Emission & Absorption of Photons

(Electric Charge & Speed of the Extended Electron in Electric Field)

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Abstract

The subject of " Emission & Absorption of Photons " has plenty of topics to be discussed . This article restricts its discussion to this specific topic : **how the emission & absorption of photons affect the <u>electric charge and speed</u> of the extended electron** when it is subject to an applying electric field **E** .

Introduction :

1/ Recall of the extended model of the electron .

2/ A new interpretation of the processes of emission & absorption of photons .

The extended electron is assumed to be a spherical particle consisting of a negatively charged core ($-q_0$) , surrounded by a cloud of static electric dipoles (+q , -q) [1]**.** This figure of the extended electron is **a version** of the electron that is screened by a cloud of virtual pairs (e^- , e^+) in the concept of vacuum polarization of QED, as shown in Fig.1 .

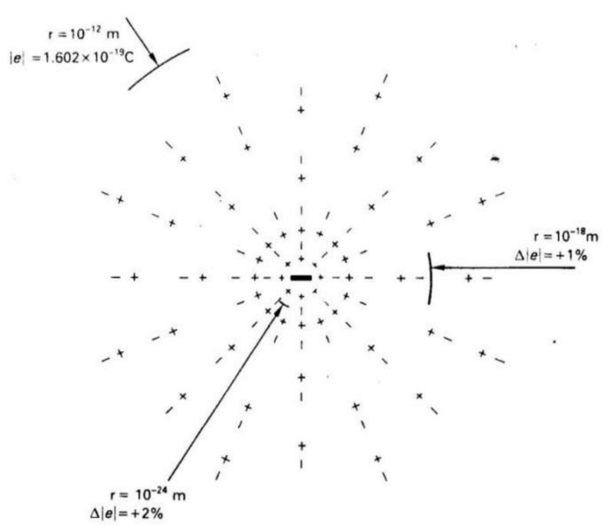


Fig. 1 : The electron is screened by virtual pairs (e^- , e^+) in the concept of vacuum polarization of QED . We notice that this figure describes the change of the effective (apparent) electric charge of the electron by the external physical condition : it may be the distance between charged particles (or equivalently , the strength of the applying field) . In the version , i.e., in the extended electron , the virtual pairs (e^- , e^+) are replaced by real static electric dipoles (+q , -q) which surround the core ($-q_0$) .

In previous articles , we have proved that when the extended electron is subject to an external electric / magnetic field , electric or magnetic forces are developed on the point charges $-q_0$, -q , +q of the electron to give rise to various features of the electron such as the **spin , radiation , and change of the effective charge Q** [2] [3]**.** In these articles , a new interpretation of the process of emission and absorption of photons has been introduced as follows :

The emission of photons of the electron means **it emits its electric dipoles (+q , -q) outwards** . That is , the electric dipoles that surround the core ($-q_0$) are identified as **photons** after they are emitted from the surface of the electron ; and thus , **photons are tiny static electric dipoles (+q , -q) that construct the electron .** And since photons are electric dipoles , they can be attracted by the self electric field of the electron . We already knew the fact that electric dipoles are pulled (attracted) into the stronger region of an inhomogeneous electric field : this is how the electric field of the electron can absorb photons from the surrounding space or from the irradiating source . Therefore , in this article we will accept the innovative idea that **when the electron emits photons , it loses some of its electric dipoles ; and when it absorbs photons , it gains more electric dipoles from the irradiating source .**

With this new interpretation of the process of emission and absorption of photons , we will demonstrate **how they affect the effective charge and speed of the electron** when it moves in an external electric field . So , the topic of this article is :

The change of electric charge and speed of the electron when it emits & absorbs photons in the external electric field E

We will try to prove two following statements :

- When the electron emits (radiates) photons : the magnitude |Q| of its effective electric charge increases to q_0 , and the electron slows down (i.e., it loses energy) . (1)

- When the electron absorbs photons : |Q| decreases to zero , and the electron speeds up (i.e., it gains energy) . (2)

The reasoning will go through three steps :

First , we prove that the **emission and absorption** of photons of the electron are linked to the **physical factor 'a'** , which represents the **physical structure of the extended electron** . (3)

In second and third steps : we prove that this **physical factor 'a'** has mathematical relationship with the **effective electric charge and speed** of the electron . (4)

1. First step : the change of factor 'a' in the emission & absorption of photons

First , let 's recall some expressions derived from the extended electron when it is subject to an external electric field **E** [4] : Two electric forces **F** and **F'** are produced on the electron :

- **F** = $\sum$ **fe** = $(\frac{1}{\varepsilon} - 1)\, q\, \mathbf{E} \sum_i^n \cos^2\alpha_i$ is the resultant force of all forces **fe** developed on **n** surface dipoles of the electron .

- **F '** = $-\frac{1}{\varepsilon}\, q_0\, \mathbf{E}$ is the electric force developed on the core $-q_0$ of the electron .

