Exploration

Particle-Wave Duality in the Macroscopic World

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ABSTRACT

This work presents an option to unite different perspectives of reality. Through literature review and considerations of visible manifestation of light and other physical effects, the author evaluates if quantum effect shows up in our daily life. Reality is an overlap of waves which our brain utilizes to produce individual perception. It is not so bizarre to consider the interference pattern of particles if we characterize the visual experience as a momentary photograph of that wave. Science is multi-disciplinary, so we attempt to reconcile diverse areas of knowledge.

Keywords: Particle-wave duality, Young's experiment, quantum Mechanics.

Introduction

Light may form an interference pattern similar to that observed between two waves (Silva and Martins, 2009). The undulatory-corpuscular nature of light is a reflection of the purest uncertainty (Mehra, 1987). Experiment also shows that the interference pattern, characteristic of wave is present at the molecular level (Nairz *et. al.*, 2003). Under uncontrolled conditions and in the routine of a radiological clinic, could we observe the particle-wave duality? (Melo, Dantas and Munhoz, 2002). The classical physics theory was questioned by the need for greater discoveries in the mass and volume of particles, in the concept of body capacity to reflect or to refract, in the influence of gravitation and among others. These critical points served as a starting factor for the emergence of wave theory in the second half of the 18th century (Da Cruz Silva, 2009). Some works report the simultaneous determination of complementary waves and particles in aspects of light similar to double-slit experiments (Afshar, 2007; Dimitrova and Weis, 2008).

Bohr's Principle of Complementarity (1931) states that the observation of a quantum interference pattern and the acquisition of this observed information are mutually exclusive. Therefore, measurement techniques disrupt the wave function and the end result of the experiment. With a single photon interferometer it was possible to investigate the relationship for various situations, including pure, mixed and partially mixed photon input states (Schwindt, Kwiat and Englert, 1999). In a complete theory of quantum gravity, new meanings will emerge. It will be possible to include the wavelength of gravity-modified matter, from oscillations of neutrinos to gravitational

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redshift (Ahluwalia, 2000). The celebrated debate of Bohr-Einstein (1949) was the starting point of new conceptions that will modify the world in which we live. How would it be if two quantum systems interacted with spatial coordinates in a particular direction and in a linear moment? Determining the position or momentum for a system would immediately modify the other interlaced system (Fine, 2004).

In the Bohm experiment (1957), the atomic fragments separate after interaction, flying off in different directions. Subsequently, measurements are made of spin components, whose measured values would be anti-correlated after dissociation. In the so-called singlet state of the atomic pair (after dissociation), if one atom's spin is found to be positive with respect to the orientation of an axis perpendicular to its flight path, the other atom would be found to have a negative spin with respect to a perpendicular axis with the same orientation. The Bohm proposal incorporates variables called hidden ones. Such values interact deterministically in the measuring apparatus and in the hamiltonian construction of the apparatus-system interaction. The theory defends the idea of nonlocality for spatially separated systems that have interacted in the past. The non-locality is due to considering the results of the measurements of physical quantities as a result of the interaction of the systems with the measuring devices (Freire, Paty and Barros, 1994).

Literature Review

The experiments involving projections of light, until we could bring calculations that confirmed macroscopic quantum events. Through a bibliographical review, we return to concepts from Young's experiment to more current considerations on the visible manifestation of visual and physical effects. The work aims to evaluate if quantum mechanics is more a part of the practical occurrences in our daily life. To complement the study material was also referenced the photoelectric effect and the double-slit beam. We verified that quantum mechanics is more a part of practical occurrences in our everyday life than we imagined. Our evolution as a science encompasses a multidisciplinarity that needs more investments, so we are tracing the methodology in a way reconciled with the most diverse areas of knowledge, such as biology.

