Electron in the Ground Energy State — Part 3
Fundamental and Physical Properties

David L. Bergman
Common Sense Science, PO Box 767306, Roswell GA 30076-7306
E-mail: bergmandavid@comcast.net

Dennis P. Allen, Jr.
17046 Lloyds Bayou Drive Apt. 322, Spring Lake MI 49456-9273
E-mail: allens10@sbcglobal.net

Abstract for Part 3. Part 1 and Part 2 describe an electrodynamics model of the electron in the form of a Spinning Charged Ring (SCR). For the first time, a model of the electron shows how the electric charge is distributed inside electrons. And the model shows precisely how this distribution impacts the other physical features of electrons, that is, their large radius *R*, small radius *r*, and the velocity *c* of charge moving along the ring circumference. In Part 3 the structural and electrical properties of an electron ring are evaluated and compared to empirical data. This model yields the electron's four fundamental properties of electric charge, mass, spin, and non-anomalous magnetic moment by the application of the laws of electrodynamics to the physical structure of the model. The SCR model also predicts the gyromagnetic ratio of a *free* electron in the ground-energy state.

Introduction. Part 3 describes the fundamental and physical properties of the spinning charged ring electron in the ground-energy state. The computed values of these properties are collected below and shown in Table 2, Fundamental and Physical Properties of the SCR Model (February 2013).

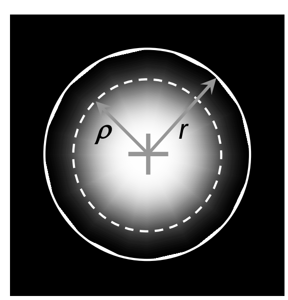
Small Radius *r* of the Ring. A tentative value[1] of the small radius *r* is taken from Part 1 equation (68) and evaluated for use here:

$$r \cong \frac{8\hbar}{\mathcal{M}c} \exp\left(\frac{-\pi}{\alpha} - \frac{1}{2}\right) = 2.0138708635589165016 \times 10^{-199} \text{ meters} \quad (85)$$

Potential Energy of Electron Fields Located Outside the Electron. Using equation (31) with the values of the fundamental physical constants of Table 1 in Part 1, and replacing the large radius and the small radius with their numerical values shown at equations (66) and (85), a close approximation of the

Figure 5a.

Cross-section of ring showing high charge density at the center decreasing to zero at the surface $\rho = r$ where the density is zero.



[1] This approximation of the small radius *r* is based on the previous 'hollow-ring model' and will be replaced in a follow-on paper where two values of the small radius *r* are derived from the model for a ring electron with distributed interior charge and energy included.

magnetic potential energy outside the electron charge boundary (where $\rho > r$) $\mathcal{E}_{\text{so}}$ is found:

$$\mathcal{E}_{\text{so}} = -\frac{c^2\,\mu_o q^2\,\left(\log\frac{8R}{r} - 2\right)}{8\pi^2 R} = -4.0698578358368962917 \times 10^{-14}\text{ Joules} \quad (86)$$

Likewise, the *electric* potential energy outside the charge boundary (where $\rho > r$) $\mathcal{E}_{\text{eo}}$ electron is found:

$$\mathcal{E}_{\text{eo}} = \frac{c^2\,\mu_o q^2\,\left(\log\frac{8R}{r}\right)}{8\pi^2 R} = 4.0888309301213177265 \times 10^{-14}\text{ Joules} \quad (87)$$

