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Wilhelm Wien's Photons Creating the BohEmian Pilot Wave for the Guiding of the Individual Huygens - de Broglie Particles on the Helical Path Governed by the Newton - Bohm Evolute (the Bohmian Pilot Wave) through the Young - Feynman Double - Slit Barrier. Wilhelm Wien's Photons in the Mach - Zehnder Interferometer (20.08.2019)

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Abstract

In our approach we have combined knowledge of Old Masters (working in this field before the year 1905), New Masters (working in this field after the year 1905) and Dissidents under the guidance of Louis de Broglie and David Bohm. In our model the quantum particle is represented as the Huygens-de Broglie's particle on the helical path (full wave) guided by the Newton-Bohm entangled helical evolute (Bohmian Pilot Wave). These individual Huygens - de Broglie particles in the Young - Feynman double - slit experiment react with Wilhelm Wien's photons that are always present inside of the apparatus (Wien's displacement law). Wilhelm Wien's photons form collectively the Wien filter guiding the Huygens - de Broglie particles through the double - slit barrier towards a detector (BohEmian Pilot Wave). The interplay of those events creates the observed interference pattern. In the very well-known formula describing the intensity of double-slit diffraction patterns we have newly introduced the concept curvature κ of the Huygens - de Broglie particle and thus giving a physical interpretation for the Newton - Bohm guiding wave (the Bohmian Pilot Wave): for photons $\kappa = \pi/\lambda$, for electrons $\kappa = 2\pi/\lambda$. Moreover, we have introduced into that formula the expression λ_{max} from the Wien's displacement law to describe geometry of the double - slit barrier. We propose to modify the value λ_{max} by the change of the system temperature. There is a second experimental possibility - we can insert into those slits filters to remove Wien's photons while the Huygens - de Broglie particles continue towards a detector - we should observe the particle behavior. The similar situation might occur in the Mach - Zehnder interferometer. In this case the individual Huygens - de Broglie particle reacts in the first beam splitter with the Wien photon: the Huygens - de Broglie particle goes through one path while the Wien photon goes through the second path. In the second beam splitter they interact again and create the interference pattern on one detector. We can experimentally modify the resulting interference pattern in the Mach - Zehnder interferometer - by the temperature change of the system or by inserting filters to remove Wien's photons from one or both paths. Can it be that Nature cleverly creates those interference patterns while the Bohmian pilot wave and the BohEmian pilot wave are hidden in plain sight? We want to pass this concept into the hands of Readers of this Journal better educated in the Mathematics and Physics.

Keywords: Huygens-de Broglie Particle on the Helical Path, Newton-Bohm Entangled Helical Evolute, Curvature of Helix, Bohmian Pilot Wave, Wien's Displacement Law, Wien's Photons, Wien Filter, BohEmian Pilot Wave, Filters to Remove Wien's photons

1. Introduction

The famous quote of Heraclitus "Nature loves to hide" was described in details by Pierre Hadot in 2008. Hadot in his valuable book gives us many examples how Nature protects Her Secrets. In several situations the enormous research of many generations is strongly needed before the right "recipe" unlocking the True reality can be found. Johann Wolfgang Goethe remarked to our research: "Nature does not suffer Her veil to be taken from Her, and what She does not choose to reveal to the spirit, thou wilt wrest from Her by levers and screws."

In our model of the photon we have found that Nature could keep Her Secrets hidden in plain sight and thus can perfectly document Her Top Art of Hiding.

Cylindrical Helix represents one of the most fascinating curves in Nature and Science and is among the oldest curves. Cylindrical Helix belongs to the Treasure of Geometry. The Cylindrical Helix seem to have been discovered and thoroughly studied by Apollonius of Perga (The Great Geometer) and his scholars as e.g. Geminus of Rhodes. Cylindrical helix is composed from two motions - circular and translational. Heron discovered the cylindrical helix construction by triangle wrapping that gives to us a deeper view in the properties of the elastic helical **WAVE**. For the details of the Heron's construction see P. Mancosu and A. Arana (2010).

