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The Electromagnetic Particle—A Backward Engineering Approach to Matter in SI Units*

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Abstract

This article describes the properties of the free elementary particles from an electromagnetic approach in SI units. The analysis is done from a backward engineering approach for the structural analysis. This also includes the origin of charge, which is modelled from a single photon and the pairing effect. Then the necessary implications for a stable particle including an explanation of the inner particle force and the quantization condition for the radius of the electron are handled. Furthermore, the properties of the myon, tauon, proton, neutron and black holes will be extrapolated and a possible reason for the mass oscillation of the Neutrino will be shown also. In addition, a possible explanation for the occurrence of matter free mass based on an EM-mass equation will be explained and will suggest an obviously resulting augmentation to the special relativity theory and finally the analytical approach of the theory is compared to the CODATA values and astronomic data for black holes.

Keywords

Electromagnetic, Dark Energy, Dark Matter, Oscillator, Particle, Structure, Pairing, Electron, Mass, Black Hole, Magnetic Moment

1. Introduction

A main question in high energy physics is the internal structure of elementary particles especially of electrons. Even from the current state of knowledge there are unanswered points, particularly concerning the global relations between the sub-aspects of elementary particles. Especially the transition of a photon to the corresponding particles e.g. the pairing effect is of great interest. In this paper a possible way to more answers will be shown.

*The observed physics is the guide for the possible mathematics behind.

It can be assumed that the particle is shaped from the electromagnetic wave which constitutes the photon and that the wave does not disappear but is transformed. The fact that the electromagnetic wave appears in form of a photon not only during the generation of particle and antiparticle pairs but also at their annihilation justifies this assumption.

Especially interesting aspects of the particle are the generation of mass, charge and a magnetic field as well as the necessary conditions behind. The usual approach neglects the explanations of the effects of the pure electromagnetic wave, especially the transition of a particle without mass to a particle with mass.

It is important that such a theory should not only be simple but should at the same time encompass all known applicable physics. To ensure this, an alternative approach was taken. The presence of all known physics in the corresponding particles was used as a starting point and the theory was constructed backwards from this point. This is an approach known in the engineering sciences as "backward engineering". The wave functions will be looked at comparable to a stroboscopic effect so that created snapshots can be observed as moveable in time and space and as a standing wave.

It will be shown that this approach is possible as long as the known formulas consistently undergo the process of a relativistic transformation. This is not easy as the relativistic transformation is anisotropic and the transformation of the formulas has to be done accordingly. This theory is confirmed by comparable results and approaches which can be found previously in this journal [1]. The strict adherence to the previously mentioned conditions leads to very astonishing relations between the individual sub-aspects of known physics and the particle. For example the quantization condition of the electron radius was unexpected, but is logical if looked closely. These results appear to be simple at first sight but they contain new, deeper parts of understanding and they can be verified by comparing to physical measurements.

This idea also leads to not expected areas like superconductors and a possible explanation to a type of electromagnetic (EM) dark matter and black holes. Further the understanding of Einstein's brilliant formula is augmented and explained in an additional EM way by keeping the famous interpretation valid. There is a rigorous approach in this article to simplify mathematics and to remove all the complex descriptions behind to get a clear and easy view to the simplest possible physics inside of a particle. At the end only four constants remain to describe all particle properties if the baselines of all matter are electromagnetic waves and this also will be the baseline for the augmentation of $E = \mathrm{mc}^2$.

To prove the theory everything must absolutely compliant with the known physics! By knowing the (quantum-)mechanics behind the origin of EM properties, consequently it is possible to make predictions up to black holes and all type of massive matter. Finally the understanding of neutrinos can be improved and show a possible reason for the mass oscillation. The main result of the article is that the quantum mechanics really isn't de-coupled from the classical physics and with augmentations the known physics can be modified and give a hint for a use inside the particles because classical physics is a part of the overall physics and the quantum mechanics too [2].

All calculations are performed in the SI-System. Furthermore the theoretical expected values were compared with the CODATA values. With exception of the scatter radius, the theory matches to particles with a more complex inner structure (e.g. Hadrons).

2. The Generation of the Electron and Positron from a Photon

The electron can be produced by the pairing effect. This effect is well known in the particle physics and occurs often if enough energy and a co-partner for the impulse are present [3]. Now the goal is to get an access for describing the mechanism behind it, especially for the generation of charge. If it is assumed that the origin of the electron is based on a linear polarized photon (ɣ-Quant) with the Energy E_γ (>1.022 MeV), then the field equations during a non-disturbed propagation are assumed to be like normal electromagnetic waves [4].

$$\boldsymbol{E} = E_y \cos(\omega t) \tag{1}$$

and

$$\boldsymbol{B} = B_x \cos(\omega t) \tag{2}$$

If the propagation then is disturbed (impacted) by an external E-field which is represented by an Electron, Nucleus or another ɣ-Quant, the wave can then be modified and the linear propagation is shifted to angular propagation which forces the wave to be localized (**Figure 1**). This only can happen if the beginning of the wave is connected to the end of the same wave so that a closed ring is formed. This condition is possible because the beginning and the end can't be separated any more then and this introduces the stability of the particle (lepton).

Usually particles interact with each trough the electrical field, if they are close together, so the modification of the E-Field was chosen in combination of the assumption that magnetic monopoles does not exist for the corresponding process with strong magnet fields. The process is shown in **Figure 2**. Note also that in the following simplified calculation it is assumed that the energy of the photon is

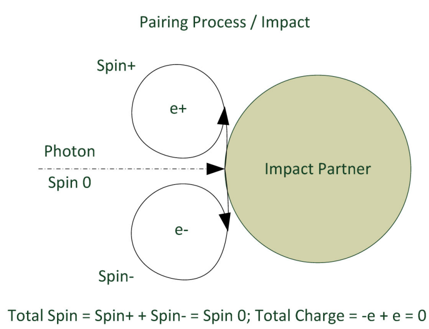

Figure 1. Principle of the pairing process.

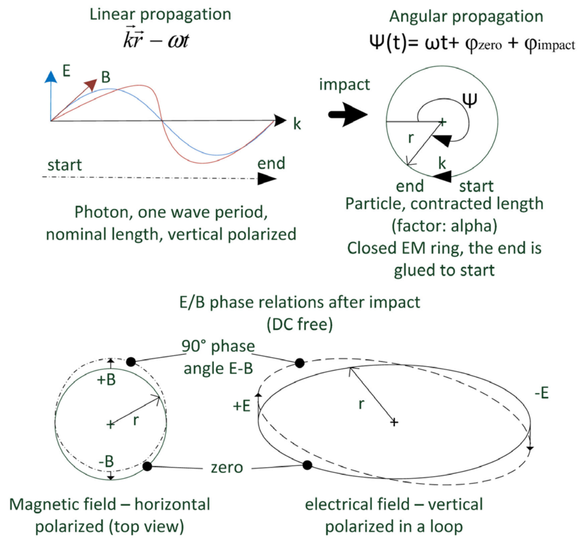

Figure 2. Folding the wave to a particle, the generation of particle volume.

high enough to perform the operation and avoid the annihilation immediately after the generation by a quick separation of the particles. The interacting counterpart is not included in the calculation because only it takes on the impulse so that all operations are in line with the impulse vectors [5]. Goal is to show the inner modification of the photon only. The external system is not dealt with here. A further part of investigation would be which conditions are necessary for the localization of the normally infinitely distributed wave to be a particle (dualism, wave character). If the mentioned, simplified assumptions are taken (dualism, getting the particle character), the EM (Electromagnetic) field equations modified them in the following matter. With $\cos(2\tilde{x}) = \cos^2\tilde{x} - \sin^2\tilde{x}$ and $\omega = 2\pi f$ it is:

$$\begin{aligned}\gamma &= \begin{pmatrix} E \\ B \end{pmatrix} = \begin{pmatrix} E_y \cos(2\omega t) \\ B_x \cos(2\omega t) \end{pmatrix} = \begin{pmatrix} E_y\left(\cos^2(\omega t) - \sin^2(\omega t)\right) \\ B_x \cos(2\omega t) \end{pmatrix} \\ &= \begin{pmatrix} E_y \cos^2(\omega t) - E_y \sin^2(\omega t) \\ \frac{B_x}{2}\cos(2\omega t) + \frac{B_x}{2}\cos(2\omega t) \end{pmatrix} = \begin{pmatrix} E_y \cos^2(\omega t) \\ \frac{B_x}{2}\cos(2\omega t) \end{pmatrix} + \begin{pmatrix} -E_y \sin^2(\omega t) \\ \frac{B_x}{2}\cos(2\omega t) \end{pmatrix}\end{aligned} \tag{3}$$

Assuming an impact $\varphi_{\text{impact}} = +\pi/2$ to the inner phase of the photon happens, and assuming that the impact is only on the *E*-field (e.g. in the strong *E*-field of a nucleus) and the reference phase angle is taken from the *B*-field, than this equation can be used: $\varphi_{\text{impact}} = \varphi_1 - \varphi_2 = \pi/2 = +\pi/4 - (-\pi/4)$. This is for the phases $\varphi_1 = +\pi/4$ and $\varphi_2 = -\pi/4$ and will now be called Compton-Resonance because of the Compton scattering of 90˚ which is a particle specific parameter. The angle is necessary for the circular motion and is in resonance with the particle wave length [6].

