Interference Induced Particle-Wave Theory

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Abstract (1.1)

I propose a theory based on wave-particle duality and many principles of the Double Slit Experiment; Mostly based on the destructive interference mechanism. Continuous interference reduces the amplitude of the wave to the size of atoms. They still behave like waves, (generating new waves) till their energy 'E_Ψ' reaches the collapsing point. (1.6) When that happens, the wave collapses (instead of the measurement collapse) and turns into a particle. This also explains the fact that observance has no effect on measurement collapse. Our objectives with this paper are to provide a novel way to look at Quantum Physics, introduce the Parent Wave model and to hopefully contribute to physics.

Introduction (1.2)

This theory introduces a novel perspective on Wave-Particle Duality and Quantum Physics. Traditionally, the collapse of the wavefunction upon measurement has been understood as the process by which a wave transitions into a particle. According to this theory, however, the collapse isn't linked to observance, but rather to the wave's energy. Specifically, waves collapse and manifest as particles when their energy to produce new waves reaches a certain collapsing point. This perspective shifts the focus from measurement to the inherent properties of the wave.

In this view, most objects on Earth have already reached an energy level where they can no longer generate new waves, thus exhibiting particle-like behaviour. In contrast, celestial phenomena such as sunlight continue to emit energy, which create photons when their energy levels reach the collapsing point (1.6). this theory suggests that there may still be objects in the universe with enough energy to exhibit wave-like behaviour, influencing their behaviour differently from the objects who have already reached energy levels of 0.

This theory provides a new perspective to look at Quantum Physics from and understanding the same, and Wave-Particle Duality, by rethinking the collapse of the wavefunction in the terms of energy levels rather than measurement, I provide a new angle from which to explore further theories. Just as Parent Waves (1.4) generate subsequent waves, contributing to the evolution of scientific thought, this theory aims to inspire new perspective and advancements in the field.

Physics has many theories for both aspects, macroscopic worlds (e.g. General Relativity, Einstein's theories) and microscopic worlds (Quantum Physics). The IIPWT, unifies both the theories into one, with mathematical evidence. This is a groundbreaking theory, and perhaps, the Theory of Everything.

Methodology (1.3)

- Inspiration of the theory was from Many-Worlds (Many Worlds Comparison)
- Mathematical equations had assistance from AIs (e.g. ChatGPT) for correctness and refinements and physicists.
- Simulations on Energy Conservation and Amplitude Reduction (Simulations)

Parent Waves (1.4)

- **Introduction (1.4.1)**

  Parent waves are waves which have been destructively interfered to atomic sizes. These parent waves usually don't have the capacity to generate a lot of waves. So, they turn into particles quicker than others. In this paper, for almost every time 'Ψ' is used, it's for a parent wave. With the example of Double Slit Experiment [1], when (suppose), a Photon is shot unobserved, it'll go through both slits and interference will show up. Here, when it was going through both slits, it was cut off, thus being reduced to a lower size, then it produces more of its waves which interfere with each other as shown in the pattern, and the gaps are the Parent waves which also agrees with the fact that the amplitudes of the "constructively interfered waves"' parts are right next to the Parent waves, supposedly the waves are generated from the Parent wave. Every time a Parent Wave generates a new wave, the Parent Wave's energy level gets reduced by the amount of energy the newly generated wave gets.

- **Generation (1.4.2)**

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:

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

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:

Where $\Delta\varphi$ is the phase difference.

- **Interference and Reduction (1.4.3)**

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

  $\boldsymbol{A_{result} = k^n A}$

  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:

$$A_n = k^n A$$

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

Conservation of Energy (1.5)

Variables for the waves generated by Parent Wave (1.5.1)

The energy of the Parent Wave is denoted by E_Ψ.

The energy of the waves produced by the parent waves are denoted by $E_{(nx^y)}$, where:

n = first waves produced by the Parent Wave.

x = waves produced by n.

y = waves produced by consecutive x's such as x_1, x_2, x_3....

So, $\lim_{\Psi \to 0,\infty} E_\Psi \geq E_{(nx^y)}$

Wavefunction Collapse (1.6)

In this theory, wavefunction collapse is not related upon observance, but when the energy reaches a certain amount which may be different for all particles. E.g.: Suppose a wave collapses at energy 4.3. So, every time it generates a new wave, some energy 'k' (1.4.3), it'll keep on generated waves till E_Ψ reaches 4.3, when it'll turn into a particle and the mass will be decided by the energy left. i.e. we have 4.3 J of energy left here, so, reversing Einstein's equation of e = mc^2, the mass will be "$m = \frac{E_{\text{remaining}}}{c^2}$".

