Central force fields described by m theory, Part III

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Abstract

This series of papers on force fields generated by spacetime itself is continued by investigating a rotating spacetime. Two tetrads are constructed that lead to metrics with diagonal and non-diagonal elements for a a rotating, spherically symmetric spacetime. The force fields are computed using the formalism developed for a path through all stages of Cartan geometry. For the non-diagonal spacetime metric, an approximation had to be defined to overcome computational problems. The resulting electric and magnetic field polarizations represent a geometrical approach to exploring both the properties of nucleons and even quarks, and the reasonable assumption that they are the smallest building blocks of matter.

Keywords: Unified field theory; m theory; central symmetry; gravitation; electromagnetism; elementary particles.

1 Introduction

In the preceding papers [1], we investigated the spherically symmetric spacetime of general relativity within the framework of ECE theory [2]. In particular, general relativity was introduced using m theory [3], in which relativistic distortions of the radial coordinate r are described by metric functions $\mathrm{m}(r)$.

A Cartan tetrad was constructed in such a way that the resulting metric of a spherically symmetric spacetime includes the m function. Applying the full formalism of ECE theory to this tetrad leads to force fields and topological charge and current densities. These fields and densities arise from the geometry alone. This is surprising because, in normal physics, field equations have to be solved to obtain field solutions in a given geometry. The ECE fields are unified fields by definition, i.e., they can be considered as electromagnetic as well as gravitational fields, or even as quantum fields (in classical approximation).

In this paper, we consider the rotation of spherical spacetime, which is an extension of the concept that we have used so far. A rotating spacetime corresponds to a frame rotation of Cartan geometry, which has already been studied

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earlier [3]. In that book, we explored this rotation using the metric directly as a basis, and found simple explanations for de Sitter and Lense-Thirring precessions, for example. In this paper, we define tetrads for a rotating spacetime, so that we can apply the full Cartan-ECE mechanism to find corresponding force fields and densities. We use two approaches that are described in [3], one uses a diagonal metric and another one uses a metric containing off-diagonal elements. These elements complicate the mathematical treatment enormously, so that a solution can be found only for an approximate version of the rotating spacetime. This approximation, although rough, is good enough to allow the results to be compared with the internal structures of elementary particles that are asserted by the Standard Model.

2 Rotating spherically symmetric spacetime

2.1 Rotation metric with diagonal elements only

A spherically symmetric spacetime is described by spherical coordinates $(r,\ \theta,\ \phi)$ and time t. The relativistic effects are restricted to the time and radial coordinate and are expressed by the m function [1,3]. The squared metric line element is

$$ds^2 = c^2 \mathrm{m}(r) dt^2 - \frac{dr^2}{\mathrm{m}(r)} - r^2 d\theta^2 - r^2 \sin(\theta)^2 d\phi^2. \tag{1}$$

We assume that the frame rotates around the Z axis with a constant angular frequency ω_0. Then, the azimuthal coordinate ϕ becomes time-dependent (written as ϕ'), and is described by the differential

$$d\phi' = d\phi + \omega_0 dt. \tag{2}$$

The above line element then becomes

$$\begin{aligned} ds^2 &= c^2 m(r,t) dt^2 - \frac{dr^2}{m(r,t)} - r^2 d\theta^2 - r^2 \sin(\theta)^2 d\phi'^2 \qquad (3) \\ &= c^2 m(r,t) dt^2 - \frac{dr^2}{m(r,t)} \\ &\quad - r^2 d\theta^2 - r^2 \sin(\theta)^2 \left(d\phi^2 + 2\omega_0 d\phi dt + \omega_0^2 dt^2 \right). \end{aligned}$$

This form of the metric has an off-diagonal term, which couples the t and ϕ coordinates. Using the standard relation for polar coordinates,

$$d\phi = \omega_0 dt, \tag{4}$$

we obtain:

$$ds^2 = \left(c^2 m(r,t) - 3\omega_0^2 r^2 \sin(\theta)^2 \right) dt^2 - \frac{dr^2}{m(r,t)} - r^2 \sin(\theta)^2 d\phi^2. \tag{5}$$