If this phase shift and the angular movement are applied to the photon-formula in this way it can be understood as (initial Phase φ_{zero} is set to 0 rad for better understanding later but can be chosen arbitrary):

$$\begin{pmatrix} E_y \cos^2\left(\boldsymbol{kr}+\omega t+\varphi_1\right)-E_y \sin^2\left(\boldsymbol{kr}+\omega t+\varphi_2\right) \\ \frac{B_x}{2}\cos\left(2\left(\boldsymbol{kr}+\omega t\right)\right)+\frac{B_x}{2}\cos\left(2\left(\boldsymbol{kr}+\omega t\right)\right) \end{pmatrix}$$
$$\xrightarrow[\text{Impact}]{} \begin{pmatrix} E_y \cos^2\left(\varphi_{\text{zero}}+\omega t+\frac{\pi}{4}\right) \\ \frac{B_x}{2}\cos\left(2\varphi_{\text{zero}}+2\omega t\right) \end{pmatrix} + \begin{pmatrix} -E_y \sin^2\left(\varphi_{\text{zero}}+\omega t-\frac{\pi}{4}\right) \\ \frac{B_x}{2}\cos\left(2\varphi_{\text{zero}}+2\omega t\right) \end{pmatrix} \tag{4}$$

And with the identity $\cos^2\left(x+\frac{\pi}{4}\right)=\sin^2\left(x-\frac{\pi}{4}\right)$:

$$\begin{pmatrix} E_y \cos^2\left(\omega t+\frac{\pi}{4}\right) \\ \frac{B_x}{2}\cos\left(2\omega t\right) \end{pmatrix} + \begin{pmatrix} -E_y \cos^2\left(\omega t+\frac{\pi}{4}\right) \\ \frac{B_x}{2}\cos\left(2\omega t\right) \end{pmatrix} = e^+ + e^- \tag{5}$$

where the e^+ is the Positron and the e^- is the Electron. It is assumed that the particles are separated fast enough before they annihilate.

Further with the identities

$\sin^2\left(\omega t-\frac{\pi}{4}\right)=\frac{1}{2}\left(1-\cos\left(2\omega t-\frac{\pi}{2}\right)\right)=\frac{1}{2}\left(1-\sin\left(2\omega t\right)\right)$ it is:

$$\begin{pmatrix} -E_y \cos^2\left(\omega t+\frac{\pi}{4}\right) \\ \frac{B_x}{2}\cos\left(2\omega t\right) \end{pmatrix} = \begin{pmatrix} -E_y \sin^2\left(\omega t-\frac{\pi}{4}\right) \\ \frac{B_x}{2}\cos\left(2\omega t\right) \end{pmatrix} = \begin{pmatrix} -\frac{E_y}{2}+\frac{E_y}{2}\sin\left(2\omega t\right) \\ \frac{B_x}{2}\cos\left(2\omega t\right) \end{pmatrix} = e^- \tag{6}$$

And it follows

$$\frac{1}{2}\begin{pmatrix} -E_y + E_y \sin\left(2\omega t\right) \\ B_x \cos\left(2\omega t\right) \end{pmatrix} = e^- \tag{7}$$

and

$$\frac{1}{2}\begin{pmatrix} E_y - E_y \sin\left(2\omega t\right) \\ B_x \cos\left(2\omega t\right) \end{pmatrix} = e^+ \tag{8}$$

This can be interpreted that an impact to a photon introduces a phase shift to the *E*-field via Compton resonance and separates the inherently existing charges from the photon into a pair of e^+ and e^-. The impact is caused from the photon by a collision with a photon, electron or nucleus, the impact partner. The following phases are used with the assumption that the phase angle only of the *E*-field is modified. The phase of the *B*-Field is set to the reference and defined to zero during the impact. In realistic impacts both phases could be shifted so in this calculation, the phase angles can be understood as difference angles too. The not mentioned phase angle to a hypothetic, global zero-angle φ_{zero} takes the still remaining uncertainty of this process so that the result can't be calculated deterministic in the real measurement case (uncertainty from Heisenberg). So only the particle itself knows its own state exactly and is still distributed over a volume which is responsible for many quantum effects (**Figure 3**).

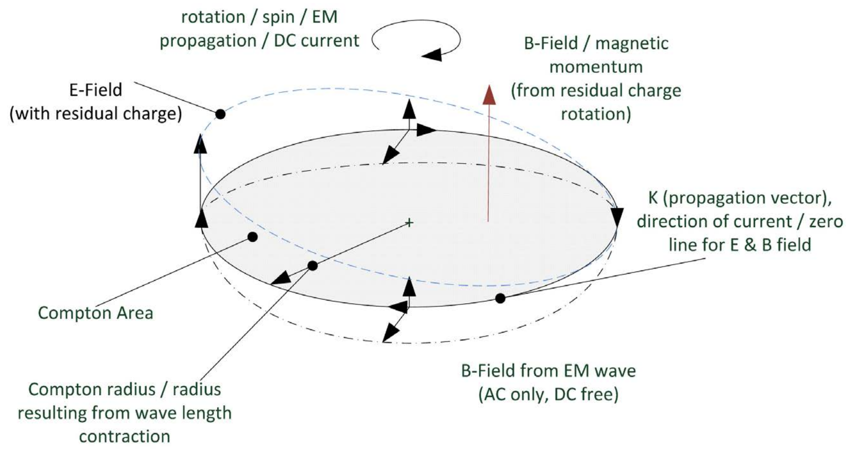

Figure 3. EM anatomy of a lepton (*E*/*B* space & radius).

It is now interpreted that the sin(*x*) and cos(*x*) in the wave equation introduce the geometric origin of the force (=circle movement or oscillation, *x* is the angle of rotation, not any location coordinate after the impact) inside the electron which is formed by the shifted EM waves. This force and the fact that there is no beginning and no end any more are responsible for the inner strength of the particle and forms this kind of matter (of the leptons). The radius will be determined by the wave length and will be smaller with increasing energy or respective shorter wave length. This process is the generation of the particle size which was not present in the initial photon before. The photon has no volume but a wave length. The particle has wavelength and radius but is still distributed over the space because of its wave origin but it does not propagate in space any more. In addition it is interesting that after the impact is finished, the electrical field of the particle has a mean value greater for the positron (or less for the electron) to zero. Note that the other counter-charge is separated to infinity and one electrical monopole is mentioned here. For simplification it will now be assumed that the *E*-field is spherical. This complies with the usual calculation of the classical electron radius.

3. The Poynting Vector (EM Power Transport)

Based on the wave equations $\boldsymbol{E} = \widehat{E_0}\cos(\boldsymbol{kr} + \omega t)$ and $\boldsymbol{H} = \widehat{B_0}\cos(\boldsymbol{kr} + \omega t)$ and $Z_0 = \sqrt{\varepsilon_0/\mu_0} = 377\ \Omega$ the Poynting vector is:
$\boldsymbol{S} = c^2\varepsilon_0(\boldsymbol{E}_0 \times \boldsymbol{B}_0)\cos^2(\boldsymbol{kr} + \omega t)$ and with $\cos^2(x) = \frac{1}{2}(1+\cos(2x))$ follows:

$$\boldsymbol{S} = (\boldsymbol{E}_0 \times \boldsymbol{B}_0)\frac{c^2\varepsilon_0}{2}\left(1+\cos\left(2(\boldsymbol{kr} + \omega t)\right)\right) \tag{9}$$

And $|\boldsymbol{E}_0 \times \boldsymbol{B}_0| = |\boldsymbol{E}_0|^2\sqrt{\mu_0\varepsilon_0}\sin(\varphi) = \frac{|\boldsymbol{E}_0|^2}{c}\sin(\varphi)$ with $\varphi = \pi/2$ it is:

$$\boldsymbol{S} = \frac{c\varepsilon_0}{2}|\boldsymbol{E}_0|^2\left(1+\cos\left(2(\boldsymbol{kr} + \omega t)\right)\right)\hat{S} = \frac{|\boldsymbol{E}_0|^2}{2Z_0}\left(1+\cos\left(2(\boldsymbol{kr} + \omega t)\right)\right)\hat{S} \tag{10}$$

This shows that a mean value of the Poynting vector greater than zero is present for nominal EM waves, as expected for nominal power transport in "*K*" direction. If the phase is shifted and the linear propagation is moved to angular movement as shown in the previous chapter during the particle generation φ_{impact} = +π/2 the equation is modified with $\boldsymbol{E} = E_0 \sin\left(\varphi_{\text{zero}} + \omega t\right)$ and leads to the result in tangential (S_t) direction of the circular movement (radial is no propagation possible) if no external movement of the particle is assumed.

$$\begin{aligned} \boldsymbol{S}_{\text{particle}} &= \frac{c\varepsilon_0}{2} E_0^2 \left(\sin\left(\varphi_{\text{zero}} + \omega t\right)\cos\left(\varphi_{\text{zero}} + \omega t\right)\right)\hat{S}_t \\ &= \frac{E_0^2}{2Z_0}\left(\sin\left(2\left(\varphi_{\text{zero}} + \omega t\right)\right)\right)\hat{S}_t \end{aligned} \tag{11}$$

The mean value of the particle EM waves inside the particle is now zero (comparable to near field/reactive behave which doesn't transfer any energy) but the impulse of the EM wave can't disappear so it is assumed that the rotating (DC-)charge must now carry the impulse alone. It is observed that all massive particles have a DC magnetic momentum—not external charge. This implies that there must be a remaining DC current which is carried by the rotating EM charge to be compliant with the law from Ampere & Maxwell.