So, the mass for this particular particle, will be $m = \frac{4.3}{c^2}$.

Here, c = speed of light, m = mass, and 4.3/e = energy remaining.

Superposition (1.7)

Definition [Based on IIPWT] (1.7.1)

Superposition is a state in which a wave is still having energy left and is constantly producing more waves, which can be called different "possibilities" until the wave has reached the collapsing energy. In this model of Superposition, every wave generated by the P.W, which has points of generating new waves are all the points of alternate realities or different positions, and the reality or position of the particle is decided when the P.W stops generating new waves, where wherever the P.W stops, the position/reality point closest to it or the one attracting it the most would be the correct reality/position.

The probability distribution done by "$Amplitude^2$" can also be acknowledged by this as the probability distribution will be on the basis of the nearest reality/position point, ergo the same as the original superposition model where the probability is on the position of the particle itself.

Mathematical Approach (1.7.2)

Each time, an x (1.5) produces the new wave, the position of x can be thought of as a new point of position/reality till the wave reaches its collapsing point.

$$\Psi = \sum_{i=0}^{N} c_i \Psi_i$$

Here,

Ψ_i are the wavefunctions generated by the P.W.

c_i are the coefficients that weigh each wavefunction.

N is the total no. of wavefunctions created.

In this superposition model, the Ψ is a sum of multiple wavefunctions Ψ_i. Each of these represent a possible reality/position generated by the P.W, and c_i represents how much each wavefunction contributes to the total wave.

Probability Distribution (1.7.3)

- $P(x) \propto |\Psi(x)|^2$

$P(x)$ is the probability density function for finding the wave/particle at position x.

$\Psi(x)$ is the wavefunction evaluated at position x.

$|\Psi(x)|^2$ is the squared magnitude of the wavefunction, which gives the probability density.

Many Worlds Interpretation – Comparison (1.8)

What is MWI? (1.8.1)

The Many-Worlds Interpretation (MWI) presents a radical perspective on quantum mechanics. It proposes that every interaction involving quantum systems, not just those related to conscious decisions, leads to a splitting of the universal wave function. This branching creates a multitude of universes, each representing a distinct outcome of the interaction. These outcomes encompass the entire spectrum of possibilities, from the opposite result occurring (e.g., a coin landing on heads instead of tails) to the interaction not happening at all.

Brief History of MWI (1.8.2)

The Many-Worlds Interpretation (MWI) has a rich history, intertwined with the development of quantum mechanics itself. While the concept of multiple worlds can be traced back to philosophers like William James, MWI's roots in quantum physics lie in the work of Hugh Everett III. In his 1957 doctoral thesis, Everett proposed the "relative state formulation" of quantum mechanics[1]. This formulation suggested that the wave function, a mathematical tool used to describe quantum systems, doesn't collapse during measurement. Instead, it remains intact, with each possibility represented by a separate branch. These branches, according to Everett, correspond to distinct universes. MWI gained further traction through the work of physicists like Bryce DeWitt [2]. DeWitt elaborated on the concept of branching universes and the idea of probabilities corresponding to the "weights" of these universes.

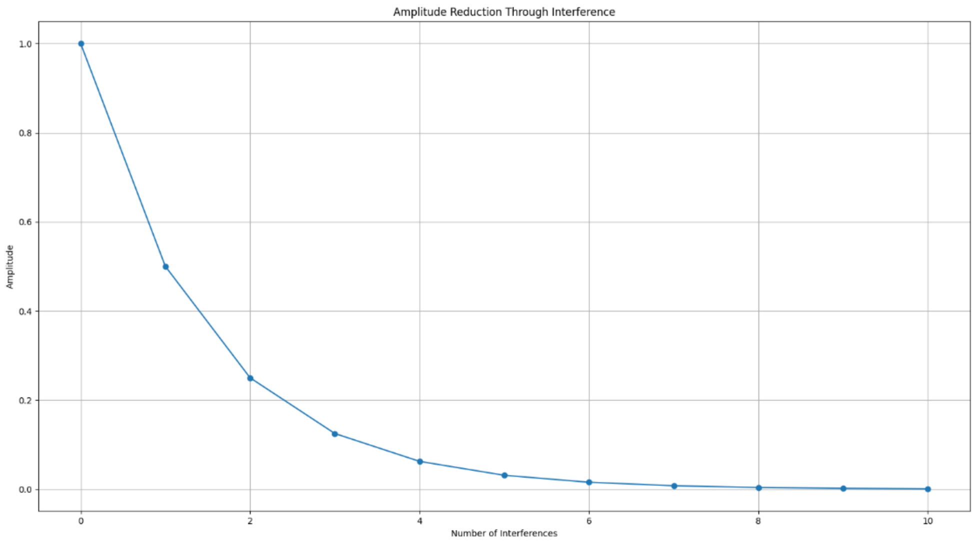
Despite its growing recognition, MWI remains a controversial interpretation of quantum mechanics. It faces challenges related to experimental verification and the problem of the preferred basis (why do we only experience one world?). Nevertheless, MWI continues to be a topic of active research and debate, offering a unique perspective on the nature of reality and the complexities of the quantum world.