This is a diagonal metric again. We can write it in matrix form as

$$(g_{\mu\nu}) = \begin{bmatrix} c^2 \mathrm{m}(r) - 3\omega_0^2 r^2 \sin(\theta)^2 & 0 & 0 & 0 \\ 0 & -\frac{1}{\mathrm{m}(r)} & 0 & 0 \\ 0 & 0 & -r^2 & 0 \\ 0 & 0 & 0 & -r^2 \sin(\theta)^2 \end{bmatrix}. \tag{6}$$

As described in [1], this metric can be derived from the tetrad

$$(q^a{}_\mu) = \begin{bmatrix} \frac{1}{2}\sqrt{c^2\mathrm{m}(r) - 3\omega_0^2 r^2 \sin(\theta)^2} & 0 & 0 & 0 \\ 0 & \frac{1}{2\sqrt{\mathrm{m}(r)}} & 0 & 0 \\ 0 & 0 & \frac{r}{2} & 0 \\ 0 & 0 & 0 & \frac{r\sin(\theta)}{2} \end{bmatrix}. \tag{7}$$

By applying the Cartan geometry formalism to this tetrad and metric, we obtain the following for the force fields:

$$\mathbf{E}^{(0)} = \begin{bmatrix} f_r(r,\theta) \\ f_\theta(r,\theta) \\ 0 \end{bmatrix}, \tag{8}$$

$$\mathbf{E}^{(1)} = \mathbf{E}^{(2)} = \mathbf{E}^{(3)} = \mathbf{0}, \tag{9}$$

$$\mathbf{B}^{(0)} = \mathbf{B}^{(1)} = \mathbf{0}, \tag{10}$$

$$\mathbf{B}^{(2)} = \begin{bmatrix} 0 \\ 0 \\ -\frac{A_0}{r_0} \end{bmatrix}, \tag{11}$$

$$\mathbf{B}^{(3)} = \begin{bmatrix} -\frac{A_0 r\cos\theta}{r_0^2} \\ \frac{A_0 \sin\theta}{r_0} \\ 0 \end{bmatrix}, \tag{12}$$

where A_0 and r_0 are constants, and $f_r(r,\theta)$ and $f_\theta(r,\theta)$ are complicated functions that are not listed here, but can be seen in the computer algebra code (available from upitec.org). This result is similar to the one in [1] for a non-rotating metric, except that the polarization field $\mathbf{E}^{(0)}$ now has an additional θ component and depends on the rotation frequency ω_0. The $\mathbf{B}$ fields are identical to those without rotation [1] (only the constants have been defined differently).

The functions f_r and f_θ contain terms of the form

$$\sqrt{c^2\mathrm{m}(r) - 3{\omega_0}^2 r^2 \sin(\theta)^2}, \tag{13}$$

which in turn contain the ϕ component of the orbital rotation velocity at radius r:

$$v_\phi = \omega_0 r \sin\theta. \tag{14}$$

As a consequence, Eq. (8) includes the relativistic γ factor

$$\begin{aligned} \gamma &= c\left(c^2\mathrm{m}(r) - 3{\omega_0}^2 r^2 \sin(\theta)^2\right)^{-1/2} \\ &= \left(\mathrm{m}(r) - 3\frac{v_\phi^2}{c^2}\right)^{-1/2}, \end{aligned} \tag{15}$$

which also appears in the theory for a general rotating frame (see de Sitter and Lense-Thirring precessions in Section 9.3.3 of [3]). In [3], the description of the general rotating frame was restricted to a plane polar coordinate system, but contained an additional translation. This translation is not present in our case, and the rotation is stationary with a constant angular velocity.

In the limit $r \to 0$, we have

$$\gamma \to \mathrm{m}(0)^{-1/2}, \tag{16}$$

which defines a relation between γ and $\mathrm{m}(r)$. In the flat space limit $\mathrm{m}(r)$=1, it follows that $\gamma = 1$, i.e., it is the non-relativistic limit for $r \to 0$.

