An Alternative Theory of Everything: Classical Quantum Physics

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Summary

This paper recaps the main results of our photon, proton and electron models and also revisits our earlier hypothesis of the neutrino being the carrier of the strong force carrier. As such, we think this paper contains all necessary ingredients of an alternative interpretation of quantum mechanics. We refer to this interpretation as a *realist* or classical interpretation because it does not require any equations or assumptions beyond the classical framework of physics: Maxwell's equations and the Planck-Einstein relation are all that is needed.

In order to distinguish our approach from mainstream physics (read: the Standard Model), we refer to our ideas as classical quantum physics.

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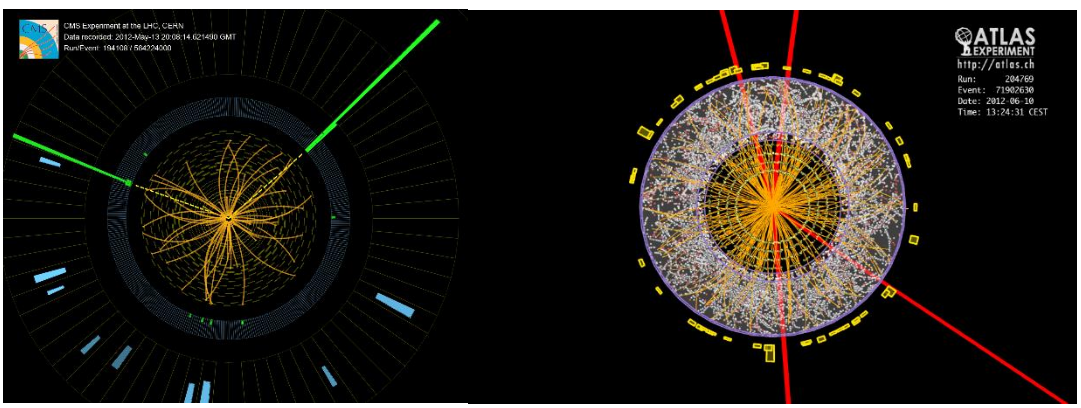
Introduction: smoking gun physics

We should be clear from the outset: we do not believe forces have to be mediated by messenger particles. This sounds revolutionary: the actual *existence* of $W^{\pm}$ and Z^0 bosons was confirmed in a series of experiments by Rubbia and van der Meer, back in 1983—wasn't it? They got the Nobel Prize for it – the next year already (1984) – so *it must be true*, right?

Likewise, the quark hypothesis was *confirmed* as early as in 1968, wasn't it? Stanford's Linear Accelerator (SLAC) had been in operation for about two years then[1], and further experiments in the 1970s and 1980s confirmed the existence of the second and third generation of quarks, isn't it? Friedman, Kendall and Taylor, who led those experiments, got a Nobel Prize for it in 1990.

Finally, there is the experimental confirmation – in 2012 – of the *reality* of the Higgs mechanism, which is supposed to explain *mass*, isn't it? We have all these beautiful images of it[2]:



The image of the left shows two gamma rays emerging from the CERN LHC CMS detector, while the one on the right shows the tracks of four muons in the CERN LHC ATLAS detector. This time it was not the experimentalists but the *theorists* (Englert and Higgs[3]) who got the Nobel Prize for it: their research goes

[1] SLAC started operations in 1966. The Wikipedia article on SLAC gives a good overview of the research since then and the related Nobel Prizes in Physics.

[2] More images and explanations can be found on CERN's website (https://home.cern/science/physics/higgs-boson).

[3] Many more contributed but were either dead (Nobel Prize are not awarded posthumously, which is the reason why John Stewart Bell didn't get his: he died from a cerebral hemorrhage the year he was nominated) or not included.

back to the early 1960s, so they must have been surprised!

Think for yourself here. All we can see are *signals,* or *traces*, or *jets* of unstable particles disintegrating into more stable configurations: **there is no *direct* evidence of W/Z bosons, of quarks, or of the reality of the Higgs field.**

These traces or signals indicate that the lifetime of the so-called Higgs boson is of the order of 10^{-22} seconds. Labelling it as a particle is, therefore, hugely misleading: even at the speed of light – which an object with a rest mass of 125 GeV/c^2 cannot aspire to attain – it cannot travel any further than a few *tenths* of a femtometer: about 0.3×10^{-15} m, to be precise. That's *smaller* than the radius of a proton, which is in the range of 0.83 to 0.84 fm.[4] Particles with such short lifetimes are not referred to as particles in high-energy physics: they are referred to as *resonances*.

We lamented about this before, so we won't repeat ourselves here: the gun may or may not be smoking, but this is no evidence.[5] It is wishful thinking. The Nobel Prize Committee has been in a hurry to *consecrate* the Standard Model but few people – including physicists – believe the Standard Model is the end of physics. In fact, we believe she Standard Model is the end of physics—but for entirely different reasons: it is not because we think it is complete (we do *not*[6]) but because we think it exposes the fundamental conceptual weaknesses of mainstream physics. We also wrote about this before so let us, without further ado, talk about what we think of as *real* physics—as opposed to *mystification* and *multiplication* of concepts.

For starters, forget about the weak force. A force explains why stuff stays together, or pushes it apart: disintegration processes are to be analyzed in entirely different terms. Think of non-equilibrium physics here. You should also erase all of the useless theoretical distinctions—such as the distinction between bosons and fermions, for example. Also forget about g-factors, which we can't measure anyway: we can measure the magnetic moment of a particle, but calculating a g-factor involves *assumptions* about its *shape* and the *distribution of its mass* over that shape. In short, think specifics: try to imagine what a photon, an electron and a proton might actually *be.*

Think of this: **while learning truly new things, you also need to try to un-learn a lot of what you've learned.** To be specific here, one of the things you need to forget is the idea that an electron or a proton have no internal structure: they are *not* the dimensionless point particles that you learnt about. These are mathematical idealizations only: the *intrinsic* properties of photons, electrons and protons – their mass, their magnetic moment (including the anomaly) and their momentum – can and should be explained. This is, in fact, the single largest failure of mainstream quantum physics: because they forgot to think of what an electron or a photon might actually *be*, mainstream physicists had to come up with all kinds of weird theories – quantum field theory is probably a good aggregate name for them – to explain wave-particle duality. Good photon, electron and proton models build that in from the start.

We're getting ahead of ourselves here, so let's get on with it.

[4] We will come back to the measurements and explanations of the proton radius.
[5] See our paper on *Smoking Gun Physics* (https://vixra.org/abs/1907.0367).
[6] Its greatest failure is that it does *not* explain the intrinsic properties of elementary particles. In fact, we blame mainstream theorists for not even *trying* to do that.

Particle classifications

We have exposed the conceptual emptiness of the oft-used distinction between bosons and fermions elsewhere: it is obvious we think the distinction is not only useless but actually *counter-productive*, in the sense that it *hampers* rather than promotes understanding.[7] We find the simpler distinctions between elementary and composite particles, and between stable and non-stable particles, much more valuable. The reader should immediately note that these distinctions are related but not the same: they complement each other. Let us give some examples:

- We think of photons, electrons and protons as elementary particles. Elementary particles are, obviously, stable. They would not be elementary, otherwise. In contrast, not all stable particles are elementary.
- We think of atoms as *stable* composite particles, for example: we can, effectively, remove electrons from them (by ionization). That reveals their composite structure. Atoms are stable but, obviously, they are *not* indestructible. In fact, ionization requires very little energy: the electromagnetic bond between the nucleus and the electrons is quite weak.
- A neutron is an example of a composite particle which is *non*-stable: outside of the nucleus, it spontaneously disintegrates into a proton and a neutron.[8] Pions are another example of non-stable composite particles.[9]

We should make a few additional notes here. First, while we think of electrons and protons as elementary particles, we think they have some internal *structure*.[10] This is why they are also *not* indestructible, as evidenced from, say, high-energy proton-proton collisions in CERN's LHC.

Second, we do not believe in the quark hypothesis. We think the quark hypothesis results from an unproductive approach to analyzing disintegration processes: inventing new quantities that are supposedly being conserved, such as strangeness (see, for example, the analysis of K-mesons in Feynman's *Lectures*[11]), is… Well… As strange as it sounds. We, therefore, think the concept of quarks confuses rather than illuminates the search for a truthful theory of matter.

Third, as mentioned above, we think all matter-particles carry charge—even if they are neutral. When they are neutral, there is a positive and negative charge inside which balances out. We think photons and neutrinos – all particles which travel at the speed of light – do *not* carry any electric charge. They are

[7] See, for example, *Feynman's Worst Jokes and the Boson-Fermion Theory* (https://vixra.org/abs/2003.0012).

[8] The neutron's *mean* lifetime is just under 15 minutes (), which is an eternity in the sub-atomic world, but quite short on the human time scale, of course. Neutron disintegration also involves the emission of the mysterious neutrino, which we shall talk about later.

[9] Pions are classified as mesons. We also have baryons. However, to make sense of the concept of mesons and baryons, one needs to believe in quarks. Mesons are supposed to consist of two quarks, while baryons are supposed to consist of three. Because we do not believe in quarks, we think the distinction is not useful. Worse, we think it is an example of *non*-productive theory. For a complete scientific overview of what happens to unstable particles, we refer the reader to the tables of the Particle Data Group (http://pdg.lbl.gov/2019/tables/contents_tables.html).

[10] Their structure is given by the ring current or *Zitterbewegung* model, which we will present in a moment.

[11] See: Feynman's *Lectures*, Vol. III, Chapter 11, Section 5 (https://www.feynmanlectures.caltech.edu/III_11.html#Ch11-S5).

nothing but a traveling field. The reader will now ask: what *is* a traveling field? Our answer is this: think of a force without a charge to act on. This brings us to our fourth and most fundamental remark:

We think a charge comes with a *very* tiny but non-zero rest mass. We also think a charge takes up some very tiny but non-zero space.[12] We think most of the mass of the electron and the proton can be explained by Wheeler's concept of 'mass without mass': the equivalent mass of the energy in a local oscillation of the charge. In other words, we think the mass of protons and electrons is relativistic. However, for the equations to make sense, some non-zero rest mass must be assumed.[13]

The remarks above lead to the following simple table of matter-particles:

Matter-particles	**Elementary**	**Composite**
Stable	Electrons and protons[14]	Atoms and molecules
Non-stable		All non-stable particles (e.g. neutrons, pions, kaons,…)

The table above suggests we should try to why some only very few (composite) particles are stable. We think it has to do with the Planck-Einstein Law. We think it models a fundamental *cycle* in Nature, and if that cycle is slightly off, particles will disintegrate into stable components, which do respect the Planck-Einstein Law—*exactly*, that is.

Stable versus non-stable particles and the Planck-Einstein Law

We think of electrons and protons as oscillations in time and in space. Because of relativity theory, we need to quickly say a few things above that first: what is relative and what isn't?

Relativity theory tells us time is relative (your clock isn't mine, and vice versa) but that is not a sufficient reason to mix the concepts of space and time into the rather vaguely defined concept of *spacetime*. Space is what it is – just three-dimensional Cartesian space – and time is also what it is: the clock that ticks away. Both are related through the idea of motion: an object moving from here to there covering some distance Δs in some time interval Δt. Its velocity – as measured in our reference frame – is equal to $v = \Delta s/\Delta t$. The relativity of time is nicely captured in the following formula for the Lorentz factor:

$$\gamma = \frac{1}{\sqrt{1 - v^2/c^2}} = \frac{\mathrm{dt}}{\mathrm{d}\tau}$$

[12] The latter remark is not as fundamental as the former, however.

[13] The non-zero rest mass also explains the anomaly in the magnetic moment (and radius) of protons and electrons, so we feel good about this assumption.

[14] The reader will note we leave the photon (and the neutrino) out of the table. We do *not* think of them as matter-particles. We might have referred to them as bosons, but the concept of bosons has been contaminated by the idea of messenger particles 'mediating' forces (think of W/Z bosons here), so we do not like to use it. If we would have to use a common term for photons and neutrinos, we'd refer to them as light or light-particles, as opposed to matter-particles.

