

## Significance of Wave Function in Physics

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**Abstract:** The probabilistic nature of quantum phenomena is also represented by a wave function, which given the state of a particle describes the amplitude of its position, momentum or other physical property. It evolves to conform to the Schrodinger equation and it holds all the measurable knowledge concerning one quantum system. The square of the size of the wave function determines the probability density that guides expectations on the result of the experiment. The complexity of quantum behavior allows the two key features of quantum behavior, namely superposition and interference. The wave function forms a central element of modern physics and a powerful asset in the theoretical and applied quantum mechanics; this is because one must understand the atomic, molecular and subatomic physical processes.

**Keywords:** Sub-atomic, Wavelength, Quantum, Component, Equation

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### I. Introduction

Wave function is one of the main notions of quantum physics that help to describe the behavior of minute particles such as atoms, photons, and electrons. A wave that was defined in the wave equation by Schrodinger provides a holistic mathematical representation of the quantum system state. In quantum mechanics a particle has definite positions and velocities, but instead of this quantum mechanics uses the wave function to determine the probabilities of any given particle being in any given state or position. This probabilistic view has transformed our interpretation about the physical reality by making the most accurate predictions to describe atomic and subatomic behavior as well as being the foundation of modern quantum theory.

### II. One Particle in One Direction

The principle example in quantum mechanics of a system used to understand the basic behavior of quantum mechanics is a one-dimensional system of one particle. The state of the particle is described by a wave function which varies with time in accordance to the time-dependent Schrodinger equation. In a time-independent case the equation simplifies and allows the investigation of stationary states. Typical potential models include the infinite square well, harmonic oscillator and free particle. Wave function must fulfill boundary conditions, it must be continuous and it must not be formalizable. The most likely place to find the particle is the spot where the wave function forms squares, showing the aspect that quantum mechanics is inherently probabilistic.

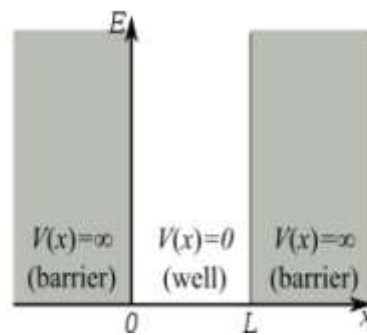
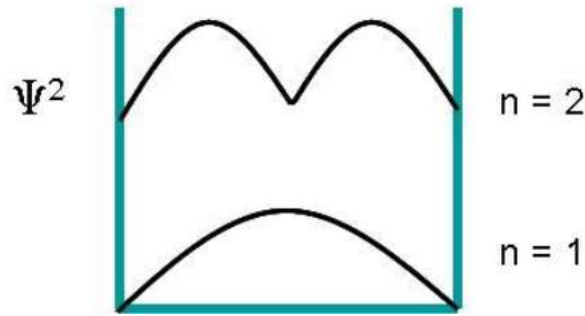
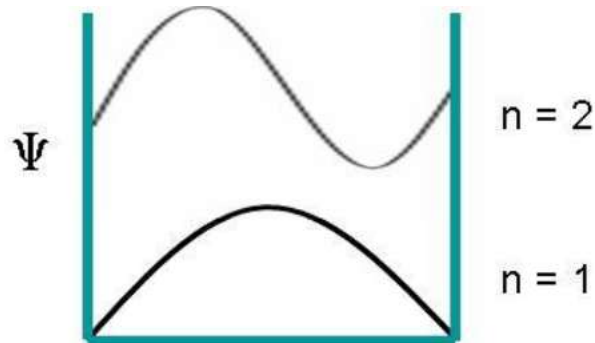
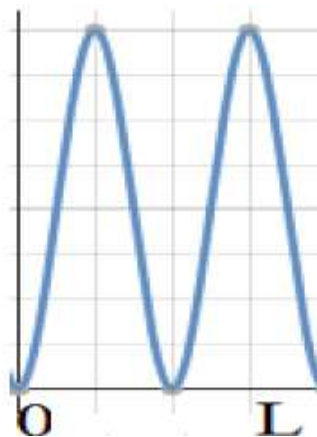


Fig 1: Zero potential of one dimensional

Fig 2: Particle in a box at the  $n=1$  and  $n=2$ 

### III. One Particle in Two Dimension

A two-dimensional single particle system, typically the quantum state, evolving under the time-dependent Schrodinger equation, extends the conditions of quantum mechanics to two space dimensions. The issue changes to a partial differential equation that includes both the geographical variables in the time independent case. The potential energy function takes the form of systems like 2D infinite square well, the harmonic oscillator or the particle in a circular box, and these determine the solutions. The general wave can often be broken into one-dimensional products in case the potential is separable. A physical solution is guaranteed through normalisation and boundary conditions. A probability density function to find it in a location of the 2D plane is the magnitude of the wave function squared. It is on this concept that knowledge regarding quantum dots, two-dimensional electron vapors, and other planar quantum systems are understood.

Fig 3: Particle in a box at the  $n=1$  and  $n=2$  energy levelsFig 4: Plot for  $n=2$

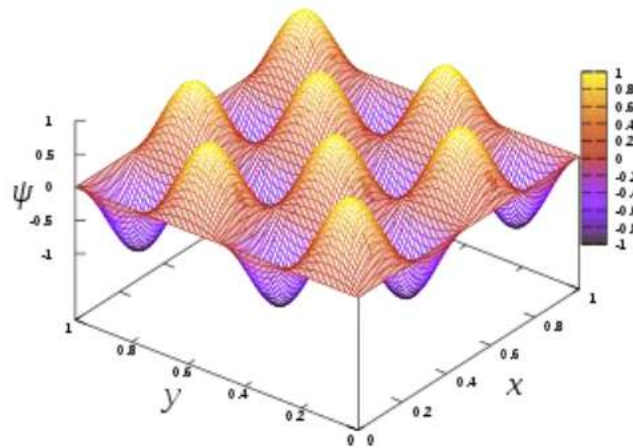


Fig 5: The wave function of a 2D

#### IV. Conclusion

In conclusion, it can be stated that a primitive part of quantum mechanics is the wave function; this characterizes all of the physical information about a quantum system. It provides a statistical model of understanding the behavior of particles by replacing classical determinism with quantum uncertainty. Superposition, interference and entanglement are some of the phenomena which can be explained and predicted making use of a wave function. To analyze an atomic, molecular and even a subatomic system it has been required to solve the Schrodinger equation through its use. Together with the increasing depth of our theoretical understanding of the nature at microscopic scales, the wave function underlies practical advances in quantum computing, quantum cryptography, and modern technologies founded on quantum logic aside.

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