

# Schrodinger equation and its historical background research papers example

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## Abstract

This paper pertains to discussing the Schrodinger equation along with its historical background. The paper starts with an introduction to quantum mechanics and requirement of Schrodinger equation. The paper highlights the need of Schrodinger equation in light of progresses made in quantum mechanics. The paper also highlights the historical background of the development of Schrodinger equation after which the paper also briefly touches the development of the same through classical means. The paper discusses about the Schrodinger equation while presenting the same for a hydrogen atom. The paper ends with conclusion in which the importance of Schrodinger equation is highlighted.

## Introduction

It is a well-known fact among scientists that nonlinear partial differential

equations are used to describe the non-linear complex physical systems. These partial differential equations are used in different fields of science including chemistry, physics and biology etc. The analysis of further solutions for the nonlinear partial differential equations reveal better understanding of the mathematical models of the nonlinear complex physical phenomena. There are several methods established by experts of the field that are quite effective in developing relatively exact solutions of the nonlinear partial differential equations. These solutions include Lie Point Symmetries method for solving nonlinear partial differential equations .

There are several theories in the history of science which were proposed in different times by various scientists and other experts. Some of these theories were later on tested and found to be wrong or misleading so they were rejected based on the evidence through experiments or observation with better equipment. On the other hand, some theories proved to be standing true based on the experiments conducted by experts of the field and they seem to be followed in every aspect hence they were made laws. In most of the theories, there exists an equation describing that theory in order to carry out some calculation and get the results. For instance, Newton's laws of motion were initially theories with one equation for each which prove to be correct in classical physics hence were renamed to be laws of motion in physics. It is well-known in classical mechanics that the motions of objects are well described by the equations postulated by Newton in his second law of motion and similarly, other simple laws govern the physics of large objects in a standard given system. However, in the case of quantum mechanics, the equation of motion presented by Newton in his second law is not sufficient to

predict the behavior of atomic and sub-atomic particles . The Schrodinger's equation serves a similar purpose in quantum mechanics for motion of small systems that the Newton's equations for motion do for large systems in classical mechanics. The Schrodinger equation is mathematically described as a partial differential equation that is used in quantum mechanics and other fields to describe the quantum behavior and state of the changes in physical system with respect to time .

## **History of Schrodinger's Equation**

In 1687, Newton postulated its laws of motion in which the second law of motion was given with equations of applied force vectors and acceleration of the object depending on the constant of mass of the object. It was thought to hold true for every single object of the universe until the start of the era of modern physics. In modern physics, when things were seen at quantum level, the motion of things were not seen to be following Newtonian laws hence demanding need for new laws and equations to solve the quantum level systems. A large number of researchers took part in forming various theories and equations in modern physics. The very notable theory and equation were presented by Einstein who presented the theory of General Relativity and its equations. He also presented the famous equation of  $E=MC^2$  .

The research of De Broglie on the matter waves was extensively studied by Schrodinger before starting with his own research. Schrodinger concluded from the research of De Broglie that the classical mechanics is not applicable to micro-mechanical systems. In his point of view, this was similar to the

already proven fact about non-applicability of geometrical optics for the diffraction phenomena as well as interference. He also concluded that it may be possible to overcome the issue of non-applicability of classical mechanics to micro-mechanical systems through applying the same laws that governed non-applicability of geometrical optics on diffraction and interference . In this manner, he further pursued his research through first taking the classical wave equation into consideration. In order to derive his equation for quantum wave with time dependency, Schrodinger also used a principle of integral-variation. He also applied the calculus of variations in determining his equation while considering the extremum condition as the variation theorem that was well-known. Schrodinger was able to extend and better analyze the variation problem through such derivation. He also discovered, through this derivation, both time-dependent and time-independent wave equations for a conservative system that is completely arbitrary .

## **Schrodinger's Equation**

In order to define a physical system, the experts of quantum physics consider the quantum mechanics' standard interpretation of quantum state as the complete description of the physical system. The quantum state is also known by the names of state vector or wave function among the community of scientists . This quantum state is fundamentally a function of complex values derived from few countable variables. If the quantum state is normalized then it becomes possible to get Absolute Square of the analysis in order to get probability density of the physical system. The real valued function obtained in such cases can be further used to determine the higher

degree of probability for finding any particle at some specific place at some specific time .

