview of the Sun's atmospheric temperature inversion and detailing the recent developments in resolving the coronal heating problem.

[1]
Date of completion: 08 Dec 2021
Date of pre-print/publication: 29 Sep 2023: OSF Preprints
Title: `Dynamics of Two Objects Considering the Minimum Total Potential Energy Principle`
Guide: Dr. Himanshu Pandey, SVNIT-Surat -
Type: UG Project I, [Jul-Dec, 2021]
DOI: **10.31219/osf.io/ukx9t**
Abstract: This work proposes an ideal process based on the minimum total potential energy principle to qualitatively explore the dynamics of two electrically neutral solid and fluid bodies in the empty space. A blend of inductive analysis and heuristic reasoning clarifies the underlying motives, such as the existence of two types of electric charges and the role of gravitation in nature, which may be realised by considering the proposed process. A mathematical formulation of the ratio of fluid's and solid's mass is also found

in terms of potential energy; under that interval, the ideal process can be executed. In its application, the ideal process also supports the law of Inertia.

Technical Projects

06/21-07/21	Internship, *The front-end development of a dummy e-commerce website* - Learning included using HTML5, CSS3 frameworks and training for web designing.
07/21-12/21	Project, *Building the student information management system using C language* -Learning included using C languages and its application in file handling