Journal of Modern Physics, 2023, 14, 1563-1577
https://www.scirp.org/journal/jmp
ISSN Online: 2153-120X
ISSN Print: 2153-1196

# Origin, Creation, and Splitting of the Electron

**Arlen Young**

Independent Researcher, Palo Alto, CA, USA
Email: arlen_young@yahoo.com

**How to cite this paper:** Young, A. (2023) Origin, Creation, and Splitting of the Electron. *Journal of Modern Physics*, **14**, 1563-1577.
https://doi.org/10.4236/jmp.2023.1412090

**Received:** September 9, 2023
**Accepted:** November 7, 2023
**Published:** November 10, 2023



## Abstract

The author's earlier papers proposed a model of the electron's internal structure comprised of both positive and negative masses and charges. Their relation to the fine structure constant $\alpha$ was calculated in the author's previous paper. In this paper, more details of the model of the electron's internal structure, in particular the thicknesses of its outer shell mass and charge, are calculated. Magnetostriction of the electron's surface is generated by the electron's spinning surface charge. It is calculated that this magnetostriction holds the electron together, counterbalancing the outward electrical and centrifugal forces. The results of these calculations enable the prediction that a sufficiently strong external magnetic field can split the electron into three equal pieces. The field strength would have to be on the order of at least 8% of the strength at the center of the electron. A model for the origin and creation of an electron from a gamma ray wave is proposed. Evidence is presented that, for certain transitions, mass might be quantized and that the quantum of mass would be $\frac{1}{2\alpha}$ times the electron mass.

## Keywords

Mass Quantization, Electron Fractionalization, Splitting the Electron, Electron Origin, Electron Creation, Electron Magnetostriction, Electron Charge Inconsistency, Electron Mass Inconsistency

## 1. Introduction

A model for the internal structure of the electron and its relationships to the fine structure constant is described in [1]. It is comprised of both positive and negative charges and masses, which were employed to resolve charge and mass inconsistencies. This document provides more details to that model, and also shows that it is conceivable that the electron can be split into three equal pieces. The topics discussed are:

- Origin of the electron—A model for the transition from a gamma ray to an electron and positron pair is presented. The initial mass, shape, and radius are determined.
- Creation of the electron—The transition of the electron from its origin to its steady state is described.
- Mass quantization—Some mass relationships suggest that certain mass transitions associated with the electron and related particles might be quantized.
- Outer shell mass thickness—The thickness of the outer shell mass is calculated from the spin angular momentum. If the outer shell's spin were to be zero, its mass is calculated and compared with its mass resulting from its actual non-zero spin.
- Charge thickness—The thickness of the charge on the outer shell's outer surface is calculated.
- Centrifugal pressure—The centrifugal pressure at the outer surface is calculated as a function of polar angle.
- Magnetostriction—Magnetostriction of the charge created by its spin is shown to counterbalance the outward centrifugal and electrical pressures, and to hold the electron together.
- Splitting the electron—When an external magnetic field is applied, the electron's charge will experience a Lorentz force due to its spin. The force is anisotropic across its surface as a result of the quantization of spin angular momentum. It is calculated that the force peaks at two polar angles which are close to the angles that partition the charge into three equal parts. The external magnetic field strength is calculated for which the Lorentz force will create a net outward force at the surface, and therefore possibly fracture the electron.

The model employs classical physics to extend, but not replace or alter, the historic model of the electron based on quantum mechanics. The model has been useful in resolving some electron attribute value inconsistencies, and in this document predicts the possibility of splitting of the charge. However, in reality it is acknowledged that the actual physical internal structure of the electron may differ from the model.

**Table 1** contains some fundamental constants from [1]. The pion mass [2] is included. **Table 2** lists some mass relationships. The values for calculated attributes are summarized in **Table 3**. Unless otherwise specified, all units are CGS.

## 2. Origin

A model is presented herein for the transition of a gamma ray to an electron-positron pair. Only the electron is considered, although the same model is expected to apply for the positron as well.

The origin is defined as that instant in time when the gamma ray ceases to exist and the electron charge $q$ is created. At the origin, the charge has a radius $R_o$, zero mass associated with it, and a spin. The electric potential energy of the

**Table 1.** Table of constants.

| Constant | Symbol | Value [cgs] |
|---|---|---|
| fine structure constant | $\alpha$ | $7.2973525693 \times 10^{-3}$ |
| Planck's constant | $h$ | $6.62607015 \times 10^{-27}$ |
| speed of light | $c$ | $2.99792458 \times 10^{10}$ |
| electron mass | $m$ | $9.1093837015 \times 10^{-28} = 0.51099895000$ MeV |
| pion mass | $\pi^{+}$ | 139.57077 MeV/c2 |
| muon mass | $m_{\mu}$ | $1.883531627 \times 10^{-25}$ g |

**Table 2.** Table of mass ratios.

| Ratio | Value |
|---|---|
| $\frac{\text{pion mass}}{\text{electron mass}}$ | $0.9966\frac{4}{2\alpha}$ |
| $\frac{\text{muon mass}}{\text{electron mass}}$ | $1.0022\frac{3}{2\alpha}$ |
| $\frac{\text{outer shell mass}}{\text{electron mass}}$ | $\frac{3}{2\alpha}$ |
| $\frac{\text{zero-spin outer shell mass}}{\text{electron mass}}$ | $\frac{2}{2\alpha}$ |
| $\frac{\text{spin mass}}{\text{electron mass}}$ | $\frac{2}{2\alpha}$ |

charge equals one-half the energy of the gamma ray photon.

