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Electron Shape Calculated for the Dual-Charge Dual-Mass Model

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Abstract

A model for the internal structure of the electron using classical physics equations has been previously published by the author. The model employs both positive and negative charges and positive and negative masses. The internal attributes of the electron structure were calculated for both ring and spherical shapes. Further examination of the model reveals an instability for the ring shape. The spherical shape appears to be stable, but relies on tensile or compressive forces of the electron material for stability. The model is modified in this document to eliminate the dependency on material forces. Uniform stability is provided solely by balancing electrical and centrifugal forces. This stability is achieved by slightly elongating the sphere along the spin axis to create a prolate ellipsoid. The semi-major axis of the ellipsoid is the spin axis of the electron, and is calculated to be 1.20% longer than the semi-minor axis, which is the radius of the equator. Although the shape deviates slightly from a perfect sphere, the electric dipole moment is zero. In the author's previously published document, the attributes of the internal components of the electron, such as charge and mass, were calculated and expressed as ratios to the classically measured values for the composite electron. It is interesting to note that all of these ratios are nearly the same as the inverse of the Fine Structure Constant, with differences of less than 15%. The electron model assumed that the outer surface charge was fixed and uniform. By allowing the charge to be mobile and the shape to have a particular ellipticity, it is shown that the calculated charge and mass ratios for the model can be exactly equal to the Fine Structure Constant and the Constant plus one. The electron radius predicted by the model is 15% greater than the Classical Electron Radius.

Keywords

Electron Shape, Classical Electron Model, Dual-Charge Dual-Mass Model, Electron Radius, Negative Mass, Electron Mass Inconsistency, Electron Charge Inconsistency, Fine Structure Constant

1. Introduction

Reference [1] addresses a great inconsistency between the measured electron spin magnetic dipole moment and the moment calculated from spinning the electron charge. It also addresses a similar inconsistency between the spin angular momentum derived from quantum theory and the classical momentum calculated from spinning the electron mass. The model presented in [1] is referred to herein as the dual-charge dual-mass (DCDM) model. The internal attributes for the model were calculated for both ring and spherical shapes. The ring shape appears to have an instability along the spin axis, while the spherical shape depends on the electron material tensile or compressibility properties for stability.

The ring shape has an outer shell of positively-charged negative mass and a central core of negatively-charged positive mass. Both lie on the equatorial plane. If a perturbation were to displace the central core along the spin axis, an unbalanced attractive electrical force would be created between the positive and negative masses. Since negative mass moves in a direction opposite to an applied force, the outer shell is repelled from the central core, creating an even stronger attractive force between the two. As a result, the outer shell and central core would fly apart.

The spherical shape appears to be stable for perturbations in all directions. It does, however, depend on the tensile or compressibility properties of the negative mass electron material. The intent of this document is to remove this dependency by slightly altering the spherical shape. Stability along the spin axis will be provided by only the internal electrical force between the outer shell and central core. There will be no tensile or compressive forces anywhere on the outer shell.

Table 1 contains electron constants that will be used in this document. Ratios of outer shell and central core charges and masses to the measured charge and mass of the composite electron are presented in Table 2 below. For comparison,

Table 1. Table of electron constants.

constant	symbol	value [cgs] [1]
charge	q	-4.8032×10^{-10}
outer shell charge for DCDM sphere	q^+	7.507×10^{-8}
central core charge for DCDM sphere	q^-	-7.555×10^{-8}
classical electron radius	R	2.82×10^{-13}
radius of DCDM sphere	R_q	3.711×10^{-13}
mass	m	9.1094×10^{-28}
spin angular momentum	S	9.1329×10^{-28}
magnetic dipole moment	M	$-9.284764 \times 10^{-21}$
fine structure constant inverse	$1/a$	137.0360 [2]
speed of light	c	$2.99792458 \times 10^{10}$

Table 2. Table of internal/external attribute ratios [1].