Note if a hypothetical constant phase shift of π to the mentioned sine wave $\boldsymbol{E} = E_0 \cos\left(\varphi_{\text{zero}} - \omega t + \pi\right)$ or dynamic locally negative impedance because of external fields of Z is assumed, the sign would theoretically introduce a negative $-\vec{\boldsymbol{S}}$. This could be understood as a forced, backward and energy consuming propagation against the nominal propagation direction. E.g. the wave wants to propagate clockwise but is "mechanically" forced to propagate counterclockwise or the wave impedance is modified by strong external fields present in materials [7] [8] [9]. For normal types of EM particle waves this is surely not expected because all these parameters are positive.

So the natural mass is positive for all natural particles because of the squared *E*-Field E_0^2 with spherical field geometry for charged particles

$$E_0 = \frac{e}{4\pi\varepsilon_0}\frac{1}{r^2} \tag{12}$$

and the positive forward-propagation for all EM waves. The Field is assumed as spherical because the observation shows this charge distribution on the surface of the particle [10].

Using the theory of circle movement of the residual DC-charge and EM wave inside of the electron, a constant acceleration of $a = \frac{v^2}{r}$ (*v*: speed, *r*: radius) for the residual DC-charge can be assumed because of elementary physics.

4. The Use of the Fine Structure Constant *α* inside the Electron

The (total) energy of the Electron can be calculated with Coulomb's law, Gauss law and magnetic momentum (refer to Chapter 7 Equation (22) & Chapter 13 for details) and is based here on the calculation of the classical electron radius for the coulomb energy part [11].

$$E_{\text{Total}} = E_{\text{Coulomb}} + E_{\text{Magnetic}} = \frac{e^2}{8\pi\varepsilon_0 r_e} + \frac{e^2 \mu_0 c^2}{8\pi r_e} \quad (13)$$

Because both fields are containing their (half) part of the energy of the electron, they must be included in the model. The energy of the electron must the total energy and must contain electrostatic and magnetic energy. Note that the result is the same as known in the calculation of the classical electron radius, but the approach is different with including the magnetic energy of the particle. It is assumed that the energy is still oscillating between both parts but evenly balanced so that constant measurable values remain like in resonators or oscillators where the energy doesn't disappear too. The electrostatic part of the energy classically is defined as the distance between two charges—both elementary—and leads to the coulomb energy. The charge distribution is chosen as the infinity thin homogeneous charged sphere. The subsequent result is the known self-energy which is compliant with the known result.

$$E_{\text{Total}} = \frac{e^2}{4\pi\varepsilon_0 r_e} = \frac{e^2 \mu_0 c^2}{4\pi r_e} \quad (14)$$

And with the photon energy $E = h\upsilon = \frac{hc}{\lambda}$, r_e = the classical electron radius and $\lambda = 2\pi\tilde{r}$ is the Compton-wavelength and if the photon is transformed into an electron and positron, the energy is equal E_{Total} = E_{photon} and E_{photon} is the energy of the half initial photon. If the photon contains more energy than minimum necessary, the amount above is transferred into the impulse of the generated particles in this theory and not handled further. The Energy can also be obtained by using Chapter 13 where the energy is handled in a comparable way (Quantum Energy Oscillation).

With the radius and energy $\tilde{r} = Xr_e$, $\frac{e^2}{4\pi\varepsilon_0}\frac{1}{r_e} = \frac{hc}{2\pi\tilde{r}} = \frac{\hbar c}{\tilde{r}} = \frac{\hbar c}{Xr_e}$ follows:

$$\frac{e^2}{4\pi\varepsilon_0} = \frac{\hbar c}{X} \leftrightarrow \frac{1}{X} = \frac{e^2}{4\pi\varepsilon_0 \hbar c} = \alpha \quad (15)$$

In summary it is

$$\tilde{r} = \frac{r_e}{\alpha} \text{ or } r_e = \alpha\tilde{r} \quad (16)$$

which represents the Compton radius (see Chapter 2).

Because of the Ehrenfest's paradox we can interpret α as relativistic contraction of the (wave-)length. Note that the Lorentz' contraction also is possible in non-inertial systems like rotation. This result is different to the use of the fine structure constant inside the atom where α represents a different velocity factor w.r.t. the speed of light. The contraction factor alpha will now be used for the following transformation for matching the observed the length outside with the length seen from inside the particle.

5. The Relativistic String Transformation (ST) Rules

The main idea of the transformation is that a known macroscopic equation can be transformed into a quantum equation with modified properties. The reason for that is the assumption that the world of quants is a part of the macroscopic world and only one set of physic rules are present for both. Hints that this is allowed are seen in many macroscopic wave observations like super conductance. The main part of this transformation is the consequent application of the relativistic properties/Lorentz transformation. This can be the compression of the magnetic field which leads to a bigger value in combination with the smaller radius or other points. The main difficulty is that the relativistic transformation is anisotropic and this must be respected in the modification of the quantum equation.

For transforming (electro-)mechanical equations into (lepton) quantum equations will be suggested:

$$v \to c\,,\quad Q_1 = Q_2 = \mp e\,,\quad \boldsymbol{l} \to \hbar$$

And $r \to \tilde{r}$ with $\tilde{r} = \frac{r_e}{\alpha}$ but only if any acceleration is present (tangential, longitudinal moves) otherwise $\tilde{r} \to r_e$ (radial, orthogonal moves). This is caused by the anisotropy of the relativity theory (Ehrenfest, Lorentz/length contraction). This handling is very important and must be done carefully because of the anisotropy of the relativistic contraction! The next chapter shows the differences in handling in an example to get the right result.

The baseline of this (string) transformation is that (gamma-)photons contain exactly one full wave period with one positive and one negative half wave (=open string, resonance length before compression) and the phase difference between electrical and magnetically field is responsible for the condensation of nominal (Maxwell) EM waves into a particle (=closed string, circle, resonance length after compression). The phase shift between the magnetic and the electric field "bends" the EM wave to a circle. Otherwise if there is no phase shift, the propagation must be nominal forward.

The speed of the particle EM wave is still (close to) the speed of light and the radius must be corrected because of the fact that the acceleration is relativistic. So it can be understood that the charge radius (assumed that a radius can be defined for an electromagnetic field) represents the "real" or scatter radius but the wave still "feels itself" like the original photon because of the length contraction. If this is not respected, all calculations will fail.

Further the accelerated charge after the split in positive and negative charge is responsible for generating the mass which it will be shown later.

6. The Planck' Constant *h* and the Mass-Radius Relation

Because of the results from Chapter 3, the EM circle movement inside the electron, it can be calculated with the classical approach and the ST transformation afterwards.

Coulomb force (assumed: the particle forces itself, so $Q_1 = Q_2 = Q$)

$F_c = \frac{1}{4\pi\varepsilon_0}\frac{Q_1 Q_2}{r^2}$, centripetal force $F_z = \frac{mv^2}{r} = m\omega^2 r$ and $\omega = vr$.

When $F_c = F_z$ and using the S-T rules ($F_z : \tilde{r} \to r_e$ because of radial force)

$$\frac{mc^2}{r} = \frac{e^2}{4\pi\varepsilon_0 r^2} \leftrightarrow m\tilde{r} = \frac{e^2}{4\pi\varepsilon_0 c^2} \leftrightarrow mr_e = \frac{e^2}{4\pi\varepsilon_0 c^2} \tag{17}$$

This is the mass-radius relation which is obviously constant for all particles with rotating charge. This relation is very useful for calculation of the expected lepton radius (and the radius of all black hole singularities, as we will see later).

Now for the angular moment it is $\boldsymbol{l} = m\boldsymbol{r} \times \boldsymbol{v}$ thus $|\boldsymbol{l}| = mrv\sin(\Xi)$ and if Ξ = π/2 then (with ST-transformation and tangential application $\tilde{r} = \frac{r_e}{\alpha}$) $\hbar = m\tilde{r}c = mr_e\frac{c}{\alpha}$ and this leads to

$$\hbar = \frac{e^2}{4\pi\varepsilon_0 c}\frac{1}{\alpha} \tag{18}$$

or

$$\alpha = \frac{e^2}{2\varepsilon_0 ch} \tag{19}$$

This result is the expected equation of the Planck constant.

