

# Thought experiments proposed for the theory of the extended electron

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## Abstract

This article proposes three thought experiments that are devised to support the theory of the extended model of the electron :

1. Variability of the electric charge of the electron in variable magnetic field .
2. Spin & Radiation of the electron moving parallel to a time-varying magnetic field .
3. Experiment on diffraction of light to prove photons being electric dipoles and vice versa .

## Overview of the theory of the extended electron

The model of the extended electron used for discussion in this article is **a version** of the screened electron created by the vacuum polarization which is a concept of QED .The physical extended and structured model of the electron is a spherical particle consisting of a negative central core ( $-q_0$ ) surrounded by an assembly of static electric dipoles ( $+q, -q$ ) : it is a spinning and radiating particle . When the extended electron is subject to an external electric or magnetic field , electric or magnetic forces are produced on these point charges ( $-q_0, -q, +q$ ) to give rise to various features of the electron such as its effective electric charge , spin and radiation ... The following thought experiments are figured out to verify these properties of the extended electron .

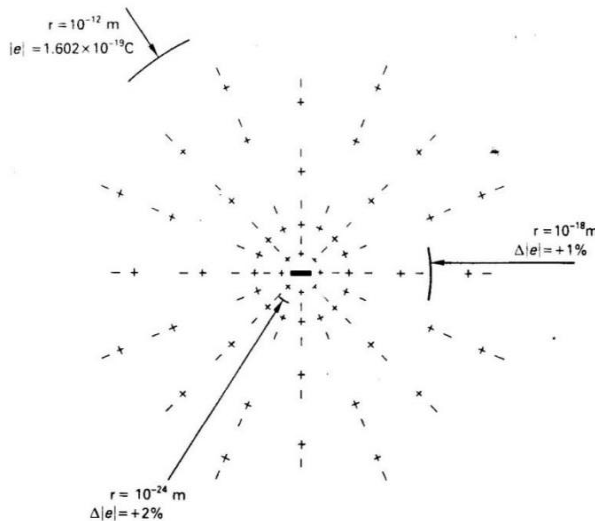


Fig.1 : This figure is scanned from Fig.13.1 in the textbook "Nuclear and Particle Physics " by W.S.C. William . The electron is screened by virtual pairs ( $e^- , e^+$ ) in the concept of vacuum polarization of QED .

In the version , i.e., in the model of the extended electron , the virtual pairs ( $e^- , e^+$ ) are replaced by real static dipoles ( $-q , +q$ ) that will be assimilated as photons when the electron radiates . In other words , when the electron emits its electric dipoles into surrounding space , we say it is radiating .

## 1/ Thought experiment to show the variability of the electric charge of the extended electron in variable magnetic field .

When the extended electron is subject to an applying magnetic field , the produced magnetic forces cause a polarization ( re-orientation ) of all electric dipoles inside the electron , and this causes a change in the permeability  $\mu$  , which causes a change in the magnitude  $Q$  of the effective electric charge of the electron following the equation :  $Q = [ \mu ( b-1 ) - b ] q_0$  .

We can set up an experiment to monitor the variability of  $Q$  , based on the equation  $Q = ( 1 - v^2/c^2 )^{N/2} q_0$  , where  $N \geq 0$  represents the strength of the magnetic field  $\mathbf{B}$  ( Fig.2)

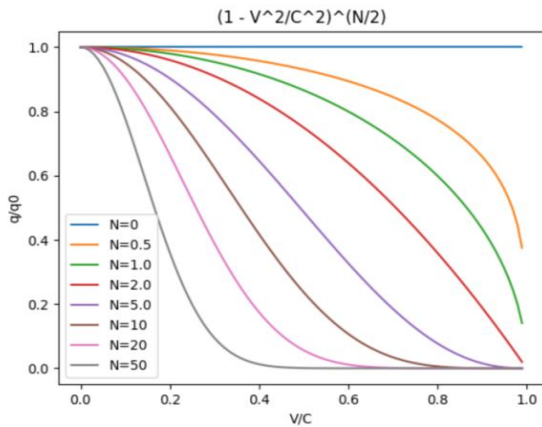


Fig.2

Correction of notation :

The ordinate ( vertical ) axis of this chart presents the ratio  $|Q| / q_0$  , not  $q / q_0$  .