The modern physics has moved way ahead of the classical physics through describing the behavior of macro as well as micro systems with the help of quantum mechanics. The motion related dynamics of micro as well as macro objects can be defined with great accuracies through resolving the system with the help of the equations of quantum physics. However, in order to keep the macro level systems much simpler, the scientists still use laws and equations of classical physics. The micro level systems are the only possible systems for use of the laws and equations of quantum mechanics including the Schrodinger's equation . Schrodinger equation is considered as the fundamental equation to define non-relativistic quantum mechanics. A simple form of Schrodinger equation could be written as following for a single Hydrogen atom: -

### **Derivation through classical arguments**

The Schrodinger equation can be driven easily with the arguments as well as equations of classical physics. This derivation is not quite simple as it may sound from the classical point of view of physics; however, such a procedure brings up the importance of Schrodinger equation in both quantum and classical mechanics. The principle of least action is required to be taken into consideration in order to develop a correspondence in between the geometrical optics and the classical mechanics. The principle of least action is a basic principle in the classical mechanics which states that a particle can be expected to move along a path that required minimum action from the

particle. Another important principle of classical mechanics that is required for the purpose of developing correspondence between the geometrical optics and the classical mechanics is the principle of least time. This principle is quite similar to principle of least action and in this it states that light travels along the shortest possible path.

In developing the correspondence,  $\lambda = h/p$  is set, where  $h$  is the proportionality constant that is undetermined. This relationship or equation does not represent frequency but it represents wavelength. The latter is related to energy. The energy in this relationship is corresponding to each frequency separately. The direct relationship between frequency and energy is not possibility derived hence it can be arbitrarily written that  $E = h' \nu$  where  $h'$  is also an undetermined constant. Here it is required that the free particle velocity ( $v_p = dE/dp$ ) should coincide with the overall group velocity ( $v$ ) of the similar wave packet hence leading to the equality of  $h' = h$ .

These two equations i. e.  $E = h\nu$  and  $\lambda = h/p$  can be used to derive differential equations of general nature that  $\Psi(r, t)$  &  $\psi(r)$  should satisfy, that are the two (02) Schrödinger equations. These are different from the main equation through the only fact that the  $h$  has taken place of the Planck's constant. A mathematical form for the classical mechanics is also derived in this manner through using the equations and principles of classical mechanics only. Wave equations of corresponding nature to the Newtonian equations for motion are taken for this purpose which results in obtaining a wave packet which is considered to be moving in the space in exact manner as the classical physics postulates. The only distinguishing property in this case is that the wave packet in such calculations is considered to have a

finite size whereas in the case of classical objects the objects are considered to be dimensionless entities. In these calculations, the proportionality constant is considered to be having the prime importance. The proportionality constant in these cases is  $h$ . The major deterministic factor that is size of the object directly depends on the proportionality constant  $h$ . Since  $p = h/\lambda$  hence the smaller the proportionality constant  $h$  is taken, the smaller would be the  $\lambda$  of the system. However,  $\lambda$  is used to determine the dimensional size of the object under study so when  $\lambda$  would be approaching zero, the dimensional size of the under study wave packet would also be approaching zero hence resulting in the consideration of a wave packet as a single point. The Quantum mechanics can be obtained through setting the value of  $h = h = 6.6256 \times 10^{-34}$  Js. Here, the  $h$  constant is very small from the view of the macroscopic observer as well; however, for the submicroscopic observer of the atoms, molecules, and ions, etc. this constant of  $h$  is not very much small. Therefore, the quantum mechanics would be radically different from the classical mechanics .

## Visualizing the Equation Results

As already discussed in this paper, taking absolute square of Schrodinger equation gives probability density of a system for finding any particle at a specific place and at a specific time. Software can be used to carry out all the relevant calculations and high resolution of data stream is used to represent the resultant probability density. This high resolution data stream of resultant probability density can be used to obtain any form of result and data pertaining to the same system. The most interesting thing that can be



done from a scientific point of view is that this high resolution data stream can be converted to visual form in order to understand the system in much simpler manner. The data can be visualized in a 3-D form. The results can be mapped through assigning different colors to the input data and acquiring corresponding colors in the results. The images obtained from such experiment would provide a good basis of understanding the effects of Schrodinger equation in defining the quantum systems. Through experimenting different visual techniques, varying and interesting results can be obtained. For instance, the system can be better understood through zooming, rotating, stretching, and translating to other forms. Such changes bring quite interesting results in the visual representation of quantum mechanics and its laws including Schrodinger equation. Another interesting way to look at such a plotted system is to insert the result of an already stretched or rotated system into another one as the feedback and then view the results .

