Journal of Applied Mathematics and Physics, 2022, 10, 2923-2939
https://www.scirp.org/journal/jamp
ISSN Online: 2327-4379
ISSN Print: 2327-4352

Fine Structure Constant Model Demonstrates the Electron Elementary Charge of Having an Intrinsic Manifold

Emmanouil Markoulakis*, Emmanuel Antonidakis

Electronic Engineering, Hellenic Mediterranean University, Chania, Greece
Email: *markoul@hmu.gr

How to cite this paper: Markoulakis, E. and Antonidakis, E. (2022) Fine Structure Constant Model Demonstrates the Electron Elementary Charge of Having an Intrinsic Manifold. *Journal of Applied Mathematics and Physics*, **10**, 2923-2939.
https://doi.org/10.4236/jamp.2022.1010196

Received: September 8, 2022
Accepted: October 10, 2022
Published: October 13, 2022

Abstract

Using our recently published electron's charge electromagnetic flux manifold fiber model of the electron, described by analytical method and numerical simulations, we show how the fine structure constant is embedded as a geometrical proportionality constant in three dimensional space of its charge manifold and how this dictates the first QED term one-loop contribution of its anomalous magnetic moment making for the first time a connection of its intrinsic characteristics with physical geometrical dimensions and therefore demonstrating that the physical electron charge cannot be dimensionless. We show that the fine structure constant (FSC) α, and anomalous magnetic moment α_μ of the electron is related to the sphericity of its charge distribution which is not perfectly spherical and thus has a shape, and therefore its self-confined charge possesses measurable physical dimensions. We also explain why these are not yet able to be measured by past and current experiments and how possible we could succeed.

Keywords

Electron Charge Manifold, Electron Fiber Model, Compton Electron, Fine Structure Constant, Anomalous Magnetic Moment, Electron Dipole Moment, Classical Electrodynamics, Electron Geometry

1. Introduction

According to the Standard Model (SM) the electron is a dimensionless point charge and massive particle [1] [2] therefore its charge and mass cannot have any shape (*i.e.*, manifold) and consequently any physical size when interacting with its environment and their origin is only intrinsic in nature. Nevertheless, the term "intrinsic" as in the case describing its other physical properties like spin can also be used for describing a possible charge manifold effectively for the purpose of analysis under the framework of an effective geometry theory [3] [4]. Our novel electron charge fiber mode [5], also based on our previous experimental observations with the macroscopic quantum emulator physical nano-magnetic device *ferrolens* [6] [7] [8], is consistent with the mass, total spin angular momentum in the xyz directions of the electron known value ($\sqrt{3/2}$)$\hbar \approx 0.866\hbar$, *i.e.* $(1/2)\hbar$ in the z-axis and also with the speed of light in a vacuum limit c (*i.e.*, *a Compton electron radius*) therefore it does not contradict with the SM. Also, the 720˚ phase rotation Dirac Belt intrinsic property of the electron [9] can also be explained with our model [5] and its wave-particle duality is demonstrated. Given our research, a novel manifold therefore also shape and size to the electron charge solves many problems arising from infinities and avoids the need for any renormalization [10] in theory. Additionally, fruitful correlations can now be found of the electron's physical properties and their deeper physical origin can be revealed with many unforeseen potential merits for the future progression of particle physics and today's many unsolvable problems [11] in physics could be explained for example how a so relative small rest mass particle of ~0.511 MeV cannot have any finite measurable size found yet?

This last question above also brings the caveat to the whole story which is that from our empirical evidence from experiments, we were not able so far to find a finite size for the electron. Notice we cannot measure the size of a free electron directly, especially at low acceleration energies because of its elastic scattering with photons property.

Basically, there are two types of experiments we are aware of, however, calculate or imply an upper limit for the size of the electron indirectly from other measured physical properties of the electron like, for example, its g-factor.

Firstly, experiments looked for a finite value of the electron dipole moment eEDM but they did not find any. This means that either the electron is an extremely symmetric object (for example, a very perfect sphere) or its size is smaller than around 10^{-30} meters. Therefore these experiments as long as they do not find any definitive eEDM value for the electron cannot tell us about the finite size of the electron.

The most accurate experimental verification we have until today from the above first type of experiments concerning the electron is the published 2018 ACMEII collaboration results [12] at $|d_e| < 1.1 \times 10^{-29}$ e·cm thus 1.76×10^{-50} C·m or 17.62×10^{-49} C·cm upper limit eEDM (*i.e.*, 1 e·cm = 1.602×10^{-21} C·m). Also, in the same year, independent institution research proposed an alternative eEDM experiment using BaF, barium monofluoride molecular beam which could improve the sensitivity up to one order from the ACMEII results at 5×10^{-30} e·cm thus, 8.01×10^{-51} C·m [13]. However, these experiments scan only for an asymmetry along the spin axis of the electron and not the rest of its charge distribution around it. Similar recent experiments were carried out also by the JILA group with similar results [14].

We show for the first time here using the results of our previously published model [5] that our model predicts that there is no *effective* far E-field interaction anisotropy of the electron charge with its environment between the two poles along its spin axis (*i.e.*, *the two poles N-S distortions are perfectly equal in amplitude thus identical and opposite symmetrical*) therefore an eEDM cannot exist between the two poles validating the current Standard Model theoretical upper limit of $d_e < 10^{-38}$ $e\cdot$cm which infers that the generated E-field by the electron charge to be for all means and purposes a perfect sphere and cancelling any attempt for further new physics and new particles beyond the existing Standard Model (SM) discovered by these type of experiments since the electron manifold is perfectly symmetrical on its two pole regions. However, our fiber charge flux model [5] instead, approximately predicts for the electron's rest electric dipole moment value $\text{eEDM}_{(\text{rest})}$ that a spatial anisotropy in the spherical charge distribution manifold exists. The spatial anisotropy our model reveals is that there is a tiny, same amount of curvature missing (vortex) from both of the poles compared to the rest of the charge sphere and equator in order for this to be a perfect $2\pi r$ sphere with r the radius at the equator. Also, our research refers ideally to free electrons at rest thus without acceleration and any translational motion, since we ansatz that acceleration further decreases any electric dipole moment eEDM from its rest value therefore our prediction can also be taken as an approximate upper limit (*i.e.*, maximum value possible) for any eEDM. The second type of most recent experiments indirectly inferring an upper limit of the size of the electron, are experiments that are primarily measuring the anomalous magnetic moment of the electron [15] [16] [17]. If the experimental results deviate with great significance, say close to 5σ from the predicted QED values or also referred to as corrections, among other conclusions, this also means that the electron interacts differently than predicted with the vacuum (*i.e.*, polarized vacuum) also suggesting that the electron can have a finite size and even possible inner structure. So far, the electron was not found to deviate from the predicted theoretical values of QED with a spatial sensitivity of the measurement around 10^{-18} m [17] therefore also an upper size limit. Nevertheless, this last type of experiment is high energy accelerator beam experiment which as we make clear in the following sections possible disturbs the charging manifold of the electron from its rest state.