7. The Natural Magnetic Moment of the Free Particle

If it is assumed that the particle is not trapped and no kind of field is present then the current can be defined classical as $I = \frac{q}{T} = \frac{qv}{2\pi r}$ because $T = \frac{2\pi r}{v}$ and with ST it can be written:

With $B = \frac{\mu_0}{2r}I$ and $r = r_e$ it follows:

$$B = \frac{\mu_0}{2r}\frac{(-e)c}{2\pi r_e}\alpha = \frac{\mu_0(-e)c}{4\pi r_e^2}\alpha = -\frac{\mu_0}{\varepsilon_0}\frac{e^3}{8\pi h r_e^2} \tag{20}$$

And for the magnetic momentum (Bohr's magnet on) we can show with the (Compton-)area of the EM wave

$$\tilde{A} = \pi\tilde{r}^2 = \frac{\pi r_e^2}{\alpha^2} \text{ that the equation is } \mu = I\tilde{A} = \frac{(-e)c}{2\pi r_e}\alpha\frac{\pi r_e^2}{\alpha^2} = -\frac{ecr_e}{2\alpha} \tag{21}$$

These results are comparable to other calculations in this journal and can confirm them [1]. The energy is calculated with $E_\mu = \mu B$ so that follows

$$E_\mu = -\frac{ecr_e}{2\alpha}\frac{\mu_0(-e)c}{4\pi r_e^2}\alpha = \frac{e^2\mu_0}{8\pi r_e}c^2 \tag{22}$$

Note that by comparing to the well-known formula from Einstein $E = mc^2$ the result is that the mass is formed as follows [12].

$$E_{\text{Total}} = \frac{e^2\mu_0}{4\pi r_e}c^2 = mc^2 \tag{23}$$

or

$$m_e = \frac{e^2\mu_0}{4\pi r_e} = \frac{e^2\mu_0}{2\lambda_c\alpha} \tag{24}$$

(λ_c: Compton wavelength of the electron). The result is based on the assumption that the current is made from the pure charge which is rotating inside and this charge is one of these two charges generated from the split during the pairing process. This charge is purely EM. So we can see e.g. at the electron that the charge is the obviously "visible" aspect of this, but the magnetic momentum must not be neglected to get the whole access.

In addition, if all known properties are looked at, there is an alternative view to Einstein's formula. Note that Einstein didn't perform a calculation inside of the particle. In his original article he accumulated energy from an external field. So the question is how the calculation can be done from a view inside the electron.

Note that any applied B-Field to the particle causes a shift in the size of Compton area and this is found in the Landé-factor [13]. The additional magnetic field concentrates because of the high μ_r in the particle. Further calculations are necessary to get more access and should be found around the theory of flux vortices in superconductors. This is because the not decaying magnetic momentum of the electron (and all other massive particles) delivers the obviously fact to be a superconductor because of the constant current inside.

8. Alternative Calculation of the Particle Mass

If the matter consists of EM waves and the charge from the generation process rotates, this can be used as base for the mechanical approach to get visibility to the mass under ST transformation aspects.

8.1. The Rotating Photon Impulse

With the knowledge of Chapter 3 (Poynting vector) the rotation of a charge in a ring is the main process because the EM wave inside the electron performs a circle movement [14].

With $F = \frac{\mathrm{d}p}{\mathrm{d}t}$ and $p = mv$ it is

$$F = m\frac{\mathrm{d}v}{\mathrm{d}t} + v\frac{\mathrm{d}m}{\mathrm{d}t} \tag{25}$$

and the prediction that the mass inside the electron is constant it follows: $F = m\frac{\mathrm{d}v}{\mathrm{d}t} = ma = m\frac{v^2}{r} = \frac{\mathrm{d}p}{\mathrm{d}t}$.

With the ST transformation for the acceleration it is

$$a = \frac{c^2}{\tilde{r}} = \alpha\frac{c^2}{r_e} \tag{26}$$

(refer also to Ehrenfest's theorem). Further it is

$$p_0 = \frac{E}{c} = \frac{h\upsilon}{c} \tag{27}$$

and $\boldsymbol{p} = \begin{pmatrix} p_x \\ p_y \end{pmatrix} = p_0\begin{pmatrix} -\sin\varphi \\ \cos\varphi \end{pmatrix}$. Then

$$\frac{\mathrm{d}\boldsymbol{p}}{\mathrm{d}t} = \begin{pmatrix} -\sin\varphi \\ \cos\varphi \end{pmatrix} \frac{\mathrm{d}p_0}{\mathrm{d}t} + \omega p_0 \begin{pmatrix} -\cos\varphi \\ -\sin\varphi \end{pmatrix}$$

and

$$m = \frac{1}{a}\frac{\mathrm{d}p}{\mathrm{d}t} = \frac{1}{a}\omega p_0 \begin{pmatrix} -\cos\varphi \\ -\sin\varphi \end{pmatrix} \tag{28}$$

where $\left|\begin{pmatrix} -\cos\varphi \\ -\sin\varphi \end{pmatrix}\right| = 1;\ \ \varphi = \omega t$

And then the result is

$$m = \frac{r_e}{\alpha c^2}\frac{E}{\hbar}\frac{E}{c} = \frac{1}{c^2}\frac{E^2 r_e}{\alpha c\hbar} \tag{29}$$

Otherwise note that it can be said with $\frac{E}{c^2} = m$ that the energy of the Electron is $E = \frac{\alpha c\hbar}{r_e}$ and the Compton radius is

$$r_c = \frac{\alpha c\hbar}{E} \tag{30}.$$

In other words—the product of Energy and particle radius is constant.

Alternatively it can be assumed that the mass is a (relativistic) impulse interaction between the electromagnetic impulse (represented by the rotating charge) and the properties of the empty space. This leads to the idea that the (EM-)mass can be written in another way (refer to Chapter 3):

The Poynting-vector can be understood as density of the impulse multiplied with the squared speed of light or impulse per volume multiplied by squared speed of light.

$$\left[\mathrm{N}\cdot\mathrm{s}/\mathrm{m}^3\cdot\mathrm{m}^2/\mathrm{s}^2 = \mathrm{N}/\mathrm{m}\cdot\mathrm{s} = \mathrm{W}/\mathrm{m}^2\right]$$

So the idea is to integrate the EM impulse over the volume of the particle. With knowing the relativistic particle charge-volume V of the (circulating) EM wave, the mass can be calculated by transformation then.

$|\boldsymbol{S}| = \frac{pc^2}{V} \Leftrightarrow p = \frac{|\boldsymbol{S}|V}{c^2}$ and for the relativistic impulse

$p = mv \Leftrightarrow m = \frac{p}{v} \xrightarrow{ST} m = \frac{p}{c}$ which is compliant to the specific relativity theory we get for the mass:

$$m = \frac{|\boldsymbol{S}|}{c^3}V \tag{31}$$

or

$$m = \left|\frac{1}{c^3}\int \boldsymbol{S}\mathrm{d}V\right| \tag{32}$$

This equation delivers the idea how circulating EM impulses can show massive behavior without being any particle (matter free mass).

By applying

$$E = mc^2 = \frac{|\boldsymbol{S}|}{c}V = \left|\frac{1}{c}\int \boldsymbol{S}\mathrm{d}V\right| \tag{33}$$

we get the matter free (dark) energy [15].

8.2. Alternative View to the Speed of Light Equation

Motivation: If the known equation

$$\mu_0 \varepsilon_0 = \frac{1}{c^2} \tag{34}$$

is taken, from the SI units' starting it follows

$\varepsilon_0 : [\text{A} \cdot \text{s/V} \cdot \text{m}]$ and $\mu_0 : [\text{N/A}^2] = [\text{kg} \cdot \text{m/A}^2 \cdot \text{s}^2]$ and in combination.

$\mu_0 \varepsilon_0 : [\text{kg} \cdot \text{m/A}^2 \cdot \text{s}^2 \cdot \text{A} \cdot \text{s/V} \cdot \text{m} = \text{kg/V} \cdot \text{A} \cdot \text{s} = \text{kg/J}]$. So for the formula's units it can be understood alternatively that $\text{kg/J} = \text{s}^2/\text{m}^2$ and this leads to the assumption that this equation is a representation of $E = mv^2$ with $v =$ speed too. And if the parts of the mass equation are known, this can be mathematically expressed.

With

$$E_{el} = \frac{e^2}{4\pi r_e} \frac{1}{\varepsilon_0} \overset{\mu_0\varepsilon_0 = \frac{1}{c^2}}{\leftrightarrow} \frac{e^2}{4\pi r_e} \mu_0 c^2 \triangleq mc^2 \tag{35}$$

and the (particle) vortex constant

$$\tau_V = \frac{e^2}{4\pi r_e} [\text{A}^2 \cdot \text{s}^2/\text{m}] \tag{36}$$

it can be expressed as

$$\tau_V = \frac{m_{\text{particle}}}{\mu_0} = \varepsilon_0 E_{\text{particle}} \tag{37}$$

So it also can be interpreted that the origin of mass (gravity) is charge in a vortex with a small radius and a high rotating speed ($\sim c$). Further the result is that the lower the radius, the higher the mass of the particle. The electric permittivity and the magnetic permeability are the conveyers between the properties to the charge.