In this thought experiment we keep the velocity  $v$  of the electrons unchanged while changing the strength of the magnetic field  $\mathbf{B}$  (  $N$  changes ) in the solenoid by changing the intensity of the current  $I$  and follow the variation of the depth of penetration of electrons in the detector ( Fig.3 )

- An electron gun produces electrons with various velocities at the point  $A$  .
- A velocity selector allows only electrons with velocity  $v$  to travel to the point  $B$  .
- A solenoid produces a uniform magnetic field  $\mathbf{B}$  along its axis which coincides

with the trajectory of the electron beam . The intensity  $\mathbf{B}$  of the magnetic field can be regulated by the current  $I$  . Since  $v \parallel \mathbf{B}$  , there is no net ( magnetic ) force produced on the electron , so electrons travel with **constant velocity  $v$**  through the solenoid to the point  $C$  . And thus , **there is no change in the mass or the kinetic energy of the electron with velocity .**

- A detector , which may be a thick block of silver bromide ( photographic emulsion ), is installed at the exit  $C$  of the solenoid to detect the changing of the electric charge  $Q$  of the electron when  $\mathbf{B}$  changes its intensity .

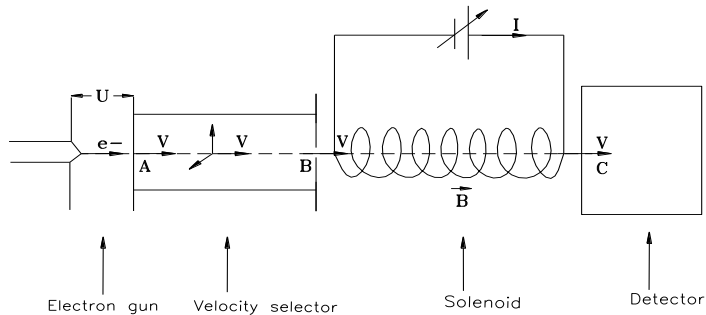


Fig 4

( Correction : this is Fig. 3 , not Fig.4)

At the entrance point  $C$  on the detector, the velocity of the electron is  $v$  , and its effective charge is  $Q$  , which is expected to change when the magnetic field  $B$  significantly changes .

Since the energy loss per unit distance<sup>[1]</sup> in the medium of the detector is proportional to  $Q^2 / v^2$ , that is  $\Delta K \propto Q^2 / v^2$  , by increasing the intensity  $B$  , the effective electric charge  $Q$  will drop and hence  $\Delta K$  decreases , resulting in a deeper penetration of electrons into the block of photographic emulsion .

In short , when we change the intensity of  $B$  , if the depth of penetration responds to the change of  $B$  , this proves that  $Q$  varies with the applying magnetic field : the experiment is qualitative<sup>[2]</sup>.

Let us extrapolate the result : the stronger the magnetic pulses , the deeper the penetration becomes , and when the magnetic pulses are sufficiently intense ,  $Q \rightarrow 0$  : the interaction between electrons and molecules of silver bromide of the detector diminishes or vanishes , the free electrons eventually can traverse the medium without hindrance .

#### References :

[1] Sternheim , M.M. & Kane , J.W. , " General Physics " 2 nd Ed. , 1991 , p. 827, 850

[2] For more details , please read the article ; " A fundamental problem in physics ( mass vs electric charge " vixra : 2109.0010

## 2/ Thought experiment for the spin & radiation of extended electrons that move parallel to the time-varying magnetic field .