The model of the double helix for the description of the photon wave appeared many times in the so-called dissident literature (outside of the mainstream literature). There are known many proposals for this double helix composition. Louis de Broglie proposed at the 1927 Solvay Conference his model of the full wave and the pilot guiding wave but could not give a deeper physical interpretation of his concept. Later Louis de Broglie (1939) proposed two component model of the photon. (Many modern Dissidents continue to develop this double-helix model of the photon where both helical paths are occupied by particles). In 1952 David Bohm rediscovered this pilot wave model and developed it as the de Broglie - Bohm theory. Since that time the concept of empty guiding waves remains still open and has been waiting for the physical interpretation. See J.S. Bell in 1992, L. Hardy in 1992, P.J. Lewis in 2007, W. Seager in 2018, and many others.

Albert Einstein called these empty waves in the de Broglie-Bohm theory as the ghost waves ("Gespensterfelder", ghost fields) and the de Broglie - Bohmian concept as "too cheap". Are we able to find a physical meaning for those empty waves? In such case we might express here the old Bohemian proverb "Salt above Gold" as "Photons above Gold".

In order to achieve our target we have combined knowledge of Old Masters (working in this field before the year 1905), New Masters (working in this field after the year 1905), and Dissidents working on the double helix model of the photon for many years.

(We are aware of the famous quote of Richard Feynman: "We choose to examine a phenomenon (the double-slit experiment) which is impossible, absolutely impossible, to explain in any classical way, and which is in the heart of quantum mechanics.")

2. Inspirations from Old Masters, New Masters, and Dissidents

We were inspired by many Great Researchers working in this field for generations. Some of those Masters with their ideas are given in the Table 1. Based on their knowledge we can model the photon as a dyon travelling on the helical path.

Table 1. Inspirations from Great Masters to formulate a model for photon

FULL WAVE: Huygens - de Broglie particle on the helical path
EMPTY WAVE: Newton - Bohm entangled guiding helical evolute
H.A. Lorentz acting force of photons and reacting force of fermions
Super-elasticity of photon **WAVES** - Doppler's super-elasticity, Zwicky's super-elasticity
Dirac's quantum of magnetic flux where α is the helical angle
$\Theta_D = \frac{h}{e} = \frac{h}{e}(\cos\alpha)^2 + \frac{h}{e}(\sin\alpha)^2$
Superconducting magnetic flux for α = 45°
$\Theta_0 = \frac{h}{2e}$
Model of quarks by Gell- Mann and Zweig
Models of dyons by Schwinger
Model of dyons by Witten

$$\frac{e\theta}{2\pi} \quad for\ \theta = \pm\pi \qquad \pm\frac{e}{2}$$

Schwinger - Zwanziger condition

$$e_1 g_2 - e_2 g_1 = nh$$

$$\frac{e}{2}\frac{h}{e} - \left(-\frac{e}{2}\right)\frac{h}{e} = h$$

Polchinski: “The existence of monopoles is one of the safest bets that one can make about physics not yet seen”.

This model of the photon particle as a dyon with the double helix structure: Huygens - de Broglie particle on the helical path guiding by the Newton - Bohm helical evolute can start a new view on some effects. With this new model of photon (dyon) we can newly describe some phenomena: e.g., the quantum of magnetic flux in superconductors, the events in the Young - Feynman experiment, the events in the Mach - Zehnder interferometer, etc.

3. Wien’s Displacement Law

Wilhelm Wien derived in 1893 his famous Wien’s displacement law: the black body radiation curve for different temperatures will peak at different wavelengths that are inversely proportional to the temperature:

Table 2. Wien’s displacement law

Wien’s Displacement Law

$$\lambda_{max} = \frac{hc}{x}\frac{1}{kT} \approx \frac{2.898 * 10^{6}\ nm\,K}{T}$$

$$\lambda_{max}\ for\ 300K \approx 10\mu m$$

Wien’s photons are always present in our apparatuses - can they participate in the development of interference structures in the Young - Feynman double - slit experiment and in the Mach - Zehnder interferometer?

4. Wien Filter in the Young - Feynman Double - Slit Experiment (BohEmian Pilot Wave)

Wilhelm Wien in 1898 invented a device consisting of perpendicular electric and magnetic fields that can be used as a velocity filter for charged particles. See, e.g. Franz Hasselbach in 1992, Karl Wien in 1999, E. Plies et al. in 2011.