We propose at the end of the paper an alternative experiment for measuring the electron for finite dimensions without disturbing it as possible, from its rest energy 0.511 MeV and with very little translational motion.

There is another type of experiment somehow irrelevant to measuring any size for the electron but still worth mentioning here, very high energy electron-positron beam scattering experiments $e^+e^- \to e^+e^-(\gamma)$ [18] but these are looking for any annihilation product new unknown sub-particles and therefore inferring also to possible inner structure of the electron besides the two known γ-photons emissions per electron-positron pair from the collision of the two beams. So far there was not really any extraordinary result reported suggesting any inner sub-particles for the electron apart from the two γ-photon emissions during the annihilation.

This is also explained in our electron charge fiber model [5] since as we show the electron is not constituted by any sub-particles but nevertheless its charge has an energy flow manifold or else specific EM flux morphology thus a coherent stream of virtual photons which are making up its charge manifold. These virtual photons coaxial dipole vortex flow as we will present later on, effectively creates a deformed twisted *spin* $0.866\hbar$ *otherwise normal photon*, essentially confined in a volume in space due to its vortexing motion[1]. The same is true for the positron. The collision of an electron with a positron particle undoes these vortices and untwists these deformed photons back to normal *spin* $1\hbar$ photons and releases these two γ-photons, one for each particle and each at the exact Compton electron wavelength predicted by theory therefore also, each γ-photon emitted from the collision has the exact rest energy of the electron or positron of 0.511 MeV! No other particle is generated during the annihilation of the electron-positron pair except these two normal γ-photons. Although this does not necessarily indicate that electrons are actually deformed twisted, spinning photons we cannot however discard this possibility also supported by other independent researchers [19] [20] [21] [22] [23] and also related rigorous mathematical physics recent research of Prof. Hans Hermann Otto [24].

The EM Flux Charge Manifold Fiber Model of the Electron

Our electron EM charge flux manifold fiber model [5] makes for the first time a novel correlation of the fine structure constant of the electron with its possible charge manifold (*i.e.*, geometrical shape of the electron charge). In order to study the proposed manifold for the charge of the electron at its most fundamental state and simplify, *our model refers to a hypothetical isolated free electron at rest with no translational motion*:

In **Figure 1**, we show our fiber model of the unified Electromagnetic flux charge manifold of the electron [5] with its FSC embedded as a geometrical proportionality constant and also expressed as an electromagnetic flux ratio of the flux flowing inside its magnetic moment (see horn tube formation at the center of horn spheroid manifold) to the charge flux on the surface of the spherical manifold. This flux ratio is essentially controlled by the radius of the magnetic moment thus radius of the horn tube $r_e \approx 2.81 \times 10^{-15}$ m classical radius of the electron, to the radius at the equator of the charging manifold $\lambda\!\!\!^- = \lambda_c / 2\pi \approx 3.86 \times 10^{-13}$ m the *reduced Compton wavelength* with the normal Compton wavelength of the electron $\lambda_c = 2\pi\lambda\!\!\!^- \approx 2.426 \times 10^{-12}$ m being the circumference of the manifold at the equator, see **Figure 1**. The vortex lines in this coaxial dipole vortex configuration of the charging manifold of **Figure 1** illustrate normal EM flux thus a coherent stream of virtual photons by which it is known the EM flux consists. The

[1]See animation of the described phenomenon with the blue ribbon representing the twisted vortexing photon: https://www.horntorus.com/particle-model/revolution-rotation-superposition.html

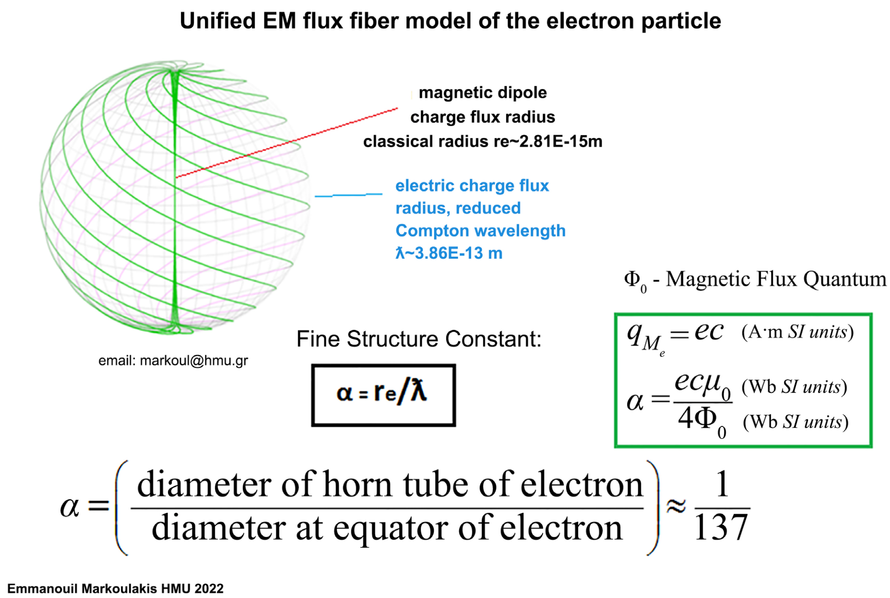


Figure 1. Electromagnetic flux charge manifold fiber model of the electron [1]. Animation: https://www.horntorus.com/particle-model/greensphere.html.

same known EM flux formation shown manifests the charge of the electron. The bare mass of the electron is positioned as a dimensionless-point, center of mass of the whole self-confined energy manifold, at the center of the charge manifold shown in **Figure 1**. The bare mass of the electron may have no physical dimensions but the self-confined charge energy of the electron has, namely the reduced Compton wavelength radius $\lambdabar$. Alternatively, you can think the classical radius r_e value of the electron, radius of horn tube formation in our model depicted in **Figure 1**, as an effective radius of its bare mass also has a center of mass. However, in this research, we consider as electron radius its charge radius from the center of the manifold to the equator, thus the reduced Compton wavelength value $\lambdabar$.