The t-time is the time in our reference frame – which is, quite aptly, referred to as the *inertial* reference frame (think of it as *my* clock) – while the τ-time is the *proper* time: the clock of the moving object (think of it as *your* clock). We may usefully distinguish between the velocity in the *x*-, *y*- or *z*-direction and it may, therefore, also be necessary – but only very occasionally – to distinguish between the Lorentz factor in the *x*-, *y*- or *z*-direction. If this comes as a surprise to you, you should note that Einstein himself – in the seminal 1905 article in which he introduces the principle of relativity – distinguished between the 'transverse' and 'longitudinal' mass of an electron, and *not* because he was confused or mistaken on the subject.[15]

Any case, that should be enough of an introduction to the concepts of space, time and motion. Let us get on with the matter—literally. We introduced a photon, electron, and proton model in previous papers.[16] So what about other particles, such as neutrons or mesons?

As mentioned above, we think of these as non-stable *composite* particles and, hence, they should be analyzed as non-equilibrium systems. The reader will, of course, immediately cry wolf: the neutron is stable, isn't? It is, but only inside of the nucleus. Hence, that too requires a different type of analysis: such analysis may or may not resemble the analysis of electron orbitals or other atomic systems. It is of no concern to us here now.

The point is this: we think non-stable particles are non-stable because their *cycle* is *not* slightly *off*. What do we mean by that? We mean their cycle time (T) does not fully respect the Planck-Einstein relation (E = *h*·*f* = ħ·ω), which – in this context – we may write as:

$$\mathrm{T} = \frac{1}{f} = \frac{h}{\mathrm{E}} \Leftrightarrow \mathrm{E} \cdot \mathrm{T} = h$$

Hence, we think of non-stable particles as non-stable *oscillations* which have some excess energy they need to get rid of by ejecting a stable or unstable *matter*-particle (electrons and protons are stable, but an unstable configuration may also eject a neutron or some meson[17]) or, else, one or more photons or neutrinos. The so-called second and third generation of charged particles are also non-stable and we think of them in the same way: we do not see any mystery in terms of explanation here.

Finally – and importantly – we here answer the question as to what *we* think of what W and Z bosons might actually *be*: we think of their nature as being essentially the same as that of any *intermediate* unstable particle—or a *resonance*, even.[18] Nothing more, nothing less. No mystery here!

[15] For a concise discussion, see: https://www.mathpages.com/home/kmath674/kmath674.htm
[16] See: https://vixra.org/author/jean_louis_van_belle.
[17] It may also be some other *baryon*. Wikipedia offers a decent introduction to the particle zoo (https://en.wikipedia.org/wiki/Hadron) but it should be obvious to the reader that we do not agree with the traditional classifications. Why? Because we do not adhere to the quark hypothesis. We think the quark hypothesis results from an unproductive approach to analyzing disintegration processes: inventing new quantities that are supposedly being conserved, such as strangeness (see, for example, the analysis of K-mesons in Feynman's *Lectures*, Vol. III, Chapter 11, section 5), is… Well… As strange as it sounds. We, therefore, think the concept of quarks confuses rather than illuminates the search for a truthful theory of matter.
[18] The difference between a unstable particle (which we sometimes refer to as a *transient* wavicle or a transient, *tout court*) and a resonance is basically a matter of appreciation: resonances have *extremely* short lifetimes: we think of these lifetimes as the time it takes to go from one energy state to another.

Let us get back to the elementary particles we want to look at: their cycle *not* slightly off. It is *on*—and very precisely so. What do we mean with that, then? Let us briefly recap our model(s) here.

The ring current model of matter-particles

As mentioned above, we do not think the distinction between spin-1/2 and spin-1 particles (bosons versus fermions) is productive.[19] We think the basic distinction is this:

1. Matter-particles carry electric charge—even if they are neutral: we think of a neutron as some combination of a proton and an electron, for example.[20]
2. In contrast, photons (and neutrinos) are, effectively, force carriers.

What's a force carrier? It is nothing but a traveling field. What's a field? A field is a force without a charge to act on. Of course, the reader may think this definition confuses as much as it explains, but we think it is clear enough. In case the reader would be confused, then we strongly advise him or her to read one or more previous papers on our photon model.[21]

We will come back to photons and neutrinos. Let us first discuss our ring current model of matter-particles—of electrons and protons, that is. Unlike other ring current or *Zitterbewegung* theorists, we do *not* invoke Maxwell's laws of electrodynamics to explain what a proton and an electron might actually *be*—not *immediately*, at least (we will need Maxwell's laws later, though). Our model only uses (1) Einstein's mass-energy equivalence relation, (2) the Planck-Einstein law, and (3) the formula for a tangential velocity. Indeed, the basics of the ring current model may well be summed up by the latter:

$$c = a \cdot \omega$$

Einstein's mass-energy equivalence relation and the Planck-Einstein relation explain everything else[22], as evidenced by the fact that we can immediately derive the Compton radius of an electron from these three equations:

$$\left.\begin{matrix} \left.\begin{matrix} \mathrm{E} = \mathrm{m}c^2 \\ \mathrm{E} = \hbar\omega \end{matrix}\right\} \Rightarrow \mathrm{m}c^2 = \hbar\omega \\ c = a\omega \Leftrightarrow a = \dfrac{c}{\omega} \Leftrightarrow \omega = \dfrac{c}{a} \end{matrix}\right\} \Rightarrow \mathrm{m}a^2\omega^2 = \hbar\omega \Longrightarrow \mathrm{m}\frac{c^2}{\omega^2}\omega^2 = \hbar\frac{c}{a} \Leftrightarrow a = \frac{\hbar}{\mathrm{m}c}$$

The geometry of the ring current model is further visualized below. We think of an electron (and a proton) as consisting of a pointlike elementary charge – pointlike but *not dimensionless*[23] - moving about at (*nearly*) the speed of light around the center of its motion.

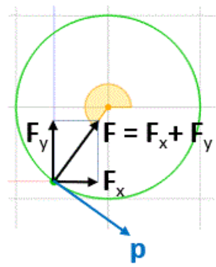
[19] We refer to our jokingly harsh conceptual analysis of this distinction in: https://vixra.org/abs/2003.0012.

[20] See our paper on protons and neutrons: https://vixra.org/abs/2001.0104.

[21] See, for example: https://vixra.org/abs/2001.0345.

[22] In this paper, we make abstraction of the anomaly, which is related to the *zbw* charge having a (tiny) spatial dimension.

[23] See footnote 22.



The relation works perfectly well for the electron. Let us illustrate this by highlighting a few implications of the theory.

The two radii of an electron: the Thomson versus the Compton radius

The model does allow us to explain the two different radii we get from elastic versus inelastic scattering experiments, or Thomson versus Compton scattering. Thomson scattering is referred to as *elastic* scattering because the energy – and, hence, the wavelength – of the incoming and outgoing photons in the scattering interaction remains unchanged. In contrast, Compton scattering does involve a wavelength change and, therefore, a more complicated interaction between the photon and the electron. To be specific, we think of the photon as being briefly absorbed, before the electron emits another photon of *lower* energy.[24] The energy difference between the incoming and outgoing photon then gets added to the *kinetic* energy of the electron according to the law you may or may not remember from your physics classes:

$$\lambda' - \lambda = \Delta f = \frac{h}{\mathrm{m_e}c}(1-\cos\theta) \Leftrightarrow \omega' - \omega = \Delta\omega = \frac{\hbar}{\mathrm{m_e}c}(1-\cos\theta)$$

The $1 - \cos\theta$ factor on the right-hand side of this equation goes from 0 to 2 as θ goes from 0 to π. Hence, the maximum possible change in the wavelength is equal to λ_C, which we get from a head-on collision with the photon being scattered backwards at 180 degrees.[25] We will not further dwell on this but just note that even (some) mainstream physicists do think of the Compton wavelength as effectively defining some *interference space*. Indeed, one of the reasons why we like Prof. Dr. Patrick LeClair's *lecture* on it[26] is that he tries to derive the very same equations for photon-proton scattering. He argues this can easily be done:

> "The only difference is that the proton is heavier. We simply replace the electron mass in the Compton wavelength shift equation with the proton mass, and note that the maximum shift is at $\theta = \pi$. The maximum shift is $\Delta\lambda_{max} = 2h/\mathrm{m_p}c \approx 2.64$ fm. Fantastically small. This is roughly the

[24] Our paper on Compton scattering combines our photon and electron model to provide a more detailed description (see: https://vixra.org/abs/1912.0251). Think of the interference as a process during which – temporarily – an unstable wavicle is created. This unstable wavicle does *not* respect the integrity of Planck's quantum of action ($E = h \cdot f$). The equilibrium situation is then re-established as the electron emits a new photon and moves away. Both the electron and the photon respect the integrity of Planck's quantum of action again and they are, therefore, *stable*.

[25] The calculation of the angle of the *outgoing* photon involves a different formula, which the reader can also look up from any standard course. See, for example, the reference below.

[26] The reader can find the basics on Compton scattering in any basic course on quantum physics, but we effectively find the *exposé* of Prof. Dr. Patrick R. LeClair particularly enlightening. We, therefore, will refer to it more than once (http://pleclair.ua.edu/PH253/Notes/compton.pdf).

size attributed to a small atomic nucleus, *since the Compton wavelength sets the scale above which the nucleus can be localized in a particle-like sense*."[27] (my italics)

This is probably as far as any mainstream physicist would go in terms of actually *interpreting* the *physical* meaning of the Compton wavelength or radius.[28] In contrast, we do not hesitate to phrase the same in much simpler terms: **the Compton radius is the distance or scale within which we can, effectively, expect the photon to interfere with the electromagnetic field of the electron or proton current ring.**

Of course, we need a photon model to corroborate this: if a photon and an electron (or a proton) are going to interfere, we need to know what interferes with what, *exactly*. What is our photon model? We have elaborated that elsewhere and, hence, we will not repeat ourselves here.[29] We need to move on! Before we do so, however, we would like to note this rather intuitive explanation of Compton scattering was the main reason why Dirac attached so much importance to what we may refer to as Erwin Schrödinger's version of the ring current model. Indeed, Erwin Schrödinger inadvertently stumbled upon the ring current idea while exploring solutions to Dirac's wave equation for free electrons.[30] He referred to it as a *Zitterbewegung* (rather than a ring current)[31], and it is always worth quoting Dirac's summary of Schrödinger's discovery:

> "The variables give rise to some rather unexpected phenomena concerning the motion of the electron. These have been fully worked out by Schrödinger. It is found that an electron which seems to us to be moving slowly, must actually have a very high frequency oscillatory motion of small amplitude superposed on the regular motion which appears to us. As a result of this oscillatory motion, the velocity of the electron at any time equals the velocity of light. This is a prediction which cannot be directly verified by experiment, since the frequency of the oscillatory motion is so high and its amplitude is so small. But one must believe in this consequence of the theory, since other consequences of the theory which are inseparably bound up with this one, such as the law of scattering of light by an electron, are confirmed by experiment." (Paul A.M. Dirac, *Theory of Electrons and Positrons*, Nobel Lecture, December 12, 1933)

The reference to the 'law of scattering of light by an electron' is not only a reference to *Compton* scattering but to *Thomson* scattering as well. Indeed, the hybrid description of the electron as a *Zitterbewegung* (we'll abbreviate this as *zbw*) charge *zittering* around some center effectively explains

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[27] See: http://pleclair.ua.edu/PH253/Notes/compton.pdf, p. 10

[28] At this point, we should probably note that the concept of a Compton *radius* is actually never mentioned in physics textbooks. They only talk about the Compton wavelength (λ_C), or its *reduced* value ($r_C = \lambda_C/2\pi$), pretty much like the difference between $\hbar$ and h, which – in our realist interpretation of quantum mechanics – is also *physical*. The non-reduced value (h) is a unit of *physical action* which, in our interpretation of the Planck-Einstein relation is as *real* as a physical dimension as, say, the concepts of energy or (linear) momentum. In contrast, its reduced value ($\hbar$) is a unit of *angular* momentum. In this regard, we may briefly note that the ring current model may also be analyzed as a rather intuitive combination of the concepts of linear and angular momentum.

[29] See, for example, our paper on *Relativity, Light and Photons* (https://vixra.org/abs/2001.0345).