The shape of the spinning charge at the origin can be deduced from the magnetic moment. The energy of the gamma ray electromagnetic wave is stored in its electric ($E$) and magnetic ($B$) fields. The energy densities are:

$$\frac{E^2}{8\pi} = \frac{B^2}{8\pi} \quad [3] \tag{1}$$

The amplitudes of the electric and magnetic fields are equal. The model assumes that this equality is preserved at the origin. The electric field $E$ is that at the surface of charge $q$:

$$E = \frac{q}{R_o^2} \tag{2}$$

The magnetic field $B$ is that produced by the spinning charge at its center:

$$B = \frac{2M_o}{R_o^3} \quad [4] \tag{3}$$

where $M_o$ is the magnetic moment of the spinning charge.

$$E = B = \frac{q}{R_o^2} = \frac{2M_o}{R_o^3} \quad M_o = \frac{1}{2}qR_o \tag{4}$$

Table 3. Summary of electron attributes.

| Attribute | Value | |
|---|---|---|
| | Origin | Steady state |
| $\frac{\text{electric field at surface } E}{\text{magnetic field at center } B}$ | 1 | $\alpha$ |
| mass | 0 | $m$ |
| shape | ring | sphere |
| outer shell radius | $0.5R$ | $R$ |
| central core radius | $0.5R$ | $0.5R$ |
| outer shell spin | | $\frac{1}{2}$ |
| central core spin | | 0 |
| quantum of mass | $\frac{1}{2\alpha}m$ | |
| spin frequency | $\frac{1}{2\alpha}$ (gamma ray frequency) | |
| outer shell circumference | $2\alpha$ (gamma ray wavelength) | |
| outer shell thickness | $0.30385418R$ | |
| surface charge thickness | $0.0023175R$ | |
| polar angles of fractures | 69.35, 110.65 degree | |
| polar angles of equal charge partitions | 70.53, 109.47 degree | |
| internal magnetic field at center $B$ | $8.29 \times 10^{17}$ gauss | |
| external magnetic field $B_{ext}$ | $0.085B$ | |

The magnetic moment expression is that of a ring spinning at the speed of light $c$ [5].

## 3. Creation

The electron at its origin is unstable. The mutual repulsion of the charge causes the ring to expand in radius and its shape to transition to a sphere. As the radius increases, the potential energy of the charge decreases and is converted to mass. The expansion stops when the mass equals the electron mass m and the radius equals the quiescent value $R$. The mass $m$ is related to the gamma ray energy by $E = mc^2$. The origin and quiescent radii are related by the change in electric energy during the creation:

$$q^2\left(\frac{1}{R_o} - \frac{1}{R}\right) = mc^2 \tag{5}$$

The classical electron radius is $R = \frac{q^2}{mc^2}$ [1]. The radius at the origin is therefore:

$$R_o = \frac{R}{2} \tag{6}$$

During the creation, mass is created from the change in electric potential energy. This mass can be resolved into positive and negative components. Likewise, the charge can be resolved into negative and positive components. Each charge has a mutual outward repulsive force. The outer shell is comprised of the positive mass and negative charge. The repulsive force causes it to expand. The negative mass with its positive charge will tend to contract inward due to its outward repulsive force, creating the central core.

$m$ = electron mass.

$m^+$ = quiescent outer shell positive mass.

$m^-$ = quiescent central core negative mass.

As the electron mass increases by $\Delta m$, the outer shell mass increases by $\left(\frac{m^+}{m}\right)\Delta m$ and the central core mass increases by $\left(\frac{m^-}{m}\right)\Delta m$.

Negative mass might be incompressible based on the following reasoning: Consider two incremental particles of negative mass material under compression pushing on each other. Neither particle yields; in fact, they just push harder against each other. The displacement of the particles is zero and the compressibility is zero. Therefore, the repulsive force of the central core's positive charge would not change the core's radius from $R_o$. If, however, negative mass is compressible, then the core's radius would be less than $R_o$. For either case, the remainder of the model is the same.

If the central core's radius is appreciable compared with the outer shell radius, the core's spin must be zero, so that it doesn't contribute to spin angular momentum or magnetic moment.