attribute	ring	sphere
$\frac{\text{charge radius}}{\text{classical electron radius}}$	1.07	1.32
$\frac{\text{outer shell mass}}{\text{electron mass}} = \frac{\text{outer shell charge}}{\text{electron charge}}$	−127.6	−156.3
$\frac{\text{central core mass}}{\text{electron mass}} = \frac{\text{central core charge}}{\text{electron charge}}$	128.6	157.3
$\frac{1}{\text{fine structure constant}}$ [3]	137.0	137.0

the Fine Structure Constant is also included in the table. It can be seen that for a spherical shape, the charge and mass ratio values are close to the Fine Structure Constant inverse value, with differences of less than 15%. An approximate calculation for an elliptical shape shows that the attribute ratios could actually be exactly equal to the inverse of the Fine Structure Constant and the inverse of the Constant plus one.

Except where otherwise noted, all constants and equations in this article are expressed in cgs units.

2. Stretch the Spherical Shape to an Ellipsoid

2.1. Introduction

In the equatorial plane of the DCDM electron model, the centrifugal force is balanced by the attractive electrical force between the outer shell and central core and the repulsive electrical force on the outer shell. Along the spin axis, the same electrical forces exit, but there is no counterbalancing centrifugal force. By stretching the sphere slightly along the spin axis, two things happen:

- The radius of curvature of the surface at the pole is increased, thereby increasing the repulsive electrical force on the outer shell at that point;
- The distance between the central core and the outer shell at the pole is increased, thereby reducing the attractive force between the two.

An ellipsoid, or ellipse of revolution, seems like a reasonable approximation for the shape required by the model.

2.2. Strategy

The parameters for an ellipsoid are to be calculated for which the electrical forces on the electron surface at the spin axis pole are balanced. Thus, there will be no force on the surface at the pole. The two forces to be balanced are

- The attractive force on the outer shell by the central core, and
- The repulsive force created by the outer shell's charge.

The repulsive electric field at the ellipsoid pole is calculated by slicing the ellipsoid into many circle rings, all having axes along the spin axis. The charge on the surface of each ring is first calculated. Then, the electric field along the spin

axis at the pole is calculated for each charged ring. Finally, the fields for all rings are added together, and from this sum, the ellipsoid parameters are calculated.

2.3. Ellipsoid Ring Charge

The equation for an ellipse is:

$$\left(\frac{x}{A}\right)^2+\left(\frac{y}{B}\right)^2=1 \quad \text{or} \quad y=B\sqrt{1-\left(\frac{x}{A}\right)^2}$$

where x = major semi-axis which aligns with the electron spin axis,

y = minor semi-axis which lies in the electron equatorial plane,

A is the intersection of the ellipse (pole) with the spin axis, and

B is the intersection of the ellipse with the equatorial plane.

The ellipsoid is formed by revolving the ellipse about its major axis. To calculate the difference between A and B required to provide a balance of electrical forces at the pole, the ellipsoid is divided into many circular rings, all having axes along the spin axis. The radius of each ring is y, and the location of the ring from the electron center is x. To calculate the charge on each ring, the width Δc of each ring is first calculated.

$$(\Delta c)^2=(\Delta x)^2+(\Delta y)^2$$

where Δx and Δy are the projections of Δc on the x and y axes, respectively.

$$y-\Delta y=B\sqrt{1-\left(\frac{x+\Delta x}{A}\right)^2}$$

$$\frac{y\Delta y}{B^2}=1-\left(\frac{x}{A}\right)^2-\sqrt{\left[1-\left(\frac{x}{A}\right)^2\right]\left[1-\left(\frac{x+\Delta x}{A}\right)^2\right]}$$

$$y\Delta c=\left[(y\Delta x)^2+(y\Delta y)^2\right]^{1/2}=\left[B^2(\Delta x)^2\left(1-\left(\frac{x}{A}\right)^2\right)+(y\Delta y)^2\right]^{1/2}$$

