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Quantum Impedance of Proton and Beta Particle by Employing the DE-Broglie Hypothesis alongside Heisenberg's Uncertainty Principle

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Abstract

In this paper, alongside Heisenberg's principle of uncertainty, the De-Broglie wavelength hypothesis was used to conclude at a new understanding of the quantum impedance shown by the proton when interacting with the material. It also extracted the quantum impedance, speed, and frequency of electron (a beta particle with energy below 1MeV). This assumed that the electrons and protons have the same wavelength when interacting with the material at a high- voltage vacuum power supply. These formulas can be considered as one of the important applications in nanotechnology that can be used in the field of radiotherapy. The findings obtained concerning beta particle velocity showed that they are compatible with their established formulations, but with a new method. Furthermore, the Beta particle frequency formula may be viewed as a new version. The use of uncertainty in determining the location and momentum of the proton and the beta particle has also been found to have a significant impact in achieving their quantum impedances. Besides that, the quantum impedance of beta particle was obtained according to the principle of conductivity. The results showed the relevance of equation 8 when evaluating the impedance of the proton. It is attributed to the inclusion of the Mp / Me ratio, in addition to the similarity of the remaining variables with the content of the beta particle's quantum impedance formula. The Die-Broglie wavelength was determined, as opposed to the usual. Results showed that a linear relationship between the velocity of the beta ray and its frequency with the power supply.

Keywords: Impedance; de – Broglie; Uncertainty principle; Proton; Beta particle frequency; Radiation interaction.

Introduction

Use of UV radiation, protons, electrons beam and centered ion was examined [1] and based on nanostructure device manufacturing. The benefits and drawbacks of their usage over the days need to be explained and clarified and the technology progresses. Radiation can be extremely useful for science and nanotechnology, and the use of a Nano-particle in combination with nuclear radiation will offer advantages [2-4]. The photon, electron and, proton, like all resonators, are known as quantum resonators and have major quantum impedances [5]. The comprehensive theoretical work to determine the characteristics of (I-V) single-molecule relationship has been improved [6-8]. Electron conductivity and impedance have been achieved by [9, 10]. Electron and photon impedance has also been demonstrated in another previous study [11].

There is an analysis to provide a concise and informative explanation of how the uncertainty principle of Heisenberg is valid without implying any realistic limitations on changing, especially utilizing the quantum fluctuation. Therefore it provides the complementary scientific concept of wave-particle, in which the principle of extended-Heisenberg instability is not only feasible but also necessary [12] as well. Several studies have used proton contact with the substance to show their tolerance to high-energy radiation. Especially in perovskite cells, and

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then nanomaterial development. It is achieved by knowing the sum of resistance the substance has faced throughout its journey [13].

The theoretical investigation of the proton and beta particle quantum impedance formula can be considered as an introduction to Nano science study. The term "dot" indicates an overly small area of space. Nonetheless, a semiconductor quantum dot is composed of about one million atoms and an equal amount of electrons. Such electrons' De-Broglie wavelength is equivalent to the scale of the dot, and the electrons hold distinct quantum stages (akin to atomic orbitals of the atoms) and have a distinct spectrum of excitation. A quantum dot has another characteristic, commonly called the loading energy, which is comparable to an atom's ionizing energy [14].

The Heisenberg uncertainty relation: $\Delta E \ \Delta t = \hbar/2$ implies that $\hbar/2$ should be bigger than the quantum impedance for the energy uncertainty to be smaller than the loading energy. To round up, the two criteria for detecting results due to the distinct existence of the charge [15, 16].

Another survey suggests that the characteristics of I-V show structure that they related to resonant tunneling by quantum states resulting from lateral confines [17]. The impacts of single-electron loading were first confirmed in semiconductors in studies on narrow wires by [18].

With an average conductance of the wire far smaller than $e^2 / \hbar$, their observations indicate a regularly oscillating conductance as a function of an applied voltage to a neighboring lock. Glazman and Shekhter had pointed it out [19].

Maximum cross-sections of ionization for O and Hg atoms were determined for negative and positive effect scattering of beta particles. In the scattering equations, a quantum mechanical equation derived from complicated atomic spherical potential was applied to two goals. Studies of the impact of electrons on Hg, atoms are scarce in the literature. Similarly, a positron (positive beta particle) has been addressed affecting ionization in comparison to electrical ionization but has not been illustrated much [20].