It would be interesting to know whether the expression

$$\tau_V = \frac{q^2}{4\pi r_{\text{rotation}}} \tag{38}$$

scales to the amount of the charge and radius. Because if there are two separated charges present as it is found in the positronium system, the theory could be used if a correction factor is inserted [16] [17]. The radius equation can be modified by the charge ratio e/q and it is

$$r_{eff} = \frac{e}{q} \frac{\alpha c \hbar}{E} \tag{39}$$

Using the right binding energy of 6.8 eV, the radius (105.9 pm) matches to Bohr's formula

$$r_c = \frac{n^2 4\pi \varepsilon_0 \hbar^2}{\mu e^2} \tag{40}$$

with the effective mass

$$\mu = \frac{m_e m_{pos}}{m_e + m_{pos}} = \frac{m_e}{2} \tag{41}$$

m_{pos} is the mass of the positron.

8.3. EM Mass & EM Energy

Because of the results in chapter 8.1 it is suggested to enhance the known energy equation of the special relativity theory to:

$$E = \sqrt{(pc)^2 + (mc^2)^2 + \left(\frac{1}{c}\int \mathbf{S}\mathrm{d}V\right)^2} \tag{42}$$

And with the EM mass $m = \frac{1}{c^3}\int \mathbf{S}\mathrm{d}V$ as discussed before, there is an indication that the theory of gravity must be augmented by the EM-energy-mass as well. If no additional EM Energy is present, the result is the well-known relativistic Energy equation. In principle all three terms are representing the energy carried by an relativistic impulse.

The EM mass does not require any representation of a particle—only the presence of (circulating) EM energy can explain this (e.g. rotating charge, virtual rotating charge). Respective the normal matter is a vortex representation of a highly rotating charge. So the presence of EM mass could be an explanation of (a kind of) dark matter because this EM mass needs no direct presence of matter to be massive.

In principle the integral is only a consequent result that the electromagnetic impulse which is carried by an EM wave also can be included by integration over the whole wave (only one wave period). So impulses are consequently found in the augmented version only.

The base of this theory is that the core of all matter (normal, strange, anti- and dark) is electromagnetic (trapped photons) and this must be reflected in handling this in the specific relativity theory. The energy content is positive in all cases of matter.

Figure 4 illustrates the different types of matter. Each type has different properties but all are EM waves. Dark Matter is represented by pure EM charged loop current and Strange Matter is based on charge free EM waves with inner oscillation and its resulting mass oscillation. Normal Matter and Dark Matter are stabilized by the inner charge movement and inner oscillations are suppressed mostly because of that.

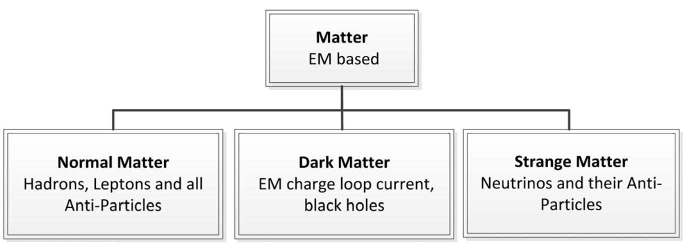

Figure 4. Types of matter.

Note that this classification does not affect the standard model because the standard model is based on other preferences and not on the presence of EM waves and the resulting mass.

9. Particle Properties under EM View

9.1. The (Charge) Volume of the Electron (Particle)

With knowing the EM mass and the carrier of the impulse, and the *E*-Field, the equation of the mass is (refer to Chapter 8.1):

$$m=\frac{1}{c^3}\frac{c\varepsilon_0}{2}\left(\frac{e}{4\pi\varepsilon_0}\frac{1}{r^2}\right)^2 V \tag{43}$$

$m=\frac{|\boldsymbol{S}|}{c^3}V$ with $|\boldsymbol{S}|=\frac{c\varepsilon_0}{2}E_0^2$ and $E_0=\frac{e}{4\pi\varepsilon_0}\frac{1}{r^2}$.

Then it must be:

$$m=\frac{c}{c^3}\frac{e^2}{2\pi^2 4^2\varepsilon_0 r^4}V \overset{!}{\Leftrightarrow} m_{\text{theor}}=\frac{e^2}{4\pi rc^2\varepsilon_0} \tag{44}$$

and if $V=2\pi 4r^3$ this would be fulfilled. Note that the volume of the sphere is $V_s=\frac{4}{3}\pi r^3$ and this is too small. An alternative interpretation is to assume to have a torus $V_T=2\pi R\pi r_x^2$ with the ratio $r_x^2=\pi\frac{4}{\pi}ab$ (and $a=\frac{4}{\pi}r_e$ and $b=r_e$ and $R=r_e$) which is the area of an ellipse shown in **Figure 5**.

Note that it is expected because of the anisotropy of the Lorentz transformation, the torus is not a classical torus and the ellipse is also an idealized assumption and requires deeper investigation later.

If the electron is assumed to have a negative impulse—generated by the previous described process, the mass could be negative and it could be written theoretically [18]:

$$m=\frac{(-1)|\boldsymbol{S}|}{c^3}V=-\frac{e^2}{4\pi rc^2\varepsilon_0} \tag{45}$$

It would be interesting to see if it is possible to perform such a measurement which provides a negative impulse and positive propagation. This process seems not to be initiated by all types of natural matter.

By taking the mass equation, the following experimental setup in **Figure 6** will be suggested to produce additional (positive) mass (or gravity). It also is possible

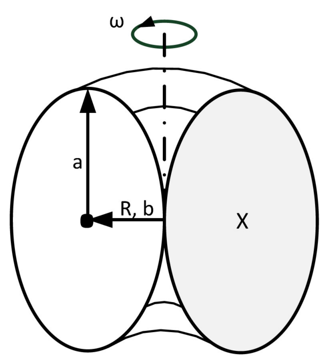

Figure 5. Cross-section & shape of the EM-charge-Impulse electron volume.

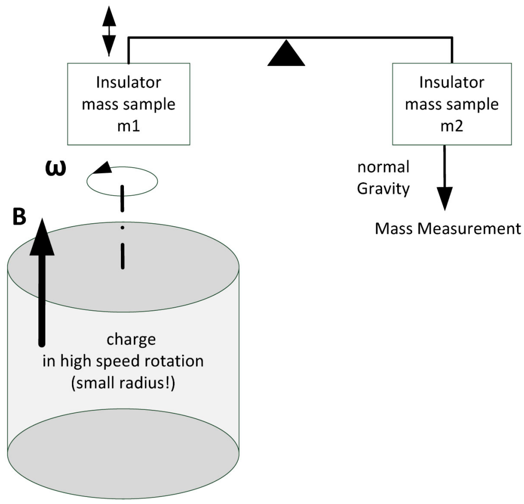

Figure 6. Suggested experimental setup for generating EM mass.

to mount the setup on a scale and track the mass while the parameters (e.g. rot. speed, voltage and *B*-Field) are stepped through. In the past any experiments with comparable setup were performed. But the lack of charge could be an explanation for the observed very small effect [7]. A better description of the used setup was found in [8].

Because of the fact that the electron consists of an enclosed EM wave which also can be interpreted as "reflected" between the inside and the outside of the particle, the Goos-Haenchen-Effect shows that there is a larger "radius" where the evanescence field is still present [19]. This is also responsible for the tunneling properties. So the classical radius represents only half of the true presence of the electron.

Further it is assumed that the position of the charge is reducible (as mean value) to the radius *R*—but is distributed over the volume because the EM wave is distributed in the space.

Note that the amount of the magnetic volume is much bigger because of the present magnetic moment and the distribution of the field into the surrounding space.

This seems to be the reason that the properties of the generation of mass and other effects are dominated by the charge. Further this could be a reason for the instability of other leptons.

Note that inside the EM volume only one EM wave can exist because of the presence of the (E/B) fields (fermions).

9.2. Additional Properties of the Electron (Particle)

9.2.1. Momentum of Inertia

Using the ST-transformation, the momentum of inertia can be taken from the known equation

$$J_z = mr^2 \xrightarrow{ST} J_{ez} = m_e \tilde{r}^2 = m_e \left(\frac{r_e}{\alpha}\right)^2 \tag{46}$$

and with $L = J\omega = m_e\left(\frac{r_e}{\alpha}\right)^2 \frac{E}{\hbar} = \hbar$ the Planck constant is retrieved again.

For other moments, the transformation is comparable

$$J_{x,y} = \frac{1}{2}mr^2 \xrightarrow{ST} J_{ex,y} = \frac{1}{2}m_e\tilde{r}^2 = \frac{1}{2}m_e\left(\frac{r_e}{\alpha}\right)^2 \tag{47}$$

9.2.2. *E*/*H* Ratio of the Particle (Z_p)

The known free space resistance for EM waves (Z_0) leads to the idea that the E and the H field inside the particle must have a special ratio too. So with the known equations (E and H field) the ratio can be calculated ($H = B/\mu_0$).

$$Z_p = \frac{E_0}{|H|} = \frac{e}{4\pi\varepsilon_0 r_e^2}\frac{8\pi\varepsilon_0 r_e^2 h}{e^3\mu_0}\mu_0 = \frac{2h}{e^2} \tag{48}$$

This result is interesting because this is twice the "von Klitzing constant" and has 51625.6 Ω and the flux in a superconductor is quantized [20]. If it can be assumed that the inner EM charge current in the electron also can be understood as a superconductor because the spin of the charge is not damped by anything. This leads to the assumption that the flux also must be quantized.