The non-vanishing curls of the force fields are

$$\boldsymbol{\nabla} \times \mathbf{E}^{(0)} = \begin{bmatrix} g_r(r,\theta) \\ g_\theta(r,\theta) \\ 0 \end{bmatrix}, \tag{17}$$

$$\boldsymbol{\nabla} \times \mathbf{B}^{(2)} = \begin{bmatrix} -\frac{A_0 \cos\theta}{r r_0 \sin\theta} \\ \frac{A_0}{r r_0} \\ 0 \end{bmatrix}, \tag{18}$$

$$\boldsymbol{\nabla} \times \mathbf{B}^{(3)} = \begin{bmatrix} 0 \\ 0 \\ \frac{A_0 (r_0 - r) \sin\theta}{r r_0^2} \end{bmatrix}. \tag{19}$$

The functions $g_r,\ g_\theta$ are complicated functions again, and they also depend on ω_0 additionally. For a non-rotating spacetime, the electric curl disappears [1], so this is a pure effect of rotation. Remarkably, the curl of the electric field corresponds to a current of magnetic monopoles, which follows from the Faraday law of ECE theory (Eq. (4.73) in [3]). Therefore, the rotation produces a monopole structure in addition to the magnetic field (which it does already without rotation). The curls of the magnetic field polarizations are identical to those without rotation, which are given in [1]. Similar results hold for the non-vanishing divergence of the electric and magnetic field polarizations:

$$\boldsymbol{\nabla} \cdot \mathbf{E}^{(0)} = h(r,\theta), \tag{20}$$

$$\boldsymbol{\nabla} \cdot \mathbf{B}^{(3)} = A_0 \left(\frac{2}{r r_0} - \frac{3}{r_0^2} \right) \cos\theta \tag{21}$$

with a complicated function h.

The results for the diagonal rotating metric are graphed in Figs. 1 - 8, similarly to how they are graphed in [1]. We start with the representation of Eqs. (8) and (17) for the electric field $\mathbf{E}^{(0)}$, computed with the model m function

$$\mathrm{m}(r) = 2 - \exp\left(\log(2) \exp(-\frac{r}{R}) \right), \tag{22}$$

as in previous papers. In Fig. 1 we see that the electric field is directed to the outside in the central plane $\theta = \pi/2$, while it points to the center at the poles. In the inner sphere it points to the center everywhere, indicating a central field. The curl of the field (Fig. 2) is always parallel to the central plane and changes direction on this plane. In the inner sphere, the direction is inverse to that in the outer sphere.

We now compare both graphs with the results for the m function $\mathrm{m}(r)$=1, which was used for Figs. 3 and 4. The curl of $\mathbf{E}^{(0)}$ is very similar to Fig. 2, but the field in the inner sphere of Fig. 3 is not centrally symmetric as in Fig. 1. This is the effect of the limit $\mathrm{m}(r) \to 0$ for $r \to 0$. This difference becomes even more apparent when we compare the radial component of the E field to its divergence, which depends on r also (Figs. 5 and 6). Close to the center, the m function leads to a pole in the electric field as well as in its divergence, revealing a strong topological charge effect. When we use the approximation $\mathrm{m}(r)$=1, these poles disappear, and both curves are linear to the center. At the right end of the graphs, the values of the rotation velocity v_ϕ become so large that we approach the ultra-relativistic limit $\gamma \to \infty$. Here, the field as well as its divergence tends to infinity. This is reminiscent of electronic orbitals in heavy elements, where the velocity of electron waves reaches the velocity of light. However, this situation is different to ours, because there is a high potential in atoms and we are only considering the geometrical ramifications here.

The divergence of the electric field in the central region is depicted in Figs. 7 and 8 for both models of the m function. As explained in [1], the horizontal plane of the images corresponds to the vertical (r, θ) plane of the sphere. The realistic m function leads to a divergence funnel similar to a Coulomb potential, while the function $\mathrm{m}(r)$=1 only leads to a peak at the center, with some angular variations close to it. These findings are in accordance with those shown in the other figures.

The properties of the magnetic fields are the same as those for the non-rotating spacetime, which have already been graphed and discussed in [1].