$\Delta q \equiv$ ring charge

$\sigma \equiv$ charge surface density

$$\frac{\Delta q}{A^2}=\frac{2\pi\sigma y\Delta c}{A^2}$$

For the following equation expansions,

$$B=A+\Delta A$$

$$\left(\frac{B}{A}\right)^2=\left(1+\frac{\Delta A}{A}\right)^2=1+2\frac{\Delta A}{A}+\left(\frac{\Delta A}{A}\right)^2=1+2\frac{\Delta A}{A}$$

It is assumed that $\frac{\Delta A}{A}\ll 1$, so terms containing higher orders of $\frac{\Delta A}{A}$ are deleted. The final evaluation of $\frac{\Delta A}{A}$ will validate this assumption. The expanded equation for $\frac{\Delta q}{A^2}$ is

$$\frac{\Delta q}{A^2} = 2\pi\sigma\sqrt{k_1}\left[1+\left(k_2+1\right)\frac{\Delta A}{A}\right]$$

where $k_1 = \left[1-\left(\frac{x}{A}\right)^2\right]\left(\frac{\Delta x}{A}\right)^2 + \left(\frac{y\Delta y}{B^2}\right)^2$ and $k_2 = \frac{\left(\frac{y\Delta y}{B^2}\right)^2}{k_1}$.

2.4. Distance from A Ring Charge to Pole A

The distance d between the charge on a ring and a polar point A is

$$d = \left[\left(A-x\right)^2 + y^2\right]^{1/2} = A^2\left(1-\frac{x}{A}\right)^2 + B^2\left[1-\left(\frac{x}{A}\right)^2\right].$$

$$\frac{d}{A} = \sqrt{2}\left[1-\frac{x}{A}+\left[1-\left(\frac{x}{A}\right)^2\right]\frac{\Delta A}{A}\right]^{1/2}$$

$$\left(1-\frac{x}{A}\right)\left(\frac{d}{A}\right)^{-3} = 2^{-3/2}\left(1-\frac{x}{A}\right)^{-1/2}\left[1-\frac{3}{2}\frac{1-\left(\frac{x}{A}\right)^2}{1-\frac{x}{A}}\frac{\Delta A}{A}\right]$$

2.5. Electric Field at Pole A from A Single Ring

The electric field along the spin axis at a pole A due to a single ring is

$$\frac{\Delta q}{d^2}\left(\frac{A-x}{d}\right) = \frac{\Delta q}{A^2}\left(1-\frac{x}{A}\right)\left(\frac{d}{A}\right)^{-3} = \frac{\pi\sigma}{\sqrt{2}}k_3\left[1+k_4\frac{\Delta A}{A}\right]$$

where $k_3 = \sqrt{k_1}\left(1-\frac{x}{A}\right)^{-1/2}$ and $k_4 = 1+k_2-\frac{3}{2}\frac{1-\left(\frac{x}{A}\right)^2}{1-\frac{x}{A}}$.

2.6. Electric Field at Pole A from All of the Rings

The following electric fields along the spin axis at pole A are defined:

E_e^+ ≡ repulsive field created by the ellipsoid surface charge q^+

= the sum of the electric fields due to all of the ellipsoid rings. $\Delta A \neq 0$.

E_s^+ ≡ repulsive field created by a spherical shell having a radius A and a surface charge q^+

$= E_e^+$ for $\Delta A = 0$ $= \frac{q^+}{A^2}$

E_s^- ≡ attractive field created by a charge q at the center of the sphere of radius A

$= \frac{\left|q^-\right|}{A^2}$

For the DCDM electron model with a spherical shape, the attractive and repulsive forces on the outer shell at the pole A are unbalanced. The ratio of the two fields at A is

$$\frac{E_s^+}{E_s^-}=\frac{\frac{q^+}{A^2}}{\frac{\left|q^-\right|}{A^2}}=\frac{q^+}{\left|q^-\right|} \quad \text{and} \quad E_s^-=\frac{\left|q^-\right|}{q^+}E_s^+$$

The sphere is stretched along the spin axis x to an ellipsoidal shape to balance the attractive and repulsive electrical fields, so that

$$\frac{E_e^+}{E_s^-}=1 \quad \text{and} \quad E_s^-=E_e^+=\frac{\left|q^-\right|}{q^+}E_s^+$$

