Are Elementary Particles Black Holes?

What shape would an event horizon have in an elementary particle, so that a stable particle with an elementary charge can arise?

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Abstrakt:
If only the Maxwell equations and the general theory of relativity are available, we need an event horizon to explain the existence of elementary particles. What would an event horizon look like that captures the electromagnetic wave and at the same time forms elementary charges. If one looks at the pair formation of elementary particles, one can assume that elementary particles consist of "trapped" electromagnetic waves.
It is assumed that the energy of the elementary particle is only stored in the electromagnetic field. The electric field is concentrated towards the event horizon, so that the energy density becomes very strong. The electric field lines end or start at the event horizon. The event horizon ensures that the particle is stable. [1]
In this work a possible event horizon will be found that fits to the elementary charge and to the energy of the particles. It is shown, that a cylindrical event horizon makes this possible.

Key words:
Electromagnetic elementary particle model, event horizon in elementary particles, elementary charge, ART, Maxwell equations, fine structure constant, quantum gravity

1. Introduction

Something about charges

Elementary particles have a constant elementary charge that is positive or negative. The charge is regardless of the mass. For example, electrons have a negative elementary charge of e = + - 1.6021917 * 10^{-19} C.
If you ask yourself what a charge is, you can answer this by using Gauss's law: Charges are the beginning (+) or the end (-) of the electric field line. If you consider the surface A of a volume and add up all the electric field lines $\vec{E}$ that enter and exit through the surface, you get a value for the charge Q in the volume:

$$Q = \varepsilon_0 \oint_A \vec{E} d\vec{A}$$

[1] http://manuel.goessling.info/Electromagnetic_waves_and_matter_in_the_gravitational_field_of_a_black_hole.pdf

Charges only exist in connection with the start and end of electric field lines. Can this starting point be an event horizon?

Something about matter

It is known that charges only appear in connection with matter. Without matter there would be no charges either. The question is: what is matter? Elementary particles are the smallest parts of matter. For every elementary particle there is an antiparticle. The antiparticle of the electron e- is the positron e+. Electrons have a negative elementary charge (end of the electric field) and positrons have a positive elementary charge (start of the electric field lines).
The ambivalence between matter and electromagnetic wave is well shown in the Feynman diagrams in Figure 1.

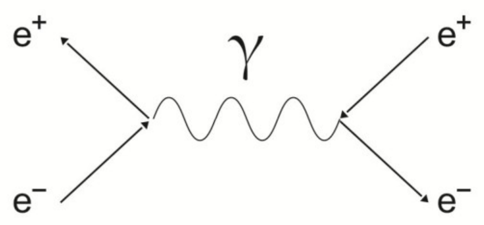

Fig. 1: Feynman diagrams for pair annihilation and pair creation [2]

If you bring an electron (e-) and a positron (e +) together, they radiate and matter becomes electromagnetic waves (γ) without charge but with an electric field. The electric field forms a loop with no beginning or end. The electromagnetic waves move with the speed of light and have no mass. When pairing, a positron and an electron can create from the electromagnetic waves γ.
The elementary particles have mass, charge and cannot move at the speed of light. This behavior of matter, antimatter and electromagnetic waves can be observed in laboratory experiments[3].
Matter and antimatter are just another state of an electromagnetic wave. When converting an electromagnetic wave into two particles, the wave is trapped in two small areas of space and forms a positron and an electron there[4]. How an electromagnetic wave has to move in this small area of space in order to generate a charge has already been described by other authors.[5][6][7][8][9]

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[2] https://de.wikipedia.org/wiki/Bhabha-Streuung
[3] http://www.slac.stanford.edu/exp/e144/e144.html
[4] Richard Gauthier, 2018, „Is the electron a superluminat half-photon with toroidal topology?" https://www.researchgate.net/publication/326098757_Is_the_electron_a_superluminal_half-photon_with_toroidal_topology
[5] John Graeme Williamson, Martin B. van der Mark "Is the electron a photon with toroidal topology?" January 1997Annales de la Fondation Louis de Broglie 22(2):133
[6] Caesar, Christoph; www.ccaesar.com/ger_index.html, 2003-2019
[7] Meyer, Carl-Friedrich; Relativistische invariante Bahnen in Elementarteilchen,