The flux is

$$\varnothing = B\tilde{A} = \frac{e^3}{8\pi h r_e^2}\frac{\mu_0}{\varepsilon_0}\frac{\pi r_e^2}{\alpha^2} = \frac{e^3\mu_0}{8h\varepsilon_0\alpha^2} = \frac{h}{2e} \tag{49}$$

And the value is 2.067833846E−15 Vs and is the elementary flux quantum for the particle.

This flux is the same for all leptons. Note that in the way the B field gets higher, the (Compton-)area thus becomes lower.

Further the fine structure constant α seems to be a matching parameter between the free space impedance (from where the photon comes) and the charge vortex constraint of the superconductor inside the particle.

$$\alpha = \frac{e^2}{2h}Z_0 = \frac{Z_0}{Z_p} = \frac{e^2}{2h}\sqrt{\frac{\mu_0}{\varepsilon_0}} \tag{50}$$

9.2.3. The Particle Radius Quantization

The calculation of r_e which can explain the stability condition from the base constants is based on Bohr's radius and leads together with the reduced mass (equal distributed mass on a ring inside the particle to balance the momentum $m_1 = m_2 = m$) $\mu = 1/2m_e$ to the result [21]. The moving charge inside a particle cannot, as it is also in the model of Bor's radius, radiate energy. This leads to a quantization condition comparable. The only difference is that the counter charge is missing.

$$E = \frac{Z^2e^4}{4\pi^2\varepsilon_0^2\hbar^2}\frac{\mu c^2}{c^2 8n^2} = \left(\frac{e^2}{4\pi\varepsilon_0\hbar c}\right)^2\frac{c^2}{2n^2}\mu = \frac{\alpha^2 Z^2}{4n^2}m_e c^2 \tag{51}$$

If $Z = 1$ (one charge inside) and with $E = c^2 m_e$. It must be $\frac{\alpha^2}{4n^2} = 1$ and this is fulfilled with

$$\frac{\alpha}{2} = n \tag{52}$$

So it seems that inside the particle the condition is related to alpha. This shows that the relativistic length contraction plays an important role in all properties and the value is not surprising because of the result from chapter 9.2.2 where it was shown that the E/H particle ratio is in a defined condition to the E/H free space ratio (Equation (48) & (50)). This must be reflected in the radius size! Refer also to Chapter 8.2 and Equation (40) + (41).

9.2.4. EM Electron (Particle) Loop Inductance

Further for the loop current the inductance can be calculated to

$$L_e = \frac{\varnothing}{I} = \frac{h}{2e}\frac{4\pi\varepsilon_0 h r_e}{e^3} = \frac{2\pi\varepsilon_0 h^2 r_e}{e^4} \approx 1.05\times10^{-16}\,H \tag{53}$$

Under the assumption that the inductance is a short ring it is ([22], page 453):

$$L_e = \frac{2\pi\varepsilon_0 h^2 r_e}{e^4} \triangleq \frac{\mu_0 AF}{l} \xrightarrow{ST} \frac{\mu_0 \pi r_e^2 F}{\alpha^2 l} = \frac{2\pi h^2 \varepsilon_0 r_e^2 F}{e^4 l} \tag{54}$$

So $\frac{F}{l} = \frac{1}{2r_e}$ and this can be interpreted as a ring with a height $l = 2$ re and the following properties in **Figure 7**. It is assumed that the current distribution follows the outer shape of the cross section (shown in **Figure 5**) and this would cause a longer length l. Note the expected length from Chapter 9.1 is $l \geq 2\frac{4}{\pi}r_e \approx 2r_e$.

The Equation (54) also can be understood as [23]:

$$L_e = \mu_r\mu_0 N^2\frac{A}{2\pi r} = \mu_r\mu_0\frac{r}{2} \triangleq \frac{\pi}{\alpha^2}\mu_0\frac{r_e}{2} \quad \text{and} \quad \frac{\pi}{\alpha^2} = \mu_r \approx 59000$$

N = turns = 1; A = Area of circle.

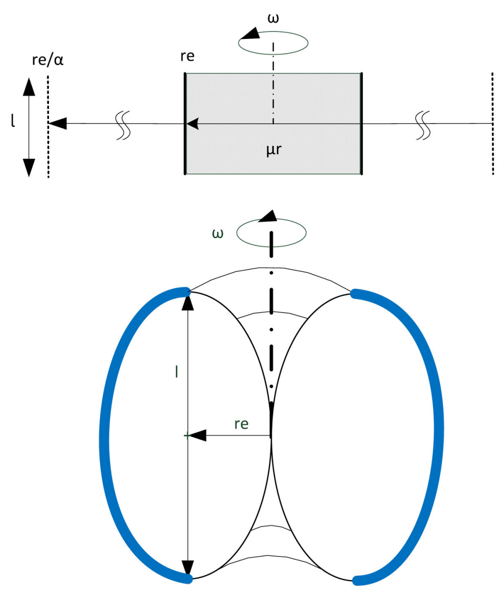

Figure 7. Cross-section for the current distribution.

The huge μ_r forces all the magnetic field to stay inside the electron and to be parallel. The magnetic field is compressed by the Lorentz contraction of the original wave length (radius r_e/α) and the strength is increased because of the relativistic area reduction effect and the contracted radius (r_e).

All of these results are from the type of normal matter, but as well known, the universe seems to consist of more than this normal matter.

10. The Neutrino

An also known type is the neutrino which is from the type of "strange" matter because it obviously violates the $E = mc^2$ condition—it oscillates in its own mass without any interaction to other matter. In this chapter this particle will be handled in principle. Because of missing data like radius, magnetic momentum and other properties the particle can't be handled like the other objects and there are still remaining questions. This theory delivers an EM-wave based explanation for the sinusoidal mass oscillation [24].

Based on the previous discussion, there are aspects which can be transferred to other types of matter—e.g. the neutrino (and other particles later). To get an access to the neutrino (**Figure 8**), a radiation process from an electron-positron interaction (with a W-Boson) can be taken.

$$e^- + e^+ \xrightarrow{W} \bar{\upsilon} + \upsilon \tag{55}$$

This (very rare) process gives the idea how to use and modify the now known wave functions from Chapter 2 (7) (8) and charge interaction [3].

$$\begin{aligned} &\frac{1}{2}\begin{pmatrix} -E_y + E_y \sin(2\omega t) \\ B_x \cos(2\omega t) \end{pmatrix} + \frac{1}{2}\begin{pmatrix} E_y - E_y \sin(2\omega t) \\ B_x \cos(2\omega t) \end{pmatrix} \\ &\xrightarrow{W} \frac{1}{2}\begin{pmatrix} +E_y \sin(2\omega t) \\ B_x \cos(2\omega t) \end{pmatrix} + \frac{1}{2}\begin{pmatrix} -E_y \sin(2\omega t) \\ B_x \cos(2\omega t) \end{pmatrix} \end{aligned} \tag{56}$$

Now, after the partial annihilation of the particles, it follows:

$$\boldsymbol{S} = \frac{c\varepsilon_0}{2} E_0^2 \left(\sin\left(2\left(\varphi_{\text{zero}} + \omega t\right)\right)\right)\hat{S} = \frac{E_0^2}{2Z_0}\left(\sin\left(2\left(\varphi_{\text{zero}} + \omega t\right)\right)\right)\hat{S} \tag{57}$$

This shows that there is a mean value of 0 over one cycle. If the neutrino is generated (e.g. by a deployment in a nuclear transformation) and a remaining

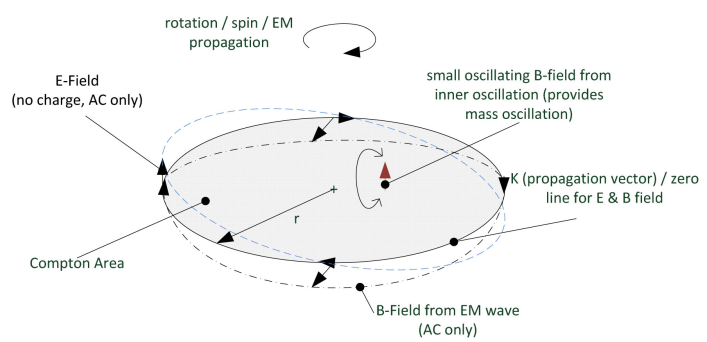

Figure 8. EM anatomy of the neutrino.

impulse oscillation at the E-Field is present, then the frequency is slightly oscillating internally with a frequency offset $\delta \ll \omega$, $\omega_x = \omega_0 + \delta$ and this leads to the result:

$$\begin{aligned} \boldsymbol{S} &= \frac{c\varepsilon_0}{2} E_0^2 \left(\sin\left(\varphi_{\text{zero}} + \omega t\right)\cos\left(\varphi_{\text{zero}} + \omega t\right)\right)\hat{S} = \cdots \\ &= \frac{c\varepsilon_0}{2} E_0^2 \left(\sin\left(\delta t\right) + \sin\left(2\left(\varphi_{\text{zero}} + \omega t\right) + \delta t\right)\right)\hat{S} \\ &\approx \frac{c\varepsilon_0}{2} E_0^2 \left(\sin\left(\delta t\right) + \sin\left(2\left(\varphi_{\text{zero}} + \omega t\right)\right)\right) \end{aligned} \tag{58}$$

This can be assumed as an internal oscillation and in addition, this can be interpreted as an oscillating mass of the particle. The oscillation can occur because no stabilizing angular momentum of a permanent charge is present. Further it is assumed that the oscillation is introduced by the generation of the particle. The now known EM-Mass can be used to explain the mass oscillation e.g.

$$m = \frac{1}{2c^2} \frac{e^2}{4^2 \pi^2 \varepsilon_0} \frac{1}{r^4} \left(\sin\left(\delta t\right) + \sin\left(2\left(\varphi_{\text{zero}} + \omega t\right)\right)\right) V_\upsilon \tag{59}$$

where V_ν is the EM-impulse-volume and r the radius of the neutrino. Further it will be assumed that the radius is comparable to the electron radius (because of the initial generation process by charge transfer between electron and positron). So the volume could be comparable to the electron volume. And then for the mean value m would remain:

$$m = \frac{e^2}{c^2 4\pi\varepsilon_0 r_e} \sin\left(\delta t\right) = m_e \sin\left(\delta t\right) \tag{60}$$

This shows that the long-time mean value of the neutrino mass is zero although the short term value differs in a sinusoidal oscillation.