**Overview :** The mechanism of the processes of spin & radiation is still quite mysterious until today. The idea of whether or not the spin is the rotation of the electron is still disputed . And we have learned from the current physics that the radiation is produced by the changing of energy levels of the electron from a higher to a lower one ; and another idea about the radiation is that it is caused by the acceleration of the electron in accelerators like cyclotron or synchrotron . All these ideas are still debated as shown in the following notes of contemporary eminent physicists :

- **Feynman** : “ We have inherited a prejudice that an accelerating charge should radiate . ”
- **Jackson** : “ Radiation is emitted in ways that are obscure and not easily related to the acceleration of a charge” .” ( Classical Electrodynamics , 2 nd Ed., Chap.15 , p. 702 )
- **Pearle** : “ A point charge must radiate if it accelerates , but the same is not true of an extended charge distribution .” ( When can a classical electron accelerate without radiating ? )  
( Foundation of physics , Vol.8, No. 11/12 , 1978 , p. 879

Because of these controversies , here , in the theory of the extended electron , **the mechanism of spin & radiation is described in another way : both spin and radiation are caused by electromagnetic forces** <sup>[3][4]</sup> which are produced by time-varying magnetic /electric fields .

The spin and radiation of the extended electron in a time-varying magnetic field can be described briefly in the following scheme :

$$\begin{array}{ccccccc} \mathbf{B} & \rightarrow & \mathbf{E} & \rightarrow & \mathbf{f}_s \text{ ( spin ) } & \rightarrow & \mathbf{f}_r \text{ ( radiation ) } \\ \text{(time-varying)} & & \text{(induced)} & & \text{( Figs.6 \& 7 ) } & & \text{( Figs.8 \& 9 ) } \end{array}$$

That is , a time-varying magnetic field  $\mathbf{B}$  generates an induced electric field  $\mathbf{E}$  ( Figs. 4&5 ) which produces **spinning forces**  $\mathbf{f}_s$  that cause the electron to spin ; and the spinning motion of the electron under the action of  $\mathbf{B}$  creates **radial forces**  $\mathbf{f}_r$  which cause the electron to radiate .

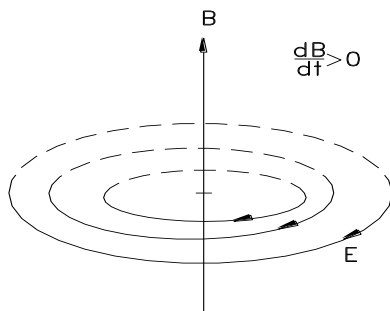


Fig.4

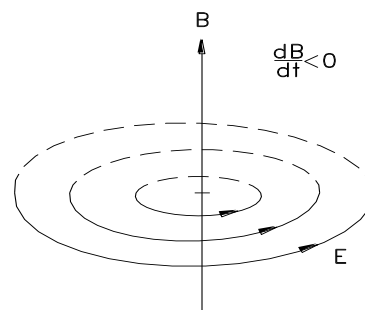


Fig.5

Fig. 4 : Direction of the induced electric field  $\mathbf{E}$  produced by the magnetic field  $\mathbf{B}$  which increases with time :  $d\mathbf{B}/dt > 0$

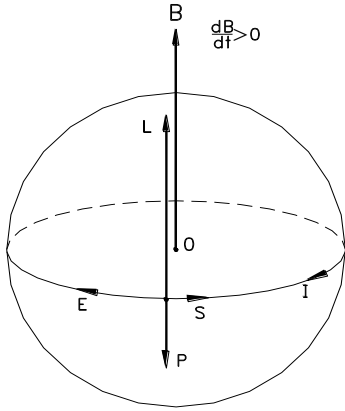


Fig.5 : Direction of the induced electric field  $\mathbf{E}$  produced by the magnetic field  $\mathbf{B}$  which decreases with time :  $d\mathbf{B}/dt < 0$

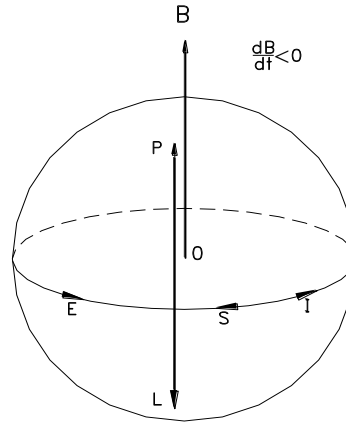


Fig. 6 : Directions of  $\mathbf{E}, \mathbf{P}, \mathbf{I}, \mathbf{S}, \mathbf{L}$  when  $d\mathbf{B}/dt > 0$ ; the electron spins up :  $\mathbf{L} \uparrow \uparrow \mathbf{B}$ ; the spin magnetic moment  $\mu\mathbf{S} \downarrow \downarrow \mathbf{P}$ .