The following equation was solved numerically for ΔA with the ellipsoid sliced into 200 rings:

$$\frac{E_e^+}{E_s^+}=\frac{\left|q^-\right|}{q^+}=\frac{\sum_{x=-A}^{x=A}E_e^+\left(\Delta A\neq 0\right)}{\sum_{x=-A}^{x=A}E_e^+\left(\Delta A=0\right)}=\frac{\sum_{x=-A}^{x=A}k_3\left(1+k_4\frac{\Delta}{A}\right)}{\sum_{x=-A}^{x=A}k_3}$$

2.7. Ellipticity of the Electron Surface

The solution to the above equation for $\frac{\Delta A}{A}$ is:

$$\frac{\Delta A}{A}=-\frac{\sum_{x=-A}^{x=A}k_3}{\sum_{x=-A}^{x=A}k_4}\left(\frac{\left|q^-\right|}{q^+}-1\right)=-0.0119$$

Note that $\frac{\Delta A}{A}$ is negative, so the ellipsoid type is prolate, *i.e.*, the distance from the center to the intersection of the electron spin axis with its surface (pole A) is 1.20% longer than the distance from the center to the intersection of the equatorial plane with the surface (R_q).

3. Outer Shell Charge Distribution

3.1. Introduction

The mysterious Fine Structure Constant [3] appears in many instances in physics, for example [4] [5] [6], although it is not completely understood why. It is a unitless constant, and is the ratio of other constants having the same unit. It has been suggested [7] that it is one of the most, and maybe the most, fundamental constant in physics.

Table 2 above lists the ratios of attributes of the electron model's internal components, as calculated according the dual-charge dual-mass model. The table also includes the value of the inverse of the Fine Structure Constant. There is a striking similarity between the attribute ratios and the Constant. In the worst case, the attribute ratio differs from the Constant by less than 15%. Possibly, the attribute ratio should actually equal the Constant, or at least have a value very much closer to it.

Attribute ratios are listed in the table for both ring and spherical electron model shapes. The attribute ratios for a ring shape are less than the Constant, while those for the spherical shape are greater. It has been assumed in the electron model that the charge density on the outer shell surface is uniform. But maybe it isn't. The fact that the Constant value lies between the ring and sphere attribute ratio values suggests that the charge density might actually be greater near the equator than elsewhere. By changing the surface charge profile from uniform to one of increasing charge density toward the equator, it should be possible to achieve attribute ratios that are within ±0.4% of the Constant value.

3.2. Surface Charge Distribution

For a perfectly spherical outer shell charge, the central core charge exerts a radial force on each charge increment. There is no tangential component to the force. The outer shell charge may be mobile or fixed. It makes no difference. If mobile, the mutually repulsive forces between the charge increments will cause them to spread out uniformly across the shell surface. However, if the outer shell is not perfectly spherical and in fact is a prolate ellipsoid, there will be a tangential force exerted by the central core on each charge increment, which tends to pull it toward the equator. (The exception is at exactly the equator and the poles.) This force is further increased by the lesser distance between the outer shell increment and the central core for increments closer to the equator than farther away. Therefore, for a prolate ellipsoidal shape and a mobile surface charge, the surface charge density will increase from the pole to the equator. The greater the ellipticity, the greater the concentration of charge near the equator.

In reality, the ellipsoid's charge density near the equator would smoothly taper down toward the poles. A rough approximation to a realistic charge profile is an overlay of a ring charge on a sphere at the equator. The relation between the ring charge value and the sphere's charge value is calculated in the following. Of course, the values calculated for this composite are approximate, but provide a general idea of how the electron's internal attribute ratios could be brought closer to the fine structure constant.