So many theoretical techniques involved the use of Landauer formalism [21] to relate the reply current of a voltage source to a molecular intersection of nano-size . In most of these conceptual frameworks, a typical aspect was the presence of a restricting conductance $G = I/V$ for the junction known as quantic conductance, $Go \geq 2e^2/h$ per conduction channel, whereas a conduction channel was not unambiguously specified but most analyses safely presume that it corresponded to the electron spin orbitals in electronic structure calculations [22].

Some studies show the application of impedance in different fields such as corrosion behaviour of some metallic compounds. There is a study has been performed using measurements of potentiodynamic polarization and electrochemical impedance spectrometry (EIS). Alongside supplemented by scanning electron microscopy and energy dispersive X-ray tests. This was achieved to expose the impact on corrosion of high strength steel in 2.0 M H2SO4 solutions by growing the treatment times from 30-90 min and further to 180 min. The goal of this research has also been expanded to describe corrosion inhibition of steel using 3-amino-5-mercapto-1, 2, 3-triazole (AMTA) as a corrosion inhibitor [23].

Other research documented the impact of immersion time in solutions of 2.0 M sulfuric acid on the electrochemical corrosion actions of the HSLA steel. Also recorded was the effect of applying specific concentrations of 3-amino-1, 2, 4-triazole (ATA) on inhibition of this steel after the multiple exposure times in the acid solution. The empirical portion of this research was performed using Open Circuit Potential, Electrochemical Impedance Spectroscopy, and analyses of Potentiodynamic Polarization. The inhibitor's inhibition performance was measured using quantum electrochemical techniques. The anatomy after treatment was examined without and with incremental green concentration levels in 3.5 wt. percent NaCl steel alloy solutions 4130 surfaces. The optimum conditions among some of the predictor parameters (i.e., inhibitor concentration, flow rate, and heat) that affect corrosion levels and inhibition efficiencies were measured using study arithmetic undertaking (Box – Behnken) [24].

The present work aims to use the De-Broglie wavelength hypothesis as an important tributary in nanotechnology, alongside Heisenberg's uncertainty principle in deriving the quantum impedance of the proton. The quantum impedance of beta particle electron along with its velocity and frequency can be inferred. The De-Broglie hypothesis was derived from Heisenberg's uncertainty principle. The formulas of proton and beta particle impedance alongside the velocity and frequency of beta particle are important. That can be used as an application area in nanoscience, for instance in electronics, chemistry, physics, biology etc.as they allow us to study the behavior of beta particle and proton travel via material or Nano-sized systems. The term impedance was used, since it is more general than resistance and conductance, respectively. Therefore, they would be an important tributary for workers in the field of application.

The Methodology Calculation of the Impedance of Single Proton, electron of beta particle less than 1MeV

This approach focused on the idea that a full proton and beta particle has the same wavelength in a given material. Such substance has been placed in a vacuum tube that is connected to a high voltage power supply to intensify the falling particles based on their form to change the nanotechnology properties of that material. By De-Broglie Principle [5]

$$\lambda = \frac{h}{p},\ p = (mv) \text{ and } (p = mv),$$

where λ and p are the wavelength and momentum of any particle, h is the plank's constant, m and v is the mass and velocity of any particle being studied. According to this theory, proton and beta particle velocities are:

$$v_p = \frac{h}{m_p \lambda_p}, \quad (1)$$

$$v_e = \frac{h}{m_e \lambda_e}. \quad (2)$$

Dividing equation (1) by (2), and noting that λe= λp, the following equation was obtained:

$$v_p = v_e\left(\frac{m_e}{m_p}\right). \quad (3)$$

According to the Heisenberg Uncertainty Principle, the standard proton position error and momentum may be given as the following form [5].

$$\Delta p_p . \Delta x_p \geq \frac{h}{2\pi}, \quad (4)$$

where (v_p) is the velocity of the proton, (t) is the time taken to travel the distance (x) and (m) is the mass of the proton. Substitute equation (3) by (4), get

$$m_p\left(v_e^2 \frac{m_e^2}{m_p^2}\right).t \geq \frac{h}{2\pi}. \quad (5)$$

The time (t) can be written as ($t = {}^{e}/_{I}$), where (e) is the charge of the electron relative to the charge of the proton, and I is the current. Beta particle velocity under high voltage is equal to [5]:

$$v_e = \sqrt{\frac{2eV}{m_e}}.$$

If (V) is the voltage applied to accelerate the beta particle, replace in the equation (5) to obtain the other form as follows:

$$\frac{2eV}{m_e} . \frac{m_e^2}{m_p} . \frac{e}{I} \geq \frac{h}{2\pi}.$$

This gives the quantum proton impedance:

$$I_{mp} \geq \frac{\hbar m_p}{2 m_e e^2}. \quad (6)$$

This leads to (12.92x 1836= 23721.1KΩ).