## 4. Mass Quantization

As detailed in [1], the fine structure constant appears in most of the electron's attribute expressions. It also relates some gamma ray attributes to certain electron attributes. For example, the gamma ray frequency and the electron spin frequency are related by $\alpha$:

$$\begin{aligned}(\text{gamma frequency})/2 &= \frac{mc^2}{h} = \frac{q^2}{Rc^2}\frac{c^2}{h} = \alpha\left(\frac{h}{2\pi}\right)c\frac{1}{Rh}\frac{\text{spin frequency}}{\frac{c}{2\pi R}} \\ &= \alpha(\text{spin frequency})\end{aligned} \tag{7}$$

where $R$ is the Classical Electron Radius, $m = \frac{q^2}{Rc^2}$, $q = -\sqrt{\alpha\left(\frac{h}{2\pi}\right)c}$ [1], and the spin frequency is $\frac{c}{2\pi R}$. Also, it can be shown that an equivalent expression relates the gamma wavelength $\lambda$ to the electron circumference:

$$2\lambda = \frac{2c}{\text{gamma wave frequency}} = \frac{c}{\alpha(\text{spin frequency})} = \frac{c}{\alpha\frac{c}{2\pi R}} = \frac{\text{circumference}}{\alpha} \tag{8}$$

There is some evidence that the fine structure constant might also define mass quantization in some instances. Table 2 lists some masses and their relationship with the electron mass $q$.

The zero-spin outer shell mass in Table 2 is calculated below. Of course, it does not exist in reality, but it is a useful concept when calculating the outer shell relativistic mass. Zero-spin implies that its spin angular moment s is zero. When the outer shell spin angular momentum steps up to $s=\frac{1}{2}$, the shell's mass correspondingly steps up by $\frac{1}{2\alpha}m$. The other entries in Table 2 show a very close integral relationship between their mass and $\frac{1}{2\alpha}m$ The pion decays to a muon, and the difference between the pion and muon masses is also very close to $\frac{1}{2\alpha}m$. This evidence suggests a mass quantum of $\frac{1}{2\alpha}m$ for these cases.

Possibly during electron creation, the mass of the outer shell does not increase continuously with radius, but rather in three quantum steps of $\frac{1}{2\alpha}m$ each.

The last entry in Table 2 relates the spin mass to the electron mass. Spin mass is defined here as the mass equivalent to the electron spin frequency $\nu$. Its expression is

$$\text{spin mass} = \frac{h\nu}{c^2} = \frac{h}{c^2}\frac{c}{2\pi R} = \frac{h}{c}\frac{mc^2}{2\pi q^2} = \frac{hmc}{2\pi}\frac{2\pi}{\alpha hc} = \frac{m}{\alpha} \tag{9}$$

## 5. Outer Shell Mass Thickness

The thickness of the outer shell is calculated from the spin angular momentum. To calculate the angular momentum as a function of the outer shell's outer and inner radii, a solid sphere is sliced into many nested cylinders, coaxial with the spin axis. The momentum is calculated for the solid sphere and also for the mass at the center to be removed to create the hollow outer shell. The momentum of the outer shell is the difference between the momentum of these two masses.

$m^+$ = outer shell mass

$dm^+$ = mass of a cylinder

$r$ = radius of a cylinder

$R$ = outside radius of the outer shell

$R_i$ = inside radius of the outer shell = radius of the hollow center

$2\sqrt{R^2-r^2}$ = height of a cylinder

$\sigma$ = mass volume density of outer shell for zero-spin

$2\pi r$ = cylinder circumference

$dr$ = cylinder thickness

$T$ = rotation period

$S$ = electron spin angular momentum $=\sqrt{s(s+1)}\frac{h}{2\pi}$, where spin $s=\frac{1}{2}$ [1].

$v$ = cylinder rotation speed: $v=\frac{2\pi r}{T}$, $c=\frac{2\pi R}{T}$, $\frac{v}{c}=\frac{r}{R}$

The outer most cylinder has zero mass and a rotation speed $v = c$.

$$dm^{+} = \frac{\left(2\sqrt{R^2 - r^2}\right)\sigma(2\pi r)}{\sqrt{1-\left(\frac{v}{c}\right)^2}}dr = \frac{4\pi\sigma R\sqrt{1-\left(\frac{r}{R}\right)^2}r}{\sqrt{1-\left(\frac{r}{R}\right)^2}}dr = 4\pi\sigma Rrdr \tag{10}$$

$$\begin{aligned} m^{+} &= 4\pi\sigma R\int_0^R rdr - 4\pi\sigma R_i\int_0^{R_i} rdr \\ &= 4\pi\sigma R\left[\frac{1}{2}r^2\right]_0^R - 4\pi\sigma R_i\left[\frac{1}{2}r^2\right]_0^{R_i} = 2\pi\sigma R^3\left[1-\left(\frac{R_i}{R}\right)^3\right] \end{aligned} \tag{11}$$

$$m^{+} = \frac{3}{2\alpha}m = \frac{3}{2\alpha}\frac{q^2}{Rc^2} \quad [1] \tag{12}$$

