# Description of Double-Slit Experiment with Modified Born Probability Interpretation

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## Abstract

This paper briefly describes the double-slit experiment through a modified probability analysis. It helps to understand quantum mechanics by making up for the lack of Copenhagen interpretation and makes it easier and more concise to explain. This paper shows that the modified probability interpretation is a sufficiently valid interpretation.

## 1. Introduction

According to the Copenhagen interpretation, the particle does not exist anywhere before the measurement, and the location of the particle is determined by the measurement. Before observation, particles exist in superimposed states, and these states can be described by a wave function. As the observation proceeds, the wave function collapses, breaking the superposition state and determining a single state. Before observation, the wave function proceeds continuously according to the Schrödinger equation, and the square of the absolute value of the wave function is considered to represent the probability density according to Born probability analysis. After observation, the wavefunction collapses to a shape with a very sharp maximum at a specific location. This Copenhagen interpretation became sufficiently valid through Bell's inequality and quantum entanglement experiments. So, here are a few questions that come to mind. Did the particle not exist before the observation? How does measurement collapse the wave function? Also, why can particles always exist in the macroscopic world? There may be various questions. However, besides these questions, there is one question that is easy to miss, and that is the question of whether the square of the absolute value of the wave function is really the same as the probability.

The paper 'Modification of Born Probability Interpretation' argues that the square of the absolute value of a wave function is not the same as the probability, and that the square of the absolute value of a wave function corresponds to the input and the probability to the output. In addition, it is argued that there is a kind of threshold in the wave function, and when this threshold is exceeded, the wave function collapses and generates an output. Let's call such an interpretation a modified probability interpretation. The modified probability analysis presents a new perspective in the interpretation of quantum mechanics. For example, the probability corresponding to the output cannot exceed 1, but the square of the absolute value of the wave function can exceed 1 and even have an infinite value. [1]

## 2. Symmetry Formation and Symmetry Breaking of the Wavefunction

There are two physical processes in the wave function, one is the process in which the wave function continuously proceeds according to the Schrödinger equation, and the other is the process in which the wave function collapses beyond a threshold. Below the threshold value, the wave function forms symmetry, and above the threshold value, the symmetry is broken, and the existing wave function collapses and a new wave function is formed. The threshold of the wave function is determined for each type of particle. Below the threshold, the wave function reaches the threshold at some point as the amplitude continues to increase due to symmetry. When the amplitude of the wavefunction reaches a threshold value, the wavefunction breaks its symmetry and amplifies the amplitude at a point. The characteristics of this wave function can be expressed in the following two propositions.

(1) The wavefunction forms symmetry below a threshold.

(2) The wavefunction breaks its symmetry above a threshold.

Below the threshold, the square of the absolute value of the wave function is proportional to the probability density, but the amplitude continues to increase within the symmetry, and when the amplitude reaches the threshold, the symmetry is broken, and the amplitude is amplified to have a maximum value at a certain point. Here, the maximum value may be an infinite value. If the length of a point is 0, the amplitude of the wave function at that point becomes infinite, which is the same as a singularity. This causes the wave function to be divided into an infinite point and a finite part, which allows the output of the wave function to be divided into 1 and 0, which will be referred to as primitive computation in this paper. If the first proposition above describes the acquisition and conservation of information in a wavefunction, the second proposition describes the computational process of a wavefunction.

The symmetry of a wave function means that the laws of physics are the same for time flow and space motion. Schrödinger's equation always has the same form even if you move position and time. Schrödinger's equation still applies even if time goes backwards. This means that the Schrödinger equation has time flow symmetry. This symmetry of time flow is broken when the wave function collapses beyond a threshold.

A wavefunction with time flow symmetry can move from a starting point toward an ending point and then return to the starting point again. Then, it can move toward another end point and return to the starting point again. By repeating this process, the wave function can store information about various states. As the wave function stores various information, the amplitude continues to increase, and at some point, the amplitude reaches a threshold value. Then, the wave function is collapsed by symmetry breaking, and the amplitude is amplified to infinity at a certain point, and then the amplitude converges to a specific value with the creation of a high-dimensional space. Accordingly, the wave function no longer returns to the starting point and has irreversibility with respect to the flow of time. And as the high-dimensional space collapses again, the wave function forms a new symmetry again and spreads through space-time. And repeat the same process.

## 3. Description of Double-Slit Experiment

If you throw a baseball through the double slit, the baseball will pass through only one hole. In a macroscopic object with a large mass, such as a baseball, the amplitude of the wave function always exceeds the threshold value, resulting in irreversibility of the time flow. Due to this, the baseball does not maintain superposition states and can pass through only one hole. On the other hand, particles in the microscopic world with low mass, such as electrons, tend to keep the amplitude of the wave function below the threshold value, forming time flow symmetry. Because of this, particles such as electrons can easily maintain superposition and pass through both holes simultaneously. The wave function of electrons passing through the two holes forms an interference fringe pattern on the screen. And when the amplitude exceeds the threshold, the superposition is broken with time irreversibility, and the electron is found at a point on the screen.

If you observe which hole the electron passes through, an endpoint is formed at the point of observation. When the wave function collapses at the observation point, a new wave function is formed and spreads out. Because of this, the wave function cannot form an interference fringe pattern on the screen, and only one stripe pattern can be formed. Therefore, when observing electrons, a two-striped pattern appears on the screen.

Observations influence the results of double-slit experiments. However, even without observation, there may be differences in experimental results. An object with a large mass, such as a baseball, shows a two-stripe pattern regardless of whether it is observed because the amplitude of the wave function is higher than the threshold value even without observation. In other words, the important factor in the experimental result is the threshold value rather than the observation.

The delayed selection experiment and the quantum eraser can also be explained through a modified probability analysis. It is the threshold rather than the observation that determines the decay of the wave function. The experimental environment influences the formation of endpoints and the wavefunction forms symmetry below a threshold value. The wave function proceeds continuously according to the laws of physics between one starting point and several ending points. Since the wave function forms time flow symmetry, the delay in observation is not a problem, and the distinction between the past and the future is meaningless. The distinction between the past and the future is meaningful only when the irreversibility of the time flow is created by the collapse of the wave function.

The threshold plays an especially significant role in the collapse of the wave function. Particles such as electrons have appropriate thresholds so that observations can affect the decay of the wave function. However, if a particle has an extremely high threshold or an infinite threshold, observation may be impossible. Particles with an infinite threshold are unobservable. Alternatively, if the threshold value is variable according to the surrounding environment, the observation behavior may increase the threshold value, making observation impossible. Even if particles with these characteristics exist, they may be impossible to observe and interact with other particles. We often refer to these particles as dark matter.

## 4. Conclusion

This paper briefly describes the double-slit experiment through a modified probability Interpretation. The modified probability interpretation complements the Copenhagen interpretation, providing a broader understanding and solving some mysteries about the observations. The collision between the macroscopic world and the microscopic world can be understood through the relationship between the amplitude of the wave function and the threshold, and it gives validity to the existence of unobservable particles. It can also be understood that the two physical progressions of the wave function are due to symmetry formation and symmetry breaking. More detailed studies and experiments will be needed in the future.

## 5. Reference.

[1] YoungDae Seo, Modification of Born Probability Interpretation.