Equation (6) can be regarded as the proton's quantum impedance. Since a proton's mass is 1836 times greater than that of the electron (m p /m n = 1836), this leads us to infer that the beta particle's quantum impedance is equal to:

$$I_{me} \geq \left({}^{\hbar}\!/_{2e^2}\right). \quad (7)$$

That agreement [8], this leads to (12.92 KΩ).

To prove the equation (7), use the equation (4) and substitute the values of each, and in addition to changing the beta particle velocity value to obtain the electron's quantum impedance:

$$2eV.\frac{e}{I} \geq \hbar.$$

Moreover, we get through rearranging:

$$R_{me} \geq \frac{\hbar}{2e^2}, \quad (8)$$

agreement with (7).

Also derive the equation (8) by another way, it is known that the following can be given to electrical conductivity (σ):

$$\left(\sigma = \frac{I}{\Delta V}\right),$$

where I is the current and V is the voltage, the qualities equal to those of:

$$I = \frac{e}{\Delta T}.\Delta V = \frac{\Delta E}{e},$$

where e is the charge of the beta particle of an electron, ΔT is the time interval, ΔE is the electrostatic charge field, by replacing the values of and in the conductivity equation, we get the following relationship:

$$\sigma = \frac{\frac{e}{\Delta T}}{\frac{\Delta E}{e}}.$$

To simplify this equation, we are getting,

$$\sigma = \frac{e^2}{\Delta E.\Delta T}.$$

Because conductivity is the reciprocal of impedance, that leads to equation validity (8). The relationship of $\Delta E.\Delta T$ is the other aspect of the concept of uncertainty principle (equal to $\frac{\hbar}{2}$) which contributes to the equation $\sigma = \frac{2e^2}{\hbar}$ equivalent to 7.73 Ω^{-1} [6].

The methodology Estimation of the beta particl e velocity

The same arguments can be used for finding the speed of the accelerated beta particle. Since beta particle, velocity can be represented as follows $\sqrt{2f/em}$ where f is the force that affects the beta particle. Substituting this formula by equation (4). Alongside the squaring values of $(p = mv)$ and $(x = v.t)$, these steps lead to:

$$\frac{2Fm}{e}.v_e^2 t^2 \geq \hbar^2,$$

Replacing the v_e and F value, we get:

$$\frac{2emv^2}{2e}.m.v^2.t^2 \geq \hbar^2,$$

Simplifying further:

$m^2.v^4.t^2 \geq \hbar^2$, replacing the $t = e/I$ having another form of the equation

$$m^2.v^4.\frac{e^2}{I^2} \geq \hbar^2$$

The current equals $I = V/R$ (ohm's law), so this equation could be written as:

$$\frac{m^2 v^4 R_e e^2}{V^2} \geq \hbar^2.$$

In this case, the value of R can be replaced by equ ation (8), produces:

$$\frac{m^2 v^4 e^2 \frac{\hbar^2}{4e^4}}{V^2} \geq \hbar^2.$$

This can be achieved by rearranging:

$$\frac{m^2 v^4}{4V^2 e^2} \geq 1 ,$$

this equation refers to the speed of the beta particles (electrons).as follows:

$$v_e \geq \left(\frac{4V^2 e^2}{m^2}\right)^{1/4}. \qquad (9)$$

Equation (9) agreement with $v = \sqrt{\frac{2Ve}{m}}$ which represents the velocity of beta particle with low energy according to Heisenberg's principle of uncertainty and the De-Broglie wavelength hypothesis.

Methodology measuring the Beta particle frequency (electrons)

After replacing the value of t as $t = \frac{1}{f}$ [6], where f is the frequency of the beta particle electron, we can also depend on equation (4), with rearrangement we get:

$$\frac{mv^2}{f} \geq \hbar.$$

Can substituting the value of v_e ,thus we get, $f \geq \frac{m\frac{2Ve}{m}}{\hbar}$ and lastly,

$$f \geq \frac{2Ve}{\hbar}. \qquad (10)$$

This new equation reflects the strong relation between the frequency of beta particles and the power supply.