Zero-spin mass volume density of the outer core:

$$\sigma = \frac{m^{+}}{2\pi R^3\left[1-\left(\frac{R_i}{R}\right)^3\right]} = \frac{\frac{3}{2\alpha}\frac{q^2}{Rc^2}}{2\pi R^3\left[1-\left(\frac{R_i}{R}\right)^3\right]} = \frac{3q^2}{4\pi c^2\alpha R^4\left[1-\left(\frac{R_i}{R}\right)^3\right]} \tag{13}$$

spin angular momentum of each cylinder:

$$dS = dm^{+}vr = dm^{+}c\frac{v}{c}r = 4\pi\sigma Rrdr\left(c\frac{r}{R}r\right) = 4\pi c\sigma r^3 dr \tag{14}$$

spin angular momentum of the outer shell:

$$\begin{aligned} S &= 4\pi c\sigma\int_0^R r^3dr - 4\pi c\sigma\int_0^{R_i} r^3dr = \pi c\sigma R^4\left[1-\left(\frac{R_i}{R}\right)^4\right] \\ &= \frac{3q^2}{4c\alpha\left[1-\left(\frac{R_i}{R}\right)^3\right]}\left[1-\left(\frac{R_i}{R}\right)^4\right] \end{aligned} \tag{15}$$

Solving Equations (13) and (15) numerically for the ratio $\frac{R_i}{R}$ of the inner radius to the outer radius of the outer shell yields a value of 0.69614582 and a radial thickness of $R - R_i = 0.30385418R$.

## 6. Outer Shell Zero-Spin Mass

zero-spin mass $m_0^{+}$ = (zero-spin mass volume density) (outer shell volume)

$$m_0^{+} = \frac{3q^2}{4\pi c^2\alpha R^4\left[1-\left(\frac{R_i}{R}\right)^3\right]}\frac{4}{3}\pi R^3\left[1-\left(\frac{R_i}{R}\right)^3\right] = \frac{m}{\alpha} \tag{16}$$

For the spin angular momentum quantum step from $s = 0$ to $s = 1/2$, the outer shell mass steps up from $\frac{2}{2\alpha}m$ to $\frac{3}{2\alpha}m$. a quantum step of $\frac{1}{2\alpha}m$.

## 7. Outer Shell Charge Thickness

The electric field $E$ at the surface of the electron and its magnetic field B at its center are:

$$E = \frac{q}{R^2} \quad B = \frac{2M}{R^3} \quad \frac{E}{B} = 0.998841691\alpha \tag{17}$$

In the author's previous paper [1], $\frac{E}{B}$ was seen to be so close to $\alpha$ that it was assumed to equal exactly $\alpha$ The small discrepancy was assumed to be the result of a small bulge at the electron's equator due to centrifugal force. When this bulge was included in the equations, the result was

$$\frac{q^-}{q} = \frac{3}{2\alpha}. \tag{18}$$

An alternative explanation for the discrepancy is considered in this document. The electron shape is assumed to be perfectly spherical, with no bulge at the equator. The surface charge $q^-$ of the outer shell is then assumed to have a non-zero thickness. And instead of assuming $\frac{E}{B} = \alpha$, it is assumed that $\frac{q^-}{q} = \frac{3}{2\alpha}$. The thickness of the surface charge $q^-$ is calculated in the following.

The charge shell is sliced into many very thin concentric spinning spheres, each having a radius $r$ and charge $dq^-$.

$R$ = charge shell outer radius

$R_i$ = charge shell inner radius

$\sigma$ = charge volume density

$dr$ = radial thickness of each sphere

$dq^-$ = charge of a sphere = $4\pi r^2 \sigma dr$

$$q^- = \frac{4}{3}\pi R^3 \left(1 - \left(\frac{R_i}{R}\right)^3\right)\sigma \quad \sigma = \frac{3q^-}{4\pi R^3 \left(1 - \left(\frac{R_i}{R}\right)^3\right)} \tag{19}$$

B is created by the sum of the magnetic moments of the concentric spinning spheres. Magnetic moment $dM$ of each sphere is:

$$dM = \frac{1}{3} dq^- \frac{\omega}{c} r^2 = \frac{1}{3}\left(4\pi r^2 \sigma dr\right)\frac{\omega}{c} r^2 = \frac{4\pi}{3R}\sigma r^4 dr \quad [5] \tag{20}$$

where $T = \frac{2\pi R}{c}$ and $\omega = \frac{2\pi}{T} = \frac{c}{R}$.

$$B = \int_{R_i}^{R} \frac{2dM}{r^3} = \int_{R_i}^{R} \frac{2}{r^3}\frac{4\pi}{3R}\sigma r^4 dr = \frac{4\pi}{3R}\sigma R^2 \left[1 - \left(\frac{R_i}{R}\right)^2\right] = \frac{E = \frac{q}{R^2}}{0.998841691\alpha} \tag{21}$$

Solving Equations (19) and (21) numerically for the ratio $\frac{R_i}{R}$ of the inner radius to the outer radius of the outer shell surface charge yields a value of 0.9976825 and a radial thickness of $R - R_i = 0.0023175R$.

## 8. Centrifugal Pressure

The centrifugal force created by the spinning outer shell mass puts an outward pressure on the electron surface. To calculate this pressure, slice a shell hemisphere into many concentric rings with their planes parallel to the equatorial plane.