## Conclusion

In classical physics the motion of objects is governed by Newton's law of motion whereas in modern physics, when things were seen at quantum level, the motion of things were not seen to be following Newtonian laws hence demanding need for new laws and equations to solve the quantum level systems. Schrodinger equation is as important in modern physics as the Newton's second law of motion's equations are important in classical physics. The Schrodinger equation tells about the behavior of an object at atomic and subatomic level in terms of conservation of energy, motion,

displacement, and time. The Schrodinger's equation serves a similar purpose in quantum mechanics for motion of small systems that the Newton's equations for motion do for large systems in classical mechanics. The Schrodinger equation is mathematically described as a partial differential equation that is used in quantum mechanics and other fields to describe the quantum behavior and state of the changes in physical system with respect to time.

The motion related dynamics of micro as well as macro objects can be defined with great accuracies through resolving the system with the help of the equations of quantum physics. However, in order to keep the macro level systems much simpler, the scientists still use laws and equations of classical physics. The micro level systems are the only possible systems for use of the laws and equations of quantum mechanics including the Schrodinger's equation. Schrodinger equation is considered as the fundamental equation to define non-relativistic quantum mechanics. Software can be used to carry out all the relevant calculations and high resolution of data stream is used to represent the resultant probability density. This high resolution data stream of resultant probability density can be used to obtain any form of result and data pertaining to the same system. The most interesting thing that can be done from a scientific point of view is that this high resolution data stream can be converted to visual form in order to understand the system in much simpler manner.

## Works Cited

Dzjaparidze M. From equation to creation: using the Schrödinger equation in an artistic context [Journal] // Centrum Wiskunde & Informatica. - 2009. - p. 3.

El-Ganaini Shoukry Ibrahim Atia The First Integral Method to the Nonlinear Schrodinger Equations in Higher Dimensions [Journal] // Abstract and Applied Analysis. - 2013. - p. 10.

Georgios TOWARDS A MEANINGFUL INTRODUCTION TO THE SCHRODINGER EQUATION THROUGH HISTORICAL AND HEURISTIC APPROACHES [Journal] // CHEMISTRY EDUCATION: RESEARCH AND PRACTICE IN EUROPE. - 2001. - pp. 203-213.

How one Equation Changed the World [Online] // [https://str.llnl.gov/str/September05/pdfs/09\\_05.2.pdf](https://str.llnl.gov/str/September05/pdfs/09_05.2.pdf). - September 2005. - December 08, 2014.

IQBAL AZHAR SOME ASPECTS ON THE SCHRÖDINGER EQUATION [Online] // <http://publications.lib.chalmers.se/records/fulltext/156456.pdf>. - February 2012. - December 08, 2014.

Magnitskii Nikolai A. ETHER EQUATIONS - A CLASSICAL ALTERNATIVE TO THE SCHRÖDINGER EQUATION [Journal] // International Journal of Latest Research in Science and Technology . - 2012. - pp. 229-233.

The Schrodinger Equation [Online] // <http://www.math.ucla.edu/~tao/preprints/schrodinger.pdf>. - December 07, 2014.

The Schrodinger Wave Equation [Online] // <http://physics.mq.edu.au/~jcresser/Phys201/LectureNotes/SchrodingerEqn.pdf>. - December 08, 2014.

<https://assignbuster.com/schrodinger-equation-and-its-historical-background-research-papers-example/>

Thomson William Wave mechanics and the Schrodinger equation [Online] // [http://www.tcm.phy.cam.ac.uk/~bds10/aqp/handout\\_foundations.pdf](http://www.tcm.phy.cam.ac.uk/~bds10/aqp/handout_foundations.pdf). - December 08, 2014.

Zhao Yang, Cheng De-Fu and Yang Xiao-Jun Approximation Solutions for Local Fractional Schrödinger Equation in the One-Dimensional Cantorian System [Journal] // Advances in Mathematical Physics. - 2013. - p. 5.