The point is that the electric field lines concentrate. The formation of mass[10] and the relativistic contraction of length and time dilation have already been described with the light trap. [11]

In the following it is to be examined what form an event horizon must have, which is created by the concentration of the electric field lines and generates an elementary charge. It is assumed that the entire energy of the elementary particle is stored in the electromagnetic field.

2. The event horizon as a source of charge

It is conceivable that the high energy density creates an event horizon which, like a gravitational lens, forces the electromagnetic wave onto a circular path. The event horizon is the beginning (+) or the end (-) of the electric field lines. What shape would an event horizon have under the assumption that an elementary charge arises and the energy of the elementary particle is stored in the electromagnetic field?

The spherical event horizon is not possible

The total energy of the elementary particle is proportional to the mass: $E = m_e * c^2$. Assuming that the total energy E is stored in the electromagnetic field, then it is the integral of the energy density over the volume. The energy density is created by the electric and magnetic fields in the volume. The energy of an electromagnetic wave oscillates between electrical energy and magnetic energy. The two energies are the same and only the energy of the electrical field needs to be integrated and doubled to determine the total energy.

$$E = \int_V \omega_{EB}\, dV = \int_V (\omega_M + \omega_E)\, dV = \int_V 2 * \omega_E\, dV$$

$$= \int_V \varepsilon_0 * \left|\vec{E}\right|^2 dV = \int_V \varepsilon_0 * \left(\frac{Q}{4 * \pi * \varepsilon_0 * r^2}\right)^2 dV$$

Let the coordinate center lie in the center of the elementary particle. The volume in which the electric fields exist is from the event horizon r_{EH} to infinity.

Shaker Verlag, Aachen 2005; ISBN 3-8322-3692-9

[8] Gößling, Manuel; Physik – Rechnen mit dem Elementarzylinder; Das Elektron als elektromagnetische Welle; 2. Auflage 2018; ISBN 978-3-9819366-1-2

[9] Richard Gauthier, „A Photon Has Inertial Mass in Mirror Reflection and Compton Scattering" 2016 https://www.researchgate.net/publication/303547243_A_Photon_Has_Inertial_Mass_in_Mirror_Reflection_and_Compton_Scattering

[10] Martin B. van der Mark, „Light is Heavy" https://www.researchgate.net/publication/301845471_Light_is_Heavy

[11] Weiß, H.; Wellenmodell eines Teilchens; Unterhaching: Herbert Weiß; 1991

$$E = \int_{r_{EH}}^{\infty} \varepsilon_0 * \left(\frac{Q}{4 * \pi * \varepsilon_0 * r^2}\right)^2 * 4 * \pi * r^2 * dr$$

$$E = \left(\frac{Q^2}{4 * \pi * \varepsilon_0 * r_{EH}}\right) = m_e * c^2 \qquad (1)$$

If you rearrange the formula, you get for the charge Q:

$$Q = \sqrt{4 * \pi * \varepsilon_0 * r_{EH} * m_e * c^2} \qquad (2)$$

The radius of the event horizon r_{EH} is still unknown. The event horizon begins where an electromagnetic wave can no longer escape from the particle's gravitational field because the curvature of space is too strong.
For the quick and easy calculation of the radius r_{EH}, I choose a classic approach. Imagine the electromagnetic wave as a particle m_T with the speed of light c, which tries to escape from the gravitational field of the mass m_e. The kinetic energy is equated with the potential energy.

$$\frac{1}{2} * m_T * c^2 = \int_{r_{EH}}^{\infty} G \, \frac{m_T * m_e}{r^2} dr$$

$$\frac{1}{2} * c^2 = \int_{r_{EH}}^{\infty} G \, \frac{m_{(r)}}{r^2} dr \qquad (3)$$