[30] We do not know if Schrödinger and Dirac were aware of earlier work done by Parson (1915). For a brief but enlightening history of the ring current model, see: Oliver Consa (April 2018), who develops his own version of it: the *Helical Solenoid Model of the Electron* (http://www.ptep-online.com/2018/PP-53-06.PDF).

[31] *Zitter* is German for shaking or trembling. Both Dirac as well as Schrödinger thought of it as local oscillatory motion—which we, obviously, now believe to be *real*.

why the electron also seems to have some *hard* core causing photons to scatter of it *elastically*, i.e. *without a change in the wavelength of the photon*. As such, apart from the fact that the ring current model offers a natural and intuitive explanation of all of the *intrinsic* properties of an electron, we think most of its appeal is in this explanation of the *dual* radius of an electron.

Needless to say, the *hybrid* wavicle-like description also offers a natural explanation for electron interference in single- and double-slit experiments—or whatever set-up one might think of.

Let us now proceed to a discussion of these intrinsic properties. Before we get into the meat of the matter – literally – we will briefly note the theory is also applicable to the heavier version of an electron: the muon.

The Compton radius of a muon-electron

As mentioned above, we think the reduced form of the Compton wavelength – $a = \lambda_C/2\pi$ – effectively defines the space in which the *Zitterbewegung* charge is actually moving, which is why we refer to it as the Compton *radius* of an electron. Let us be specific and calculate this radius so we know what we are talking about:

$$r_C = a = \frac{c}{\omega} = \frac{c\hbar}{E} = \frac{c\hbar}{mc^2} = \frac{\hbar}{mc} = \frac{\lambda_C}{2\pi} \approx 0.38616 \text{ pm}$$

Hence, we interpret this as an effective radius for inelastic (Compton) scattering of photons—as opposed to the radius for *elastic* scattering, which is the classical electron radius whose value you will find listed among the CODATA values for *fundamental physical constants*[32]:

$$r_e = r_{CODATA} = 2.8179403262(13)\times10^{-15} \text{ m}$$

The reader will remember this classical radius – expressed in femto-meter (1 fm = 10^{-15} m) rather than pico-meter (1 pm = 10^{-12} m) – can be related to the Compton radius and/or wavelength through the fine-structure constant:

$$r_e = \alpha\cdot r_C$$

Indeed, when applying the $\alpha = \frac{q_e^2}{4\pi\varepsilon_0\hbar c}$ CODATA definition, we get this:

$$r_e = \alpha\frac{\hbar}{mc} = \frac{q_e^2}{4\pi\varepsilon_0\hbar c}\cdot\frac{c\hbar}{mc^2} = \frac{q_e^2}{4\pi\varepsilon_0 mc^2} = 2.81794032666895\ldots \text{fm}$$

The reader should note that the final digits of the two values above are different. Hence, the relation is very precise but it is not *quite* there.

We will explain the relation – and this tiny discrepancy – later: we think the $r_e = \alpha\cdot r_C$ relation is *directly* related to the anomaly of the magnetic moment—which, in our view, is not an *anomaly* at all: we think the fine-structure constant tells us that we should think of the *zbw* charge as having some tiny but non-zero rest mass, as well as tiny but non-zero *spatial* dimension.

[32] See: https://physics.nist.gov/cgi-bin/cuu/Value?re

Any case, we will come back to that. Let us first show the ideas we have developed so far also apply to the heavier version of the electron: the muon-electron.

It also works for the heavier version of an electron: the *muon* electron. In fact, we should remind the reader that the electron has *two* heavier versions. Both of them are unstable, however:

1. The muon energy is about 105.66 MeV, so that's about 207 times the electron energy. Its lifetime is much shorter than that of a free neutron but longer than that of other unstable particles: about 2.2 *micro*seconds (10^{-6} s). That's fairly long as compared to other non-stable particles.[33]

2. The energy of the tau electron (or tau-*particle* as it is more commonly referred to[34]) is about 1776 MeV, so that's almost 3,500 times the electron mass. Its lifetime, in contrast, is *extremely* short: 2.9×10^{-13} s only. Hence, we think of it as some resonance or very *transient* particle. We, therefore, think that – in line with the reasoning we presented in the introduction to our paper – the Planck-Einstein relation does *not* apply: we think the tau-electron quickly disintegrates because its cycle is *way* off.

In contrast, the calculation of a Compton radius for the muon-electron might or might not make sense. Let us see what we get:

$$r_{\mathrm{C}} = \frac{c}{\omega} = \frac{c \cdot \hbar}{\mathrm{E}} \approx \frac{(3 \times 10^{8}\,\frac{\mathrm{m}}{\mathrm{s}}) \cdot (6.582 \times 10^{-16}\mathrm{eV} \cdot \mathrm{s})}{105.66 \times 10^{-6}\mathrm{eV}} \approx 1.87\ \mathrm{fm}$$

The CODATA value for the Compton *wavelength* of the muon is the following:

$$1.173444110\times10^{-14}\ \mathrm{m}\ \pm 0.000000026\times10^{-14}\ \mathrm{m}$$

If you divide this by 2π - to get a *radius* instead of a wavelength – you get the same value: about 1.87×10^{-15} m. So our oscillator model seems to work for a muon as well! Why, then, is it not stable? We think it is because the oscillation is *almost* on, but not quite. Let us, therefore, be more precise in our calculation and use CODATA values for all variables here[35]:

$$\lambda_{\mathrm{C}} = \frac{2\pi}{2\pi} \cdot \frac{\left(299{,}792{,}458\,\frac{\mathrm{m}}{\mathrm{s}}\right) \cdot (6.62607015 \times 10^{-34}\mathrm{eV} \cdot \mathrm{s})}{1.6928338 \times 10^{-11}\ \mathrm{J}} \approx 1.1734441131 \ldots \times 10^{-14}\ \mathrm{m}$$

The calculated value still falls within CODATA's uncertainty interval. Hence, we cannot be conclusive, but we do think the result is quite telling.

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[33] This presumed longevity of the muon-electron should not be exaggerated, however: the mean lifetime of charged pions, for example, is about 26 *nano*seconds (10^{-9} s), so that's only 85 times less.

[34] In light of its short lifetime, I would prefer to refer to it as a resonance. I like to reserve the term 'particle' for *stable* particles. Within the 'zoo' of unstable particles Longer-living particles may be referred

[35] In the new calculation, we will also express Planck's quantum of action and the muon energy in *joule* so as to get a more precise wavelength value. Note that the $2\pi/2\pi = 1$ factor in the ratio is there because we calculate a wavelength (which explains the multiplication by 2π) and because we do *not* use the reduced Planck constant (which explains the division by 2π).

We will leave it to the reader to repeat the exercise for the tau-electron: he will find the theoretical $a = \hbar/mc$ radius will *not* match the CODATA value for its radius.[36] We think this *indirectly* confirms our interpretation of the Planck-Einstein relation.

The Compton radius of a proton

We may now try to apply the ring current model to a proton. We recommend the reader to do the actual calculation. He or she will see that, when applying the $a = \hbar/mc$ radius formula to a proton, we get a value which is about 1/4 of the *measured* proton radius: about 0.21 fm, as opposed to the 0.83-0.84 fm charge radius which was established by Professors Pohl, Gasparan and others over the past decade.[37]

In previous papers[38], we motivated the 1/4 factor by referring to the energy equipartition theorem and assuming energy is, somehow, equally split over electromagnetic field energy and the kinetic energy in the motion of the *zbw* charge. However, the reader must have had the same feeling as we had: these assumptions are rather *ad hoc*. We, therefore, propose a more radical assumption:

When considering systems (e.g. electron orbitals) and excited states of particles, angular momentum comes in units (nearly) equal to ħ, but when considering the internal structure of elementary particles, (orbital) angular momentum comes in an integer fraction of ħ. This fraction is 1/2 for the electron[39] and 1/4 for the proton.

Let us write this out for the proton radius:

$$\left.\begin{array}{r}\left.\begin{array}{r}\mathrm{E} = \mathrm{m}c^2 \\ \mathrm{E} = \dfrac{\hbar}{4}\omega\end{array}\right\} \Rightarrow \mathrm{m}c^2 = \dfrac{\hbar}{4}\omega \\ c = a\omega \Leftrightarrow a = \dfrac{c}{\omega} \Leftrightarrow \omega = \dfrac{c}{a}\end{array}\right\} \Rightarrow \mathrm{m}a^2\omega^2 = \frac{\hbar}{4}\omega \Longrightarrow \mathrm{m}\frac{c^2}{\omega^2}\omega^2 = \frac{\hbar c}{4a} \Leftrightarrow a = \frac{1}{4}\frac{\hbar}{\mathrm{m}c}$$

The reader will probably find this very uncomfortable, but we will let this sink in to come back to it later.[40] Indeed, **the 4E = ħ·ω relation suggests the force(s) inside of the proton are, effectively, some *stronger* variant of the electromagnetic force.**

However, before we can proceed to further discussions and reflections on this, we first need to further elaborate our electron model—and how the electromagnetic force fits into it! That is what we will do now.

[36] CODATA/NIST values for the properties of the tau-electron can be found here: https://physics.nist.gov/cgi-bin/cuu/Results?search_for=tau.
[37] For the exact references and contextual information on the (now solved) 'proton radius puzzle', see our paper on it: https://vixra.org/abs/2002.0160.
[38] See reference above.
[39] The reader may wonder why we did not present the ½ fraction in the first set of equations (calculation of the electron radius). We refer him or her to our previous paper on the effective mass of the *zbw* charge (https://vixra.org/abs/2003.0094). The 1/2 factor appears when considering *orbital* angular momentum only.
[40] We will offer extra remarks both in the body of this paper as well as in its Annex, in which we discuss the unsolved questions and/or ambiguities of our approach.

The intrinsic properties of an electron: the magnetic moment

One critical reviewer of an earlier manuscript[41] accused us of just 'casually connecting formulas.' We think we have refuted such accusations in very much detail[42] but, here, we will just limit ourselves to some more general remarks.

The calculation of the electron's Compton radius is very straightforward but it raises the following question: the $a = \hbar/mc$ relation is undetermined. Indeed, because $\hbar$ and c are constants, the radius effectively depends on the *mass*. **Why is the mass of the electron what it is?** In other words, **what are the other relations that would allow us to determine a *unique* radius of the electron?** The limited set of equations that we have used so far effectively allow us to dream up *any* elementary particle—with any mass or any radius. So what makes an electron an electron and what makes a proton a proton?

Here, we do need to invoke Maxwell's laws indeed, and the other constants of Nature – most notably the electric and magnetic constants ε_0 and μ_0, which are related to each other and to the fine-structure constant as follows[43]:

$$(1)\ \varepsilon_0\mu_0 = \frac{1}{c^2} \qquad (2)\ \varepsilon_0 = \frac{q_e^2}{2\alpha hc} \qquad (3)\ \mu_0 = \frac{2\alpha h}{q_e^2 c}$$

Only then we can see that everything is related to everything in this model: our model is, effectively, not only determined by Einstein's mass-energy equivalence, the Planck-Einstein relation and the geometry of the model (the tangential velocity formula). No! We also need the electron charge and the electric/magnetic constant. Our oscillator model and the traditional ring current (or *Zitterbewegung* model) need each other! In other words, we have to get *very* real here, and so we need to think in terms of an effective circular electric current generating some electromagnetic field and force that keeps the charge in its orbit. Such calculations are quite complicated and we, therefore, refer to previous papers[44] and/or other authors for the detail. We will just mention some key results here.

1. The electric current inside of the electron – we talk about *the actual ring current itself* here – can be calculated as being equal to:

$$\mathrm{I} = q_e f = q_e\frac{\mathrm{E}}{h} \approx (1.6\times10^{-19}\ \mathrm{C})\frac{8.187\times10^{-14}\ \mathrm{J}}{6.626\times10^{-34}\ \mathrm{Js}} \approx 19.8\ \mathrm{A}\ (ampere)$$

That is *huge*: it is, effectively, a household-level current at the sub-atomic scale. Based on this, we can do many other interesting calculations. Oliver Consa, for example, uses the Biot-Savart Law to calculate the magnetic field at the center of the ring[45]:

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[41] Jean Louis Van Belle, *The Emperor Has No Clothes: A Realist Interpretation of Quantum Mechanics*, Easter 2019 (https://vixra.org/pdf/1901.0105vG.pdf).