Hence , the net force developed on the electron is **Fe** = **F** + **F '**

$$\mathbf{Fe} = (\frac{1}{\varepsilon} - 1)\, q\, \mathbf{E} \sum_i^n \cos^2\alpha_i - \frac{1}{\varepsilon}\, q_0\, \mathbf{E}$$

by factoring $q_0 \mathbf{E}$, we get $\mathbf{Fe} = \left[(\frac{1}{\varepsilon} - 1)\, (q / q_0) \sum_i^n \cos^2\alpha_i - \frac{1}{\varepsilon} \right] q_0 \mathbf{E}$

Let’s set

$$\boxed{a \equiv (q / q_0) \sum_i^n \cos^2\alpha_i} \qquad (5)$$

hence

$$\mathbf{Fe} = (\frac{a-1}{\varepsilon} - a)\, q_0\, \mathbf{E} \qquad (6)$$

(**Note** : for the electron , **Fe is in opposite direction to the applying field E** ; hence the factor $(\frac{a-1}{\varepsilon} - a)$ in Eq.(6) is negative . We will use this factor later)

'a' is thus a dimensionless positive number since q , q_0 and $\sum_i^n \cos^2\alpha_i$ are positive numbers belonging to the extended electron . It represents the *physical structure of the extended electron* and depends on the number **n** of surface dipoles of the electron .

Eq.(5) leads to the following relationship between **emission & absorption** and **the factor 'a'** :

When the electron radiates , it loses some of its surface dipoles ; i.e., **n** decreases and hence **'a'** decreases accordingly , because $\sum_i^n \cos^2\alpha_i$ is the sum of **n** positive terms $\cos^2\alpha_i$.

Therefore , **in the emission of photons : n decreases , hence 'a' decreases** (7)

Conversely , when the electron absorbs photons , it gains more surface dipoles ; i.e., **n** increases and hence **' a '** increases accordingly .

Therefore , **in the absorption of photons : n increases , hence 'a' increases** (8)

This is the first step of reasoning : we have linked the **emission and absorption of photons to the physical factor 'a'** by two expressions (7) and (8)

2 . Second step : the change of the effective charge |Q| in the emission & absorption of photons

Now , we move to the second step , we will relate the factor **'a'** to **the effective charge Q** of the electron .

From Eq.(6) we can deduce the effective electric charge Q of the electron (since **Fe =** Q **E)** :

$Q = \left(\frac{a-1}{\varepsilon} - a \right) q_0$ where $a > 1$, $\varepsilon < 1$, $\left(\frac{a-1}{\varepsilon} - a \right) < 0$ (refs.[1] and [4]) (9)

In Eq.(9) Q is negative because $\left(\frac{a-1}{\varepsilon} - a \right) < 0$ as noted from Eq.(6) .

But what we need for calculations is the magnitude of Q ; we denote it as |Q| , so

$$|Q| = \left(a - \frac{a-1}{\varepsilon} \right) q_0 > 0 \qquad (10)$$

Let ' s take derivative of |Q| with respect to ' a ' , at a constant value of ε :

$\boxed{d|Q| / da = (1 - 1 / \varepsilon)\, q_0 < 0}$ because $\varepsilon < 1$ (11)

From Eq.(11) we conclude that |Q| **is monotonic decreasing with respect to the factor 'a'** .
This means that , if 'a' increases , |Q| decreases **;** and if 'a' decreases , |Q| increases .
This is the result of the second step .

By combining the first and second steps , we come to two results :

- **in the emission of photons : 'a' decreases** (first step) **, |Q| increases** (second step) (12)

- **in the absorption of photons : 'a' increases** (first step) **, |Q| decreases** (second step) (13)

3 : Third step : the change of the speed of the electron in the emission & absorption of photons

Finally , the third step will complete the reasoning ; we will show that

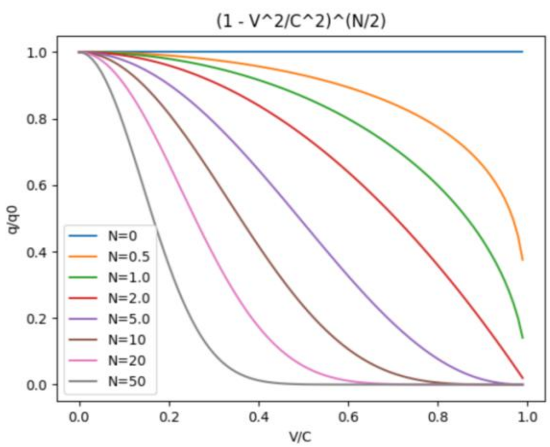
- **in the emission of photons : the electron slows down ,**

- **in the absorption of photons : the electron speeds up .**

Let us recall that in the previous article [5] entitled **" Electron's mass and electric charge, which one changes with velocity ?** " we have obtained the general expression for the effective electric charge $|Q|$ of the electron when it is subject to an applying field that is represented by the real number $N \geq 0$.