The Equation (1) for the fine structure constant α below is already known from the literature [25] [26] [27] [28]:

$$\alpha = \frac{r_e}{\lambdabar}. \tag{1}$$

However, it was never shown until now how this equation is correlated to the physical geometrical characteristics structure of a possible charge flux manifold of the electron [5] expressed by novel Equation (2) of the illustrated manifold of **Figure 1**:

$$\alpha = \frac{\text{diameter of horn tube of electron}}{\text{diameter at equator of electron}} \approx \frac{1}{137} \tag{2}$$

where r_e, the classical radius of the electron is the radius of the horn tube formation of the manifold shown in **Figure 1**; thus, the intrinsic magnetic dipole moment charge of the electron $q_\mu(_e) = ec$ in A·m SI units or expressed as magnetic flux $\Phi_\mu(_e) = ec\mu_0$ in Weber SI units and $\lambdabar$ the reduced Compton wavelength of the electron is the radius at the equator of the charge spheroid of the manifold. The charge flux on the sphere surface represents the electric elementary electric charge |−e| of the electron responsible for generating its interaction E-field with its environment whereas the flux inside the horn tube generates the intrinsic magnetic moment of the electron and consequentially its M-field interaction with its environment. This radii ratio of Equation (2) controls the flux ratio of the flux inside the horn tube of manifold (*i.e.*, magnetic moment) to the flux outside on the surface of the spheroid as shown in the below novel derived Equation (3) [5]:

$$\alpha = \frac{ec\mu_0}{4\Phi_0}. \tag{3}$$

Both the numerator and denominator of Equation (3) represent magnetic flux in Weber (Wb) *SI units* with $\Phi_0 = 2.06783385 \times 10^{-15}$ Webers being *the magnetic flux quantum* known value, e the elementary absolute charge value, μ_0 the permeability of vacuum space and c the speed of light in a vacuum.

Further analyzing Equation (3), we derive that the electric charge e of the electron can be expressed in electric flux $\Phi_{E(e)}$, V·m *SI units* by Equation (4). Using the known Equation (4) below and the previous Equation (3) we derive the novel Equation (5) where e is the absolute of the elementary charge of the electron and ε_0 the permittivity of vacuum space,

$$\Phi_{E(e)} = \frac{|e|}{\varepsilon_0} \tag{4}$$

$$\Phi_{E(e)} = 4\Phi_0 \alpha c. \tag{5}$$

which gives the amount of unified electromagnetic flux on the surface of the horn spheroid of **Figure 1**, thus electric charge component of the electron expressed in electric flux V·m *SI units* and with Equation (6):

$$\Phi_{\mu(e)} = ec\mu_0 \tag{6}$$

Given the amount of unified electromagnetic flux inside the horn tube **Figure 1**, thus magnetic moment charge component of the electron expressed in magnetic flux Webers (Wb) *SI units*. Both Equations (4) & (5) give the same exact electric flux value $\Phi_{E(e)} = 0.1809 \times 10^{-7}\ \text{V}\cdot\text{m}$ whereas the magnetic flux component of the manifold of Equation (6) calculates to $\Phi_{\mu(e)} = 6.039 \times 10^{-17}\ \text{Wb}$.

The ratio of the above two calculated flux, results in the speed of light c in a vacuum shown by Equation (7):

$$\frac{\Phi_{E(e)}}{\Phi_{\mu(e)}} = c. \tag{7}$$

2. Results and Discussion

2.1. The FSC α, Anomalous Magnetic Moment α_μ and Their Correlation with a Non-Dimensionless Point Electron Charge Flux Distribution in Space

With the extrapolated fine structure constant (FSC) from our previous EM charge flux manifold fiber model for the electron publication [5] as a geometrical proportionality constant of the electron charge manifold and analysis presented, it was made clear that the FSC of the electron dictates the sphericity of the electron electric charge distribution in space which is not perfect $2\pi r$ spherical but tiny anisotropic, departing from a perfect spherical flux charge distribution due to the two opposite symmetrical and equal amount apertures, vortex magnetic poles N-S distribution anomaly observed along the spin axis of the electron, see **Figure 2**.

This anomaly best illustrated in **Figure 2**, of missing r_a part of the radius at the equator, on each pole of the manifold and therefore also missing amount of curvature $\kappa_a = 1/r_a$ on the poles of the manifold in order to be a perfect $2\pi R$ sphere, is also the physical origin and cause for the first QED term one-loop contribution of the anomalous magnetic moment [29] of the electron a_μ also expressed by the Schwinger equation [30]:

$$a_\mu = \frac{g-2}{2} = \frac{\alpha}{2\pi} \approx 0.0011614 \tag{8}$$

where $\alpha \approx 1/137$ is the fine structure constant (FSC) of the electron and g is the g-*factor* of the electron. Although the Equation (8) anomalous magnetic moment has been known for many decades as a dimensionless constant we show here for the first time as far as we know, its deeper actual physical geometric origin and