[42] We may refer to this paper, in particular: *The Electron as a Harmonic Electromagnetic Oscillator* (https://vixra.org/abs/1905.0521).

[43] The reader can easily *google* these results. We get the second and third equation from combining the first and the definition of the fine-structure constant.

[44] See the reference above (https://vixra.org/abs/1905.0521)

[45] See the reference above (Oliver Consa, 2018). In case the reader would want to verify Consa's calculations, we may refer to Feynman's rather straightforward derivation of the relevant formulas. See: https://www.feynmanlectures.caltech.edu/II_13.html#Ch13-S5.

$$B = \frac{\mu_0 \mathrm{I}}{2\mathrm{R}} \approx 3.23 \times 10^7\ \mathrm{T}$$

This is yet another humongous value.[46] Last but not least, we can calculate the magnitude of the centripetal force inside of the electron[47]:

$$\mathrm{F} = \frac{1}{2}\frac{\mathrm{E}}{a} \approx \frac{8.187 \times 10^{-14}\ \mathrm{J}}{\frac{2}{2\pi} \cdot 2.246\ \times 10^{-12}\ \mathrm{m}} \approx 0.115\ \mathrm{N}$$

This force is equivalent to a force that gives a mass of about 115 *gram* (1 g = 10^{-3} kg) an acceleration of 1 m/s per second. This is, once again, a rather enormous value considering the sub-atomic scale.

Finally, dividing the force by the charge, we can calculate a value for the *field strength* inside of the electron[48]:

$$E = \frac{F}{\mathrm{q_e}} \approx \frac{11.5 \times 10^{-2}\ \mathrm{N}}{1.6\ \times 10^{-19}\ \mathrm{C}} \approx 0.7 \times 10^{18}\ \mathrm{N/C}$$

Another humongous value: just as a yardstick to compare, we may note that the most powerful man-made accelerators reach field strengths of the order of 10^9 N/C (1 GV/m) only. So this is a *billion* times more. Hence, we may wonder if this value makes any sense at all. We think they do. Why?

Our answer is this: the related energy and mass *densities* are still very much *below* the threshold triggering worries about the effects of such mass/energy densities on the curvature of spacetime. We offered some thoughts on that in previous papers[49] so we will limit ourselves to a very simple calculation to prove the point: if we would pack all of the mass of an electron into a black hole, then the Schwarzschild formula gives us a radius that is equal to:

$$r_s = \frac{2\mathrm{Gm}}{c^2} \approx 1.35 \times 10^{-57}\mathrm{m}\ (meter)$$

One can see this exceedingly small number has no relation whatsoever with the Compton radius. In fact, its scale has no relation with whatever distance one encounters in physics: it is *much* beyond the Planck scale, which is of the order of 10^{-35} meter and which, for reasons deep down in relativistic quantum mechanics, physicists consider to be the smallest possibly sensible distance scale. We, therefore, trust our calculations.[50]

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[46] Consa dutifully notes the largest artificial magnetic field created by man is only 90 T (*tesla*).

[47] Our calculation differs from Consa's by a 1/2 factor. Indeed, Consa gets *twice* the value for the force holding the pointlike charge in orbit: 0.23 N instead of 0.115 N. That is because our electron model is, effectively, somewhat different from Consa's. We think of the *zbw* charge as having an *effective* (relativistic) mass that is 1/2 (*half*) of the total electron mass. Hence, that explains the 1/2 factor: while we feel our model adds some complication, we also feel our additional assumptions are justified and, therefore, *more real*. We will come back to this.

[48] We use the same symbol for field and energy here. The reader should not confuse the two concepts, though!

[49] See the reference above (https://vixra.org/abs/1905.0521).

[50] Having said that, we are very much intrigued by suggestions that the Schwarzschild formula can or should not be used as it because of the particularities of our model. The hybrid structure of the electron would, effectively, seem to imply that, perhaps, we should not calculate the Schwarzschild radius of our electron as we would calculate it for, say, a baseball or some other more or less uniformly distributed mass. To be precise, we are particularly intrigued by models that suggest that, when incorporating the above-mentioned properties of an electron, the

2. The above-mentioned calculations for currents, internal forces and field strengths are very interesting but we will never be able to *measure* these: they will, therefore, remain hypothetical, *always*. In contrast, **we can measure the magnetic moment** and – as we know too well – we know that measurement reveals an *anomaly* – i.e. a *difference* between some theoretical value and the actual measurement – which needs to be explained.

Indeed, the experimental measurements and the theoretical calculations of the anomalous magnetic moment are usually hailed as the 'high-precision test of quantum mechanics'. The Wikipedia article on this describes this as follows:

> "The most precise and specific tests of QED consist of measurements of the electromagnetic fine-structure constant, α, in various physical systems. Checking the consistency of such measurements tests the theory. Tests of a theory are normally carried out by comparing experimental results to theoretical predictions. In QED, there is some subtlety in this comparison, because theoretical predictions require as input an extremely precise value of α, which can only be obtained from another precision QED experiment. Because of this, the comparisons between theory and experiment are usually quoted as independent determinations of α. QED is then confirmed to the extent that these measurements of α from different physical sources agree with each other. The agreement found this way is to within ten parts in a billion (10^{-8}), based on the comparison of the electron anomalous magnetic dipole moment and the Rydberg constant from atom recoil measurements as described below. This makes QED one of the most accurate physical theories constructed thus far."[51]

Oliver Consa's seminal February 2020 article on the actual history of this theory and the measurements suggests a huge scientific scam fueled by the need to keep the funds flowing for upgrades of technological infrastructure such as high-value particle accelerators and other prestigious projects costing hundreds of millions of dollars.[52] We think it is a good point to make: applying for grants by saying physics is basically dead because all problems have been solved is not a great business strategy. Top academics may also have other motives for keeping the mystery alive. Religious ones, perhaps: God must be hiding somewhere, isn't it?[53] And the last place He can hide is in modern-day versions of

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Compton radius might actually be the radius of an electron-sized black hole. See, for example, the papers published by Dr. Alexander Burinskii (2008, 2016). Could the integration of gravity into the model provide some path to unifying gravity with particle physics? We are not well versed in these more advanced theories, so we will just refer the reader here to more advanced treatments. The exact reference of Alexander Burinskii's work is this: *The Dirac–Kerr–Newman electron*, 19 March 2008, https://arxiv.org/abs/hep-th/0507109. Adepts of string and other theories should probably read Dr. Burinskii's more recent articles, such as this: *The New Path to Unification of Gravity with Particle Physics*, 2016 (https://arxiv.org/abs/1701.01025), in which Dr. Burinskii relates his model to theories such as the "supersymmetric Higgs field" and the "Nielsen-Olesen model of dual string based on the Landau-Ginzburg (LG) field model." Instinctively, we feel these models are way too complicated and, therefore, not very convincing—but we readily admit this is just our non-informed and, therefore, non-scientific guts instinct.

[51] See: https://en.wikipedia.org/wiki/Precision_tests_of_QED, accessed on 10 March 2020.

[52] Oliver Consa, *Something is Rotten in the State of QED*, February 2020 (https://vixra.org/abs/2002.0011).

[53] Keeping the mystery alive is, of course, a tendency that is also present in much of the non-mainstream research. We are appalled, for example, by attempts trying to incorporate consciousness into particle physics. See, for example, the work of Richard Gauthier (https://www.researchgate.net/profile/Richard_Gauthier2) who – after having produced some fine electron models – now seems to focus on the idea of some 'cosmic intelligence creating and maintaining our multiverse.' Let us be clear: this sounds like utter nonsense to us!

medieval metaphysical principles— think of the largely unexplained Uncertainty Principle here.[54] We are not religious, and so we want to strictly stick to logic and science. Let us, therefore, proceed with some more calculations.

The ring current model allows us to calculate a theoretical value for the magnetic moment. Indeed, from Maxwell's Laws one can derive an easy formula for the magnetic moment: it is equal to the current times the area of the loop.[55] We, therefore, get this:

$$\mu_a = \mathrm{I}\pi a^2 = \mathrm{q_e} f \pi a^2 = \mathrm{q_e}\frac{c}{2\pi a}\pi a^2 = \frac{\mathrm{q_e}c}{2}a = \frac{\mathrm{q_e}}{2\mathrm{m}}\hbar \approx 9.27401\ldots \times 10^{-24}\ \mathrm{J}\cdot\mathrm{T}^{-1}$$

As mentioned above, this is a *theoretical* value. The CODATA value – which is supposed to be based on measurements[56] – is slightly different:

$$\mu_{\mathrm{CODATA}} = 9.2847647043(28)\times 10^{-24}\ \mathrm{J}\cdot\mathrm{T}^{-1}$$

The difference is the so-called anomaly, which we can easily calculate as follows[57]:

$$\frac{\mu_a - \mu_{\mathrm{CODATA}}}{\mu_{\mathrm{CODATA}}} = 0.00115965\ldots$$

The reader will recognize this value: it is, effectively, equal to about 99.85% of Schwinger's factor: $\alpha/2\pi$ = 0.00116141…

We think of the anomaly as the litmus test of our model too, so how do we explain it?

The intrinsic properties of an electron: the anomaly

We do not think of the anomaly as an anomaly. We see an immediate perfectly rational explanation for it: we think the *zbw* charge has some very tiny (but non-zero) rest mass. As a result, its tangential velocity is *very near* but not exactly equal to *c*. Let us get through the logic here.

We should, first and foremost, note the crucial assumption here, which is that we think the accuracy of the Planck-Einstein relation is preserved, *always*! We, therefore, think we should not only distinguish between a theoretical and an actual (i.e. experimentally determined) magnetic moment but also between a theoretical and an actual radius of the ring current. To be precise, based on the *measured* value of the magnetic moment (i.e. the CODATA value), we can calculate the anomaly of the *radius* of

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[54] A careful philosophical reading of the comments on this quantum-mechanical dogma reveals most authors prefer to *not* define what they mean by 'uncertainty': for us, it's just statistical (in)determinism, but most writers make it look like yet another non-scientific God-like concept playing the role of the ultimate 'hidden variable'.
[55] For a straightforward derivation of this formula, we refer – once again – to the *Great Teacher*: Richard Feynman (https://www.feynmanlectures.caltech.edu/II_14.html#Ch14-S5). In case the reader wonders: our reference to Richard Feynman as a great teacher is somewhat ambiguous: we feel he is part of the group of post-WW II physicists which I now think of *mystery Wallahs*.
[56] One reason why we think Oliver Consa's criticism of both the (mainstream) theory as well as the measurements of the anomalous magnetic moments is justified is that the US National Institute of Standards and Technology (NIST) – which is the institution which publishes these CODATA values – is not very clear about how they *weigh* the various experimental results to arrive at some *weighted* average that, by some magic, then sort of corresponds to the theoretical two-, three- or *n*-loop calculations based on quantum field theory.
[57] You should watch out with the minus signs here – and you may want to think why you put what in the denominator – but it all works out!

the presumed ring current. Indeed, the frequency is, of course, the velocity of the charge divided by the circumference of the loop. Because we assume the velocity of our charge is equal to *c*, we get the following radius value:

$$\mu = \mathrm{I}\pi a^2 = \mathrm{q_e} f \pi a^2 = \mathrm{q_e}\frac{c}{2\pi a}\pi a^2 = \frac{\mathrm{q_e} c}{2} a \Leftrightarrow a = \frac{2\mu}{\mathrm{q_e} c} \approx 0.38666\ \mathrm{pm}$$

We should note that we get a value that is slightly different from the theoretical $a = c/\omega = \hbar/mc$ radius which was equal to 0.38616… pm. We, therefore, have an anomaly, indeed! We can confirm this anomaly by re-doing this calculation using the Planck-Einstein relation to calculate the frequency:

$$\mu = \mathrm{I}\pi a^2 = \mathrm{q_e} f \pi a^2 = \frac{\mathrm{q_e}\omega a^2}{2} \Leftrightarrow a = \sqrt{\frac{2\mu}{\mathrm{q_e}\omega}} = \sqrt{\frac{2\mu\hbar}{\mathrm{q_e E}}} = \sqrt{\frac{2\mu\hbar}{\mathrm{q_e m}c^2}} \approx 0.38638\ \mathrm{pm}$$