Potential Energy of Electron Fields Located Inside the Electron. With the radius *R* found in Part 2 equation (66) and with knowledge of the interior distribution of the unit charge carried by an electron (see equation (83) and figures 7 and 8 in Part 2), the inside magnetic potential energy $\mathcal{E}_{\text{si}}$ and the inside electric potential energy $\mathcal{E}_{\text{ei}}$ of the ring electron are found by substituting the fundamental physical constants (Table 1 in Part 1) into equations (62) and (63):

$$\mathcal{E}_{\text{si}} = \frac{c\left(-4h\pi^2 - 2c\mu_o q^2 + c\mu_o \log\left[\frac{8R}{r}\right]\right)}{8\pi^2 R} = -\mathcal{E}_{\text{ei}}$$

$$= -1.42078102457052219 \times 10^{-16}\text{ Joules} \quad (88)$$

Total Potential Energy of a Ring Electron. The total potential energy $\mathcal{E}$ of a free (isolated) electron in the ground-energy state is the algebraic sum of its four components:

$$\mathcal{E} = \mathcal{E}_{\text{eo}} + \mathcal{E}_{\text{ei}} + \mathcal{E}_{\text{so}} + \mathcal{E}_{\text{si}} = \frac{c^2\mu_o q^2}{4\pi^2 R}$$

$$= 1.897309428442143 \times 10^{-16}\text{ Joules} \quad (89)$$

Total Electromagnetic Rest Energy of a Ring Electron. The components of an electron's electromagnetic rest energy can be summed to compute an electron's total rest energy using equation (50):

$$\mathcal{U} = |\mathcal{E}_{\text{ei}}| + |\mathcal{E}_{\text{eo}}| + |\mathcal{E}_{\text{si}}| + |\mathcal{E}_{\text{so}}| = 8.18710438644962446 2 \times 10^{-14}\text{ Joules} \quad (90)$$

This value is in agreement with the value of CODATA-2006 [16].

Magnetic Rest Energy of a Ring Electron. The magnetic components of an electron's electromagnetic rest energy can be summed to compute an electron's magnetic rest energy using equation (56):

$$\mathcal{U}_\text{s} = \mathcal{U}_\text{si} + \mathcal{U}_\text{so} = 4.0840656460826015136 \times 10^{-14} \text{ Joules} \quad (91)$$

Gyromagnetic Ratio. By definition, the gyromagnetic ratio γ is the ratio of an object's magnetic moment μ and its angular momentum (spin) p_s. For an electron

$$\gamma_\text{e} \equiv \frac{\mu_\text{e}}{p_\text{s}} \quad (92)$$

For the SCR model the magnetic moment of the electron μ_e is found in Part 2 equation (67):

$$\mu_\text{e} = \frac{c\ e\ R}{2} \quad (67)$$

The angular momentum (spin) p_s is the result of the ring's *magnetic* field energy as shown in Part 2:

$$p_\text{s} \equiv \mathcal{M}_\text{s} R c \quad (93)$$

where $\mathcal{M}_\text{s} = \mathcal{U}_\text{s}/c^2$ and c is the velocity of charge moving along the ring's circumference.

Combining the four preceding equations gives the gyromagnetic ratio of the ring electron:

$$\gamma_e = \frac{c^2 e}{2\,\mathcal{U}_\text{s}} = 1.7629055701912068653 \times 10^{11} \quad (94)$$

Properties of the SCR Model of a Free Electron. Table 2 shows that the SCR model yields realistic properties of a 'free electron' which are consistent with causality, logic, conservation of energy, laws of electromagnetics, and empirical data.

Property #	Property	Value	Data/Equation
1	Electric charge, *e*	$-1.602176487(40) \times 10^{-19}$ Coulomb	CODATA-2006, Table 1
2	Mass, $\mathcal{M} = \mathcal{U}/c^2$	$9.10938215(45) \times 10^{-31}$ kg	CODATA-2006, Part 3 Equation (90)
3	Large radius, *R*	$3.87056242(5426759) \times 10^{-13}$ meter	Part 2 Equation (66)
4	Small radius, *r*	$2.01387086(35589165016) \times 10^{-199}$ meter	Part 3 Equation (85)
5	Velocity of loop charge, v_s	*c* (speed of light) meter/second	CODATA-2006, Part 1 Equation (29)
6	Magnetic moment, μ_e	$-9.29555099(050) \times 10^{-24}$ J/T	Part 2 Equation (67)
7	Angular momentum, p_s	$-5.27285814(265) \times 10^{-35}$ J s	CODATA-2006, Part 2 Equation (57)
8	Gyromagnetic ratio, γ_e	$1.76290557(019) \times 10^{11}$ s^{-1} T^{-1}	Part 3 Equation (94)