The Methodology derivation of the de-Broglie

wavelength according to uncertainty principle

To achieve the de- Broglie wave length according to the principle of uncertainty. Fourier transformation of the wave function has been used for this purpose [11].

Therefore, k number can be written as $k = \frac{2\pi}{\lambda}$ also Δk is reciprocal of ΔX.

In addition, employing the principle of uncertainty (equation 4): $\Delta p \geq \hbar.\Delta k$ replacing the value of the Δk, we get:

$$\Delta p \geq \hbar.\frac{2\pi}{\lambda} = \Delta p \geq \frac{h}{2\pi}.\frac{2\pi}{\lambda}.$$

This leads to de-Broglie wavelength, as following:

$$p = \frac{h}{\lambda}. \qquad (11)$$

Therefore, the de- Broglie wavelength follows the principle of uncertainty.

Results and discussions

All mathematical inferences and derivations showed that the uncertainty principle could be used to obtain physical properties, such as the impedance of a proton and beta particle as in equations 6 and 7. The velocity, frequency of beta particle, and de-Broglie hypothesis were all identified by the same argument as in 9, 10 and 11 equations.

Since the beta particles are charged particles (positive or negative), they interact through Coulomb scattering with the atomic electrons. When the low-energy beta particle (less than 1MeV) interacts with the material, great deviations can occur and travel in an erratic path mode. A significant part of the primary energy was passed into the struck electron when it is in a vertical collision.

Beta particles also vary in the fraction of energy lost by the radiation cycle is known as the breaking ray from other particles (heavy charged). From the classical theory, it must give energy when a charged particle is accelerated or decelerated and the deceleration radiation is known as bremsstrahlung ("breaking radiation"). The positrons similarly interact with the material when energetic. Nevertheless, when the positron comes to rest it interacts with electrons (negative charge), allowing the electron-positron pair to be annihilated. Low-energy beta particles are classically interpreted, not as high-energy, where energy was lost from electromagnetic radiation emissions.

As the beta particle travels faster than the velocity of light (phase velocity) in the material, it produces an electromagnetic ray shock wave as the Cherenkov radiation) [25, 26]. By comparing our findings, especially concerning the quantity impedance of low-energy beta-electrons (Equation 8), we find that they are consistent with previous studies such as [9-11, 27]. While the other results, as in the equations (9–11), were obtained by mathematical derivations, which are in contrast to the regular ones. As for the proton's quantum impedance, it can be considered a valuable finding for applications in nanotechnology. The term impedance was used, since it is more general than resistance. This simple relationship is important for applications in Nano science to research single proton behavior via a Nano-sized device. To further generalize the problem, we find that the amount of high energy left in the matter by a bundle of protons is dependent on the interaction with the nucleus and electron in the matter. The process of collision of protons with electrons is slightly more than for nuclear scattering in the first 50 per cent of its course, particularly in nanotechnology applications. Due to the massive difference in mass between the proton and the electron, the interaction does not affect the path of the proton. Therefore, the path of the proton will be on the straight line, and there will be some collisions before the proton rests. That makes writing protons beams predictable and using the lithographic technique to a great degree [28]. Because of low energy (less than 1MeV), beta particles remain within the non-relativistic velocity. **Fig. 1** illustrate the relationship between the velocity of beta particles with the power supply. While **Fig. 2** illustrate the relationship between the frequency of beta particles with the power supply.