We again get a slightly different value. Hence, we will want to think of the radius based on the mass or the Compton wavelength as some kind of *theoretical* radius and so we will put it in the denominator. We can write it like we want, with or without some subscript: $a = a_{\mathrm{CODATA}} = a_{\mathrm{m}} = a_{\lambda} = a_{\mathrm{C}}$. We can then write the anomaly as[58]:

$$\frac{a_\mu - a}{a} \approx 0.00115965 \Leftrightarrow \frac{a_\mu}{a} = 1.00115965\ \ldots$$

We get the same thing here: the anomaly of the *radius* is, once again, equal to about 99.85% of Schwinger's factor: $\alpha/2\pi = 0.00116141\ldots$

This allows us to guide the reader through the following calculations.[59]

1. Let us first confirm our theoretical value for the magnetic moment by equating the two formulas for the radius that we have presented so far. Both are based on a different *physical* concept of the frequency of the oscillation. While *different*, we can only have one theoretical radius, of course. We, therefore, get this:

$$\left.\begin{aligned} a &= \sqrt{\frac{2\mu\hbar}{\mathrm{q_e m}c^2}} \\ a &= \frac{2\mu}{\mathrm{q_e}c} \end{aligned}\right\} \Leftrightarrow \sqrt{\frac{2\mu\hbar \mathrm{q_e^2} c^2}{4\mu^2 \mathrm{q_e m} c^2}} = \sqrt{\frac{\hbar \mathrm{q_e}}{2\mu \mathrm{m}}} = 1 \Leftrightarrow \mu = \frac{\mathrm{q_e}}{2\mathrm{m}}\hbar$$

2. Our assumption is that the anomaly is not an anomaly at all. We get it because of our mathematical idealizations: we do not *really* believe that pointlike charge are, effectively, pointlike and, therefore, mass- and/or dimensionless. In other words, we think the assumption that the electron is just a pointlike or dimensionless charge is non-sensical: when thinking of what might be going on at the smallest scale

[58] We used the first of the two radii one can calculate from the magnetic moment. The reader can re-do the calculations using the second of the two anomalous radii.

[59] We realize this is a long text. However, we beg the reader to bear with us. We feel the view from the top warrants the climb—and more than a bit! Of course, this is just a mountaineer's opinion. 😊

of Nature, we should abandon these mathematical idealizations: an object that has no physical dimension whatsoever does – quite simply – not exist.

Likewise, we should not assume that the pointlike *zbw* charge is whizzing around at *exactly* the speed of light. It can be very *near c*, but not *quite* equal to *c*. Hence, its theoretical rest mass will also be very close to zero, but not *exactly* zero. As a result, we will have some *real* radius *r* that is probably *not quite* equal to the Compton radius $a = \hbar/mc$ as well. Let us write it all out. What should we put where? The greater value – based on the greater radius – should be in the denominator, so we write:

$$\frac{\mu_r}{\mu_a} = \frac{\frac{q_e}{2m}\hbar}{\frac{q_e v}{2}r} = \frac{\hbar}{m \cdot v \cdot r} = \frac{c \cdot a}{v \cdot r}$$

Now, we know the anomaly is *very* nearly equal to 1 + α/2π. Hence, for practical purposes – we think a 99.85% explanation is pretty good – we may just equate the expression above with 1 + α/2π to get this:

$$1 + \frac{\alpha}{2\pi} = \frac{2\pi + \alpha}{2\pi} = \frac{c \cdot a}{v \cdot r} \Leftrightarrow v \cdot r = \frac{2\pi \cdot c \cdot a}{2\pi + \alpha} = \frac{2\pi \cdot c \cdot \frac{\hbar}{mc}}{2\pi + \alpha} = \frac{h}{m(2\pi + \alpha)} \Leftrightarrow L = m \cdot v \cdot r = \frac{h}{2\pi + \alpha}$$

So now we need to answer the question: what is the real velocity *v* and what is the real radius *r* of our *zbw* charge? We will come to that. We first ask the reader to note something quite essential here:

Mainstream quantum mechanics assumes angular momentum must come in units of ħ, and mainstream physicists think that is a direct implication of – or even an equivalent to – the Planck-Einstein law: $E = h \cdot f = \hbar \cdot \omega$. The calculation above brings some nuance to this statement: angular momentum does *not* come in *exact* units of ħ. There is an anomaly, and we think the anomaly is part and parcel of Nature.

3. We stated it a couple of times already: for *stable* (elementary) particles, we believe the Planck-Einstein relation to be true—not approximately but *exactly*. Hence, we must believe that the frequency *f* or ω of the *Zitterbewegung* oscillation is, effectively equal to $f = E/h$ or $\omega = E/\hbar$, *precisely*. If we believe that to be true, then the following relations *explain* the anomaly[60]:

$$\frac{\mu_r}{\mu_a} = 1 + \frac{\alpha}{2\pi} = \frac{c \cdot a}{v \cdot r} = \frac{\omega \cdot a^2}{\omega \cdot r^2} = \frac{a^2}{r^2} \Leftrightarrow r = \frac{a}{\sqrt{1 + \frac{\alpha}{2\pi}}} \approx 0.99942 \cdot \frac{\hbar}{mc}$$

We get a radius that is slightly *smaller* than the theoretical $a = \hbar/mc$ radius. Does that make sense? It does: if the real and theoretical frequency are the same, and if the real tangential velocity of our zbw charge (*v*) is slightly smaller than the speed of light (*c*), then the real radius must be slightly smaller too. In fact, the *v*/*c* and *r*/*a* ratios must be exactly the same, as we can see from the tangential velocity formula:

[60] We are just using the tangential velocity formula here to do the substitution that is being done: $c = a \cdot \omega$ and $v = r \cdot \omega$ and – yes – we assume stable particles respect the Planck-Einstein relation, which we believe to be true—as opposed to the quantum-mechanical theorem in regard to angular momentum which, as mentioned, we believe to be very *nearly true*.

$$1 = \frac{\omega}{\omega} = \frac{v/r}{c/a} \Leftrightarrow \frac{v}{c} = \frac{r}{a}$$

We can, therefore, calculate the relative velocity as:

$$\beta = \frac{v}{c} = \frac{r}{a} = \frac{a}{a \cdot \sqrt{1 + \frac{\alpha}{2\pi}}} = \frac{1}{\sqrt{1 + \frac{\alpha}{2\pi}}} \approx 0.99942$$

Very nice! Now we can calculate what we wanted to calculate—the real rest mass of the pointlike *zbw* charge:

$$\mathrm{m}_0 = \sqrt{1-\beta^2} \cdot \mathrm{m}_\gamma = \sqrt{1-\beta^2} \cdot \frac{\mathrm{m}_\mathrm{e}}{2} = \sqrt{1 - \frac{1}{1 + \frac{\alpha}{2\pi}}} \cdot \frac{\mathrm{m}_\mathrm{e}}{2} = \sqrt{\frac{\alpha}{2\pi + \alpha}} \cdot \frac{\mathrm{m}_\mathrm{e}}{2} \approx 0.017 \cdot \mathrm{m}_\mathrm{e} \approx 0.034 \cdot \mathrm{m}_\gamma$$

Hence, we arrive at the conclusion that the rest mass of the pointlike *Zitterbewegung* charge is equal to about 1.7% of the rest mass of the electron (m_e), or 3.4% of its relativistic mass (m_γ). Is this a credible result? We think so, but we will let the reader re-do the calculations.

The electron versus the proton: separate forces or *modes* of the same?

We have many more things to talk about but – as we're reaching 20 pages here – we should probably think of a way to wrap things up. We are not sure how to go about this. We have so many papers already[61] – as mentioned before – we feel we shouldn't repeat ourselves too much. Hence, we should probably limit ourselves to some of the quintessential ideas in what may or may not amount to a wholistic alternative interpretation of quantum physics.

These quintessential ideas include (1) the idea of the *effective* mass of the *zbw* charge and (2) the idea of a *stronger* version of the electromagnetic force—so as to explain the mass and the radius of a proton. We will probably further expand on the following quick calculations in a future version of this paper. As for now, we kindly request the reader to accept them – not on face value but on his or her own intuition in regard to what might of might not make sense – while going through the motions so as to arrive at the final conclusions of this paper.

1. Let us do some more calculations by doing some more thinking about the geometry of that centripetal force which we think keeps the elementary charge in motion. One approach might be to calculate the centripetal acceleration, which should be equal to:

$$a_c = v_t^2/a = a \cdot \omega^2$$

It is probably useful to remind ourselves how we get this result so as to make sure our calculations are relativistically correct. The position vector ***r*** (which describes the position of the *zbw* charge) has a horizontal and a vertical component: $x = a \cdot \cos(\omega t)$ and $y = a \cdot \sin(\omega t)$. We can now calculate the two components of the (tangential) velocity vector $\boldsymbol{v} = \mathrm{d}\boldsymbol{r}/\mathrm{d}t$ as $v_x = -a \cdot \omega \cdot \sin(\omega t)$ and v_y $y = -a \cdot \omega \cdot \cos(\omega t)$ and,

[61] We think our papers over the last two or three years covering a pretty bewildering array of quantum-mechanical topics—ranging, as they do, from physical explanations of the wavefunction (and Schrödinger's equation) to the weird interference patterns one gets from one-photon Mach-Zehnder interference experiments. For a full list, see: https://vixra.org/author/jean_louis_van_belle.

in the next step, the components of the (centripetal) acceleration vector $\boldsymbol{a}_c$: $a_x = -a\cdot\omega^2\cdot\cos(\omega t)$ and $a_y = -a\cdot\omega^2\cdot\sin(\omega t)$. The magnitude of this vector is then calculated as follows:

$$a_c^2 = a_x^2 + a_y^2 = a^2\cdot\omega^4\cdot\cos^2(\omega t) + a^2\cdot\omega^4\cdot\sin^2(\omega t) = a^2\cdot\omega^4 \Leftrightarrow a_c = a\cdot\omega^2 = v_t^2/a$$

Now, Newton's force law tells us that the magnitude of the centripetal force $|\mathbf{F}| = F$ will be equal to:

$$F = m_\gamma\cdot a_c = m_\gamma\cdot a\cdot\omega^2$$

As usual, the m_γ factor is, once again, the *effective mass* of the *zbw* charge as it *zitters* around the center of its motion at (nearly) the speed of light: it is *half* the electron mass.[62] If we denote the centripetal force inside the electron as F_e, we can relate it to the electron mass m_e as follows:

$$F_e = \frac{1}{2}m_e a\omega^2 = \frac{1}{2}m_e\frac{\hbar}{m_e c}\frac{E^2}{\hbar^2} = \frac{1}{2}\cdot\frac{m_e{}^2c^3}{\hbar}$$

2. Assuming our logic in regard to the *effective* mass of the *zbw* charge inside a proton is also valid – and using the $4E = \hbar\omega$ and $a = \hbar/4mc$ relations – we get the following equation for the centripetal force inside of a proton[63]:

$$F_p = \frac{1}{2}m_p a\omega^2 = \frac{1}{2}m_p\frac{4\hbar}{m_p c}\frac{4^2E^2}{\hbar^2} = 32\cdot\frac{m_p{}^2c^3}{\hbar}$$

How should we think of this? In our oscillator model, we think of the centripetal force as a restoring force. This force depends linearly on the displacement from the center and the (linear) proportionality constant is usually written as k. Hence, we can write F_e and F_p as $F_e = -k_e x$ and $F_p = -k_p x$ respectively. Taking the ratio of both so as to have an idea of the respective strength of both forces, we get this:

$$\frac{F_p}{F_e} = \frac{k_p}{k_e} = \frac{32\cdot\dfrac{m_p{}^2c^3}{\hbar}}{\dfrac{1}{2}\cdot\dfrac{m_e{}^2c^3}{\hbar}} = 64\cdot\frac{m_p{}^2}{m_e{}^2} \Leftrightarrow \frac{F_p}{m_p{}^2} = 64\cdot\frac{F_e}{m_e{}^2}$$

Nice – you might think – but how *meaningful* are these relations, really? We try to be very honest, so we'll admit we actually feel rather uncomfortable with these formulas.[64] If we would be thinking of the

[62] The reader may not be familiar with the concept of the effective mass of an electron but it pops up very naturally in the quantum-mechanical analysis of the linear motion of electrons. Feynman, for example, gets the equation out of a quantum-mechanical analysis of how an electron could move along a line of atoms in a crystal lattice. See: Feynman's *Lectures*, Vol. III, Chapter 16: *The Dependence of Amplitudes on Position* (https://www.feynmanlectures.caltech.edu/III_16.html). We have been criticized by fellow physicists for our calculations of the 1/2 factor. We feel they are sound – see, once again, our paper on the oscillator model of an electron (https://vixra.org/abs/1905.0521) – but, yes, we welcome constructive criticism because we do admit that the whole argument does somewhat heuristic right now.