Table 2. Fundamental and Physical Properties of the SCR Model of the Electron (February 2013)

Notes on the Properties Shown in Table 2. The SCR model is adapted to conform to the empirical data of electron charge, electron mass, and the fundamental physical constants reported in CODATA-2006 and listed in Table 1. This model produces the actual properties listed in Table 2 of a *free* electron in the *ground-energy state.*

The computations in Table 2 are shown with twelve digits precision although the working precision for computations was usually much greater than twelve digits. However, the accuracy of the properties shown in Table 2 may not exceed nine digits, i.e., the minimum accuracy of the fundamental constants of Table 1.

Specific details about each of the eight physical and electrical properties are listed below:

1. **Electric charge, *e*.** The SCR model of the electron uses the empirical value reported in CODATA-2006.

2. **Mass, $\boldsymbol{\mathcal{M}}$.** The SCR model of the electron produces the empirical value reported in CODATA-2006.

3. **Large radius, *R*.** The SCR model of the electron produces a real, finite-size 'physical object' with radius *R* shown in Table 2.

   The Standard Model insists that the electron is a *point-particle* and asserts that the electron is a "quantum object" with inherent properties of mass, charge, magnetic moment, and angular moment (spin). But compression of an electron's charge to a point would require an infinite amount of force and mass-energy—a scientific fact that was intentionally ignored by Dirac [29] and is still ignored by contemporary particle physicists. The point-particle assertion is made in spite of empirical evidence for finite-sized particles, and in violation of the well-established, fundamental laws of classical physics, especially the 'law of conservation of mass and energy.'

   Arthur H. Compton wrote in 1919 that "the experimental observations on the scattering of high frequency radiation by matter could be explained only on the hypothesis that the radius of the electron is comparable with the wave-length of hard γ-rays. The phenomena of scattering were found to be quantitatively accounted for, within the probable errors of observation, if the electron was considered to be a flexible ring of electricity with a radius of 2×10^{-10} cm." [30]

4. **Small radius, *r*.** The SCR model of the electron produces a real, finite-size 'physical object' with radius *r* shown in Table 2 (February 2013). This computation, equation (85), of size of the small radius *r* is based on the previous 'hollow-ring model' and will be replaced in a follow-on paper where *two* values of the small radius *r* are derived from the SCR model with interior charge and energy included. The follow-on paper will also include the induced energy from the recent discovery that the magnetic field has the same rotation velocity as the rotation velocity of the charge that generates the field—in effect doubling the energy density. When all induction

effects are included, the computed value of the small radius *r* is found to be much bigger than the very tiny value shown in Table 2 (February 2013).

For the same reasons given above for rejecting the point-particle conjecture of the large radius *R* (three paragraphs above), neither can the real dimension of the small radius *r* be construed to be actually zero.[2]

5. **Velocity of loop charge, $\boldsymbol{v_s}$.** Distributed charge located inside the spinning ring generates electrostatic pressure that is in equilibrium with magnetostatic pressure throughout the interior *only when the charge velocity along the ring circumference is at the speed of light.*

6. **Magnetic moment, $\boldsymbol{\mu_e}$.** The value of the *magnetic moment* of the Standard Model is described in CODATA-2006 as an "anomaly" (with respect to the Bohr magneton); but no deviation from reality (one Bohr magneton) is embedded in the magnetic moment of the SCR model of a ring electron. *There is no anomaly in the SCR model*.

7. **Angular momentum, $\boldsymbol{p_s}$.** The SCR model of the electron uses the empirical value reported in CODATA-2006. Here, the ring model has been conformed to the undisputed experimental data, but a follow-up paper on the stability of the spinning charged ring will show that a theoretical basis exists to support the accepted data.