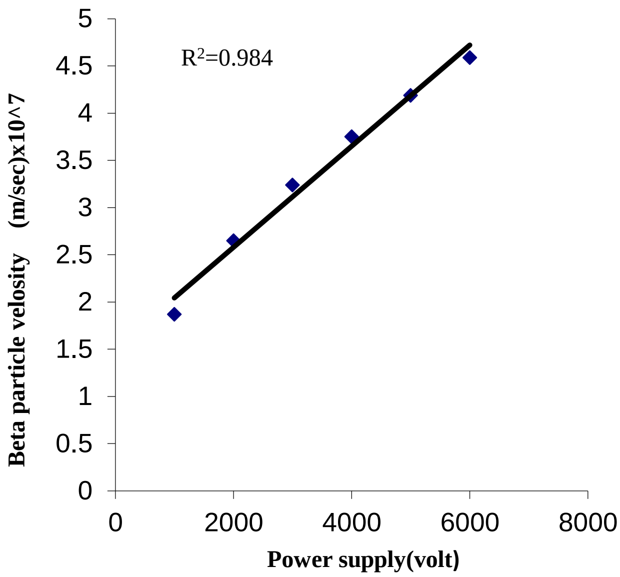

Figure 1: The beta particle velocity versus power supply

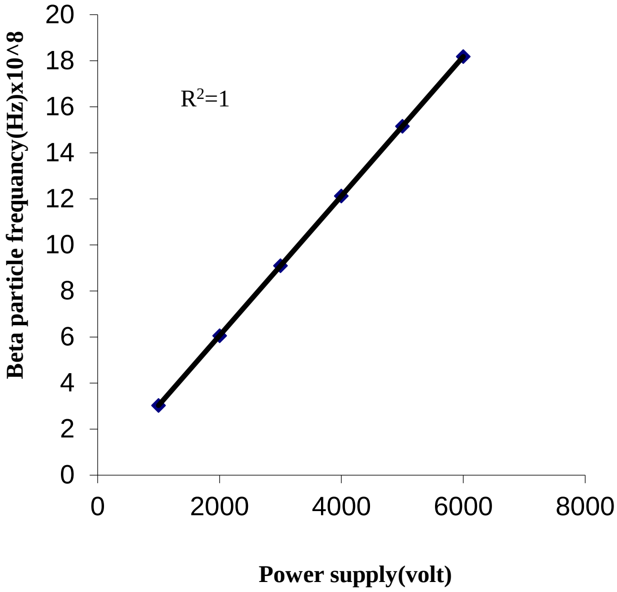

Figure 2: The beta particle frequency versus power supply.

The correlations between the velocity, frequency beta particle and power supply were 0.984 and 1, respectively. These relationships confirms the equations of 9 and 10. These formulas can be used in the field of beta particle diffraction as negative electrons through interacting with the medium. The results showed the relevance of equation 8 when evaluating the impedance of the proton. That is due to the inclusion of the Mp / Me ratio, in addition to the similarity of the remaining variables with the content of the beta particle's quantum impedance formula. One can review our findings in **Table. 1**, to explain further. That reveals a proton's quantum impedance and a beta particle. Besides the beta particle velocity and frequency, and the correlation values of its velocity and frequency with the power supply.

Table 1: Reveals a proton's quantum impedance and a beta particle. Besides the beta particle velocity and frequency, and the correlation values of its velocity and frequency with the power supply.

Proton Impedance	Beta particle impedance	Beta particle velocity	B f	and velocity	and frequency
$I_{mp} \geq \frac{\hbar m_p}{2m_e e^2}.$	$R_{me} \geq \frac{\hbar}{2e^2},$	$v_e \geq \left(\frac{4V^2e^2}{m^2}\right)^{1/4}.$	$f \geq \frac{2Ve}{\hbar}.$	0.984	1

The analyses and measurements were made easy and more concise in the table above. Therefore, such relationships may be used, particularly for those who work in the nanoscience-applied area. Via the values of these calculations, it was possible to decide the energies required to build nanomaterials with different parameters for the proton and beta particles. Besides the great benefit in the field of radiotherapy in nuclear medicine.

Conclusions

1. The quantum impedance of the proton and the electron (beta particles) was obtained from the use of the De-Broglie wavelength and Heisenberg's uncertainty principle, based on the hypothesis that their wavelengths are identical during the material interaction with qualitative or quantitative indicators of research results.

2. Quantum impedance of beta particles according to the principle of conductivity was also obtained with qualitative or quantitative indicators of research results.

3. The frequency and velocity of the beta particles (electrons) were derived from Heisenberg's uncertainty principle with qualitative or quantitative indicators of research results.

4. The de-Broglie wavelength was derived, as opposed to the normal, from the Heisenberg principle of uncertainty with qualitative or quantitative indicators of research results.

5. In particular, the quantum impedance to protons can be considered as one of the significant applications of nanotechnology, which can be used in the field of radiotherapy with qualitative or quantitative indicators of research results.