$dm^+$ = mass of a ring

$\sigma$ = mass volume density of outer shell for zero-spin

$dC$ = increment of the pole-to-pole circumference

$\theta$ =polar angle

$r$ = radial length from the shell center to a ring

$R$ = electron radius

$v$ = rotation speed of a ring = $\frac{r\sin\theta}{R}c$

$$dm^+ = \frac{\sigma}{\sqrt{1-\left(\frac{v}{c}\right)^2}} 2\pi\left(r\sin\theta\right)\left(\frac{r}{R}dC\right)dr = \frac{\sigma}{\sqrt{1-\left(\frac{r\sin\theta}{R}\right)^2}} 2\pi dCr^2\sin\theta\frac{dr}{R} \quad (22)$$

Centrifugal force on each ring is in the plane of the ring:

$$df = dm^+\frac{v^2}{r\sin\theta} = \frac{\sigma}{\sqrt{1-\left(\frac{r\sin\theta}{R}\right)^2}} 2\pi\left(\frac{c}{R}\right)^2 r^3\sin^2\theta dC\frac{dr}{R} \quad (23)$$

Assuming the electron material is compliant, a force along $dC$ will create a force along the radial, and vice versa.

$dC = rd\theta$, $d\theta = \frac{dC}{r}$, where $d\theta$ is the angle subtended by $dC$.

$$\frac{d\left(dC\right)}{dr} = d\theta = \frac{dC}{r} \quad \frac{d\left(dC\right)}{dC} = \frac{dr}{r} \quad (24)$$

Therefore, when a radial force is applied, $dC$ changes by the same fraction as the radius $r$. According to Hooke's Law, $dr$ is created by the radial force, and the force on $dC$ is changed by $d(dC)$. So outward radial forces will reduce the surface tension force across $dC$ by an amount equal to the radial force.

Hooke's Law:

$$\text{force along } dC = k\frac{d\left(dC\right)}{dC} = k\frac{dr}{r} = \text{force along a radial}$$

Therefore, a force along $dC$ is also a force along a radial, and vice versa.

$df$ is parallel to the equatorial plane. The centrifugal force in the radial direction from the center is required for calculating the centrifugal pressure on the surface. Project $df$ onto both the radial and $dC$. The $df$ projection vector onto $dC$ points toward the equator, and therefore increases the outward force along the radial. The sum of the centrifugal force components along the radial is then

$$df\left(\cos\left(90-\theta\right)+\sin\left(90-\theta\right)\right) = df\left(\sin\theta+\cos\theta\right) \quad (25)$$

area of the outermost ring = $2\pi R\sin\theta dC$

radial pressure of a ring contributing to the total radial centrifugal pressure at and normal to the outer shell surface:

$$dP_c = \frac{df\left(\sin\theta + \cos\theta\right)}{2\pi R\sin\theta dC} = \sigma c^2 \frac{\sin\theta + \cos\theta}{\sin^3\theta} \frac{x^3}{\sqrt{1-x^2}} dx \tag{26}$$

where $x = \frac{r\sin\theta}{R}$.

centrifugal pressure normal to $dC$ at the outer shell surface:

$$P_c = \int_{\text{inner ring}}^{\text{outer ring}} dP_c = \sigma c^2 \frac{\sin\theta + \cos\theta}{\sin^3\theta} \int_{\frac{R_i\sin\theta}{R}}^{\sin\theta} \frac{x^3}{\sqrt{1-x^2}} dx \tag{27}$$

where $\frac{R_i}{R} = 0.69614582$.

$$P_c = \sigma c^2 \frac{\sin\theta + \cos\theta}{\sin^3\theta} \left[ \frac{1}{3}\sqrt{\left(1-\sin^2\theta\right)^3} - \sqrt{1-\sin^2\theta} - \frac{1}{3}\sqrt{\left(1-0.4846\sin^2\theta\right)^3} + \sqrt{1-0.4846\sin^2\theta} \right]$$

$$\sigma = \frac{3q^2}{4\pi c^2 \alpha R^4 \left[1-\left(\frac{R_i}{R}\right)^3\right]} = \frac{3}{4\pi\alpha R^3\left(1-0.69614582^3\right)} m \tag{28}$$

Centrifugal force is greatest at the equator ($\theta = 90$ deg):

$$P_c\left(\theta = 90\right) = \sigma c^2 \left[ -\frac{1}{3}\sqrt{\left(1-0.4846\right)^3} + \sqrt{1-0.4846} \right] = \sigma c^2 0.5946 = 1.0739 \times 10^{33} \tag{29}$$