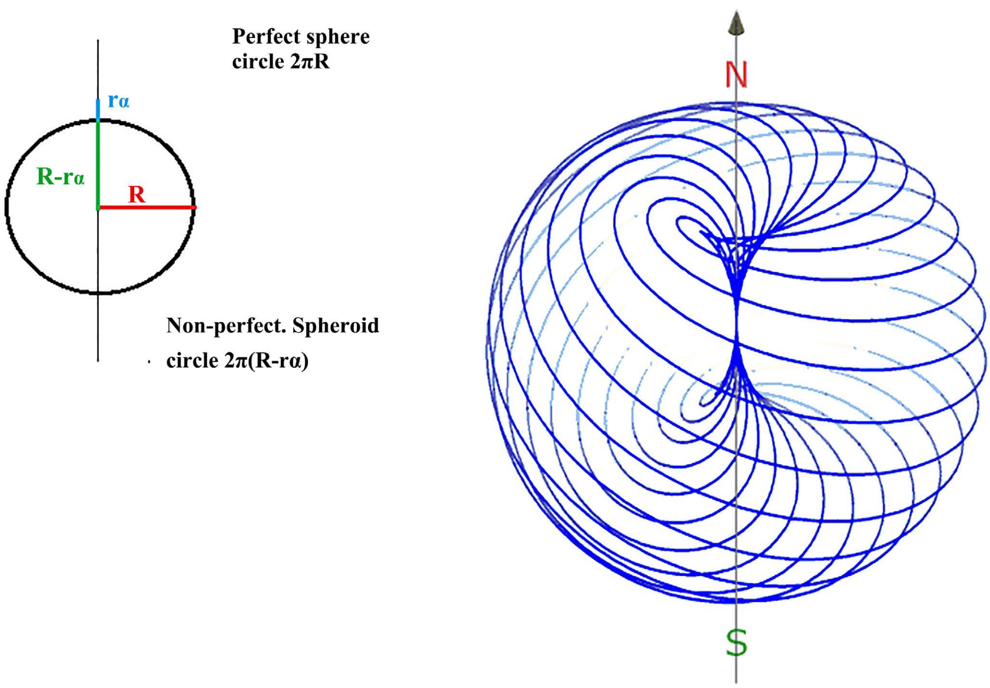


Figure 2. Exaggerated illustration of the N and S pole apertures of the electron charge manifold (not to be scaled). Because the North and South pole vortex apertures of the electron charge manifold the manifold departs by a tiny amount from being perfect spherical $2\pi R$. An r_a amount of curvature radius is missing from each pole in order the manifold to be a perfect sphere. Therefore a spheroid charge distribution in space. Charge manifold at the equator is a tiny bit wider than at the poles. Animation: https://www.horntorus.com/particle-model/mm-index.html.

meaning embedded inside the electron charge manifold. This small anomaly in the sphericity of electron charge due to its fine geometric structure constant is mainly responsible for the anomalous excessive gyromagnetic rotation factor of the electron.

Also the product of the one-loop anomalous magnetic moment a_μ value, see novel Equation (9), with the electron Compton wavelength $\lambda_c \approx 2.426 \times 10^{-12}$ m results in the classical radius r_e of the electron which in our proposed manifold model is the radius of the horn tube, magnetic moment as shown in Figure 1 and the normal Compton wavelength value [5] being the circumference of the manifold sphere at the equator:

$$r_e = a_\mu \cdot \lambda_c \approx 2.81 \times 10^{-15}\ \text{m} \tag{9}$$

Thus the classical electron radius r_e is equivalent to the missing curvature radius of the manifold for being a perfect sphere. This manifold anomaly creates a toroidal axial electric dipole moment on each pole relative to the equator of the manifold calculated from our data [5] of $\text{eEDM}_{(\text{rest})} \approx 4.5 \times 10^{-36}\ \text{C} \cdot \text{m}$ or else $\approx 2.81 \times 10^{-15}\ \text{e} \cdot \text{cm}$ (*i.e.*, 1 e·cm = 1.602×10^{-21} C·m).

However, this is the ideal case and because of the vortex structure on the poles of the manifold, we have approximate analytical and numerical calculated [5], see Figure 3, that the pole aperture is even larger in radius corresponding approximate to a toroidal axial electric dipole moment on each pole relative to the equator of $\approx 18.2 \times 10^{-15}\ \text{e} \cdot \text{cm}$. We have to stress here that this value is not referring to the upper limit electric dipole moment eEDM measured by QED experiments like ACME [12] and other similar experiments either made or proposed [13] [14] which are searching for an electric dipole moment *between the*

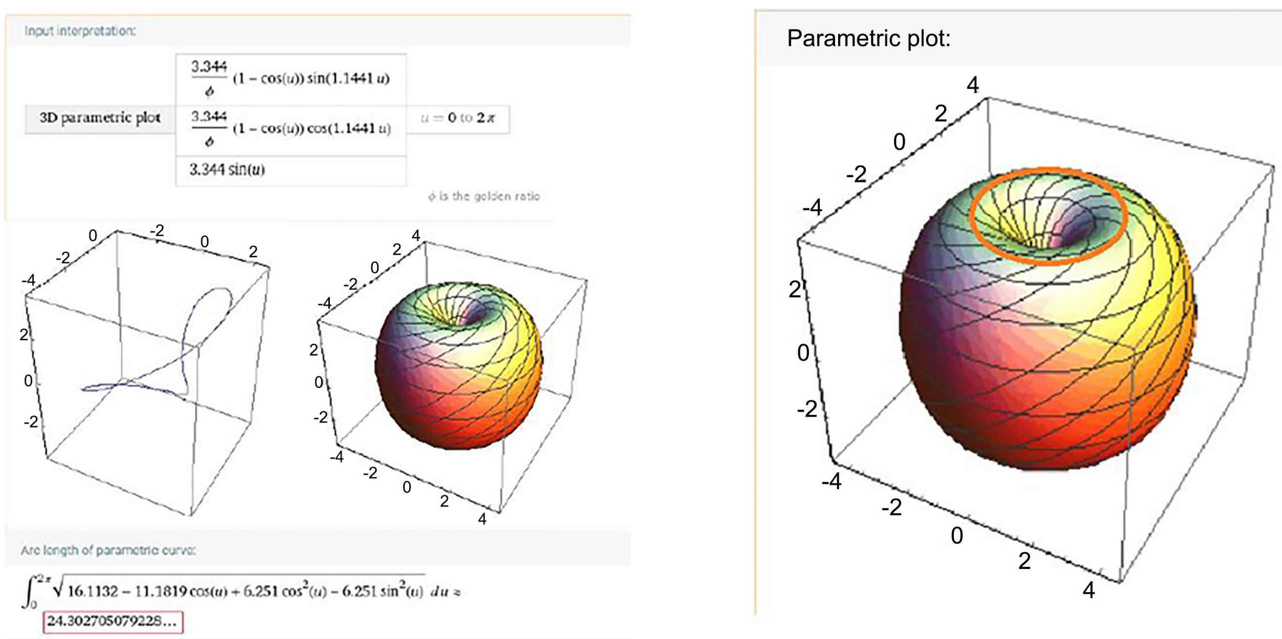


Figure 3. Wolfram Alpha parametric simulation of the fiber model of the electron's charge flux manifold showing its magnetic moment's N and S *pole dip aperture* of radius approximate calculated at $r_{dip} = 0.1821\text{E}{-13}$ m (Appendix III of [5]).

two poles on the spin axis of the electron but our value refers instead to the overall anomalous toroidal sphericity of the electron charge when *each pole is compared with the equator of the manifold*.