Fig. 7 : Directions of  $\mathbf{E}, \mathbf{P}, \mathbf{I}, \mathbf{S}, \mathbf{L}$  when  $d\mathbf{B}/dt < 0$ ; the electron spins down :  $\mathbf{L} \downarrow \uparrow \mathbf{B}$ ; the spin magnetic moment  $\mu\mathbf{S} \uparrow \uparrow \mathbf{P}$ .

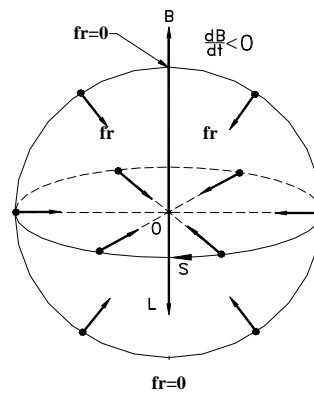
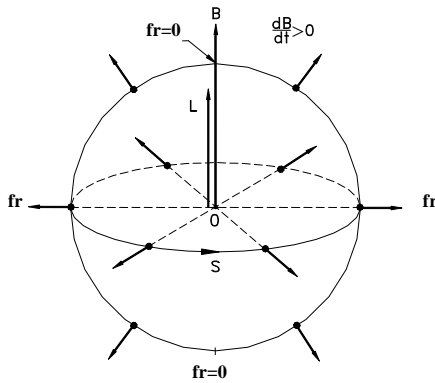


Fig.8 .  $d\mathbf{B}/dt > 0$  : magnetic radial forces  $\mathbf{fr}$  produced on all surface dipoles are **centrifugal** , they can cause the electron to radiate .

Fig.9 .  $d\mathbf{B}/dt < 0$  , magnetic radial forces  $\mathbf{fr}$  produced on all surface dipoles are **centripetal** , they cannot cause the electron to radiate .

The following thought experiment is proposed to demonstrate the mechanism of spin and radiation in a time-varying magnetic field . We set two different solenoids on the same vertical axis . The lower solenoid carries a time-varying electric current , it produces a time-varying magnetic field along the axis . The upper solenoid carries a constant current : it creates a constant magnetic field on the same axis . We arrange the solenoids and the electric currents such that the magnetic field  $\mathbf{B}$  in both solenoids always point upwards as shown in the above figures . A beam of electrons is injected along the axis , from below through both solenoids . When electrons pass through the lower solenoid , they spin and radiate in the time-varying magnetic field  $\mathbf{B}$  ( when  $d\mathbf{B}/dt > 0$  , Figs.6 & 8 ) . When they enter the upper solenoid , they spin by inertia because the magnetic field  $\mathbf{B}$  becomes constant , the induced electric field  $\mathbf{E}$  disappears , and hence the spinning forces  $\mathbf{f}_s$  also disappear : electrons spin by inertia and keep on radiating under the action of the constant magnetic field  $\mathbf{B}$  .

Now , let 's change the time- rate  $d\mathbf{B}/dt$  to negative , i.e.,  $d\mathbf{B}/dt < 0$  in the lower solenoid , the induced electric field  $\mathbf{E}$  reverses its direction ( Fig.5 ), the spin direction  $\mathbf{S}$  also reverses ( Fig.7 ) . Electrons that enter the upper solenoid spin by inertia in constant  $\mathbf{B}$  , but all radial forces  $\mathbf{f}_r$  become centripetal ( Fig.9 ) : the electron cannot radiate .