6. The formulas of proton and beta particle impedance alongside the velocity and frequency of beta particle are important. That can be used as an application area in nanoscience, for instance in electronics, chemistry, physics, biology etc.as they allow us to study the behavior of beta particle and proton travel via material or Nano-sized systems. The term impedance was used, since it is more general than resistance and conductance, respectively. Therefore, they would be an important tributary for workers in the field of application.

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References

[1] S. Sakaguchi, T. Sakurai, J. Ma, M. Sugimoto, T. Yamaki, A. Chiba, Y. Saito, S. Seki, Conjugated Nanowire Sensors via High-Energy Single-Particle-Induced Linear Polymerization of 9, 9′-Spirobi [9 H-fluorene] Derivatives, The Journal of Physical Chemistry B, 122 (2018) 8614-8623.

[2] A. Henglein, Mechanism of reactions on colloidal microelectrodes and size quantization effects, in: Electrochemistry II, Springer, 1988, pp. 113-180.

[3] S. Chen, F. Xiong, W. Huang, Surface chemistry and catalysis of oxide model catalysts from single crystals to nanocrystals, Surface Science Reports, 74 (2019) 100471.

[4] S.V. Kalinin, O. Dyck, N. Balke, S. Neumayer, W.-Y. Tsai, R. Vasudevan, D. Lingerfelt, M. Ahmadi, M. Ziatdinov, M.T. McDowell, Toward electrochemical studies on the nanometer and atomic scales: Progress, challenges, and opportunities, ACS nano, 13 (2019) 9735-9780.

[5] C. Eichler, A. Sigillito, S.A. Lyon, J.R. Petta, Electron spin resonance at the level of 1 0 4 spins using low impedance superconducting resonators, Physical review letters, 118 (2017) 037701.

[6] N. Ikematsu, H. Takahashi, Y. Hattori, M. Kitamura, Formation of a mixed monolayer on a gold surface using fluorobenzenethiol and alkanethiol, Japanese Journal of Applied Physics, 59 (2019) SDDA09.

[7] Z. Lv, Y. Wang, J. Chen, J. Wang, Y. Zhou, S.-T. Han, Semiconductor quantum dots for memories and neuromorphic computing systems, Chemical Reviews, (2020).

[8] S. Gunasekaran, J.E. Greenwald, L. Venkataraman, Visualizing quantum interference in molecular junctions, Nano Letters, 20 (2020) 2843-2848.

[9] J.M. Seminario, Quantum current–voltage relation for a single electron, Journal of Physics B: Atomic, Molecular and Optical Physics, 40 (2007) F275.

[10] T. LaFave Jr, R. Tsu, Capacitance: A property of nanoscale materials based on spatial symmetry of discrete electrons, Microelectronics journal, 39 (2008) 617-623.

[11] P. Cameron, Electron Impedances, Apeiron: Studies in Infinite Nature, 18 (2011).

[12] M.V. Putz, On Heisenberg uncertainty relationship, its extension, and the quantum issue of wave-particle duality, International journal of molecular sciences, 11 (2010) 4124-4139.

[13] O. Malinkiewicz, M. Imaizumi, S.B. Sapkota, T. Ohshima, S. Öz, Radiation effects on the performance of flexible perovskite solar cells for space applications, Emergent Materials, 3 (2020) 9-14.

[14] M.A. Kastner, Artificial atoms, Physics today, 46 (1993) 24-24.

[15] S.C. Tunneling, Vol. 294 of NATO Advanced Studies Institute Series B: Physics, edited by H, Grabert and MH Devoret Plenum Press, New York, (1991).

[16] S. Washburn, Mesoscopic Phenomena in Solids, edited by Al'tshuler, BL, Lee, PA, and Webb, RA, in, Elsevier Science Publishers, 1991.

[17] M. Reed, J. Randall, R. Aggarwal, R. Matyi, T. Moore, A. Wetsel, Observation of discrete electronic states in a zero-dimensional semiconductor nanostructure, Physical Review Letters, 60 (1988) 535.

[18] J. Scott-Thomas, S.B. Field, M. Kastner, H.I. Smith, D. Antoniadis, Conductance oscillations periodic in the density of a one-dimensional electron gas, Physical review letters, 62 (1989) 583.

[19] L. Glazman, R.I. Shekhter, Coulomb oscillations of the conductance in a laterally confined heterostructure, Journal of Physics: Condensed Matter, 1 (1989) 5811.