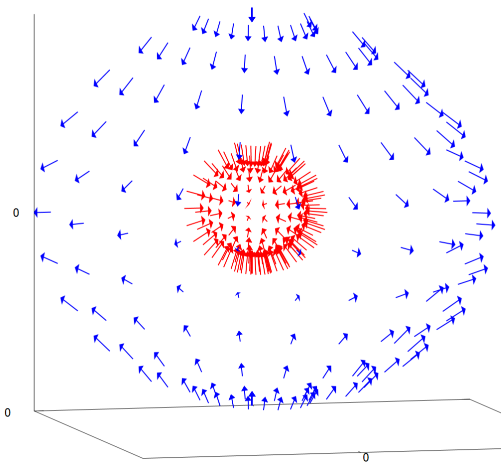

Figure 1: $\mathbf{E}^{(0)}$, with the $\mathrm{m}(r)$ model function.

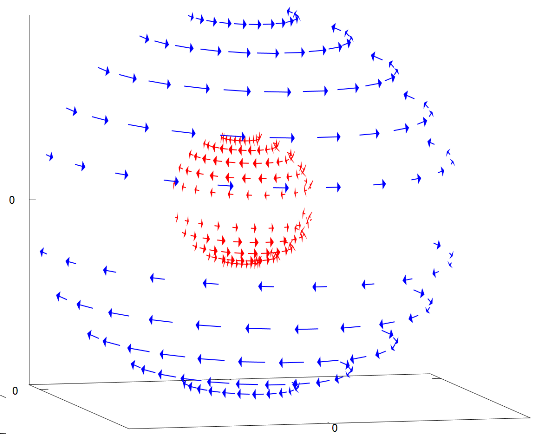

Figure 2: $\mathrm{curl}(\mathbf{E}^{(0)})$, with the $\mathrm{m}(r)$ model function.

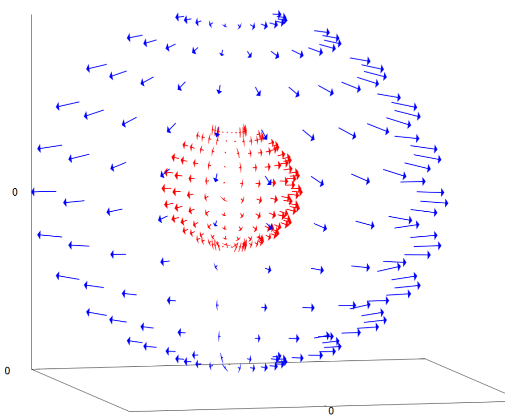

Figure 3: $\mathbf{E}^{(0)}$, with m(r)=1.

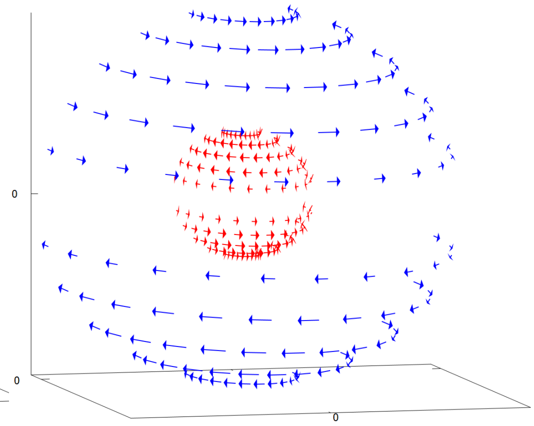

Figure 4: curl($\mathbf{E}^{(0)}$), with m(r)=1.

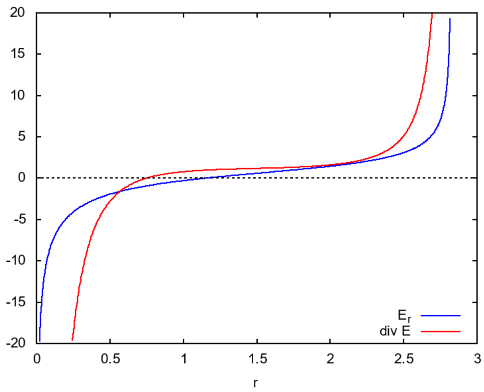

Figure 5: Radial functions $E_r^{(0)}$ and div($\mathbf{E}^{(0)}$) at the equator ($\theta = \pi/2$), for the m(r) model function.