With the two equations (2) and (3) and the two unknowns Q and r_{EH} we obtain for the charge (see Appendix A):

$$Q = m_e * \sqrt{4 * \pi * \varepsilon_0 * G}$$

$$Q_{Elektron} = m_{Elektron} * \sqrt{4 * \pi * \varepsilon_0 * G} = 7{,}85 * 10^{-41} C \ll e$$

With a spherical event horizon, the charge becomes much too small. It is also proportional to the mass of the elementary particle. This cannot be correct because the elementary charge *e* does not depend on the mass of the elementary particle. The event horizon cannot therefore be spherically symmetric. A spherical event horizon would also contradict the Heisenberg uncertainty principle, since the wavelength of the electromagnetic wave (Compton wavelength) is much larger than the diameter of the event horizon.

The cylindrical event horizon

If the electric field lines concentrate on a line rather than a point, a cylindrical event horizon is created.

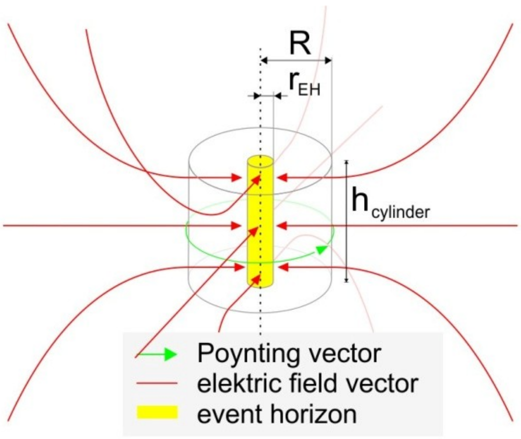

Fig. 2: Concentration of the electric field lines on one line

The cylindrical event horizon has a length $h_{Cylinder}$ and a radius r_{EH}.
If one assumes that the energy is only stored in the electromagnetic field, the approximation for the charge Q and the radius is (see Appendix B):

$$Q = \sqrt{\frac{2*\varepsilon_0*h*c}{\frac{1}{2\pi} + \frac{h}{h_{Cylinder}*\pi*m_e*c}*\ln\left(\frac{h}{m_e*c*r_{EH}}\right)}} \tag{4}$$

$$r_{EH} = \frac{G*Q^2}{\pi*\varepsilon_0*c^4*h_{Cylinder}} \tag{5}$$

The charge Q is known as the elementary charge. We have two equations with two unknowns: $h_{cylinder}$ and r_{EH}. For the different elementary particles, the radius r_{EH} and the height $h_{Cylinder}$ of the event horizon can calculated as follows:

	mass [kg]	charge Q [e]	$h_{Cylinder}$ [m]	$h_{Cylinder}$ / λ_0	r_{EH} [m]
Electron	$9{,}109558*10^{-31}$	-1	$6{,}143*10^{-13}$	0,2532	$1{,}241*10^{-59}$
Muon	$1{,}883532*10^{-28}$	-1	$2{,}678*10^{-15}$	0,2282	$2{,}846*10^{-57}$
Tau	$3{,}167\ 54*10^{-27}$	-1	$1{,}500*10^{-16}$	0,2149	$5{,}084*10^{-56}$
Up	$3{,}85 * 10^{-30}$	2/3	$3{,}237*10^{-13}$	0,2506/(2/3)^2	$1{,}047*10^{-59}$
Down	$8{,}32*10^{-30}$	-1/3	$6{,}106*10^{-13}$	0,2555/(-1/3)^2	$1{,}387*10^{-60}$

The charge Q must be independent of the mass m_e of the elementary particle.
The logarithm (equation 4) of the very large number $\left(\frac{h}{m_e*c*r_{EH}}\right)$ is almost constant and hardly dependent on the mass m_e. This is given because the radius of the event

horizon r_{EH} is very small. The radius of the event horizon r_{EH} is proportional to the mass or the energy of the elementary particle.
The height of the event horizon $h_{Cylinder}$ is inversely proportional to the mass of the elementary particle m_e.