[20] M. Pindariya, A.S. Chaudhari, F.M. Joshi, K. Joshipura, H.N. Kothari, Electron and Positron Impact Ionization Cross Sections of O and Hg Atoms, Journal of Atomic, Molecular, Condensate and Nano Physics, 5 (2018) 229-237.

[21] R. Landauer, Electrical resistance of disordered one-dimensional lattices, Philosophical magazine, 21 (1970) 863-867.

[22] E.-S.M. Sherif, A.T. Abbas, H. Halfa, A. El-Shamy, Corrosion of high strength steel in concentrated sulfuric acid pickling solutions and its inhibition by 3-amino-5-mercapto-1, 2, 3-triazole, Int. J. Electrochem. Sci, 10 (2015) 1777-1791.

[23] E.-S.M. Sherif, A.T. Abbas, D. Gopi, A. El-Shamy, Corrosion and corrosion inhibition of high strength low alloy steel in 2.0 M sulfuric acid solutions by 3-amino-1, 2, 3-triazole as a corrosion inhibitor, Journal of Chemistry, 2014 (2014).

[24] A. El-Shamy, M. El-Hadek, A. Nassef, R. El-Bindary, Optimization of the Influencing Variables on the Corrosion Property of Steel Alloy 4130 in 3.5 wt.% NaCl Solution, Journal of Chemistry, 2020 (2020).

[25] J. O'Connell, Comparison of the four fundamental interactions of physics, The Physics Teacher, 36 (1998) 27-27.

[26] O. Langhelle, Why ecological modernization and sustainable development should not be conflated, Journal of environmental policy and planning, 2 (2000) 303-322.
[27] http://www.electronspin.org.
[28] J.A. Van Kan, A.A. Bettiol, K. Ansari, E.J. Teo, T. Sum, F. Watt, Proton beam writing: a progress review, International journal of nanotechnology, 1 (2004) 464-479.

الملخص

توظيف فرضية طول موجة دي برولي الى جانب مبدأ عدم اليقين لهايز نبيرك في تحديد الممانعة الكمية للبروتون وجسيم بيتا

تم توظيف فرضية طول موجة دي برولي الى جانب مبدأ عدم اليقين لهايز نبيرك لتحقيق فهم جديد للمانعة الكمية التي سوف يظهرها البروتون عند تفاعله مع المادة. كما تم التوصل الى الممانعة الكمية لجسيم بيتا (الالكترون) ذي طاقة منخفضة اقل من 1 ميكا الكترون فولت الى جانب سرعته وتردده. تم التوصل الى تلك الصيغ بناءا على فرضية تساوي الطول الموجي لكلا من البروتون وجسيم بيتا اثناء تفاعلهما مع المادة في محيط مفرغ من الهواء تحت الجهد العالي. يمكن اعتبار تلك العلاقات المشتقة نظريا ذات فائدة مهمة في تقنية علوم النانو تكنلوجي الى جانب تطبيقها في مجال العلاج الاشعاعي المستخدم في الطب النووي. أظهرت النتائج التي تم الحصول عليها فيما يتعلق بسرعة جسيم بيتا أنها متسقة مع صيغتها المعروفة ولكن بنهج جديد، اما تردده فيمكن اعتباره كصيغة جديدة يمكن التعويل عليها بعد ان اثبتت صحتها وتناسبها الخطي مع الجهد المسلط. أشارت النتائج الى إمكانية توظيف مبدأ عدم اليقين في تحديد موقع وزخم كلا من البروتون وجسيم بيتا وصولا الى ممانعتهما الكلية. بالإضافة إلى ذلك، تم الحصول على نفس الممانعة الكمية لجسيم بيتا وفقًا لمبدأ التوصيلية وبتوافق تام. أوضحت النتائج دقة المعادلة 8 عند تقييم الممانعة الكمية للبروتون ويعزى ذلك الى وجود النسبة ما بين كتلة البروتون الى كتلة الالكترون في الصيفة المشتقة بالإضافة الى تشابه المتغيرات الأخرى بالموازنة مع الممانعة الكمية لجسيم بيتا. تم توظيف مبدأ عدم اليقين لهايز نبيرك لاشتقاق طول موجة دي برولي على عكس المعتاد دائما. وجد ان هناك ترابط قوي ما بين سرعة وتردد جسيم بيتا مع الجهد المسلط.