The radiation of the electron requires two conditions :

1/ the radial forces  $\mathbf{f}_r$  must be centrifugal as shown in Fig.8 ; this condition requires  $d\mathbf{B}/dt > 0$ ,  
 2/ the strength of  $\mathbf{f}_r$  must overcome the cohesive forces  $\mathbf{G}$  inside the electron<sup>[5]</sup> :  $\mathbf{f}_r > \mathbf{G}$  ,  
 this condition can be done by regulating the strength of  $\mathbf{B}$  and the magnitude of the time-rate  $d\mathbf{B}/dt$  .

In short , the electron can radiate only if these two conditions are met .

If this experiment succeeds , it proves that when  $d\mathbf{B}/dt > 0$  , electrons radiate while spinning by forces in the lower solenoid or by inertia in the upper solenoid . And thus , **the spin causes the radiation , not the acceleration** , ( because no net magnetic forces are produced on electrons that travel parallel to the magnetic field , hence there is no acceleration in both solenoids ) .

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#### References :

[3] Extended Electron in Time-Varying Magnetic Field : Spin and radiation . vixra : 1312.008

[4] Visualizing the extended electron and its spin & radiation in magnetic field . vixra : 2112.0030

[5] A new extended model for the electron . vixra : 1305.0025

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### 3. Thought experiments on diffraction of light to prove that photons behave like electric dipoles

#### Diffraction of light and electrons

We already knew that electric dipoles are pulled into the stronger region of an inhomogeneous electric field . Now , if photons are electric dipoles , they too are pulled to the stronger region of an electric field . This idea can help account for the phenomenon of diffraction of light .

Let 's consider the classical experiment of diffraction of light on a sharp metallic straight edge ( e.g., a razor blade ) . The outermost layers of atoms of the edge create a microscopic inhomogeneous electric field over the edge . When a beam of light strikes the edge , the photons ( electric dipoles ) which are closer to the edge , are deflected more towards the edge where the electric field is stronger . The angles of deflection depend on the gradient of the inhomogeneous electric field . So , photons of different angles of deflection form different fringes of diffraction .

Now , let's create a disturbance in the inhomogeneous electric field of the edge to see the impact on the deflection of different paths of the photons ( and hence on the diffraction pattern ) . We can make such an intense disturbance on the strength of the electric field on the edge by :

- 1/ heating the edge by a heat source , or
- 2/ by passing an electric current through the edge , or
- 3/ by accumulating extra electrons (or other charged particles) onto the edge by using a Van de Graaff generator .

If the " disturbed" electric field on the edge could cause a disturbance in the diffraction pattern , ( which is the "image" of the microscopic inhomogeneous electric field created by various layers of atoms on the edge ) , this proves that photons behave as tiny electric dipoles that construct the extended electron (Fig.1 ) .

Now if we use a beam of electrons in place of a beam of light , we will get a diffraction pattern of the electrons on the photographic plate . And if we place a magnet between the obstacle and the plate , the diffraction pattern is distorted . “ *The distortion produced in an electron diffraction pattern by a magnetic field – a striking and convincing demonstration that the diffraction phenomenon is directly related to the charged electrons and is not due to an electromagnetic or other wave that might be thought to accompany the particles* ”. <sup>[6]</sup>

The diffraction of electrons suggests that electrons have *electric dipole moments* ( like photons or electric dipoles) which cause them to deflect to the stronger region of the inhomogeneous electric field on the edge of the obstacle . And thus they must be regarded as extended particles containing both positive and negative charges , not point particles with only negative charge .

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[6] A.P. French & E.F. Taylor , *An introduction to Quantum Physics* ,1978 , p. 75-76

[7] [www.vixra.org/author/hoa\\_van\\_nguyen](http://www.vixra.org/author/hoa_van_nguyen)

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**Conclusion :**

Experiments are the last judges who decide whether a theory is right or wrong .

Three thought experiments proposed in this article aim at justifying three major subjects of the theory of the extended electron<sup>[7]</sup> as mentioned earlier in the overview : the effective electric charge , spin and radiation of the extended electron . They need to be performed to decide the fate of the extended model of the electron .

For that reason , I would like to call on Physicists who are working in the Universities , Research Centers and Institutes of Technology around the world to help carry out these experiments , which may open up a new door to an innovative path of research on the enigmatic electron .

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