## 9. Surface Tension

The electron's spinning charge shell creates a magnetostriction force tangential to its surface. This force can be calculated by slicing the charge shell into many concentric rings parallel to the equatorial plane. Two adjacent rings are considered to have the same current *I*, so they will be attracted to each other. Their separation is *d*, which is assumed to be much less than the ring circumference. Therefore, at any point along the rings, the two currents appear to flow along infinitely long straight wires. The following formula can then be used to calculate the force/length:

$$\frac{F}{l} = \frac{2}{c^2} \frac{I^2}{d} \quad [6] \tag{30}$$

$$d = dC \ll l$$

$dC$ = an increment of the pole-to-pole circumference

$l = 2\pi R\sin\theta$ = circumference of a ring

$\theta$ = polar angle of the circumference increment $dC$

$c\sin\theta$ = rotation speed of a ring

$$I = \frac{q^-}{4\pi R^2}\left(2\pi R\sin\theta dC\right)\left(\frac{c\sin\theta}{2\pi R\sin\theta}\right) = \frac{cq^-}{4\pi R^2}\sin\theta dC \tag{31}$$

The attractive force between two rings is:

$$F = \frac{2}{c^2}\left(\frac{cq^-}{4\pi R^2}\sin\theta dC\right)^2\left(\frac{1}{dC}\right)(2\pi R\sin\theta) = \frac{(q^-)^2}{4\pi R^3}(\sin\theta)^3 dC \quad (32)$$

The magnetic pressure $dP$ between two adjacent rings from their mutual attraction is both tangential and radial, and is assumed to be uniformly distributed across a hemisphere. (For simplicity, only one hemisphere is considered.)

$$dC = Rd\theta \quad (33)$$

$$dP = \frac{F}{2\pi R^2} = \frac{\frac{(q^-)^2}{4\pi R^3}(\sin\theta)^3 dC}{2\pi R^2} = \frac{(q^-)^2(\sin\theta)^3}{8\pi^2 R^4}d\theta \quad (34)$$

The magnetic pressure on the outer shell hemisphere from all ring pairs is:

$$P = \int_0^{\pi/2} dP = \frac{(q^-)^2}{8\pi^2 R^4}\int_0^{\pi/2}(\sin\theta)^3 d\theta = \frac{(q^-)^2}{12\pi^2 R^4} = 1.305287\times 10^{34} \quad (35)$$

## 10. Electric Force on a Ring

Outward repulsive electrical force normal to $dC$ on each ring:

$$dq^- = \frac{q^-}{4\pi R^2}(2\pi R\sin\theta dC) = \frac{q^-}{2R}\sin\theta dC \quad (36)$$

$$f_e = \frac{qdq^-}{R^2} = \frac{q}{R^2}\frac{q^-}{2R}\sin\theta dC = \frac{qq^-}{2R^3}\sin\theta dC \quad (37)$$

outward repulsive electrical pressure normal to $dC$ on each ring:

$$P_e = \frac{f_e}{2\pi R\sin\theta dC} = \frac{\frac{qq^-}{2R^3}\sin\theta dC}{2\pi R\sin\theta dC} = \frac{qq^-}{4\pi R^4} \quad (38)$$

The electric pressure is the same for all rings.

$$\frac{\text{electrical pressure } P_E}{\text{surface tension pressure}} = \frac{\frac{qq^-}{4\pi R^4}}{\frac{(q^-)^2}{12\pi^2 R^4}} = 2\pi\alpha = 0.045850618 \quad (39)$$

## 11. Holding the Electron Together

$$\frac{\text{electrical } P_e + \text{centrifugal } P_c(\theta = 90)}{\text{surface tension pressure}} = 0.045851 + \frac{1.0739\times 10^{33}}{1.305287\times 10^{34}} = 0.1281 \quad (40)$$

The inward surface pressure due to the surface tension is greater than the sum of the outward surface pressures. Therefore, the surface tension (magnetostriction) holds the electron together.

## 12. Splitting the Electron

The surface tension can be overcome by an external magnetic field. The following looks at the external magnetic field $B_{ext}$ as a function of polar angle required to break surface tension. For electrons in the Zeeman ground state, the force will be outward.

The magnetic pressure required to break the surface tension is calculated from

$$\frac{\text{external magnetic pressure}}{\text{surface pressure}} = 1 - \frac{\text{electrical pressure} + \text{centrifugal pressure}}{\text{surface pressure}} \tag{41}$$

It is assumed that the surface tension will break where the greatest net outward pressure is applied.

The tilt angle $\phi$ of the electron spin axis with respect to the external magnetic field is determined by quantum spin angular momentum $S$ and its projection $S_Z$ along the magnetic field:

$$\cos\phi = \frac{S_z}{S} = \frac{s\frac{h}{2\pi}}{\sqrt{s(s+1)}\frac{h}{2\pi}} = 0.577350269 \quad \phi = 54.736 \text{ deg} \tag{42}$$

The component of the external field along the spin axis that creates an outward force normal to the spin axis is $B_{ext}\cos\phi$. The component of the external field normal to the spin axis that creates a force parallel to the spin axis is $B_{ext}\sin\phi$. The integral of this force component for one spin rotation is zero. However, during one half of the spin cycle, this force will create an axial component of force that has an outward projection along the radials.