[63] The reader may briefly wonder why we would assume that the effective mass of the elementary charge inside the proton would also be *half* of the mass of the (elementary) particle, which is the *proton* here—not the electron! We will invoke the energy equipartition theorem here: half of the *total* energy (or mass) of the particle is kinetic (so that is the effective mass of the *zbw* charge inside), while the other half is in the force field that keeps the *zbw* charge in its orbital motion.

[64] We calculate *actual* numerical values in the Annex to this paper. They do *not* look good. They look even worse than the numerical values we got when calculating ratios between the electromagnetic and strong force using

centripetal or restoring force as modeling some *elasticity* of spacetime – which is nothing but the *guts* intuition behind all of the more complicated string theories of matter – then we may think of distinguishing between a *fundamental* frequency and higher-level harmonics or overtones.[65] However, it's not so easy to sort of 'translate' the relations above into such simple statements. The strong force – and the proton itself – remains, therefore, a bit of a mystery![66]

The neutrino as the carrier of the strong(er) force

We think of a photon a simple oscillation of the electromagnetic *field*: it does not carry any electric charge itself.[67] This is why the concept of virtual photons does not appeal to us—*not at all, actually*: **if we believe that two electric charges – static or in relative motion one to another – produce some electromagnetic field that keeps them together, then we don't need virtual photons to carry energy or momentum between them.[68]**

We can now think of neutrinos as oscillations of the above-mentioned 'strong' or – there may be higher modes – strong*er* version of the electromagnetic field.[69] Why? Let us – for reasons of convenience – refer to the stronger version of the centripetal force as… Well… The strong force. 😊

If we have two forces, we must also have two different energies. Why? Energy is force over a distance. Distance is distance, so they do not have any stronger or weaker variant. In contrast, if we distinguish between a strong force and an electromagnetic force, then we should also distinguish between electromagnetic from strong energy. Hence, the idea of neutrinos taking care of the energy equation when some shake-up involves a change in the energy state of a nucleus makes perfect sense to me.

In other words, the idea of a counterpart of the photon (as the carrier of the electromagnetic force) for the strong force – i.e. the neutrino as the carrier of the strong force – makes perfect sense to us.

Inter-nucleon forces: what keeps protons and neutrons together?

We must now, of course, answer the question which led Yukawa and others to propose an entirely different force must be present inside the nucleus: what keeps protons (and neutrons) together? Here

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Yukawa's equation for the nuclear potential. See, for example: https://vixra.org/abs/1906.0311, in which we do a rough calculation showing the nuclear force must be in the range of 358,000 N! Now we get a value of 22.9 *million* N! We probably made some huge mistake somewhere! Or perhaps we didn't: the very different *orders of magnitude* of natural constants often produce shocking ratios that – after some reflection – then turn out to be not all that crazy! We invite the reader to go through all of the calculations: we very much welcome critical comments! [Our guts instinct tells us we're missing gravity in these equations—but integrating that requires very advanced math, which we don't have.]

[65] For a basic introduction, see my blog posts on *modes* or on music and physics (e.g. https://readingfeynman.org/2015/08/08/modes-and-music/).

[66] We think we solved quite a few mysteries already, but this one seems very intractable!

[67] See our papers on this, including but not limited to our *Relativity, Light and Photons* (https://vixra.org/abs/2001.0345).

[68] This reflects our earlier remarks: as far as we are concerned, the concept of a field versus that of a matter-particle – with the former *not* carrying any charge, as opposed to the latter – deals with it all. No need for quantum field theory mixing up the two.

[69] If the charge remains the same, but the force is stronger, then the field (think of it as the force without a charge to act on) will be stronger as well.

we must thank another *Zitterbewegung* theorist (Giorgio Vassallo[70]) for pointing us to the exciting work of Dr. Paolo Di Sia of the University of Padova, who shows the nuclear force between protons (and neutrons) can be explained by the classical electromagnetic force between current coils. These current coils are, of course, the ring currents inside the proton and – we think – inside of the neutron too![71]

Indeed, just by using the classical Biot-Savart Law once again, Di Sia derives what is generally referred to as a nuclear lattice effective field theory (NLEFT). The results match the typical assumptions in regard to inter-nucleon *distances*, which are of the order of 0.2 fm. For more detail, we advise the reader to download Di Sia's work[72] which, unlike the bulk of other quantum-mechanical publications, is very readable for the amateur physicist as well.

We should add an additional note: we think of the neutron as a *composite* particle—combining a proton and an electron. Hence, we should probably also think of the electron as some kind of *gluon* between nucleons.[73]

What about the weak force?

We now have both the electromagnetic and strong force covered—*sort of*. What about the weak force? We have stated our point of view before here, and very clearly so. Our answer is, effectively, brutally short—or just brutal, I guess: **we think the concept of a weak force doesn't make sense.**

We know Glashow, Salam and Weinberg got a Nobel Prize in Physics for modeling the weak force but – from what we wrote above – it is rather obvious we think it is a crucial mistake to think of the weak force as a force.[74] We think decay or disintegration processes should be analyzed in terms of transient or resonant oscillations and in terms of classical laws: conservation of energy, linear and angular momentum, charge and – most importantly – in terms of the Planck-Einstein relation. Forces keep things together: they should not be associated with things falling apart.

Again, we are getting beyond 20 pages here, so we will leave further reflections on this for the next version of this paper. Let us proceed to some kind of conclusion.

[70] For his profile and research, see: https://www.researchgate.net/profile/Giorgio_Vassallo.
[71] We think the neutron combines a proton and an electron, with the oscillating electron also serving to keep nucleons together. See: *Electrons as Gluons?* (https://vixra.org/abs/1908.0430)
[72] See: Paolo Di Sia, *A Solution to the 80 years old problem of the nuclear force*, International Journal of Applied and Advanced Scientific Research (IJAASR), Volume 3, Issue 2, 2018 (https://www.researchgate.net/publication/328701802_A_SOLUTION_TO_THE_80_YEARS_OLD_PROBLEM_OF_THE_NUCLEAR_FORCE).
[73] See the Annex to this paper as well as our first tentative paper on this: *Electrons as Gluons*, (https://vixra.org/abs/1908.0430).
[74] The reader will think that's brutal. We actually think of it as an understatement. In order to shock the reader into thinking for himself, let us put it this way: we think the idea of a weak force is plain nonsensical. From a philosophical point of view, we think one can easily show it is a *contradiction in terminis*.

An alternative Theory of Everything? What about gravity?

The reader will probably think all of the above is a rather meagre alternative Theory of Everything. We acknowledge that: in any case, the reader is always right, right? 😊 There are two or three reasons why we kept it meagre—perhaps only one, really:

1. We wanted to keep the paper short—and we realize we are not doing a good job at that.
2. We want the reader to have some fun thinking through the concepts themselves.
3. See the reason(s) above.
4. We are rather tired of repeating things we talked about in previous papers.[75]

Having said that, we should note we did cover *all* of the stable and non-stable particles in this paper—in about 20 to 25 pages only (excluding the Annex, of course)! 😊 That, in itself, is quite an achievement, isn't it?

The second of the two questions in the title of this section must be the final question: if the strong force is just another *mode* of the electromagnetic force, then what about gravity?

The honest answer is this: we have no clue whatsoever. In this regard, we can only note that the *scope* of our theory is not any larger – nor any smaller! – than that of the Standard Model: it's a theory about *almost* everything. Having said that, the reader will have to acknowledge it's much simpler and – therefore – much more fun !

Back to the question. What's *gravity*? Gravity is and remains a mystery. Efforts to think of it as some residual force (electromagnetic and strong forces may not cancel out) look equally tedious and non-productive as, say, trying to think about what quarks or W/Z bosons might actually *be*. Einstein's geometrical approach to gravity continues to make sense, intuitively—but that's only because of its mathematical beauty, basically. Of course, we fully acknowledge that a beautiful theory is not necessarily true. On this point, we may quote Dirac[76]:

> "It seems that if one is working from the point of view of getting beauty in one's equations, and if one has really a sound insight, one is on a sure line of progress. If there is not complete agreement between the results of one's work and experiment, one should not allow oneself to be too discouraged, because the discrepancy may well be due to minor features that are not properly taken into account and that will get cleared up with further development of the theory."

The gravitational force, obviously, keeps the Universe together – even as it expands.[77] Indeed, we have

[75] We refer the reader to our 50+ papers covering other relevant topics, which include but are not limited to a physical interpretation of the wavefunction (https://vixra.org/abs/1901.0105) and the *de Broglie* wavelength (https://vixra.org/abs/1902.0333). We also think our interpretation of one-photon Mach-Zehnder interference should interest the reader (https://vixra.org/abs/1812.0455).

[76] We quickly *googled* and the results indicate Dirac wrote these words in an article for the May 1963 issue of *Scientific American*. Dirac was born in August 1902, so he was getting closer to retirement then. It is interesting to see how Dirac distanced himself from mainstream quantum mechanics at a later age. He must have had the same feeling: al this hocus pocus can*not* amount to a *real* explanation.

[77] The Universe is expanding, of course! We do not doubt the measurements here. At the same time, it is sticking together! Fortunately! Otherwise we would not be here to write any stories about it.

the Earth going around the Sun (or – in a Ptolemaian world view – the Sun around the Earth, but we don't like to think that way because then we have too many reference frames to deal with), and we also have the Milky Way next to Andromeda, and so on and so on. In other words, perhaps we should think of gravity as a very simple idea: we live in One Universe. Full stop. Without gravity, the Universe wouldn't stick together, would it? Hence, Einstein's geometrical approach to gravity – which basically amounts to saying gravitation is, effectively, *not* a force but a structure – makes a lot of sense to us.

For more advanced theories or research integrating gravity and particle physics, we must refer to the already mentioned work of Dr. Alexander Burinskii.[78]

Conclusions

While this paper is only 20-25 pages, we do think it offers a simple but correct explanation of (almost) everything. The reader should probably think of it as a Great Simplification Theory rather than a Great Unification Theory but – if the simplifications are mathematically correct, which we think they are – then that should be good enough.

Jean Louis Van Belle, 11 March 2020

[78] See Footnote 50.

Annex: Unsolved questions

We've presented some rather grand results of our ring current model. However, we will not hide there are some issues and questions that we have *not* been able to solve. Let us go through these.

The neutron model

We think of photons, electrons and protons – and neutrinos – as elementary particles. Elementary particles are, obviously, stable. They would not be elementary, otherwise. The difference between photons and neutrinos on the one hand, and electrons, protons and other matter-particles on the other, is that we think all matter-particles carry charge—even if they are neutral.

A neutron is an example of a neutral matter-particle. We know it is unstable outside of the nucleus but its longevity – as compared to other non-stable particles – is remarkable. Let us explore what it might be—if only to provide some kind of model for analyzing other unstable particle, perhaps.