In our model we assume that Wien’s photons (dyons) (Wien replacement law) are always present inside the double-slit apparatus and interact with individual Huygens - de Broglie particles as the Wien Filter. This interaction between Wien’s photons and Huygens - de Broglie particles leads to the observed interference patterns. The collective of self-organized Wien’s photons guiding the Huygens - de Broglie particle will be termed as the BohEmian Pilot Wave.

We can experimentally observe the influence of temperature (λ_{max}) on the resulting interference patterns. There is another experimental possibility to insert filters into the slits to selectively remove Wien’s photons guiding those Huygens - de Broglie particles.

5. Young - Feynman Double - Slit Experiment with Individual Photons

There were done numerous experiments to observe the pattern formation with individual photons below the double - slit barrier. See the References.

In the Table 2 is the traditional formula for the calculation of the intensity of double slit patterns for photons: *I* is the intensity at the angle θ, I_0 is the maximum intensity, *d* is the separation between slits, *a* is the slit width, *λ* is the pitch of the photon double helix creating the interference structure.

We have modified this Formula in two steps:

1) We have "discovered" the hidden expression for the photon helical curvature κ = π/λ - this is the hidden Bohmian pilot wave for photons.

2) We have described the separation between slits d as d = D λ_{max} and the slit width a = A λ_{max} where λ_{max} is from the Wien displacement law. We assume that Wien's photons create a BohEmian pilot wave that contribute to the formation of the resulting pattern structure. In our experiment we should find the optimal values of D and A for the geometry of the double - slit barrier.

3) The thickness of the double - slit barrier b = B λ_{max} should play a significant role, too.

4) Temperature will change λ_{max} and should modify the intensity of the pattern structure.

5) Heraclitus' condition "Nature loves to hide" is fulfilled.

Table 3. Young - Feynman double - slit experiment for photons

Intensity of Double Slit Patterns for Photons

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

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

$$I = I_0 \cos^2\left(\frac{\pi}{\lambda} D \ \lambda_{max} \sin\theta\right)\left[\frac{\sin\left(\frac{\pi}{\lambda} A \ \lambda_{max} \sin\theta\right)}{\frac{\pi}{\lambda} A \ \lambda_{max} \sin\theta}\right]^2$$

$$d = D \ \lambda_{max} \quad \textit{separation between slits}$$

$$a = A \ \lambda_{max} \quad \textit{slit width}$$

$$\kappa = \frac{\pi}{\lambda} \quad \textit{photon helical curvature, Newton} - \textit{Bohm evolute}$$

$$r = \frac{\lambda}{2\pi} \quad \textit{photon helical radius}$$

The similar analysis can be done with the atom interferometry where individual atoms might react with Wien's photons. This atom interferometry experimentally opened Olivier Carnal and Jürgen Mlynek (1991) and David W. Keith with his Team (1991).

6. Young - Feynman Double - Slit Experiment with Individual Electrons

There were done numerous experiments to observe the pattern formation with individual electrons below the double - slit barrier. See the References.

In the Table 2 is the traditional formula for the calculation of the intensity of double slit patterns for electrons: I is the intensity at the angle θ, I_0 is the maximum intensity, d is the separation between slits, a is the slit width, λ is the pitch of the electron double helix.

We have modified this Formula in two steps:

1. We have "discovered" the hidden expression for the electron helical curvature κ = 2π/λ - this is the hidden Bohmian pilot wave for electrons.

2. We have described the separation between slits d as d = D λ_{max} and the slit width a = A λ_{max} where λ_{max} is from the Wien displacement law. We assume that Wien's photons create a BohEmian pilot wave that contribute to the formation of the resulting pattern structure. In our experiment we should find the optimal values of D and A for the geometry of the double - slit barrier.