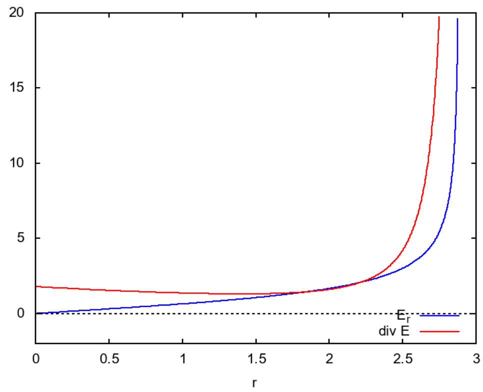

Figure 6: Radial functions $E_r^{(0)}$ and div($\mathbf{E}^{(0)}$) at the equator ($\theta = \pi/2$), for m(r)=1.

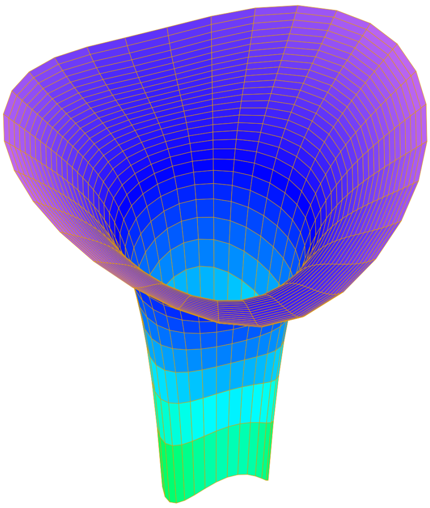

Figure 7: Contour plot of div($\mathbf{E}^{(0)}$) in the vertical (r, θ) plane for the m(r) model function.

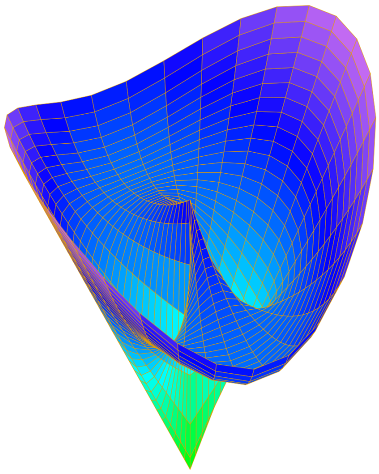

Figure 8: Contour plot of div($\mathbf{E}^{(0)}$) in the vertical (r, θ) plane for m(r)=1.

2.2 Rotation metric with non-diagonal elements

As an alternative to the diagonal metric of rotation, we will now use the metric (3) directly, without replacing the mixed term $d\phi dt$ with Eq. (4). The result is

$$\begin{aligned} ds^2 &= c^2 m(r,t) dt^2 - \frac{dr^2}{m(r,t)} - r^2 d\theta^2 \\ &\quad - r^2 \sin(\theta)^2 \left(d\phi^2 + 2\omega_0 d\phi dt + \omega_0^2 dt^2 \right) \\ &= (c^2 m(r,t) - \omega_0^2 r^2 \sin(\theta)^2) dt^2 - \frac{dr^2}{m(r,t)} - r^2 d\theta^2 \\ &\quad - 2r^2 \sin(\theta)^2 \omega_0 d\phi dt - r^2 \sin(\theta)^2 d\phi^2. \end{aligned} \tag{23}$$

This metric, written in matrix form, is

$$(g_{\mu\nu}) = \begin{bmatrix} c^2 \mathrm{m}(r) - \omega_0^2 r^2 \sin(\theta)^2 & 0 & 0 & -2\omega_0 r^2 \sin(\theta)^2 \\ 0 & -\frac{1}{\mathrm{m}(r)} & 0 & 0 \\ 0 & 0 & -r^2 & 0 \\ -2\omega_0 r^2 \sin(\theta)^2 & 0 & 0 & -r^2 \sin(\theta)^2 \end{bmatrix} \tag{24}$$

and contains the off-diagonal elements $g_{03} = g_{30}$. In principle, this is the Kerr metric of general relativity, but the Kerr metric is written in "Boyer-Lindquist coordinates", which results in a more complicated structure [4]. Nevertheless, the Kerr metric has non-vanishing off-diagonal elements similar to those in