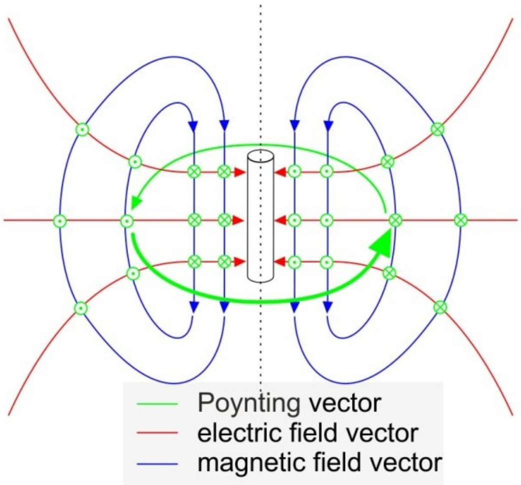

Fig. 3: The magnetic field lines (blue) form a loop

If one assumes that the electromagnetic wave, which forms an elementary particle, moves in a circle, then the magnetic field lines form a loop (see Fig. 3). This loop cannot become smaller than the wavelength of the electromagnetic wave. The wavelength is therefore proportional to the height of the event horizon and inversely proportional to the mass of the elementary particle.

$$h_{Cylinder} \sim \lambda \sim \frac{1}{m_e}$$

The height is a rough approximation $h_{Cylinder}$:

$$h_{Cylinder} \approx \frac{\lambda}{\pi * \sqrt{2}} * \frac{e^2}{Q^2}$$

3. Result

Even if a simplified model was used to calculate the electromagnetic field, the result is clear: The elementary charge can arise because the electric field lines find a beginning and an end at the cylindrical event horizon. With a cylindrical event horizon this is possible for all elementary particles. The maximum energy density at the event horizon of leptons is always:

$$\omega_{max} = \frac{\varepsilon_0 * c^8}{4 * G^2 * e^2}$$

In the electromagnetic model proposed here, the event horizon r_{EH} of an elementary particle becomes larger with increasing energy or increasing mass of the particle. However, the height decreases with increasing energy.
The diameter of the cylindrically shaped event horizon becomes very small in relation to the height of the cylinder. The event horizon is like a string. The ratio of height to diameter for the event horizon of the electron is $2*10^{46}$. This is an unimaginably large number. This ratio is greater than the ratio of the diameter of the universe to the diameter of the proton. But despite this large number, the diameter is not zero or one-dimensional, as in the string theory. It depends on the energy of the elementary particle.
The string-shaped event horizon can explain the formation of elementary charges. However, it is not a black hole because the diameter is much smaller than the Compton wavelength of all known particles. The event horizon can't swallow particles like a black hole.

4. Outlook:

If one considers an elementary particle exclusively as an electromagnetic wave, many physical quantities can be clearly explained. The elementary charge arises from the fact that the electric field lines find a beginning and an end at the event horizon. The wave-particle dualism becomes understandable through the electromagnetic wave and the event horizon.
The diameter of the cylindrically shaped event horizon depends on the energy of the elementary particle. This dependency can explain very clearly the gravitation.
The event horizon becomes a truncated cone in the gravitational field, because the particle gets energy in the gravitational field when it falls or loses it when it rises (gravitational red-blue shift[12]). The gravitational acceleration can be calculated with the course of the Poynting vector on the truncated cone. The gravitational force can be determined with the course of the Poynting vector[13] and the radiation pressure of the Poynting vector[14]. If one looks at the elementary particle as a light clock, the change in time due to gravity and movement can be calculated very clearly.
The total energy in a point in space is generated by the superposition of the field energies of all electromagnetic fields. This also includes the electromagnetic fields of the elementary particles. The total energy in a point is proportional to the gravitational potential in that point.