3. The thickness of the double - slit barrier b = B λ_{max} should play a significant role, too.

4. Temperature will change λ_{max} and should modify the intensity of the pattern structure.

5. Heraclitus' condition "Nature loves to hide" is fulfilled.

Table 4. Young - Feynman double - slit experiment for electrons

Intensity of Double Slit Patterns for electrons

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

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

$$I = I_0 \cos^2\left(\frac{2\pi}{\lambda} D\ \lambda_{max} \sin\theta\right)\left[\frac{\sin\left(\frac{2\pi}{\lambda} A\ \lambda_{max} \sin\theta\right)}{\frac{2\pi}{\lambda} A\ \lambda_{max} \sin\theta}\right]^2$$

$$d = D\ \lambda_{max} \quad \textit{separation between slits}$$

$$a = A\ \lambda_{max} \quad \textit{slit width}$$

$$\kappa = \frac{2\pi}{\lambda} \quad \textit{electron helical curvature, Newton} - \textit{Bohm evolute}$$

$$r = \frac{\lambda}{4\pi} \quad \textit{electron helical radius}$$

7. Wilhelm Wien's Photons in the Mach - Zehnder Interferometer

Ludwig Mach (the son of Ernst Mach) and Ludwig Zehnder in 1891 proposed the now very well-known Mach-Zehnder interferometer.

The Mach - Zehnder interferometer has been intensively studied by all scholars of quantum mechanics and is very well described in the existing literature.

In our proposal we assume that the individual Huygens - de Broglie particle reacts at the first beam-splitter with one Wilhelm Wien's photon. After that the Huygens - de Broglie particle propagates as the "sample beam" through one path while the "entangled" Wien's photon propagates as the "reference beam" through the other path. At the second beam-splitter they meet themselves again and can create the observed interference pattern at one detector.

We can experimentally test this model by inserting of filters in one or both arms of the Mach - Zehnder interferometer that are able to remove the "entangled" Wien's photons from the system while the Huygens - de Broglie particles can arrive to the detectors. In this case the Huygens - de Broglie particles should reveal their "particle behavior".

The Great New Master in the theoretical physics Paul Dirac in 1958 assumed that: "Each photon then interferes only with itself. Interference between different photons never occurs."

However, the Great New Master in the experimental quantum optics Leonard Mandel with his Team showed that two photons can interfere. See, G. Magyar and L. Mandel in 1963, R.L. Pfleeger and L. Mandel in 1967, and C.K. Hong, Z.Y. Ou and L. Mandel in 1987.

The detailed discussions to this topic were published by another Great New Masters in the experimental physics - P.G. Kwiat in 2009, Markus Perner in 2013, Toshiki Kobayashi et al. in 2016, D.A. Kalashnikov et al. in 2017, D.J. Zhang et al. in 2017, and many others.

In our model the Huygens - de Broglie particles meet their Wilhelm Wien's photon partners in the first beam-splitter. After a short interaction they are separated and interacting again at the second beam-splitter and interfere with Wien's photons at the second beam-splitter. It could be another Great Surprise used by Nature to cleverly employ one of the many Wien's photons as the hidden partner for the Huygens - de Broglie particle for their joint interference. We want to pass this model into hands of Readers of this Journal better educated in Mathematics and Physics.

8. Conclusions

1. We have combined knowledge of Old Masters, New Masters, and Dissidents in order to newly formulate events in the Young - Feynman double- slit experiment and in the Mach- Zehnder interferometer.

2. In the classical formula for the intensity of the double-slit patterns we have identified the curvature for the Newton - Bohm evolute for photons as $\kappa = \pi/\lambda$. (Bohmian pilot wave).

3. In the classical formula for the intensity of the double-slit patterns we have identified the curvature for the Newton - Bohm evolute for electrons as $\kappa = 2\pi/\lambda$. (Bohmian pilot wave).

4. In the Young - Feynman double - slit experiment we have assumed that Wilhelm Wien's photons might contribute to the interference patter formation as the BohEmian pilot wave (Wien filter).

5. In the Mach - Zehnder interferometer we have assumed that Wilhelm Wien's photons might interact with the Huygens - de Broglie particles in the first and in the second beam-splitters.

6. We have proposed to modify those experiments by the insertion of filters to remove those Wilhelm Wien'photons and/or to change the temperature to modify the λ_{max} (Wien displacement law).

7. Nature might hide Her Beauty in plain sight protected by the mathematical camouflage.

8. Are there some more "hidden curves" in the Plato's Realm connected to the Photon and Electron Secrets? How to distinguish the real physical meaning written in those curves from fictious events if both are mathematically correct? How to work with the mathematical camouflage used by Nature to protect Her Secrets?

9. We want to pass this model into hands of Readers of this Journal better educated in Mathematics and Physics.

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Conflict of interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

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