3.3. Calculation of Approximate Charge Distribution

A ring-shaped outer shell is superimposed on the spherical outer shell at the equator. The two shells have the same radius *r*. The charge on the ring is kq^+, and $(k-1)q^+$ on the sphere. The scaling factor k is calculated as follows:

The magnetic moments for the ring and sphere are

$$M(\text{ring}) = -\frac{kq^+}{2}r \text{, and } M(\text{sphere}) = -\frac{(k-1)q^+}{3}r \text{ .} \quad [1]$$

The composite magnetic moment is

$$M = M(\text{ring}) + M(\text{sphere}) = -\frac{(k+2)q^+}{6}r \text{,}$$

where the radius r is

$$r = -\left(\frac{m^-}{m}\right)\frac{q^4}{mc^3 S} \quad [1]$$

Assume that

$$-\frac{q^+}{q} = -\frac{m^-}{m} = \frac{1}{\text{fine structure constant}} = 137$$

and therefore

$$\frac{q^-}{q} = \frac{m^+}{m} = \frac{1}{\text{fine structure constant}} + 1 = 137 + 1.$$

By merging and rearranging the above equations,

$$k = \frac{6Mmc^3 S}{137^2 q^5} - 2 = 0.60$$

$$\text{ring charge} = 0.60q^+$$

$$\text{sphere charge} = 0.40q^+$$

3.4. Radius

The radius for a ring-shaped outer shell in the dual-charge dual-mass model can be calculated from

$$R(\text{ring}) = \sqrt{\frac{2M}{mS}\left(\frac{q}{c}\right)^3} \quad [1]$$

The radius for the ring and sphere charge composite can be calculated by replacing "2M" with $\frac{6}{k+2}M$ in the above equation.

$$R(\text{ring} + \text{sphere}) = 3.255 \times 10^{-13} = 1.15R$$

Therefore, by allowing the outer shell charge to be mobile on an ellipsoidal surface and assuming the outer shell charge and mass ratios to be equal to the inverse of the Fine Structure Constant, the resulting electron radius is only 15% greater than the Classical Electron Radius.

4. Summary

Reference [1] describes a model for the internal structure of the electron. Attributes for two possible shapes, a ring and a sphere, were calculated. The purpose of this document is to explain a stability problem for the ring shape and to modify the spherical shape slightly such that its stability is not dependent upon the tensile or compression properties of the electron material. The calculations presented in this document show that this dependency can be eliminated for a shape close to that of a prolate ellipsoid having a length 1.20% greater along its spin axis than its width in the equatorial plane. The net force at every point on the outer shell surface will be zero.

Table 3. Table of electron model attributes.

	outer shell charge	
attribute	fixed, uniform	mobile
$\frac{\text{outer shell mass}}{\text{electron mass}} = \frac{\text{outer shell charge}}{\text{electron charge}}$	−156.3	−137.0
$\frac{\text{central core mass}}{\text{electron mass}} = \frac{\text{central core charge}}{\text{electron charge}}$	157.3	137.0 + 1.0
$\frac{\text{central core mass}}{\text{outer shell mass}} = \frac{\text{central core charge}}{\text{outer shell charge}}$	$-\left(1+\frac{1}{156.3}\right)$	$-\left(1+\frac{1}{137.0}\right)$
$\frac{1}{\text{fine structure constant}}$	137.0	137.0
$\frac{\text{charge radius}}{\text{classical electron radius}}$	1.32	1.15
ellipticity	1.012	1.035

Ratios of the charge and mass attributes for the electron model were calculated in [1] assuming a fixed and uniform surface charge, and are summarized in Table 3. It is interesting to note that all of these ratios are nearly equal to the inverse of the Fine Structure Constant, with differences of less than 15%. A model of the surface charge has been calculated that shows if the charge is mobile and more concentrated near the equator than elsewhere, the charge and mass attribute ratios can be exactly equal to the inverse of the Fine Structure Constant (137.0) and the inverse plus one (138.0). These results are summarized in Table 3. An explanation is presented which describes how the ellipsoidal shape of the outer core and charge mobility could result in such a charge concentration.

The ellipticity in this table is defined as the distance along the spin axis from the center to a pole divided by the radius at the equator.

Conflicts of Interest

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

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