We should first note that the neutron radius is about the same as that of a proton. How do we know this? We quickly *googled* but – funnily enough – NIST only gives the *rms* charge radius for a proton (based on the various proton radius measurements). There is only a CODATA value for the Compton wavelength for a neutron, which is more or less the same as that for the proton. To be precise, the two values are this.

$$\lambda_{neutron} = 1.31959090581(75)\times10^{-15}\text{ m}$$

$$\lambda_{proton} = 1.32140985539(40)\times10^{-15}\text{ m}$$

These values are just mechanical calculations based on the *mass* or energy of protons and neutrons respectively: the Compton wavelength is, effectively, calculated as $\lambda = h/mc$.[79] A comparison between the energies is, therefore, more interesting. The neutron's energy is about 939,565,420 eV. The proton energy is about 938,272,088 eV. Hence, the difference is about 1,293,332 eV. This mass difference, combined with the fact that neutrons spontaneously decay into protons but – conversely – there is no such thing as spontaneous proton decay[80], makes us think a neutron must, somehow, combine a proton and an electron. The mass of an electron is 0.511 MeV/c^2, so that's only about 40% of the energy difference, but the kinetic and *binding* energy could make up for the remainder.[81] So, yes, let us think of a neutron as carrying both positive and negative charge inside. These charges balance each other out (there is no *net* electric charge) but their respective motion still yields a small magnetic moment, which we think of as some *net* result from the motion of the positive and negative charge inside. To be precise,

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[79] The reader should note that the Compton wavelength and, therefore, the Compton radius is *inversely* proportional to the mass: a more massive particle is, therefore, associated with a *smaller* radius. This is somewhat counterintuitive but it is what it is.

[80] None of the experiments (think of the Super-Kamiokande detector here) found any evidence of proton decay so far.

[81] The reader should note that the mass of a proton and an electron add up to *less* than the mass of a neutron, which is why it is only logical that a neutron should decay into a proton and an electron. Binding energies – think of Feynman's calculations of the radius of the hydrogen atom, for example (see: https://www.feynmanlectures.caltech.edu/III_02.html#Ch2-S4) – are usually *negative*.

the CODATA value for the magnetic moment of a neutron is equal to[82]:

$$\mu_{neutron} = 9.6623651(23)\times10^{-27}\ \mathrm{J\ T^{-1}}$$

The CODATA value for the magnetic moment of an electron is (almost) 961 times *larger*:

$$\mu_{electron} = 9.2847647043(28)\times10^{-24}\ \mathrm{J\cdot T^{-1}}$$

Can we, perhaps, try some easy calculations combining the magnetic moment of a proton and an electron? Let us see. The CODATA value for the magnetic moment of a proton is equal to:

$$\mu_{proton} = 14.1060679736(60)\times10^{-27}\ \mathrm{J\cdot T^{-1}}$$

The ratio between μ_e and μ_p is about 658, more or less. These are strange numbers. We already mentioned that, if we accept a theoretical radius for the proton that is equal to $a_p = 4\hbar/mc$, then the ring current model yields the following theoretical value for the magnetic moment:

$$\mu_L = \mathrm{I}\pi a^2 = \mathrm{q_e} f\pi a^2 = \mathrm{q_e}\frac{c}{2\pi a}\pi a^2 = \frac{\mathrm{q_e}c}{2}a = \frac{\mathrm{q_e}c}{2}\frac{4\hbar}{\mathrm{m}c}\hbar = 2\frac{\mathrm{q_e}}{\mathrm{m}}\hbar \approx 20.203135\times10^{-27}\ \mathrm{J\cdot T^{-1}}$$

This value differs from the CODATA value by a $\sqrt{2}$ factor, more or less[83]. In previous papers, we argued the a $\sqrt{2}$ factor can be explained by the precession of the current loop in the magnetic field.[84] We also think that the actual velocity of the proton charge in its circular motion must be somewhat *less* than the velocity of light. This echoes our explanation of the anomalous magnetic moment for the electron. We calculated the anomaly for the proton based on the *actual* magnetic moment – as given by its CODATA value – and found that the anomaly for the proton is actually *larger*, relatively speaking, than for the electron. The calculation is this[85]:

$$\frac{\mu_L - \mu_{CODATA}}{\mu_L} \approx \frac{20.203 - 19.949}{19.949} \approx 0.0127\ldots$$

One should compare this value to the $\alpha/2\pi$ factor for the electron, which is equal to 0.001161, more or less. Hence, the anomaly for the proton is about 11 times *larger* than the anomaly for the electron. We are not worried about this because the most recent precision measurement of the proton radius – we refer to the 2019 PRad experiment here[86] – yields the same order of magnitude for the anomaly of the radius:

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[82] We make abstraction of the sign of the electron and proton charge. The reader can add it if he or she wishes to do so.

[83] Multiplying the CODATA value for μ_p by $\sqrt{2}$ yields a value that is equal to about $19.949\times10^{-27}\ \mathrm{J\cdot T^{-1}}$.

[84] See our previous calculations on the theoretical and actual radius and magnetic moment of a proton: https://vixra.org/pdf/2001.0685v8.pdf. We think the argument is solid but it triggers an obvious question: why is there no such factor for the CODATA value of the magnetic moment of an electron? We have no answer to that: we must, somehow, assume the electron value has already been corrected for precession. Prof. Dr. Randolf Pohl, who not only knows all about proton radius measurements but who is also a member of the CODATA Task Group for Fundamental Constants, may know more in this regard.

[85] One can do the calculations with or without the $\sqrt{2}$ precession factor: they yield the same result. We also left the 10^{-27} scale factors out because these cancel each other out.

[86] See: https://phys.org/news/2019-11-yields-smaller-proton-radius.html.

$$\frac{r_{\mathrm{p}} - r_{\mathrm{PRad}}}{r_{\mathrm{p}}} = \frac{\frac{4\hbar}{\mathrm{m_p}c} - r_{\mathrm{PRad}}}{\frac{4\hbar}{\mathrm{m_p}c}} \approx 0.0121674\ldots$$

Based on this, we think the PRad value might be the actual proton radius, while the results from the muonic hydrogen spectroscopy experiments (the 2010 experiments done by Prof. Dr. Pohl, that is) may not include the anomaly—although we have no idea what that would be so.

However, we got distracted here. We were trying to do some calculations with the magnetic moments but we can readily see we do not get anywhere when adding or subtracting the magnetic moments of the electron and the proton. The only sensible thing we can say is that the magnetic moment of the neutron and the proton have the same *order of magnitude*. To be precise, the magnetic moment of a proton is about 1.46 times that of a neutron. What can we do with this? Perhaps there is some forgotten $\sqrt{2}$ factor in the magnetic moment of a neutron too? If so, then the two magnetic moments would be the same—more or less, at least: $9.66\ldots \cdot \sqrt{2} = 13.66\ldots$.

However, it is obvious we get into a rather shaky line of argument here. In short, the summary conclusions have to be these:

> If a neutron somehow combines a proton and an electron, then how should we *imagine* such combination? The measured values for the magnetic moments seem to give no clue.
>
> We should also note another problem here: the classical electron radius is *much* larger than the proton or neutron radius. Hence, how can we possibly *fit* an electron into a neutron?

Let us analyze this question in a separate section.

The size of the electron charge

Our ring current model of an electron implies the anomaly of the magnetic moment is the anomaly of the radius. It also implies the anomaly is not an anomaly at all: we simply assume the *Zitterbewegung* (zbw) charge inside of the electron has an effective mass. Let us quickly redo our calculations, so as to have a more informed discussion of what the radius of our *zbw* charge might be. It went like this:

1. We had two formulas for the magnetic moment because we can calculate the frequency in two different ways:

$$\mu = \mathrm{I}\pi a^2 = \mathrm{q_e} f \pi a^2 = \mathrm{q_e}\frac{c}{2\pi a}\pi a^2 = \frac{\mathrm{q_e}c}{2}a \Leftrightarrow a = \frac{2\mu}{\mathrm{q_e}c}$$

$$\mu = \mathrm{I}\pi a^2 = \mathrm{q_e} f \pi a^2 = \frac{\mathrm{q_e}\omega a^2}{2} \Leftrightarrow a = \sqrt{\frac{2\mu}{\mathrm{q_e}\omega}} = \sqrt{\frac{2\mu\hbar}{\mathrm{q_e E}}} = \sqrt{\frac{2\mu\hbar}{\mathrm{q_e m}c^2}}$$

Combining these two equations, we get the following theoretical value for the magnetic moment:

$$\left.\begin{aligned} a &= \sqrt{\frac{2\mu\hbar}{\mathrm{q_e m}c^2}} \\ a &= \frac{2\mu}{\mathrm{q_e}c} \end{aligned}\right\} \Leftrightarrow \sqrt{\frac{2\mu\hbar\mathrm{q_e^2}c^2}{4\mu^2\mathrm{q_e m}c^2}} = \sqrt{\frac{\hbar\mathrm{q_e}}{2\mu\mathrm{m}}} = 1 \Leftrightarrow \mu = \frac{\mathrm{q_e}}{2\mathrm{m}}\hbar$$

We can then calculate the anomaly using the above-mentioned theoretical value against the CODATA value. Let us use a bit of a different notation here so as to facilitate the interpretation: we will denote the above-mentioned theoretical value as μ_a, while we'll write the *actual* value (for which we use the CODATA value) as μ_r. So we get what we expect to get[87]:

$$\frac{\mu_a - \mu_r}{\mu_r} = 0.00115965 \ldots \approx \frac{\alpha}{2\pi}$$

We equate the anomaly to Schwinger's factor here, so we make abstraction of the higher order factors in the anomaly. Because we know Schwinger's factor explains about 99.85% of the anomaly, we have a 'good enough' equation here—for a first approximation, at least!

2. The subscripts (*a* and *r*) refer to the associated theoretical and actual value for the radius respectively. What are these? That should be obvious: $a = \hbar/\mathrm{m}c$, while *r* is the *actual* radius, which should be slightly smaller because we assume the actual velocity of our *zbw* charge – which we denote as *v* – must also be slightly smaller than *c*. In fact, that's the whole point: we use the anomaly of the magnetic moment to calculate both *r* and *v*. The formulas are these[88]:

$$\frac{\mu_a}{\mu_r} = \frac{\frac{\mathrm{q_e}}{2\mathrm{m}}\hbar}{\frac{\mathrm{q_e}v}{2}r} = \frac{\hbar}{\mathrm{m}\cdot v\cdot r} = \frac{c\cdot a}{v\cdot r} == \frac{\omega\cdot a^2}{\omega\cdot r^2} = \frac{a^2}{r^2} = 1 + \frac{\alpha}{2\pi}$$

$$\Leftrightarrow r = \frac{a}{\sqrt{1+\frac{\alpha}{2\pi}}} \approx 0.99942\cdot\frac{\hbar}{\mathrm{m}c}$$

We get the same 0.99942 factor for the actual velocity of the *zbw* charge. Indeed, from combining the Planck-Einstein relation and the tangential velocity formula, we know that the *v*/*c* and *r*/*a* ratios must be exactly the same. We can, therefore, write:

$$1 = \frac{\omega}{\omega} = \frac{v/r}{c/a} \Leftrightarrow \frac{v}{c} = \frac{r}{a}$$

This allows us to calculate the (relative) velocity of the *zbw* charge as:

$$\beta = \frac{v}{c} = \frac{r}{a} = \frac{a}{a\cdot\sqrt{1+\frac{\alpha}{2\pi}}} = \frac{1}{\sqrt{1+\frac{\alpha}{2\pi}}} \approx 0.99942 \Leftrightarrow v \approx 0.99942\cdot c$$

[87] You should watch out with the minus signs here – and you may want to think why you put what in the denominator – but it all works out!
[88] The formula uses the $a = \hbar/\mathrm{m}c \Leftrightarrow \hbar/\mathrm{m} = a\cdot c$ formula.

This, in turn, allowed us to calculate the rest mass of the pointlike *zbw* charge[89]:

$$\mathrm{m_0} = \sqrt{1-\beta^2}\cdot \mathrm{m_\gamma} = \sqrt{1-\beta^2}\cdot\frac{\mathrm{m_e}}{2} = \sqrt{1-\frac{1}{1+\frac{\alpha}{2\pi}}}\cdot\frac{\mathrm{m_e}}{2} = \sqrt{\frac{\alpha}{2\pi+\alpha}}\cdot\frac{\mathrm{m_e}}{2} \approx 0.017\cdot \mathrm{m_e} \approx 0.034\cdot \mathrm{m_\gamma}$$

Hence, we effectively arrive at the conclusion that the rest mass of the pointlike *Zitterbewegung* charge is equal to about 1.7% of the rest mass of the electron ($\mathrm{m_e}$), or 3.4% of its relativistic mass ($\mathrm{m_\gamma}$). That is nice, but it doesn't give us any information about the *size* – the spatial dimension or radius, that is – of the *zbw* charge. So what can we say about that?