As far as we know, this was never experimentally undertaken and is therefore our prediction and proposed experiment. Also, notice the described asymmetry here in is not violating any parity symmetry or time inversion.

Nevertheless, we have to add here, from our previous fiber model of the electron publication [5] the hypothesis and inferred conclusion of the analyzed data, the possibility that the increased angular velocity observed of the charge flux near the magnetic pole regions due the vortexing action, see **Figure 2** & **Figure 3**, to be able to compensate fully for any spatial anisotropy in our proposed charge flux fiber model [5] of the electron and therefore still generating effectively a completely homogeneous and isotropic perfect spherical, interaction electric field *E-far field*, around the electron charge with its environment. If this would be the case predicted as well as being possible by our charge fiber model [5], then the Standard Model (SM) known theoretical prediction holds which sets the upper limit of any possible electron's eEDM at $d_e < 10^{-38}$ e·cm [31] for any direction thus as close as it gets to a perfect sphere concerning the generated interaction E-*far* field of the electron and leaving no chance for experimental new physics beyond the SM concerning this particular subject.

Drawing further in our last conclusion above of the possibility shown by our electron fiber model [5] of the anisotropic charge manifold of the electron which can be described essentially as a coaxial spherical dipole vortex (*i.e.*, horn sphere), to generate in the *far field* a total spatial isotropic perfect spherical electric E *far-field*, *we show bellow a paradigm from nature.* Observe the anisotropic flux of a water pool, joined dipole vortex (called else water Modon) [32] see **Figure 4**, representing the 2D flat version of our dipole vortex electron charge

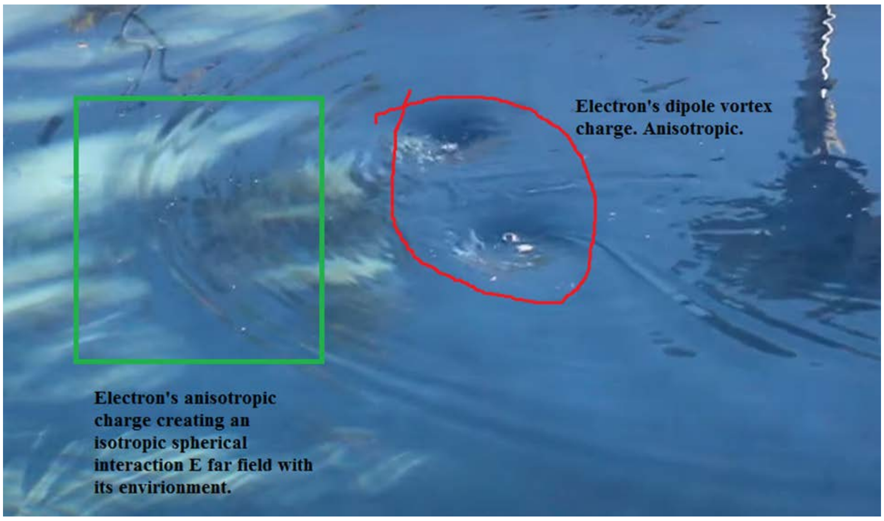


Figure 4. A water pool joined dipole vortex formation (*i.e.* water modon), paradigm found in nature where an anisotropic charge creates a perfect isotropic and symmetrical *far*-interaction field. Base image credits: https://tinyurl.com/y2hje88t.

manifold in our model, creating isotropic ripples in the water in the far field representing the spherical interaction E-field of the electron charge with its environment.

If this is the case, then the only possibility we can see for future eEDM experiments to ever measure a substantial eEDM value is not by increasing further the sensitivity of the measurement; according to our model, the actual charge anisotropy is far greater than the expected and estimated, but instead to find a way to get as close as possible to the *near E-field* of the electron charge although this is very difficult to accomplish because the elastic scattering of the electron. As close as possible to the actual charge flux vortex manifold and not try to only measure the eEDM between the two poles on the spin axis but also the possible existing eEDM between each pole and the rest of the spherical charge surface of the electron charge manifold.

2.2. Proposed Experiment for Measuring the Sphericity of the Electron's Charge Monopole E-Far Interaction Field

Assuming the anomaly in the spatial charge distribution of the charge flux manifold of the electron is induced towards its generated electric E-*far* interaction monopole field with its environment, it could be possible within today's experiment precision to measure this anomaly. Opposite to the ACME eEDM experiments and other similar we will not search exclusively for an eEDM on the spin axis of the electron which our model shows is non-existing since the two pole *aperture anomalies are equal in size and opposite symmetrical*, *see* Figure 2 & Figure 3*.* Instead, we will scan the whole E-field of the electron around the unit circle. Also, high energy experiment is out of the question because of the strong indication we have from our research and will discuss later on that the charging manifold of the electron shrinks in dimensions proportional to its given acceleration beside any relativistic effects. The free electron must be physically as close to its rest energy 0.511 MeV therefore preferably as close as possible to zero translational speed at the moment of measurement. Also, it is almost impossible to measure the electron's charge generated E-*near field* at low energies, undisturbed as possible because of its elastic scattering with photons.

An outline description of the proposed experiment illustrated in Figure 5 could be as follows:

The above configuration resembles a penning trap with a homogeneous static magnetic dipole N-S field crossing an electrostatic field as shown. A net EM Lorentz force inhomogeneous field is created on the inside apparatus area of Figure 5 with the Lorentz field EM flux vectors oriented in xyz space as shown in Figure 5. The vectors orientation in space can be adjusted by holding the B-field strength fixed and varying the E-field strength. A free electron could be decelerated initially and enter the apparatus at the center with *near* zero velocity $v \approx 0$. It will align momentarily its intrinsic magnetic moment vector (*shown in green in* Figure 5) to the external Lorentz field vector and also start gyromagnetically precessing around the Lorentz vector and the electron's instantaneous magnetic

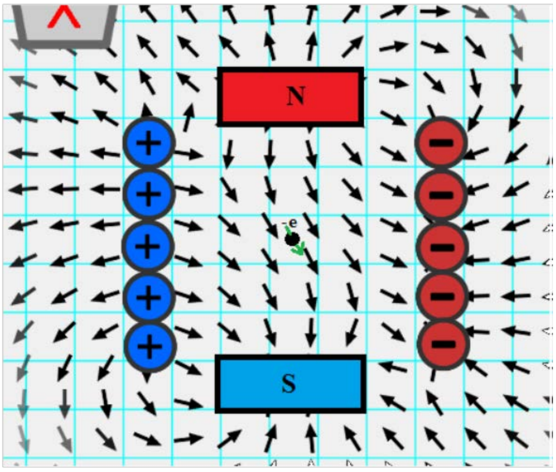


Figure 5. Proposed experiment for measuring the sphericity of the electron's monopole E-far field.