Comparison to this theory (1.8.3)

Just like we saw in Superposition, on every x point when new realities/positions were created, it could be that those points were the new branches of MWI. So, this would mean that every single branch with alternate REALITIES would just be the x's or n's of the P.W generated till the wavefunction energy levels reach the collapsing point. It COULD be that every x which has an alternate reality would be collapsing when the actual collapse goes on one singular reality/position.

Simulations (1.9)

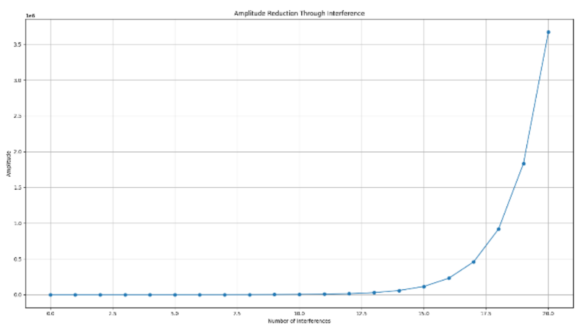
Amplitude Reduction for different values (1.9.1)



(img. 1 Amplitude Reduction (1))

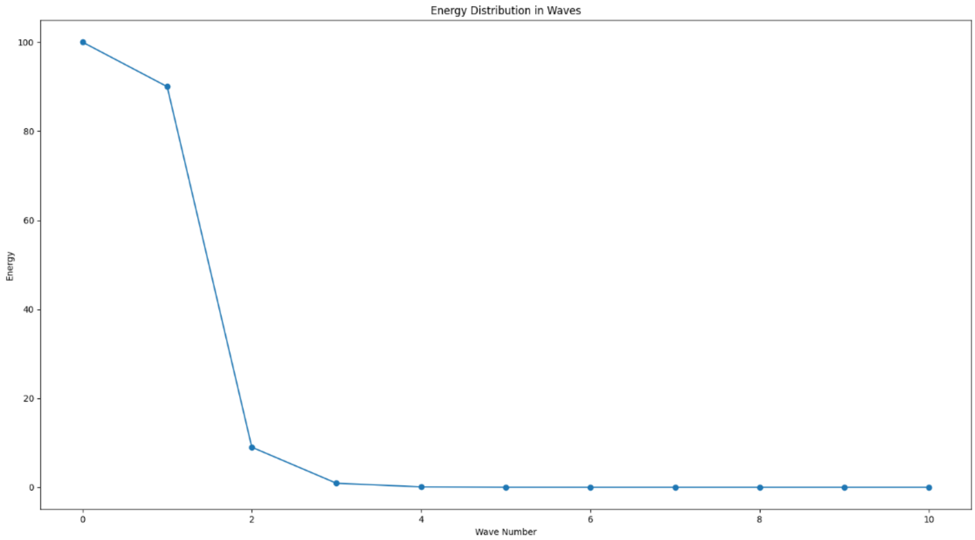
Equation (1 and 2): k^nA

Values: k = 0.5; n = 10; A = 1;



(img. 2 Amplitude Reduction (2))

Values: k = 2; n = 20; A = 3.5;



(img. 3 Energy Distribution in Waves)

Values: initial factor = 100; reduction factor = 0.9; number of waves = 10;

Acknowledgements (1.10)

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Citations (1.11)

[1] Hugh Everett Theory of the Universal Wavefunction, Thesis, Princeton University, (1956, 1973), pp. 1–140

[2] Bryce S. DeWitt; Quantum mechanics and reality. *Physics Today* 1 September 1970; 23 (9): 30–35. https://doi.org/10.1063/1.3022331