Because of missing data, it is also possible that the mass is ~$\sin^2(\delta t)$ and the mass would oscillate between zero and it's max value (this is more expected because of actual research) [24]. The volume V_ν also could be smaller because of unknown effects and the effective mass is affected. So this chapter must also be understood as a baseline for further investigations and for guidelines for deeper investigation and research.

The class of neutrinos will be called "strange" matter here because there is only virtually rotating charge caused by inner oscillation. Theoretical it is possible to get particles without any mass because of the absence of any inner oscillation. These objects would be hard to find because of the extremely weak interaction to other types of matter.

It would interesting to know if the neutrino itself can generate mass by sticking together and separating the charges [22].

11. The Myon

Based on the previous calculations the discussed equations can be extrapolated for the myon and therefore the particle-magnetic-momentum μ_μ must be defined.

Because of the measurement process of the myon, it is mainly measured in a trap—this is a non-free configuration [13]. This article calculates only free particles—so the Lande' factor can't be applied and this caused the introduction of the extra momentum μ_μ (applicable for other particles too)

$$\mu_\mu = \frac{e\hbar\lambda_{c\mu}}{4\pi} = \frac{ec\tilde{r}_\mu}{2} = \frac{ec^2 h}{4\pi E_\mu} = \frac{eh}{4\pi\mu_0 E_\mu \varepsilon_0} \tag{61}$$

Further there are the radius mass and the radius magnetic moment relation

$$r_\mu = r_e \frac{m_e}{m_\mu} \tag{62}$$

and

$$\mu_\mu = \mu_B \frac{m_e}{m_\mu} \tag{63}$$

The other equations and ratios are fully transferable without modifications.

12. The Properties of the Electron (Leptons)-Compact

Mass: $m_e = \frac{e\hbar}{2\mu_B} = \frac{h}{c\lambda_c} = \frac{\hbar}{\tilde{r}c} = \frac{e^2\mu_0}{4\pi\alpha\tilde{r}_e} = \frac{e^2\mu_0}{4\pi r_e} = \frac{e^2\mu_0}{2\alpha\lambda_c} = \left|\frac{1}{c^3}\int \boldsymbol{S}\mathrm{d}V\right|$ (64)

Relativistic length shortening: $\alpha = \frac{e^2}{2h}\sqrt{\frac{\mu_0}{\varepsilon_0}} = \frac{Z_0}{Z_P} \approx \frac{1}{137}$ (65)

Inner charge current: $I = -\frac{ec}{\lambda_c} = \frac{(-e)c}{2\pi r_e}\alpha = -\frac{e^3}{4\pi\varepsilon_0 h r_e}$ (66)

The magnetic field: $B = -\frac{E_e}{\mu_B} = -\frac{e^3}{8\pi h r_e^2}\frac{\mu_0}{\varepsilon_0}$ (67)

The electrical field: $E_0 = \frac{e}{4\pi\varepsilon_0}\frac{1}{r^2}$ (68)

Magnetic moment: $\mu_B = \frac{-ecr_e}{2\alpha} = -\frac{hr_e}{e\mu_0}$ (69)

Vortex-Constants: $mr_e = \frac{e^2\mu_0}{4\pi}$, $\tau_V = \frac{e^2}{4\pi r_e}\{1\}$ (70) (71)

Moment of inertia: $J_z = m_e\left(\frac{r_e}{\alpha}\right)^2$ and $J_{x,y} = \frac{1}{2}m_e\left(\frac{r_e}{\alpha}\right)^2$ (72) (73)

Compton wavelength: $\lambda_c = 2\pi\tilde{r}_e$ (74)

Compton radius: $\tilde{r} = \frac{r_e}{\alpha}$ (75)

Time domain wave function: $\frac{1}{2}E_0\begin{pmatrix} -1+\sin(\omega t) \\ \sqrt{\varepsilon_0\mu_0}\cos(\omega t)\end{pmatrix} = e^-$ (76)

Energy radius equation: $E = \frac{\alpha c\hbar}{r_e}$ (77)

The quantum of the electron: $\frac{E_0}{|B|} = \frac{2h}{e^2} = Z_P$ and $\varnothing = B\tilde{A} = \frac{h}{2e}$ (78) (79)

$E = \alpha^2\frac{c^2}{4n^2}m_e$ with $\frac{\alpha}{2} = n$ (80) (81)

$$\text{Energy:}\quad E_{el} = \frac{e^2}{4\pi r_e}\frac{1}{\varepsilon_0} = \frac{e^2}{4\pi r_e}\mu_0 c^2 = mc^2 = \hbar\omega \tag{82}$$

13. The Quantum Energy Oscillation

If the free photon is propagating, the energy and the corresponding impulse (represented by $E = \hbar\omega$) are transferred between E- and B-Field (by using the free space impedance Z_0). But if the particle is generated, some unexpected results occur. If the energy is a constant, the energy must still be transferred forward inside the particle—but it is not a free space anymore and indeed this is reflected in with the particle impedance Z_P and a rotation inside. When the calculation for the magnetic energy and the electric energy is done, they must carry the energy of the inner wave. Especially if it is assumed that the EM wave is still present. The particle can't be static with EM waves inside! So the assumption is that the energy is comparable to the Maxwell's energy calculation [25]. Note that the inner "-" of the trigonometric function shows a spin into the opposite direction as handled in the chapters before but can be chosen arbitrary and the sign must be handled correctly.

$$\boldsymbol{E} = -\omega\frac{e^2}{4\pi\alpha}\begin{pmatrix} -\frac{1}{c\varepsilon_0}\cos\left(\varphi_{\text{zero}} - \omega t\right) \\ -c\mu_0\sin\left(\varphi_{\text{zero}} - \omega t\right) \end{pmatrix} = \omega\frac{e^2}{4\pi\alpha}\begin{pmatrix} -Z_0\cos\left(\varphi_{\text{zero}} - \omega t\right) \\ Z_0\sin\left(\varphi_{\text{zero}} - \omega t\right) \end{pmatrix} \tag{83}$$

And the length is (Pythagoras)

$$\begin{aligned} \left|E_{\text{Particle}}\right| &= \omega\frac{e^2}{4\pi}\frac{Z_0}{\alpha}\left|\begin{matrix}\cos\left(\varphi_{\text{zero}} - \omega t\right) \\ \sin\left(\varphi_{\text{zero}} - \omega t\right)\end{matrix}\right| = \omega\frac{e^2}{4\pi}Z_P\left|\begin{matrix}\cos\left(\varphi_{\text{zero}} - \omega t\right) \\ \sin\left(\varphi_{\text{zero}} - \omega t\right)\end{matrix}\right| \\ &= \omega\frac{e^2}{4\pi}\frac{Z_0}{\alpha}\sqrt{\sin^2\left(\varphi_{\text{zero}} - \omega t\right) + \cos^2\left(\varphi_{\text{zero}} - \omega t\right)} = \hbar\omega \end{aligned} \tag{84}$$

Because the energy is calculated from the Action with

$$E = \frac{\mathrm{d}\tilde{W}}{\mathrm{d}t} = \hbar\omega \quad \text{it is with} \quad \omega = 2\pi f = \frac{c\alpha}{r} = \frac{c}{\tilde{r}}$$

$$\tilde{W} = \frac{e^2}{4\pi\alpha}\begin{pmatrix} -\frac{1}{c\varepsilon_0}\sin\left(\varphi_{\text{zero}} - \omega t\right) \\ c\mu_0\cos\left(\varphi_{\text{zero}} - \omega t\right) \end{pmatrix} \tag{85}$$

This chapter was included because the expected symmetry in the energy leads to this equation. In this theory the particle has equally distributed energy in all of its parts, so the inner rotation must be reflected (the particle only exists in its movement of the EM waves because of the presence of the time in the particle Equation (7) and (8)).

14. Comparing the Theory with CODATA and Other Measurements

To prove the theory, the analytical equations can be used for checking with real measurements and in addition predictions can be done.

