Interference-Induced Particle-Wave Theory

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(Abstract 1.1)

We propose a theory based on wave-particle duality and many of the principles of the Double Slit Experiment; Mostly the destructive interfering part. Continuous interference reduces the wave amplitudes to atomic scales, explaining particle-like behaviour without having the wavefunction collapse. Our “Parent Wave” model suggests that particles are localized manifestations of underlying waves.

(Introduction 1.2)

Our theory revolves around the measurement barrier not being real, but rather there just being a “made-up” world that we have, called the Quantum World. Electrons and Photons, which are the main focus of our theory, behave consistently across both the quantum and real worlds. In both domains, their wave-like properties persist through continuous destructive interference, reducing to atomic scales without requiring wavefunction collapse.

Keywords: Destructive Interference; Wave-Like Properties; Parent Wave

Objectives: (1.3)

- To propose a theory that can also support other theories such as Many Worlds Interpretation.
- To introduce “Parent Wave as a new variable to the scientific community”

Methodology: (1.4)

- Our theory is made from being inspired by many of the key experiments/theories of the Quantum Physics world.
- Our theory lies on the basics of wave interference, how constructive and destructive interference can cause a wave to get a whole another form.
- Assistance in mathematical equations provided by AI’s and other Physicists.

Parent Wave (1.5)

When waves interfere destructively, they combine to form a wave with a smaller amplitude. This wave, when reduced to the size of atoms, is called, “the Parent Wave”. The P.W can generate new waves, which also interfere and reduce in size. This process is continued by the new P. W’s also being made. This explains how waves like Light-Waves and Electrons can appear as particles without collapsing the wavefunction.

- **Generation**

1. Parent Wave generates successive waves due to its wave-like nature.
2. These generated waves interact and destructively interfere to match the Parent Wave's scale, making it a loop/cycle of a kind. If 2 waves A_1 and A_2 interfere, the resultant amplitude will be:

$$A_{result} = \sqrt{A_1^2 + A_2^2 + 2A_1A_2cos(\Delta\phi)}$$

[Click here to see the Derivation]

Where Δφ is the phase difference.

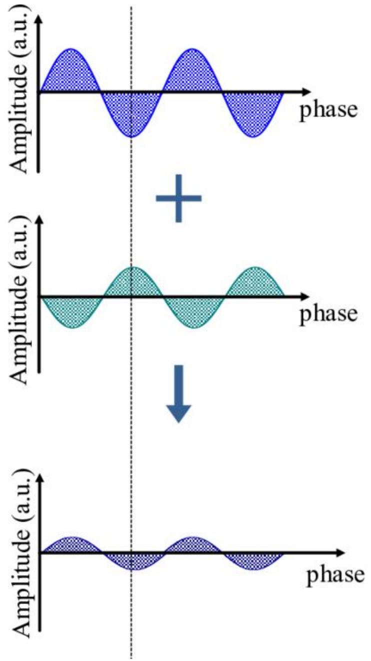
- **Interference and Reduction**

1. With each step of interference, the amplitude is reduced by a factor *k*.

   $A_{result} = k^nA$ [Click here to see the Derivation]

   Where *k*, is the reduction factor, *n*, is the no. of interferences and A_{result} is the resulting amplitude after the destructive interference

2. This continuous process explains the quantum behaviour of particles as waves.



[img. 1- Destructive Interference shown; Constructive interferences' part of the img. cropped (edit)]

Energy of the Waves (1.6.1)

The Energy of the P.W can be denoted by "E_Ψ"

The Energy of the waves generated by the P.W can be denoted as "$E_{(nx^x)}$".

Where, n = waves generated by the Parent Wave and x = waves generated by n.

So, this can be said as: $E_\Psi - E_{(nx^x)}$, whose limit is infinity, because nothing can have infinite energy.

Energy Expression (1.6.2)

Energy of generated waves can be represented as:

$$E_{(nx^x)} = \sum_{i=0}^{n} E_{(x^i)}$$

Here, $E_{(x^i)}$ represents the energy of the i-th wave generated from the i-th instance of the wave n.

Summation Notation (1.6.3)

i: Indicates each wave generated from the P.W.

n: Is the total no. of waves generated by the P.W.

Energy Conservation (1.6.4)

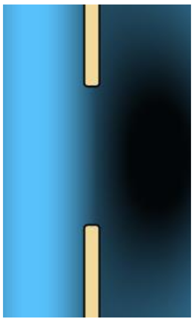
To ensure Energy Conservation:

$E_\Psi \geq \sum_{i=0}^{n} E_{(x^i)}$

This means that the total energy generated by the Parent Wave should be greater than, or equal to the energy generated by the waves as they are taking the energy of the Parent wave. So, the Parent wave basically loses energy every time a new wave is created.