moment orientation position at the moment it has entered the apparatus around the 360˚ *unit circle* on the plane of the apparatus could be statistically sampled for analysis. Following, by tuning the E-field strength and appropriately rotating the apparatus we could check the electron's magnetic moment orientation each time around the *unit circle* for all of its four-quarter spaces from 0 to π/2 → π → 3π/2 → 2π and plot the graph of the applied varying electric field strength E with the statistically measured angle on the unit circle plane of the electron's magnetic moment orientation in space. This angle could be measured with the highest possible resolution and sensitivity the same as the corresponding E-field strength very accurately measured value applied each time.

The final plotted function obtained should be highly linear. Any noticeable deviation outside the experiment's error bars of this graph will conclusively prove anisotropy in the sphericity of the electron's charge monopole E-*far field* in space. Any eEDM value can be further extrapolated from the experiment's data set. Special care must be taken for the experimental results and goal to be achieved with the lowest possible externally applied electric E-field varying values to avoid any possible excessive distortion of the electron charge manifold at rest.

2.3. A Shrinking and Elastic Electron Charge Manifold

We have discussed in the previous section the possibility shown by our model [5] the charge flux manifold of the electron shrinks symmetrically for its rest and stationary state when a free electron translates in vacuum space proportional to its moving speed beside any relativistic effects. However, our model also shows that its fine structure constant (FSC) value $\alpha \approx 1/137$ and subsequent anomalous magnetic dipole moment a_μ and therefore also g-factor dimensionless constants are all preserved in vacuum space and of fixed value. Only at the extreme case of an electron-positron pair annihilation the FSC of the electron is destroyed. This could mean the possibility of the electron charge manifold preserving its form and geometrical proportions all times in a vacuum but overall and symmetrical shrink in size when subjected to translational speed or acceleration or even subjected to a strong externally applied electric field.

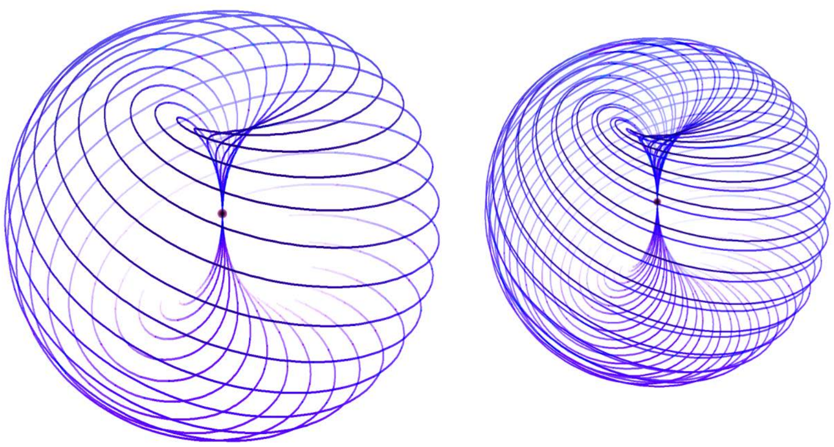
Furthermore, there is the possibility shown by our model that the electron inside an atom adapts its charge radius to encompass each time the given electron orbital which corresponds to the Bohr radius around the nucleus in a coaxial nested horn spheroid configuration, see **Figure 6**. In this case the charging manifold of our model becomes the amplitude probability wavefunction of the bound electron in the atom, see **Figure 6**.

Coming back to the free stationary electron case, it can be shown also using our model, see **Figure 1**, that the intrinsic spin magnetic dipole moment value of one Bohr magneton μ_B for the Compton electron model can be expressed semi-classical as:

For $\upsilon = c$,

$$\mu = \frac{e\omega r^2}{g} = \frac{e\upsilon r}{g} = \mu_B \quad (10)$$

where ω the angular velocity of the spin, e is the absolute value of the electron elementary charge, r is the charge radius and g is the electron g-*factor*, υ is the tangential spin velocity and c is the speed of light in a vacuum. Ideally, for $g = 2$ the dimensionless Dirac value [9] for the electron (*i.e.*, *not accounting for any anomalous magnetic moment* a_μ *of the electron*) results in the known value of the spin magnetic dipole moment of the electron at rest, *absolute* value of ≈9.28 × 10^{-24} A·m^2 in *SI units* or else 9.28 × 10^{-24} J/T.



(a) (b)

Figure 6. Coaxial nested configuration of the orbital electron inside the atom. The electron charge manifold adjusts its radius to the given orbital (Bohr radius) around the nucleus shown as a red sphere at the center. The charge manifold of the electron then becomes its wavefunction. (a) Hydrogen-1 Atom. One electron charge (blue) around the nucleus (red) single proton. (b) Helium-4 Atom. Two counter spinning electron charge manifolds (blue) in the same orbital around the He-4 nucleus (red). Animation H-1 Atom: https://www.horntorus.com/particle-model/H-1-m-flux.html Animation He-4 Atom: https://www.horntorus.com/particle-model/He-4-m-flux.html.

For $\upsilon = c$ *tangential* spin velocity value at the equator of the manifold, in the above Equation (10) (*i.e.*, *υ not to be confused with particle translational velocity*), the upper limit, thus *minimum allowed* charge radius *r* for a stationary electron at rest without any translational motion in space is calculated to be:

$$\lambda\!\!\!^{-} = \frac{\lambda_c}{2\pi} \approx 3.86 \times 10^{-13}\ \text{m} \tag{11}$$

where $\lambda\!\!\!^{-}$ is the *reduced* Compton wavelength value for the electron.

After that, for any smaller charge radius *r* values, the electron in order to match the known measured value of its spin magnetic dipole moment of one Bohr magneton μ_B, must spin with a tangential velocity $\upsilon > c$ at the equator, thus at *superluminous* speed exceeding the *speed of light c* in the vacuum, therefore a condition which is not allowed by Special Relativity theory.