Eq. (24). The metric of Eq. (24) can be constructed from the tetrad

$$
(q^a{}_\mu) = \begin{bmatrix} \frac{1}{2}\sqrt{c^2 \mathrm{m}(r) + 3\omega_0^2 r^2 \sin(\theta)^2} & 0 & 0 & 0 \\ 0 & -\frac{1}{2\sqrt{\mathrm{m}(r)}} & 0 & 0 \\ 0 & 0 & -\frac{r}{2} & 0 \\ \omega_0 r \sin(\theta) & 0 & 0 & -\frac{r\sin(\theta)}{2} \end{bmatrix}, \tag{25}
$$

where variations in sign are possible that give the same result (24). Applying the Cartan geometry formalism, however, leads to an inconsistent equation system for the Christoffel symbols (Γ connections), so that no solution is possible and the formalism stops working at this point. It is not clear what the reason is for this failure. Finding the cause would require a thorough mathematical analysis of the corresponding equation system of 64 equations with 64 variables and has been postponed. Instead, we introduce an approximation for the metric. Results show that a solution for the non-diagonal metric is possible, when g_{03} and g_{30} are constants. Therefore, we modified these elements to

$$
g_{03} = g_{30} = -2\omega_0 r_1^2. \tag{26}
$$

This means that we assumed $r \approx r_1 = const.$ and $\theta \approx \pi/2$ with $\sin\theta \approx 1$, which corresponds to a region in the spherical geometry near the equatorial plane with a restricted radius around r_1. The metric then reads

$$
(g_{\mu\nu}) = \begin{bmatrix} c^2\mathrm{m}(r) - \frac{\omega_0^2 r_1^4 \sin(\theta)^2}{r^2} & 0 & 0 & -2\omega_0 r_1^2 \\ 0 & -\frac{1}{\mathrm{m}(r)} & 0 & 0 \\ 0 & 0 & -r^2 & 0 \\ -2\omega_0 r_1^2 & 0 & 0 & -r^2\sin(\theta)^2 \end{bmatrix}, \tag{27}
$$

and is derived from the modified tetrad

$$
(q^a{}_\mu) = \begin{bmatrix} \frac{1}{2}F_0 & 0 & 0 & 0 \\ 0 & -\frac{1}{2\sqrt{\mathrm{m}(r)}} & 0 & 0 \\ 0 & 0 & -\frac{r}{2} & 0 \\ \frac{\omega_0 r_1^2}{r\sin(\theta)} & 0 & 0 & -\frac{r\sin(\theta)}{2} \end{bmatrix} \tag{28}
$$

with the function

$$
F_0 = \sqrt{c^2\mathrm{m}(r) + \frac{4\omega_0^2 r_1^4}{r^2\sin(\theta)^2} - \frac{{\omega_0}^2 {r_1}^4 \sin(\theta)^2}{r^2}}. \tag{29}
$$

Please note that the tetrad matrix is not symmetric.

The resulting magnetic force fields are the same as for the static metric and the rotational metric with only diagonal elements. Therefore, the curl and divergence of the magnetic force fields are identical in all three cases. In contrast, the electric force fields are non-zero for all four polarizations, and the same holds for their curls. Concerning their divergence, only polarizations (0) and (3) have non-vanishing values. The results for all three cases of the metric have been compiled in Table 1, as an overview. As already mentioned, the magnetic fields, as well as their curl and divergence values, are identical in all three cases.