Double Slit Experiment (1.7)

The Double Slit Experiment [1] also shows destructive interference. It has shown the interference pattern which is directly related to our theory. In the observations of the Double Slit Experiment, the wave was said to be in superposition. But according to us, it was everywhere at the same time, without being in superposition. The wave sent to the screen was our Parent Wave, and when it generated more waves, they destructively interfered with each other, to create the pattern.

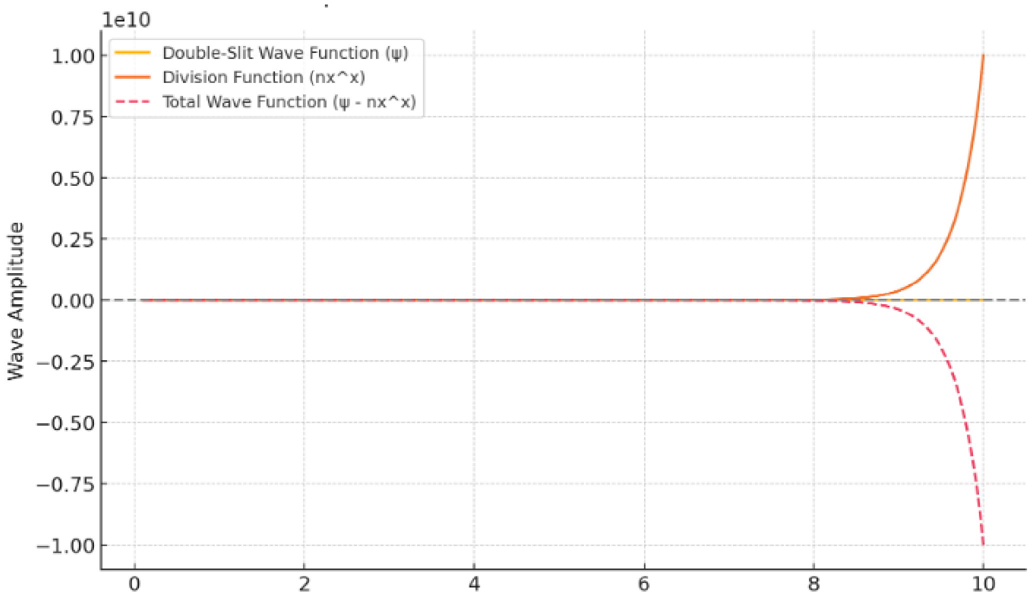


[img 2- The origin of Parent wave according to our theory]

The Intensity 'I' at a point on the screen can be described by:

$$I = I_0 \left(\cos \frac{\pi d \sin\theta}{\lambda}\right)^2$$

Simulations and their Results (1.8)



[img. 3- Simulation Results (Double Slit experiments with Destructive Interference)]

Key components of the simulation:

1. **Wave function for Double-Slit:**

- Represents the combined wavefunctions from the two slits, showing the characteristic interference pattern.
- In Img. 4., d is the distance between the slits and k is the wave-number.

$$\psi(x) = \psi_0 \left(\sin\left(k\left(x + \frac{d}{2}\right)\right) + \sin\left(k\left(x - \frac{d}{2}\right)\right)\right)$$

[img. 4- Wave Function for Double Slit]

2. **Division function "nx^x"**

- Represents the energy division (Img. 5) of the parent wave into smaller waves, affecting the interference pattern. The function is:

$$\text{division\_function}(x, n) = n \cdot x^x$$

[img. 5- Division Function]

3. **Total Wave-function**

- Combines the wave-function and the division function to simulate the destructive interference. (Img. 6)

$$\psi_{\text{total}} = \psi - \text{division\_function}(x, n)$$

[img. 6- Total Wave Function]

Simulations for different ranges:

We run simulations for three different *x,* ranges to see how the interference changes.

- **Range 1: x=0.1x = 0.1x=0.1 to 555**
  - **Expected Behaviour:**
    - The wave function will show a clear interference pattern with relatively high frequency.
    - The division function nx^x will start small but grow rapidly, significantly altering the interference pattern as x increases.
    - The total wave function will show the combined effect, highlighting points of destructive interference.
- **Range 2: x=5x = 5x=5 to 101010**
  - **Expected Behaviour:**
    - The wave function will have a lower frequency compared to the first range.

- The division function nx^x will be much larger, leading to more pronounced destructive interference.
- The total wave function will show significant deviations due to the larger values of nx^x with more frequent points of collapse.

- **Range 3: x=10x = 10x=10 to 202020**
  - **Expected Behaviour:**
    - The wave function will continue to have a low frequency.
    - The division function nx^x will dominate, causing the wave function to collapse at most points.
    - The total wave function will show almost complete destructive interference due to the overwhelming influence of nx^x.