8. **Gyromagnetic ratio, $\boldsymbol{\gamma_e}$.** The "best" measurements of the gyromagnetic ratio are made on single electrons captured and held by a Penning trap composed of electric and magnetic fields [31]. These fields couple with the *trapped* electron, changing its size and the measured value of gyromagnetic ratio.

   No high-precision gyromagnetic ratio measurement of a *free* electron (in contrast to a *trapped* electron) has been performed, but an expected value is predicted here. Of course, the value predicted at equation (94) and the CODATA-2006 value of a trapped electron are different because the ambient environment is different.

   And this apparent difference in gyromagnetic ratio of the electron is resolved by recognizing that the specimen electron is not free but instead is bound in a Penning trap by electric and magnetic fields [31] which act on the spinning charged ring to affect and change its dimensions.

Other Electron Properties. In addition to the fundamental and physical properties of a free electron in the ground energy state, electron properties have been measured in various environments with corresponding data collected, e.g., Compton wavelength, photoelectric effect, line spectra, and the important double-slit interference experiments.

---

[2] Although it certainly is true that the electron and proton cannot be point-particles, it is nevertheless also true that the point-particle *approximation* has led to nuclear weapons (for example) which work very well indeed (too well, in fact!), and so this point-particle model cannot be too far off either, whence an extremely small value of the small radius *r* cannot be unexpected!

Some previous studies by Common Sense Science [32] seem to show that the flexible ring model known as the spinning charged ring is able to account for all of the experimental observations of electron properties. One such property is electron-positron annihilation.

Electron-Positron Annihilation. "Electron-positron annihilation can occur when an electron and a positron violently collide. The result of the collision is the annihilation of the electron and positron and the creation of gamma rays [radiation].... In the most common [low energy] case, two [gamma rays] are created, each with energy equal to the rest energy of the electron or positron (511 KeV)" [33].

The SCR model explains how electron-positron annihilation occurs. Under static environments, the ring is durable because the total interior pressure is zero from the sum of compression pressure (from the magnetic effect) and expansive pressure (from the electric effect). Annihilation occurs when another electromagnetic field or fields (e.g. from collision with a charged particle or from radiation by a powerful laser) sufficiently upsets the zero-pressure balance.

In terms of electron-Volts, the SCR model predicts an electron-positron annihilation event to occur when the energy of collision $\mathcal{U}_a$ equals or exceeds the electron rest energy:

$$\mathcal{U}_a = \frac{\mathcal{U}}{|e|} = 510998.9099724959839 \text{ electron Volts} \qquad (95)$$

Acknowledgements. We acknowledge the help of the Holy Spirit of God, who is the Spirit of Truth and the source of all Wisdom and Knowledge, without Whom this work on the electron ring model could not have been successfully accomplished [21]. Charles W. Lucas, Jr., explained that deformation of elastic objects is the mechanism for exchange of energy between charged particles. We thank Thomas G. Barnes (deceased) for his pioneering work on *physical models of the electron* [22], and for showing that accelerating a charged particle modifies the electric and magnetic fields that surround the particle and *produce a self-force such as the force of inertia on the particle* [23]. We thank Glen C. Collins who proof-read and edited this paper. Finally, the second author would refer the reader to [21] in connection with the above.

References and Notes for Part 3. For references [1] through [23] see Part 1. For references [24] through [28] see Part 2.

[29] P.A.M. Dirac, "Classical Theory of Radiating Electrons," Proc. Royal Society, Volume 167, p. 148 (1938).

[30] Arthur H. Compton, "The Size and Shape of the Electron," Phys. Rev. Sec. Series, Volume 14, Number 3, pp. 247-259 (1919).

[31] Hans Dehmelt, "Structure of an Individual Elementary Particle," Science, 247:539-544, February 2, 1990.

[32] Common Sense Science, www.CommonSenseScience.org/.

[33] Wikipedia, "Electron-positron annihilation," retrieved from the Internet on Sept. 14, 2011 from http://en.wikipedia.org/wiki/Electron-positron_annihilation/.

To be continued.