The chart shows the magnitude of the electric charge of the electron in function of the speed for various values of N .

$$|Q| = (1 - v^2 / c^2)^{N/2} q_0 \qquad \text{Fig.2} \qquad (14)$$



Correction : the ordinate (vertical) axis of the chart in Fig.2 shows the ratio $|Q| / q_0$, not q / q_0

From Eq.(14) we extract v^2 / c^2 :

$$v^2 / c^2 = 1 - [|Q| / q_0]^{2/N} \qquad (15)$$

Let ' s take derivative of v^2 / c^2 with respect to $|Q|$ we get

$$\boxed{d(v^2/c^2)/d|Q| = -(2/N)(1/q_0)(|Q|/q_0)^{(2/N)-1} < 0} \qquad (16)$$

Eq.(16) means that v^2/c^2 **is monotonic decreasing with respect to** $|Q|$ **,** that is

if $|Q|$ increases , v^2/c^2 decreases ; and conversely , if $|Q|$ decreases , v^2/c^2 increases .

This is the result of the third step . In short , by combining these three steps , we get

- **in the emission of photons : 'a' decreases** (first step) **, |Q| increases** (second step)

and $\mathbf{v^2/c^2}$ **decreases** (third step) **,** i.e., **the electron slows down .** (17)

- **in the absorption of photons : 'a' increases** (first step) **, |Q| decreases** (second step) and

and $\mathbf{v^2/c^2}$ **increases** (third step) , i.e., **the electron speeds up** . (18)

Summary and conclusion

First let's talk about **<u>the factor 'a'</u>** defined by Eq.(5) . It originates from the net electric force **Fe** (Eq.(6)) which is produced on the extended electron . Since it changes with the number **n** of surface dipoles of the electron , it can be used to relate other physical quantities like electric charge or speed of the electron to the emission (radiation) and absorption of photons .
Two expressions (7) and (8) in the first step are new statements which did not exist in the mainstream physics .

Next is the change of **<u>the effective electric charge</u>** of the electron . Nowhere in the mainstream physics do physicists talk about the changeability of the electric charge of the electron : they are determined that it is a fundamental constant of physics , and this is because the electron is a solid point charge ! But in the theory of the extended electron , the electron is assumed to have a core ($-q_0$) surrounded by a cloud of static electric dipoles (+q , -q) . When exerted upon by an external field , these dipoles change their polarization (orientation) , cause a change in the permittivity **ε** or in the permeability **μ** of the electron and hence , a change in its electric charge . In the emission & absorption of photons, the change of the factor **'a'** is the cause of change in the electric charge . Both **ε** and **'a'** are present in Eq.(10) : this means that **the electric charge can be changed by the applying field or by the emission or absorption of photons .** Eq.(10) and Eq.(14) and its chart (Fig.2) are innovative findings of the theory of the extended electron .

Last but not least , let's talk about the change of **<u>the speed of the electron</u>** in the process of emission & absorption . Physicists have long revealed that electrons that radiate in the accelerators slow down and electrons in the photoelectric effect speed up. So , the result of the third step is **not a new discovery** ; it simply shows that the change of speed of the electron in the emission and absorption can be proved by using equations and expressions deduced from the extended model of the electron . This means that the model is meaningful and suitable for **explaining the mechanism of the emission and absorption of photons of the electron [6].**

Conclusion : To provide experimental evidence to support the theory of the extended electron , a thought experiment has been proposed in the article [7] : **" A Fundamental Problem in Physics : Mass vs Electric Charge "** to show the variability of the electric charge of the electron in a variable magnetic field .
More thought experiments will be proposed in coming articles to demonstrate :
- Spin & Radiation of the electron in a time-varying magnetic field ,
- Electric dipoles are Photons and vice versa , (using the diffraction of light) .

References

All following articles of the theory of the extended electron are showed in the **classical physics website : www.vixra.org/author/hoa_van_nguyen**

[1] A new extended model for the electron : www.vixra.org /abs/ 1305.0025

[2] Extended electron in time-varying electric field : Spin & Radiation : www.vixra.org/abs/ 1312.0110

[3] Extended electron in time-varying magnetic field : Spin & Radiation : www. vixra.org/abs/ 1312.0018

[4] Extended electron in constant electric field : www.vixra.org/abs/1306.0235

[5] Electron ' s mass and electric charge , which one changes with velocity ? : www.vixra.org/abs/:1304.0066

[6] Visualizing spin and radiation of the extended electron in electric field (Emission & Absorption of photons) :

www.vixra.org/abs/ 2112.0029

[7] A Fundamental Problem in Physics : Mass vs Electric Charge : www.vixra.org/abs/2109.0010