Visual interpretation:

For each plot, you'll observe the following:

- **Blue curve – (Double Slit Wavefunction ψ)**

  Shows the interference pattern created by 2 slits.

- **Orange curve – (Division Function nx^x)**

  Represents the energy division, which grows exponentially.

- **Green dashed curve (Total Wave-function $\psi - nx^x$)**

  Combines the original wave-function and the division function, showing the destructive interference pattern.

Summary:

- Small x range (0.1 to 5):
  The interference pattern is clear, with the division function starting to impact the pattern.
- Medium x range (5 to 10):
  The division function has larger effect, causing more points of destructive interference.
- Large x range (10 to 20):
  The division function dominates, resulting in a collapsed wave function at most points due to destructive interference.

These simulations will provide insights into how the division function affects the interference pattern at different scales of x, illustrating the impact of our hypothesis in a quantum wave interference context.

Comparison to other theories (1.9)

theory also supports the theory made by Hugh Everett, Many Worlds which says that the wavefunction doesn't collapse but rather splits into different branches, which are different universes. This could be said for our theory as well; As those waves, when destructively interfering with each other, generate new waves (Done by P.Ws). That could show that every new wave created, is a branch of a different universe.

Conclusion (1.10)

The proposed "Parent Wave" model offers a new perspective on wave-particle duality, suggesting that particles arise from the continuous interference of underlying waves. While experimental verification is currently challenging, this theory presents a potential framework for understanding quantum phenomena without involving the wavefunction's collapse, just like the Many Worlds interpretation

We anticipate that the "Parent Wave" concept will stimulate further theoretical and experimental researches. Advances in experimental techniques and theoretical understanding may ultimately lead to an evaluation of this model.

Summary of the theory:

- The Wavefunction doesn't collapse but rather the waves are destructively interfered by other waves, causing their amplitudes to be reduced to the size of atoms, therefore making them LOOK like particles.
- The wave generating newer waves is known as, the "Parent Wave".
- Every time a new wave is generated, the Parent Wave loses its energy, which then goes into the newer wave generated which can generate its own waves. This cycle goes on till the main Parent waves' energy is 0.
- This theory does support the proposal of Hugh Everett, of MWI.

Appendix (1.11)

Derivations:

[a]: $\mathbf{A_{result}} = \sqrt{\boldsymbol{A_1^2 + A_2^2 + 2A_1A_2cos(\Delta\phi)}}$

This equation is derived from the principle of superposition for two interfering waves. Breakdown of it:

1. When two waves A_1 and A_2 interfere, the resultant amplitude, A_{result} depends on their individual amplitudes and the phase difference ($\Delta\phi$) between them.
2. Using the low of cosines for vector addition, the resultant amplitude is:

$$\mathbf{A_{result}} = \sqrt{\boldsymbol{A_1^2 + A_2^2 + 2A_1A_2cos(\Delta\phi)}}$$

[b]: $\boldsymbol{A_{result} = k^n A}$

Suppose we have a wave with initial Amplitude ***A.*** After each destructive interference, the amplitude is reduced by a factor *k*.

1. After the first interference, the amplitude A_1 is:
$$A_1 = kA$$
2. After the second interference, the amplitude A_2 *is:*
$$A_2 = kA_1 = k(kA) = k^2A$$
3. After the third interference, the amplitude A_3 is:
$$A_3 = kA_2 = k(k^2A) = k^3A$$

Continuing this process for *n* interferences, the amplitude A_n is:

$$A_n = k^nA$$

References (1.12)

[1]: Vaidman, Lev, "Many-Worlds Interpretation of Quantum Mechanics", *The Stanford Encyclopedia of Philosophy* (Fall 2021 Edition), Edward N. Zalta (ed.),

URL = <https://plato.stanford.edu/archives/fall2021/entries/qm-manyworlds/>.

Img. 1 - Gao, Shuai. (2019). A combined theoretical and experimental analysis on performance and functionality of printed dielectric mirrors.

URL = https://www.researchgate.net/publication/338146983_A_combined_theoretical_and_experimental_analysis_on_performance_and_functionality_of_printed_dielectric_mirrors

Edit: Constructive interferences' part of the image was cropped.

Img. 2: Simulation by PhET Interactive Simulations, University of Colorado Boulder, licensed under [https://creativecommons.org/licenses/by/4.0/]; [https://phet.colorado.edu/]

Img. 3: Simulation Results of Double Slit experiments with Destructive Interference.

Img. 4: Wavefunction for Double Slit

Img. 5: Division Function

Img. 6: Total Wave Function