14.1. The Base Constants

The following table shows the values for the used constants for performing the calculations. The fundamental necessary constants are not exchangeable for this theory. The other constants are useful for better handling and understanding the formulas. The equations with the selected entry value are taken from Chapter 12. With the Energy-Radius Equation (77) the entry parameter can be changed. All formulas are in an analytical type with SI base units [26] [27] [28].

Elementary constants for all calculations:

$h = 6.62607015 \times 10^{-34}$ Js

$e = 1.602176634 \times 10^{-19}$ AS

$\varepsilon_0 = 8.8541878128\ (13) \times 10^{-12}$ (As)/(Vm)

$\mu_0 = 1.25663706212\ (19) \times 10^{-6}$ (Vs)/(Am)

Useful constants—for easy handling, not necessary for calculation:

$c = 299{,}792{,}458$ m/s

$\alpha = 7.2973525693\ (11) \times 10^{-3}$

$\hbar = 1.054571818 \times 10^{-34}$ Js

$Z_0 = 376.730313668\ (57)$ V/A

Origin: CODATA [28]—from 22/11/2019

Geometric necessary:

$\pi = 3.141592653589793238462643383279502 88$

All calculations are performed with a usual table calculation program with using the mentioned formulas and fundamental constants.

14.2. The Properties of the Electron—With CODATA Values

CODATA	calculated
$m_e = 9.1093837015\ (28) \times 10^{-31}$ kg	$9.1093837014873 \times 10^{-31}$ kg
$\lambda_c = 2.42631023867\ (73) \times 10^{-12}$ m	$2.4263102386791 \times 10^{-12}$ m
$r_e = 2.8179403262\ (13) \times 10^{-15}$ m	Entry Parameter
$E_e = 8.1871057769\ (25) \times 10^{-14}$ J	$8.1871057768374 \times 10^{-14}$ J
$\mu_B = -9.2740100783\ (28) \times 10^{-24}$ J/T	$-9.2740100783751 \times 10^{-24}$ J/T
J_z = missing	$1.3583820081164 \times 10^{-55}$ kg m^2
I = missing (charge current)	$I = 19.79633369$ A

14.3. The Properties of the Myon—With CODATA Values

CODATA	calculated
$m_\mu = 1.883531627\ (42) \times 10^{-28}$ kg	$1.8835316273271 \times 10^{-28}$ kg

Continued

$\lambda_{c\mu} = 1.173444110\ (26) \times 10^{-14}$ m	$1.1734441101124 \times 10^{-14}$ m
r_μ = missing	$1.3628494104872 \times 10^{-17}$m
$E_\mu = 1.692833804\ (38) \times 10^{-11}$ J	Entry Parameter
$\mu_\mu = -4.49044830\ (10) \times 10^{-26}$ J/T	$-4.490448298 \times 10^{-26}$ J/T[#]
$\mu = 2\mu_\mu/g_\mu = -4.485218889 \times 10^{-26}$ J/T	−4.4852188850826E-26
$g_\mu = -2.0023318418\ (13)$	N/A for free particle
$J_{z\mu}$ = missing	$6.5695859552349 \times 10^{-58}$ kg·m[2]
I = missing (charge current)	4093.253925 A

[#]Only measured with Landè-factor—not free particle must be corrected for comparison.

14.4. The Properties of the Tauon—With CODATA Values

CODATA	calculated
$m_\tau = 3.16754\ (21) \times 10^{-27}$ kg	$3.1675387996011 \times 10^{-27}$ kg
$\lambda_{c\tau} = 6.97771\ (19) \times 10^{-16}$ m	$6.9777175091772 \times 10^{-16}$ m
r_τ = missing	$8.1039890285167 \times 10^{-19}$ m
$E_\tau = 2.84684\ (19) \times 10^{-10}$ J	Entry Parameter
μ_τ = missing	$-2.6670712373284 \times 10^{-27}$J/T
$J_{z\tau}$ = missing	$3.9065102933190 \times 10^{-59}$ kg·m[2]
I = missing (charge current)	$6.8836330880754 \times 10^{4}$ A

Further the prediction can be augmented to the hadrons also and only the scatter radius is exceptional. This is expected because the inner structure is different (three quark-strings instead one closed lepton-string). The general gravity properties seem not to be affected.

This leads to the assumption that the EM mass-radius-energy relation is universal and could be an explanation for some unknown gravity effects.

14.5. The Properties of the Proton with CODATA Values

CODATA	calculated
$m_p = 1.67262192369\ (51) \times 10^{-27}$ kg	$1.6726219236843 \times 10^{-27}$ kg
$\lambda_{cP} = 1.32140985539\ (40) \times 10^{-15}$ m	$1.3214098553898 \times 10^{-15}$ m
$r_P = 8.414\ (19) \times 10^{-16}$ m[$]	$r_{CP} = 1.5346982671867 \times 10^{-18}$ m
$E_P = 1.50327761598\ (46) \times 10^{-10}$ J	Entry Parameter
$\mu_N = 5.0507837461\ (15) \times 10^{-27}$ J/T[#]	$5.0507837461136 \times 10^{-27}$ J/T
$J_{z\tau}$ = missing	$7.3979796330019 \times 10^{-59}$ kg·m[2]

[$]Differs because of different inner geometry and effective shielding to the charge-gravity radius $r_P \approx \frac{4}{\alpha} r_{CP}$;

[#]Because of the properties of a free particle, this parameter must be used for comparison.

14.6. The Properties of the Neutron with CODATA Values

CODATA	calculated
$m_n = 1.67492749804\ (95) \times 10^{-27}$ kg	$1.6749274980421 \times 10^{-27}$ kg
$\lambda_{cn} = 1.31959090581\ (75) \times 10^{-15}$ m	$1.3195909058041 \times 10^{-15}$ m
r_N = missing ($\sim 8 \times 10^{-16}$) m[#]	$1.5325857214342 \times 10^{-18}$ m
$E_n = 1.50534976287\ (86) \times 10^{-10}$ J	Entry Parameter
μ_n = missing[§]	$-5.0438312317479 \times 10^{-27}$ J/T
μ_n/μ_N momentum deviation*	−0.9986234781145
$J_{z\tau}$ = missing	$7.3877961521283 \times 10^{-59}$ kg·m[2]

[§]Free particle without interaction to ext. magnetic fields, compared to itself and not to other particles, difficult because of missing unshielded charge; Intrinsic momentum. Because of different inner structures, the magnetic properties in interaction to an external B-field will be difficult to predict within this theory. Especially the charge distribution isde-localized because of the three Quarks, so a difference is expected. [#]Not further analyzed, *in line with the $E_{neutron}/E_{proton}$ ratio and expected.

14.7. The Properties of a Black Hole (e.g. M87)

If it is assumed that the singularity of a black hole collapses to the probably simplest object in the universe—a closed loop matter free single EM string with mass, then the properties can be calculated too (note that if the mass is known, all other values are determined!). This theoretically can be assumed because the energy can be taken by one incredible high energetic photon and folded to a loop. Note that the singularity mathematically does not diverge and all properties can be proven by measurements (if possible, because these objects are a little bit dangerous to handle). The Schwarzschild-Radius will not be taken into account by this calculation. One of the open questions is why the EM wave function collapses to this small loop [29] [30]. The size of this object is much less than the Planck-length, so this could be an adequate reason. One other reason for this assumption is that a black hole can't be compressed any more by structure change (no-hair theorem) [31]. This assumption is only possible for this configuration because a Hadron would consist in three quarks which can be compressed further!

M87	calculated
Total Mass = $6 \times 10^{12} \times 1.98892 \times 10^{30}$ kg	
$m_{M87} = 1.19335 \times 10^{43}$ kg	Entry parameter, mass of M87 in kg
Compton wavelength	$\lambda_{cn} = 1.85210 \times 10^{-85}$ m
Singularity radius	$r_{M87} = 2.15105 \times 10^{-88}$ m
Energy	$E_{M87} = 1.07253 \times 10^{60}$ J
Black Hole magnetic momentum	$\mu_{M87} = 7.079262 \times 10^{-97}$ J/T
Angular Momentum (Z Axis)	$J_{zM87} = 1.036913 \times 10^{-128}$ kg·m[2]
Magnetic field	$B = 7.575163 \times 10^{155}$ T
Loop Current	$I = 2.5933691211392 \times 10^{74}$ A
Compton Area	$A = 2.7297549260358 \times 10^{-171}$ m[2]

Note that these properties are mainly determined by the mass (or energy), so the calculation of this "mystic" object is just straight forward [29] [32].

15. Conclusion

If it is valid to assume the presence of EM waves inside of particles, automatically some constraints are necessary to w.r.t. the known physics. One of the most astonishingly facts is that the time inside of black holes must be still present to keep the "mass running" which is observed and well known from outside. The length contraction and the relativity theory can be used to transform known physics into particles which makes it easy to get a view inside and find new equations and laws. Finally the energy relations must be fulfilled in all cases and this leads sometimes to crazy results like the radius quantization which is plausible in the whole view that the space impedance must match the particle impedance because matter is a possible content of the space.

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Conflicts of Interest

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

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