[12] https://de.wikipedia.org/wiki/Pound-Rebka-Experiment
[13] http://manuel.goessling.info/Elektromagnetischer_Wellen_und_Materie_im_Gravitationsfeld_eines_Schwarzen_Loches2020.pdf
[14] http://manuel.goessling.info/Gravitation%20Manuel%20Goessling%202020.pdf

5. Appendix

A: Calculation of the sphere field

$$Q = \sqrt{4 * \pi * \varepsilon_0 * r_{EH} * m_e * c^2} \tag{1}$$

$$\frac{1}{2} * c^2 = \int_{r_{EH}}^{\infty} G \frac{m_{(r)}}{r^2} dr \tag{2}$$

$$m_{e(r)} = \frac{Q^2}{4 * \pi * \varepsilon_0 * c^2 * r}$$

$$\frac{1}{2} * c^2 = \frac{G * Q^2}{4 * \pi * \varepsilon_0 * c^2} \int_{r_{EH}}^{\infty} \frac{1}{r^3} dr = \frac{G * Q^2}{4 * \pi * \varepsilon_0 * c^2} * \left(\frac{1}{2 * {r_{EH}}^2}\right)$$

$$r_{EH} = \sqrt{\frac{G * Q^2}{4 * \pi * \varepsilon_0 * c^4}}$$

$$\frac{Q^2}{4 * \pi * \varepsilon_0 * r_{EH}} = \frac{Q * c^2}{\sqrt{4 * \pi * \varepsilon_0 * G}} = m_e * c^2$$

$$Q = m_e * \sqrt{4 * \pi * \varepsilon_0 * G}$$

B: Calculation of the cylindrically symmetrical event horizon

From a macroscopic point of view, the electric field of an elementary charge appears spherically symmetrical. In the microscopic range, however, the field is cylindrically symmetrical (see Fig. 2). The energy is mainly stored in the cylindrical field. The spherically symmetrical, electric field hardly plays an energetic role.

For a simple calculation, the stepless transition from the cylindrical field to a spherical field is made abruptly at the radius λ_0.

For the energy you get:

$$E = \int_V \omega_{EB}\, dV = \int_V (\omega_M + \omega_E)\, dV = \int_V 2 * \omega_E\, dV = \int_V \varepsilon_0 * \left|\vec{E}\right|^2 dV$$

$$E = \int_{r_{EH}}^{\lambda_0} \varepsilon_0 * \left|\vec{E}\right|_{Cylinder}^2 * 2 * \pi * r * h_{Cylinder}\, dr + \int_{\lambda_0}^{\infty} \varepsilon_0 * \left|\vec{E}\right|_{Sphere}^2 * 4 * \pi * r^2\, dr$$

$$E = \int_{r_{EH}}^{\lambda_0} \frac{Q^2}{4 * \pi^2 * \varepsilon_0 * r^2 * h_{cylinder}{}^2} * 2 * \pi * r * h_{cylinder}\, dr + \int_{\lambda_0}^{\infty} \frac{Q^2}{16 * \pi^2 * \varepsilon_0 * r^4} * 4 * \pi * r^2\, dr$$

$$E = \frac{Q^2}{2 * \pi * \varepsilon_0 * h_{cylinder}} \int_{r_{EH}}^{\lambda_0} \frac{1}{r}\, dr + \int_{\lambda_0}^{\infty} \frac{Q^2}{16 * \pi^2 * \varepsilon_0 * r^4} * 4 * \pi * r^2\, dr$$

The Compton wavelength λ_0 is replaced by the mass of the elementary particle m_e and the integrals are solved:

$$\lambda_0 = \frac{h}{m_e * c}$$

$$E = \frac{Q^2}{2 * \pi * \varepsilon_0 * h_{cylinder}} \left(\ln\left(\frac{h}{m_e * c * r_{EH}}\right) + \frac{h_{cylinder} * m_e * c}{2 * h} \right)$$