Visible light has a wavelength in the range between 400 and 700 nm, at which time the human eye is sensitive to this radiation (Hecht, 2002). The Geometric Optics, when considering the phenomena by the trajectories followed by the light (whether in convergent conical beam, divergent conic or parallel cylindrical), allows us to understand that we interpret relatively what we see through the values that include the angle of incidence, angle of reflection, considering the types of lenses and related factors.

Images made up of material points present in everyday life are constantly altered as we consider their momentary projections (by plotting minimum values in space-time). Storage times for luminous images are generally limited due to interactions with the environment. However, when we consider large bodies in sizes of celestial bodies and with the projection of their images spanning years at the speed of light, an understanding of the resulting images stored in space-time begins. We have the feeling that the light emitted was fixed in the sky full of stars, because they travel so extreme distances that make us think that the celestial bodies would be fixed.

Since Einstein wrote about the photoelectric effect (1905), it is accepted that in certain phenomena light behaves as a wave and in others as a particle. The removal of electrons from the polished surface of certain materials, when illuminated with electromagnetic radiation of certain frequency (and color). The maximum kinetic energy of the photoelectrons depends on the frequency of the light and the illuminated material.

Scientists have tried to store light and have concluded that memories of electromagnetically induced transparency (EIT) with external magnetic control fields can greatly increase storage times (Heinze, Hubrich and Halfmann, 2013). According to Arnaldo Paiva Neto (2017), the visual image, apparently punctual and fixed in millions of light years, is composed of a visual record, a memory (studied better by the action of time) and a Universal Memory System (De Paiva Neto, 2017).

Perseus galaxy cluster has undergone a gravitational disturbance that has generated hot gas waves, about twice the size of our own Milky Way. NASA's Chandra X-ray Observatory provided extremely detailed images of Perseus. One feature they observed was a feature known as "bay". The bay surfed through the mixture of hot and cold gas layers, giant waves were formed persistent for hundreds of millions of years. We also note that the large celestial body appears to be fixed in an image comparable to the steady state.

However, we know that imperceptible movements occur because the emitted light functions as a record of the storage of light in the Universe (which translates into the function of memory). The light has stationary character, when in distances measured in light years or in the photographs. In day-to-day, four-dimensional occupancy of light provides dynamic and instantaneous modifications.

Discussion

If a quantum particle has mass “m” and moves under the influence of a potential energy V (x, y, z, t), the probability p (x, t) of finding the particle at position x at time t could be obtained from the wave function. The probability of finding the particle in a region between the coordinates “a” and “b” at time “t” (Figure 1).

$$P[a,b] = \int_a^b \left|\Psi(x,t)\right|^2 dx$$

Figure 1. Probability of wave function.

Young described an experimental apparatus as a "wave tank." His purpose was to demonstrate the interference pattern of water waves (Figure 2).

Figure 2. Two-wave tank

This pattern occurs when two rocks are thrown on a lake, we consider the phase difference "Δθ" represented between the two waves having the same frequency (as in Young's experiment, Figure 3).

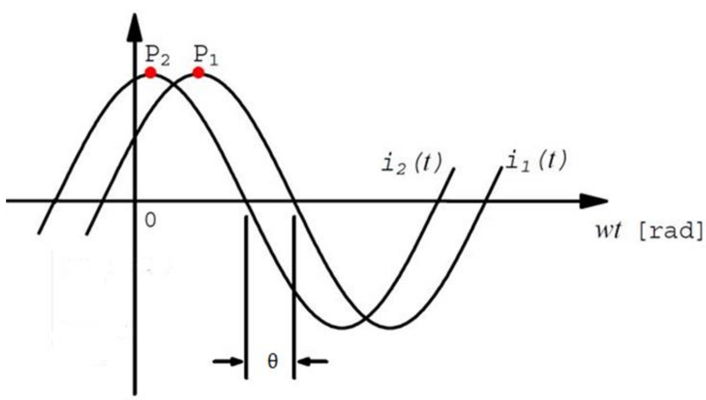

Figure 3: Phase difference between the two waves.