Force $f_B$ is created by the axial component of $B_{ext}$. It is parallel to the plane of the ring

$$v = c\sin\theta$$

$$f_B = dq^- \frac{v}{c} B_{ext}\cos\phi = dq^- \frac{c\sin\theta}{c} B_{ext}\cos\phi = dq^- B_{ext}\cos\phi\sin\theta \quad [6] \tag{43}$$

Force $f_B'$ is created by the component of $B_{ext}$ parallel to the plane of the ring. It is parallel to the spin axis. Its direction reverses during the spin cycle. Consider the direction that creates an outward force along the radial.

$$f_B' = dq^- \frac{v}{c} B_{ext}\sin\phi = dq^- \frac{c\sin\theta}{c} B_{ext}\sin\phi = dq^- B_{ext}\sin\phi\sin\theta \tag{44}$$

$$dq^- = \text{ring charge} = \frac{q^-}{4\pi R^2} 2\pi R\sin\theta dC = \frac{q^-}{2R}\sin\theta dC \tag{45}$$

$$f_B = \frac{q^-}{2R}\sin\theta dC B_{ext}\cos\phi\sin\theta = \frac{q^-}{2R} B_{ext}\cos\phi\sin^2\theta dC \tag{46}$$

$$f_B' = \frac{q^-}{2R}\sin\theta dC B_{ext}\sin\phi\sin\theta = \frac{q^-}{2R} B_{ext}\sin\phi\sin^2\theta dC \tag{47}$$

component of $f_B$ along a radial having a polar angle $\theta$:

$$f_B\cos(90-\theta) = f_B\sin\theta \tag{48}$$

The component of $f_B$ along $dC$ tends to stretch $dC$ and therefore $R$, becoming an outward force along the radial.

$$f_B\sin(90-\theta) = f_B\cos\theta \tag{49}$$

component of $f_B'$ along a radial having a polar angle $\theta$:

$$f_B' \cos\theta \tag{50}$$

The component of $f_B'$ along $dC$ that tends to stretch $dC$ and therefore $R$, becoming an outward force along the radial.

$$f_B' \sin\theta \tag{51}$$

sum of all force components along the radial:

$$\begin{aligned} F_B &= f_B \sin\theta + f_B \cos\theta + f_B' \cos\theta + f_B' \sin\theta \\ &= \frac{q^-}{2R} B_{ext} \sin^2\theta dC\left(\cos\phi + \sin\phi\right)\left(\sin\theta + \cos\theta\right) \end{aligned} \tag{52}$$

The pressure $P_B$ normal to the outer shell surface due to the external magnetic field is:

$$P_B = \frac{F_B}{2\pi R \sin\theta dC} = \frac{q^-}{4\pi R^2} B_{ext} \sin\theta\left(\cos\phi + \sin\phi\right)\left(\sin\theta + \cos\theta\right) \tag{53}$$

A ring can fracture when the net outward pressure normal to the surface is greater than the surface tension pressure:

$$\frac{P_B + P_E + P_C}{\text{surface tension pressure } P} = 1 \tag{54}$$

The electron can therefore fracture when the external magnetic field $B_{ext}$ is at least the value calculated from:

$$\begin{aligned} B_{ext} &= 0.9541 \frac{q^-}{3\pi R^2\left(\cos\phi + \sin\phi\right)} \frac{1}{\sin\theta\left(\sin\theta + \cos\theta\right)} \\ &\quad - \frac{4\pi R^2 \sigma c^2}{q^-\left(\cos\phi + \sin\phi\right)} \frac{\frac{1}{3}\left(\sqrt{\left(1 - \sin^2\theta\right)^3} - \sqrt{\left(1 - 0.4846\sin^2\theta\right)^3}\right) - \sqrt{1 - \sin^2\theta} + \sqrt{1 - 0.4846\sin^2\theta}}{\sin^4\theta} \\ &= 9.0303 \times 10^{16}\left[\frac{1}{\sin\theta\left(\sin\theta + \cos\theta\right)}\right. \\ &\quad \left. - 0.1450 \frac{\frac{1}{3}\sqrt{\left(1 - \sin^2\theta\right)^3} - \frac{1}{3}\sqrt{\left(1 - 0.4846\sin^2\theta\right)^3} - \sqrt{1 - \sin^2\theta} + \sqrt{1 - 0.4846\sin^2\theta}}{\sin^4\theta}\right] \end{aligned} \tag{55}$$

The external magnetic field $B_{ext}$ for which a fracture can occur is at a minimum for:

$$\theta = 69.35 \text{ degree} \tag{56}$$

and 110.65 degree for the opposite hemisphere. The corresponding value of $B_{ext}$ is:

$$B_{ext} = 7.02 \times 10^{16} \text{ gauss} = 7.02 \times 10^{12} \text{ T} \tag{57}$$

By comparison, the magnetic field at the center of the electron is:

$$B = \frac{q}{\alpha R^2} = 8.29 \times 10^{17} \text{ gauss} \tag{58}$$

Therefore, the magnetic field required to split the electron is extremely large, but yet only 8.5% of the field inside of the electron. Maybe clustered electrons can create such a field.