However, the above analysis refers to a stationary electron at rest without any translational motion. Assuming that the electron charge manifold apart from any relativistic effects, *shrinks in size* symmetrically inside its inertial frame of reference when translating in space proportional to the translational speed and also that the intrinsic charge manifold maintains all time its tangential velocity at the equator fixed at the speed of light value limit *c* in a vacuum, then Equation (10) above shows that the spin magnetic moment cannot remain invariant but actually reduces with the increase in translatioanal speed of the electron. This is further supported by Equations (1) & (9) which show that in high-energy electron beam physics where the Compton wavelength λ_c of the electron is known, it reduces with acceleration. Therefore, according to Equation (9) for an invariant dimensionless anomalous magnetic moment value a_μ, the radius r_e (*i.e.*, *see radius of the horn tube in* **Figure 1**) of the charging manifold of the electron under acceleration must also reduce in size and because the invariant FSC α Equation (1), the charge radius of the electron $\lambda\!\!\!^{-}$ (see **Figure 1**) must also proportionally shrink in order to keep the FSC *a*, a constant.

We cannot dismiss and reject lightly the above described scenario of a shrinking electron proportional to its translational speed. There is no theoretical proof against this, also supported by our model, hypothesis. Besides, that would explain why there is not yet found any finite size for the electron and explain the experiments given extreme upper limits for its size (*i.e.*, very tiny size limits reported) which are unheard of for a relative so small mass particle of just 0.511 MeV/c^2 and a persisting mystery in particle physics. The electron should be much bigger at rest when not disturbed and close to stationary.

Notice, also here that in high-energy QED experiments in a cyclotron or synchrotron for example, the spin magnetic moment μ_e of the electron and also anomalous magnetic moment a_μ final values cannot be measured directly in the beam but rather the g-factor value is extrapolated by the measurement data using the formula:

$$\nu_s = \frac{g}{2}\nu_c \tag{12}$$

where v_s is the gyromagnetic spin frequency [33] (*i.e.*, *Larmor frequency*) of the electron and v_c the spin frequency of the cyclotron apparatus. However, our model shows that because the g-factor is tightly correlated to the fine structure constant of the electron, it is invariant for any translational speed of the electron [34]. Therefore, this type of experiments will not show up any possible variation of the spin magnetic dipole moment μ_e of the electrons inside the accelerated beam from the rest value.

3. Conclusions

We have conclusively shown herein using our EM flux charge fiber model of the electron [5], that the physical electron must possess an intrinsic charge manifold and therefore have shape and finite dimensions strongly inferred and correlated by its fine structure constant and anomalous magnetic dipole moment which for the first time are shown these to actually be geometrical features embedded inside the proposed intrinsic charge manifold of the electron. Predictions were made about a possible toroidal axial electric dipole moment eEDM of the free electron at rest with close to zero translational velocity which is induced and also possible and measurable in its generated E-far interaction field with its environment. But also keeping open the possibility also predicted by our model, that the dynamic dipole vortexing action of the manifold although anisotropic by itself, actually generates an isotropic monopole electric E-*far* interaction field with its environment.

Additionally, it was shown why the electron charge has possible no eEDM dipole moment on its spin axis between its two N-S poles but instead only between each pole and the equator of its manifold as a consequence of not having perfect sphericity caused by its fine structure constant. Therefore, current eEDM experiments which try to measure an asymmetry only on the spin axis of the electron comparing only its two poles N-S, are in our best knowledge and experience drawn by our research, destined to fail since our model [5] demonstrate both poles N-S vortex deformations to be as identical as possible and opposite symmetrical thus there is no eEDM between the two poles on the spin axis of the electron to be found.

Alternatively, an experiment was proposed on how we could measure the total sphericity of the electron's charge manifold instead in space and the general experiment requirements that must be fulfilled and limitations that must be obeyed in order to succeed in this goal. It was also proposed that the current high energy experiments for measuring any eEDM for the electron charge are unsuitable because the possibility that our research indicates that the electron charge manifold besides any relativistic effects, enormously shrinks in size when the free electron is accelerated beyond its rest energy of 0.511 MeV and even by the application of a relative strong external electric stasis field in a penning trap type experiment.

Of course, these last mentioned prohibits with the current technology from directly measuring any cross-section size of the electron charge manifold since low energy experiments cannot come close to the E-near field of the free electron due to its elastic photon scattering property. It seems that the elusive electron resists any measurement of its possible spatial dimensions.

Acknowledgements

We thank Wolfgang W. Däumler for the mathematical animations he generously made for this research and for general support. Also, Prof. John Chatzakis and Prof. Antonios Konstantaras of the Hellenic Mediterranean University for the fruitful discussions and support.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Weinberg, S. (1967) A Model of Leptons. *Physical Review Letters*, **19**, 1264-1266. https://doi.org/10.1103/PhysRevLett.19.1264

[2] Gaillard, M.K., Grannis, P.D. and Sciulli, F.J. (1999) The Standard Model of Particle Physics. *Reviews of Modern Physics*, **71**, S96-S111. https://doi.org/10.1103/RevModPhys.71.S96

[3] Atiyah, M. and Sutcliffe, P. (2002) The Geometry of Point Particles. *Proceedings of the Royal Society of London. Series A: Mathematical, Physical and Engineering Sciences*, **458**, 1089-1115. https://doi.org/10.1098/rspa.2001.0913

[4] Felsager, B. (1998) Geometry, Particles, and Fields. Springer, New York.

[5] Markoulakis, E. and Antonidakis, E. (2022) A ½ Spin Fiber Model for the Electron. *International Journal of Physical Research*, **10**, 1-17. https://doi.org/10.14419/ijpr.v10i1.31874

[6] Markoulakis, E., Konstantaras, A., Chatzakis, J., Iyer, R. and Antonidakis, E. (2019) Real Time Observation of a Stationary Magneton. *Results in Physics*, **15**, Article ID: 102793. https://doi.org/10.1016/j.rinp.2019.102793

[7] Markoulakis, E., Chatzakis, J., Konstantaras, A. and Antonidakis, E. (2020) A Synthetic Macroscopic Magnetic Unipole. *Physica Scripta*, **95**, Article ID: 095811. https://doi.org/10.1088/1402-4896/abaf8f

[8] Markoulakis, E., Vanderelli, T. and Frantzeskakis, L. (2022) Real Time Display with the Ferrolens of Homogeneous Magnetic Fields. *Journal of Magnetism and Magnetic Materials*, **541**, Article ID: 168576. https://doi.org/10.1016/j.jmmm.2021.168576