A quantum operator acts on a wave function, and the result is another function. We consider two slits when their width is smaller than the distance between them. The double crack diffraction is calculated in item (1) of the Figure 4.

$$(1)\ \Delta\theta = kd\sin\theta = \frac{2\pi.d}{\lambda}\sin\theta$$

$$(2)\ \Delta\theta \times 100\% = 140^{\circ} \times \text{Ç}$$

$$\frac{\frac{2\pi.d}{\lambda}\sin\theta \times 100\%}{140^{\circ}} = \text{Ç}$$

Figure 4. Phase difference between the two waves.

However, if the width of the slits is negligible, we consider only the interference of two rays from them. The preference for the angular value between the phases of the diffracted waves tries to highlight the comprehensiveness of the total visual effect projected on the fluorescent screen. In humans, binocular vision that is important for depth perception only covers 140 degrees of the field of vision. The remaining 40 degrees cannot participate in the overlap of images created in the eyes representing such parts of the field of view.

Let us consider the phase with difference of the waves to establish how much it represents in front of our visual fields. The vision of the individual has its maximum extension of field of vision of 140 degrees. If 100% represents the 140 ° in its maximum possible manifestation in that situation, we can understand the difference of the wave's phases (Δθ) corresponds to a percentage within those 140 degrees. By drawing a rule of three, we can represent as "Ç" the percentage in relation to the maximum field that we can see at that moment.

We calculate the "Ç" in item (2) of Figure 4. Faced with this field of vision, each eye would tend to see the same image in different positions. However, the eyes align to identify only one image. This self-regulation occurs and allows us to visualize only one figure. That is why the particle is nothing more than the photograph of the wave. Material bodies are also waves, although they become a particle when there is mechanism for capturing the shapes represented in "Ç". In the face of probabilities, an adaptation occurs that nature uses to interpret in a singular way what is being propagated in several different dimensions.

Quantum objects exist as a superposition of possibilities until our observation causes the reality of potentiality, generating a real and localized event among the many possible events (Goswami, 2015, p.19).

Results & Conclusions

We have decided to place a unit whose glass is under a lamp. Subsequently, we calculated the various distances with respective incidence angles, reflection angles and even diffraction with the image formed in an exhibition. Figure 5 shows the different images formed, but with different angles and different reflection values.

Figure 5. Different images formed with different angles.

We see the image of the same object in different places. If we close one eye and alternate with the other eye, we also observe different locations. Refraction experiments also occur in different portions of the glasses. In order to follow the experiment, we decided to consider the overlap of the visualized images (Figure 6).

Figure 6. The overlap of the visualized images.

We noticed that there were images on all sides. There would be uncertainty as to the location of the initial object, until we get close enough to have the full conviction that it is there. It is not so bizarre to consider the interference pattern of particles when we characterize the visual experience as a momentary photograph of that wave. The particle is a form of memory of the wave in analogy to the Universe that carries for years light the memory of the stars.

In fact, Quantum Mechanics may seem confusing for the idea of standardizing such accurate calculations of physics, since universal models have been used for people who observe the world in individual ways. It makes good sense to believe that reality is an overlap of waves by which our organisms tend to simplify through individual perception. The mechanisms that made our species evolve are proportionately direct to this ability to select an angle to survive in the face of constant interferences and perceptions. The concluding notion revolves around the conception that we interpret in a limited way a much greater complexity of reality. Quantum Physics is not strange. What is strange is the multi-diversity through which each sees the same world. We are emerging in a new science that considers the observer as a factor of influence in the final results. To admit the existence of an overlapping of images by which the field of vision selects only one of these projections to see every minute, only confirms to us that there is a percentage of field visible in all the dimensions by which the light propagates. The Universe or Multiverse of possibilities can also act similar to the observer who changes the data, especially the Self-conscious Universe.

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