The value of the polar angle at which the electron will split into three exactly equal parts is calculated in the following:
surface area of a sphere from pole to polar angle $\theta$:

$$\int_0^{\theta}(2\pi R\sin\theta)(Rd\theta)=2\pi R^2(1-\cos\theta) \tag{59}$$

polar angle for which the surface charge is equal to $\frac{1}{3}q$:

$$2\pi R^2(1-\cos\theta)=\frac{1}{3}4\pi R^2 \quad \theta=70.52877937 \tag{60}$$

Therefore, the polar angles calculated from the model of the fractures which split the electron into three equal pieces has a discrepancy of −1.2 degree, or −1.7%.

The points on the electron surface at which it fractures are not determined primarily by anisotropies within the electron. They are determined primarily by the anisotropy across the electron surface of the Lorentz magnetic force caused by an external field. And this anisotropy is the result of the electron's precession angle, which in turn is the result of quantized angular momentum.

The angle of the precessing electron axis in a magnetic field is determined by the ratio of $S_Z$ and S, which are specified by quantum theory. The Lorentz field is resolved into two orthogonal components, as determined from this angle. The expression for the sum of the forces from these two components yields the basic polar angle for which the Lorentz force normal to the electron surface is the greatest. This polar angle is shifted up slightly by the centrifugal force, to produce the polar angle at which the electron is predicted to split into three parts.

Reference [7] proposes that the electron can split into two parts having equal charge. There might be more than one mechanism that can split the electron, with different quasiparticles created and having different charges. The model presented in this document assumes an external magnetic field as the splitting mechanism. The model predicts the locations of the two splits on the electron surface and that the resulting quasiparticles produced have equal charges. It predicts nothing more about the quasiparticles. It is conceivable that only the charge splits and not the mass. Or if the masses split also, they might not be equal. References [8] and [9] discuss quantum Hall effect experiments that indicate the electron charge is split into three equal charges of $\frac{q}{3}$. Evidence that the fundamental charge is $\frac{q}{3}$ and not that of the electron's charge $q$ is also provided by the existence of quarks, which have charges of integral multiples of $\frac{q}{3}$.

## 13. Summary

A model has been presented for the electron and positron at the instant, or origin, of their creation from a gamma ray. The electron's expansion to its steady state is discussed. Mass relationships within the electron and among some related particles suggest that certain mass transitions might be quantized. The thicknesses of the positive-mass outer shell and the negative surface charge have been calculated. It appears that the binding force which holds the electron together is the magnetostriction force created by the spinning charge. This force can be overcome by a sufficiently strong external field. The result could be a fracture along two lines of latitude, having polar angles such that the charge is divided into three equal parts. The values for these results are summarized in **Table 3**.

## Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

## References


[1] Young, A. (2023) *Journal of Modern Physics*, **14**, 553-561. https://doi.org/10.4236/jmp.2023.145031

[2] Daum, M., Frosch, R. and Kettle, P.-R. (2019) *Physics Letters B*, **796**, 11-14. https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwj-84qZ54SBAxWhPEQIHa_JD50QFnoECBAQAQ&url=https%3A%2F%2Fs3.cern.ch%2Finspire-prod-files-f%2Ffc2607a3e1402604764842decf1d4151&usg=AOvVaw0UpZflQqxrRFyOLpZ3wM-G&opi=89978449

[3] Energy Densities of Electric and Magnetic Fields. University of California, Berkeley. https://casper.astro.berkeley.edu/astrobaki/index.php/Energy_Density

[4] McDonald, K.T. (August 10, 2008) Electromagnetic Fields of a Rotating Shell of Charge. Princeton University, Princeton. https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwii0fvEyLb9AhXJiO4BHReXBIEQFnoECCUQAQ&url=http%3A%2F%2Fkirkmcd.princeton.edu%2Fexamples%2Frotatingshell.pdf&usg=AOvVaw3nuuv3640EW2oztXV2nNdL

[5] Young, A. (2022) *Journal of Modern Physics*, **13**, 1117-1127. https://doi.org/10.4236/jmp.2022.137064

[6] Napolitano, J. SI and CGS Units in Electromagnetism. Rensselaer Polytechnic Institute, Troy. https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwjh2oGO9YKAAxXEIEQIHfFUBCsQFnoECCkQAQ&url=https%3A%2F%2Fwww.rpi.edu%2Fdept%2Fphys%2FCourses%2FPHYS4210%2FS10%2FNotesOnUnits.pdf&usg=AOvVaw3fYZimlaQZ6Nb56guaTbJ1&opi=89978449

[7] Freulon, V., *et al.* (2015) *Natural Communications*, **6**, Article Number: 6854. http://www.nature.com/articles/ncomms7854 https://doi.org/10.1038/ncomms7854

[8] Weis, J. (2015) *Encyclopedia of Condensed Matter Physics*, Academic Press, Cambridge. https://www.sciencedirect.com/topics/chemistry/quantum-hall-effect

[9] Arovas, D., Schrieffer, J.R. and Wilczek, F. (2002) *Selected Papers of J Robert Schrieffer. In Celebration of His* 70*th* *Birthday*, 270-271. https://doi.org/10.1142/9789812777041_0033