3. We can start by calculating the actual difference between the theoretical and actual radius. That is easy enough, indeed! Re-inserting the higher-order factors – but just using the … symbol for them – we get:

$$\frac{a_\mu - a}{a} = \frac{\alpha}{2\pi} + \cdots \Leftrightarrow a_\mu - a = (\alpha + \cdots)\cdot\frac{a}{2\pi}$$

This is a very interesting equation. *A priori*, one might have expected that the *difference* between the *a* = ħ/m*c* Compton radius and the *actual* radius *r* would be of the order of α·*a*. Why? Because α·*a* is the classical electron radius, which explains elastic scattering. We, therefore, think it is, in effect, some kind of actual radius of the *zbw* charge inside of the electron.

However, the result above shows we should probably *not* think of the *zbw* charge as some *solid* sphere of charge. The 1/2π factor is, effectively, equal to about 0.16, so the *difference* between what we think of the *real* radius of the ring current and its theoretical radius *a* = ħ/m*c* is just a *fraction* of α·*a*. We are not sure how to make sense of this. Perhaps we should think of some kind of fractal structure here: is the *zbw* charge itself a smaller version of the *zbw* electron? We have no idea. It is a great mystery!

So, yes, that is *not* so good: We like to think our model has clarified a lot of mysteries but, yes, *some* mystery is left! 😊 On the positive side, we should remind the reader our model does seem to solve one of the questions which Richard Feynman struggled with. Indeed, he got the following interesting formula when calculating the electromagnetic mass or energy of a sphere of charge with radius *a*[90]:

$$\mathrm{U} = \frac{1}{2}\frac{\mathrm{e}^2}{a} = \frac{1}{2}\frac{\mathrm{q_e^2}}{4\pi\varepsilon_0}\frac{1}{r_\mathrm{e}} = \frac{1}{2}\frac{\mathrm{q_e^2}}{4\pi\varepsilon_0}\frac{\mathrm{m}c}{\alpha\hbar} = \frac{1}{2}\frac{\mathrm{q_e^2}}{4\pi\varepsilon_0}\frac{4\pi\varepsilon_0\hbar\mathrm{m}c^2}{\mathrm{q_e^2}\hbar} = \frac{1}{2}\mathrm{m}c^2$$

Feynman was puzzled by that ½ factor: where is the other half of the energy (or the mass) of the electron? Our ring current model shows the ½ factor is quite logical: Feynman is assembling the *zbw* charge here—*not* the electron as a whole. Hence, the missing mass is in the *Zitterbewegung* or

[89] We used the concept of the effective mass of the *zbw* charge in the formula above ($\mathrm{m_\gamma}$), which is *half* (1/2) of the total rest mass of the electron ($\mathrm{m_\gamma} = \mathrm{m_e}/2$). We have explained this assumption before and, hence, will *not* do so here.

[90] See: https://www.feynmanlectures.caltech.edu/II_28.html. The basic idea is to 'assemble' the elementary charge by bringing infinitesimally small charge *fractions* together. We should note that Feynman did not write it like this, but we inserted and used the $\alpha = \frac{\mathrm{q_e^2}}{4\pi\varepsilon_0\hbar c}$ and $a = r_\mathrm{e} = \alpha\frac{\hbar}{\mathrm{m}c}$ identities.

orbital/circular motion of the *zbw* charge. We can now *derive* the classical electron radius from the formula above:

$$\mathrm{U} = \frac{1}{2}\frac{\mathrm{e}^2}{r_\mathrm{e}} = \frac{1}{2}\frac{\mathrm{q}_\mathrm{e}^2}{4\pi\varepsilon_0}\frac{1}{r_\mathrm{e}} \Leftrightarrow r_\mathrm{e} = \frac{1}{2}\frac{\mathrm{q}_\mathrm{e}^2}{4\pi\varepsilon_0 \mathrm{U}} = \alpha\frac{\hbar c}{2\mathrm{m}_\gamma c^2} = \alpha\frac{\hbar}{\mathrm{m}_\mathrm{e} c} = \alpha r_\mathrm{C} \approx 2.82 \times 10^{-15}\ \mathrm{m}$$

However, as mentioned, while we get a very sensible formula for the classical electron radius here, it does *not* solve our question: this value is about 3.4 times the (assumed) radius of the neutron, so how can it possibly *fit* into the neutron? It cannot. In contrast, if the radius would, effectively, be equal to the above-calculated $\alpha a/2\pi \approx 0.45$ fm value, then we might think it could work: 0.45 fm is, effectively, radius might make more sense because that's just a bit more than *half* the proton radius.

We let this matter rest for the time being, so the reader can have some fun thinking this through for himself!

We will now raise another fundamental question: what is the nature of the 'stronger' force inside of the proton? Indeed, we vaguely distinguished between the fundamental frequency and one or more higher modes of spacetime – but that needs to be 'translated' into a better 'visual' image of what might or might not be going on. So let us try to develop some thoughts on that.

The nature of the strong(er) force

The assumption we introduced to calculate the (theoretical) proton radius looks quite ad hoc. Let us repeat what we wrote:

When considering systems (e.g. electron orbitals) and excited states of particles, angular momentum comes in units (nearly) equal to *ħ*, but when considering the internal structure of elementary particles, (orbital) angular momentum comes in an integer fraction of ħ. This fraction is 1/2 for the electron[91] and 1/4 for the proton.

Hence, we derived the proton radius as follows:

$$\left.\begin{array}{r}\left.\begin{array}{r}\mathrm{E} = \mathrm{m}c^2 \\ \mathrm{E} = \frac{\hbar}{4}\omega\end{array}\right\} \Rightarrow \mathrm{m}c^2 = \frac{\hbar}{4}\omega \\ c = a\omega \Leftrightarrow a = \frac{c}{\omega} \Leftrightarrow \omega = \frac{c}{a}\end{array}\right\} \Rightarrow \mathrm{m}a^2\omega^2 = \frac{\hbar}{4}\omega \Rightarrow \mathrm{m}\frac{c^2}{\omega^2}\omega^2 = \frac{\hbar c}{4a} \Leftrightarrow a = \frac{1}{4}\frac{\hbar}{\mathrm{m}c}$$

Importantly, we mentioned that **the 4E = *ħ*·ω relation suggests that we may want to think of the force inside of the proton as some *stronger* variant of the electromagnetic force.**

Let us illustrate that point by doing the calculations we did for the electron, notably the current and force calculations. Let us first look at the current which – using the $f = 4\mathrm{E}/h$ relation – we should calculate as follows:

$$\mathrm{I} = \mathrm{q}_\mathrm{e} f = \mathrm{q}_\mathrm{e}\frac{4\mathrm{E}}{h} \approx (1.6 \times 10^{-19}\ \mathrm{C})\frac{4 \times 938{,}272{,}088\ \mathrm{eV}}{4.135667696 \times 10^{-15}\ \mathrm{eV\cdot s}} \approx 145{,}396\ \mathrm{A}\ (\mathit{ampere})$$

[91] The 1/2 factor for the electron appears when considering *orbital* angular momentum only. We admit this argument sounds *ad hoc* too. We welcome the reader to send us their suggestions and/or reflections.

Wow! If we thought the household-level current we got for the electron (19.8) was huge, then this is outright *monstrous*! The *mechanics* are obvious, of course: the radius of the proton is a zillion times smaller than that of the electron, so the elementary charge passes through the same point much more rapidly—a zillion times more rapidly, in fact!

What about the magnetic field at the center of the ring? We will let the reader calculate that. The Biot-Savart Law tells us it should be this[92]:

$$B = \frac{\mu_0 \mathrm{I}}{2a}$$

The μ_0 in the formula is the magnetic constant—not the magnetic moment. Any case, the formula will yield yet another humongous value.[93]

Last but not least, we can calculate the value of the force from the formula that we used in the text. We get this:

$$\mathrm{F_p} = \frac{1}{2}\mathrm{m_p}a\omega^2 = \frac{1}{2}\mathrm{m_p}\frac{4\hbar}{\mathrm{m_p}c}\frac{4^2\mathrm{E}^2}{\hbar^2} = 32 \cdot \frac{\mathrm{m_p}^2c^3}{\hbar} \approx 22{,}873{,}440\ \mathrm{N}$$

By way of comparison, the reader may or may not remember that we got a somewhat more modest value – what an understatement, isn't it? 😊 – for the centripetal force inside of an electron:

$$\mathrm{F_e} = \frac{1}{2}\frac{\mathrm{E_e}}{a} = \frac{1}{2}\frac{\mathrm{m_e}^2c^3}{\hbar} \approx \frac{8.187 \times 10^{-14}\ \mathrm{J}}{\frac{2}{2\pi} \cdot 2.246\ \times 10^{-12}\ \mathrm{m}} \approx 0.115\ \mathrm{N}$$

More modest? Even this much smaller value is quite monstrous considering the sub-atomic scale: it is equivalent to a force that gives a mass of about 115 *gram* (1 g = 10^{-3} kg) an acceleration of 1 m/s per second. That's serious. However, it's obviously small in comparison to the $\mathrm{F_p}$ force! This makes us wonder whether these results are sensible.

As mentioned, we feel we're missing some crucial *variable* here, and it's probably got to do with gravity and how it *shapes* spacetime itself. We should probably immerse ourselves in Kerr-Newman geometries but… Well… We're just amateur physicists, aren't we? :-/

Pair creation and annihilation: what's the *nature* of anti-matter?

We want to raise another obvious question in regard to our model(s). Electron-positron pair creation and annihilation—or the question in regard to the *nature* of anti-matter in general. We do not have many ideas here—but then we don't feel too dumb because we are in good company here: from all of Dirac's formal or informal remarks on the *state* of our knowledge, it's clear he struggled very much with that too.

The gist of the matter is this: our world could be an anti-matter world. We may think of that as a mathematical fiction: who cares if we write q or −q in our equations? No one, right? It's just a

[92] See: https://www.feynmanlectures.caltech.edu/II_13.html#Ch13-S5.

[93] Oliver Consa dutifully notes the largest artificial magnetic field created by man is only 90 T (*tesla*), so we'll let the reader judge whether or not we get sensible results here.

convention, and so we can just swap signs, right?

Well... No. Dirac had noticed the *mathematical* possibility early on—in 1928, to be precise, as soon as he had published his equation for the free electron. He said this about it in his 1933 Nobel Prize Lecture:

> "If we accept the view of complete symmetry between positive and negative electric charge so far as concerns the fundamental laws of Nature, we must regard it rather as an accident that the Earth (and presumably the whole solar system), contains a preponderance of negative electrons and positive protons."

The carefully chosen 'preponderance' term shows he actually did imagine some stars could possibly be made of anti-matter, and he said as much in the very same lecture:

> "It is quite possible that for some of the stars it is the other way about, these stars being built up mainly of positrons and negative protons. [...] The two kinds of stars would both show exactly the same spectra, and there would be no way of distinguishing them by present astronomical methods."

Strangely enough, he doesn't mention Carl D. Anderson who - just the previous year (1932) - had actually found the trace of an *actual* positron on one of his cloud chamber pictures of what happens to cosmic radiation when it enters... Well... Anderson's cloud chamber. :-) Anderson got his own Nobel Prize for it - and one that's very well deserved (the reader who's read our previous posts will know we have serious doubts on the merit of some (other) Nobel Prizes).

The point is this: we should not think of matter and anti-matter as being 'separate worlds' (theoretical and/or physical). No. Pair creation/annihilation should be part and parcel of our 'world view' (read: our classical explanation of quantum physics). So what can/should we do with this?

[...]

Nothing at all, perhaps. If we stare at the equations long enough, they all start making sense after a while, don't they? Especially when enjoying a Belgian beer or a good glass of wine. Feynman quoted an unknown poet in one of his introductory lectures to his *Lectures*:

"The whole universe is in a glass of wine."

Again, after having deified Feynman for decades, I regret to say that I now have to think of Richard Feynman as being a very complicated personality *defending mainstream thought rather than trying to be revolutionary*. :-/ Having said that, I still fully agree with most of his metaphorical statements, and the one above surely tops *my* list. :-)