If one equates this field energy with the total energy of the particle, one obtains:

$$\frac{Q^2}{2*\pi*\varepsilon_0*h_{cylinder}}\left(\ln\left(\frac{h}{m_e*c*r_{EH}}\right)+\frac{h_{cylinder}*m_e*c}{2*h}\right)=m_e*c^2$$

$$Q=\sqrt{\frac{2*\pi*\varepsilon_0*h_{cylinder}*m_e*c^2}{\ln\left(\frac{h}{m_e*c*r_{EH}}\right)+\frac{h_{cylinder}*m_e*c}{2*h}}}$$

$$Q=\sqrt{\frac{2*\varepsilon_0*h*c}{\frac{1}{2\pi}+\frac{h}{h_{cylinder}*\pi*m_e*c}\ln\left(\frac{h}{m_e*c*r_{EH}}\right)}}$$

The 1 / 2π in the denominator stand for the energy in the spherical field. The other values in the denominator stand for the energy in the cylinder field. Together the denominator must add up to 137, so that the elementary charge e comes out.
The radius r_{EH} of the event horizon is calculated as follows:
The event horizon begins where an electromagnetic wave can no longer escape from the particle's gravitational field because the curvature of space is too strong. For the quick and easy calculation of the radius r_{EH} we choose a classic approach. Imagine the electromagnetic wave as a particle m_T with the speed of light c, which tries to escape from the gravitational field of the mass m_e. The kinetic energy is equated with the potential energy.

$$E_{Kinetic}=E_{Gravitation}$$

$$\frac{1}{2}m_T*c^2=\int_{r_{EH}}^{\infty}G\frac{m_T*m_{e(r)}}{r^2}dr$$

The particle m_T moves in the particle m_e, from the event horizon to infinity. For gravity, therefore, only the mass m_e (r) that the particle has already passed must be taken into account. The spherically symmetric far field is neglected.

$$m_{e(r)}=\frac{E_{(r)}}{c^2}=\frac{Q^2}{2*\pi*\varepsilon_0*c^2*h_{cylinder}}\ln\left(\frac{r}{r_{EH}}\right)$$

If you insert this and abbreviate m_T, you get:

$$\frac{1}{2}*c^2=\frac{G*Q^2}{2*\pi*\varepsilon_0*c^2*h_{cylinder}}\int_{r_{EH}}^{\infty}\frac{\ln\left(\frac{r}{r_{EH}}\right)}{r^2}dr$$

$$\frac{\pi*\varepsilon_0*c^4*h_{cylinder}}{G*Q^2}=\frac{1}{r_{EH}}$$

$$r_{EH}=\frac{G*Q^2}{\pi*\varepsilon_0*c^4*h_{cylinder}}$$

6. Constants

Electric field constant

$\varepsilon_0 = 8.854185 * 10^{-12}$ $\frac{A * s}{V * m}$

Elementary electric charge

$e = 1.6021917 * 10^{-19}$ C

Gravitational constant

$G = 6.6732 * 10^{-11}$ $\frac{m^3}{kg * s^2}$

Speed of light

$c = 299\,792\,458$ $\frac{m}{s}$

Magnetic field constant

$\mu_0 = 4 * \pi * 10^{-7}$ $\frac{V * s}{A * m}$

Planck's quantum of action

$h = 6.62607004 * 10^{-34}$ Js

reduced Planck's quantum of action

$\hbar = \frac{h}{2 * \pi}$ Js

Rest mass of the electron or the positron

$m_{\text{Electron}} = 9.109558 * 10^{-31}$ kg

Compton wavelength of the electron or positron

$\lambda_0 = 2.42631023 * 10^{-12}$ m

Fine structure constant

$$\alpha = \frac{1}{137.035999046} = \frac{e^2}{2 * \varepsilon_0 * h * c}$$

7. Literature

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