[9] Dirac, P.A.M. (1931) Quantised Singularities in the Electromagnetic Field. *Proceedings of the Royal Society of London. Series A, Containing Papers of a Mathematical and Physical Character*, **133**, 60-72. https://doi.org/10.1098/rspa.1931.0130

[10] Stefanovich, E.V. (2001) Quantum Field Theory without Infinities. *Annals of Physics*, **292**, 139-156. https://doi.org/10.1006/aphy.2001.6175

[11] Ginzburg, V.L. (2001) The Physics of a Lifetime : Reflections on the Problems and Personalities of 20th Century Physics. Springer, Berlin, Heidelberg, 513 p. https://doi.org/10.1007/978-3-662-04455-1

[12] Andreev, V., Ang, D.G., DeMille, D., Doyle, J.M., Gabrielse, G., Haefner, J., Hutzler, N.R., Lasner, Z., Meisenhelder, C., O'Leary, B.R., Panda, C.D., West, A.D., West, E.P. and Wu, X. (2018) Improved Limit on the Electric Dipole Moment of the Electron. *Nature*, **562**, 355-360. https://doi.org/10.1038/s41586-018-0599-8

[13] Aggarwal, P., Bethlem, H.L., Borschevsky, A., Denis, M., Esajas, K., Haase, P.A.B., Hao, Y., Hoekstra, S., Jungmann, K., Meijknecht, T.B., Mooij, M.C., Timmermans, R.G.E., Ubachs, W., Willmann, L. and Zapara, A. (2018) Measuring the Electric Dipole Moment of the Electron in BaF. *The European Physical Journal D*, **72**, Article No. 197. https://doi.org/10.1140/epjd/e2018-90192-9

[14] Cairncross, W.B., Gresh, D.N., Grau, M., Cossel, K.C., Roussy, T.S., Ni, Y., Zhou, Y., Ye, J. and Cornell, E.A. (2017) Precision Measurement of the Electron's Electric Dipole Moment Using Trapped Molecular Ions. *Physical Review Letters*, **119**, Article ID: 153001. https://doi.org/10.1103/PhysRevLett.119.153001

[15] Hanneke, D., Hoogerheide, S.F. and Gabrielse, G. (2011) Cavity Control of a Single-Electron Quantum Cyclotron: Measuring the Electron Magnetic Moment. *Physical Review A*, **83**, Article ID: 052122. https://doi.org/10.1103/PhysRevA.83.052122

[16] Hanneke, D., Fogwell, S. and Gabrielse, G. (2008) New Measurement of the Electron Magnetic Moment and the Fine Structure Constant. *Physical Review Letters*, **100**, Article ID: 120801. https://doi.org/10.1103/PhysRevLett.100.120801

[17] Odom, B., Hanneke, D., D'urso, B. and Gabrielse, G. (2006) New Measurement of the Electron Magnetic Moment Using a One-Electron Quantum Cyclotron. *Physical Review Letters*, **97**, Article ID: 030801. https://doi.org/10.1103/PhysRevLett.97.030801

[18] Bourilkov, D. (2001) Hint for Axial-Vector Contact Interactions in the Data on [Formula Presented] at Center-of-Mass Energies 192 - 208 GeV. *Physical Review D*, **64**, Article ID: 071701. https://doi.org/10.1103/PhysRevD.64.071701

[19] Jennison, R.C. (1989) A New Classical Relativistic Model of the Electron. *Physics Letters A*, **141**, 377-382. https://doi.org/10.1016/0375-9601(89)90852-9

[20] Williamson, J.G. and Van Der Mark, M.B. (1997) Is the Electron a Photon with Toroidal Topology? *Annales de la Fondation Louis de Broglie*, **22**, 133-160.

[21] Nader, B., Dgania, P. and Tikva, I. (2021) A New Theory for the Essence and Nature of Electron Charge. *Journal of High Energy Physics, Gravitation and Cosmology*, **7**, 1190-1201. https://doi.org/10.4236/jhepgc.2021.73070

[22] Consa, O. (2018) Helical Solenoid Model of the Electron. *Progress in Physics*, **14**, 80-89.

[23] Storti, R.C. and Desiato, T.J. (2009) Derivation of Fundamental Particle Radii: Electron, Proton, and Neutron. *Physics Essays*, **22**, 27-32. https://doi.org/10.4006/1.3062144

[24] Otto, H.H. (2022) Golden Quartic Polynomial and Moebius-Ball Electron. *Journal of Applied Mathematics and Physics*, **10**, 1785-1812. https://doi.org/10.4236/jamp.2022.105124

[25] Griffiths, D.J. (1995) Introduction to Quantum Mechanics. Prentice Hall, Hoboken, 155.

[26] Mac Gregor, M.H. (2014) The Enigmatic Electron. Springer, Dordrecht.

[27] Compton, A.H. (1919) The Size and Shape of the Electron. *Physical Review*, **14**, 20-43. https://doi.org/10.1103/PhysRev.14.20

[28] Sommerfeld, A. (1916) Zur Quantentheorie der Spektrallinien. *Annalen der Physik*, **356**, 125-167. https://doi.org/10.1002/andp.19163561802

[29] Weinberg, S. (2005) The Quantum Theory of Fields. Vol. 1: Foundations. Cambridge University Press, Cambridge.

[30] Schwinger, J. (1948) On Quantum-Electrodynamics and the Magnetic Moment of the Electron. *Physical Review*, **73**, 416-417. https://doi.org/10.1103/PhysRev.73.416

[31] Pospelov, M. and Ritz, A. (2005) Electric Dipole Moments as Probes of New Physics. *Annals of Physics*, **318**, 119-169. https://doi.org/10.1016/j.aop.2005.04.002

[32] Hughes, C.W. and Miller, P.I. (2017) Rapid Water Transport by Long-Lasting Modon Eddy Pairs in the Southern Midlatitude Oceans. *Geophysical Research Letters*, **44**, 12375-12384. https://doi.org/10.1002/2017GL075198

[33] Kusch, P. and Foley, H.M. (1948) The Magnetic Moment of the Electron. *Physical Review*, **74**, 250-263. https://doi.org/10.1103/PhysRev.74.250

[34] Straser, V. (2021) Calculation of G Gravity Constant from the Mass and Electron Charge, and Fine Structure Constant. *Journal of Modern Physics*, **12**, 1172-1181. https://doi.org/10.4236/jmp.2021.128071