Metric	Static		Diagonal		Off-Diagonal	
	m(r) var.	m(r)=1	m(r) var.	m(r)=1	m(r) var.	m(r)=1
$\mathbf{E}^{(0)}$	x	-	x	x	x	x
$\mathbf{E}^{(1)}$	-	-	-	-	x	x
$\mathbf{E}^{(2)}$	-	-	-	-	x	x
$\mathbf{E}^{(3)}$	-	-	-	-	x	x
$\mathbf{B}^{(0)}$	-	-	-	-	-	-
$\mathbf{B}^{(1)}$	-	-	-	-	-	-
$\mathbf{B}^{(2)}$	x	x	x	x	x	x
$\mathbf{B}^{(3)}$	x	x	x	x	x	x
curl $\mathbf{E}^{(0)}$	-	-	x	x	x	x
curl $\mathbf{E}^{(1)}$	-	-	-	-	x	x
curl $\mathbf{E}^{(2)}$	-	-	-	-	x	x
curl $\mathbf{E}^{(3)}$	-	-	-	-	x	x
curl $\mathbf{B}^{(0)}$	-	-	-	-	-	-
curl $\mathbf{B}^{(1)}$	-	-	-	-	-	-
curl $\mathbf{B}^{(2)}$	x	x	x	x	x	x
curl $\mathbf{B}^{(3)}$	x	x	x	x	x	x
div $\mathbf{E}^{(0)}$	x	-	x	x	x	x
div $\mathbf{E}^{(1)}$	-	-	-	-	-	-
div $\mathbf{E}^{(2)}$	-	-	-	-	-	-
div $\mathbf{E}^{(3)}$	-	-	-	-	x	x
div $\mathbf{B}^{(0)}$	-	-	-	-	-	-
div $\mathbf{B}^{(1)}$	-	-	-	-	-	-
div $\mathbf{B}^{(2)}$	-	-	-	-	-	-
div $\mathbf{B}^{(3)}$	x	x	x	x	x	x

Table 1: Non-vanishing elements (x) of force fields and their derivatives.

In the third case, the electric field polarizations $\mathbf{E}^{(0)}$ and $\mathbf{E}^{(3)}$ are quite complicated. The other two electric polarizations are

$$\mathbf{E}^{(1)} = \begin{bmatrix} 0 \\ 0 \\ -\frac{2A_0\omega_0 r_1^2\sqrt{\mathrm{m}(r)}}{r r_0} \end{bmatrix}, \tag{30}$$

$$\mathbf{E}^{(2)} = \begin{bmatrix} 0 \\ 0 \\ -\frac{2A_0\omega_0 r_1^2\cos(\theta)}{r r_0\sin(\theta)} \end{bmatrix}. \tag{31}$$

These fields have only a ϕ component and are rotational. From Table 1, it can be seen that all $\mathbf{E}$ fields display a curl, but $\mathbf{E}^{(0)}$ and $\mathbf{E}^{(3)}$ also diverge, so they are partially source fields. The same applies to $\mathbf{B}^{(3)}$. The curl and divergence of the $\mathbf{B}$ fields have already been graphed in [1].

3 Interpretation of the results

To further analyze the three cases of the metric, we consider the total charge that arises from the charge densities

$$\rho^{(a)} = \epsilon_0 \boldsymbol{\nabla} \cdot \mathbf{E}^{(a)} \tag{32}$$

for each polarization a. The total charge is given by the integral

$$Q^{(a)} = \int \rho^{(a)} d^3 r \tag{33}$$

with the spherical volume element

$$d^3 r = r^2 \sin\theta \ dr \ d\theta \ d\phi. \tag{34}$$

The integral is not analytically solvable in most cases. Therefore, we restrict ourselves to the simplest case, the non-rotational metric. The charge integral gives

$$Q^{(0)} = 0, \tag{35}$$

but when we consider the radial integral only in a range between 0 and a specific r, we see that the value of the integral is finite across a wide range and approaches zero only for $r \to \infty$. This is graphed by the green curve in Fig. 9. The charge density $\rho^{(0)}$ (blue curve) diverges for $r \to 0$ similarly to how it does for a point charge, but it has positive values above a certain radius. In order to better understand the behavior of the charge at a radius r, we have graphed the density of a spherical shell segment

$$S^{(a)}(r) = 4\pi r^2 \rho^{(a)}(r), \tag{36}$$

as the red curve in Fig. 9. This looks like a wave function or a charge distribution of elementary particles. In an ECE paper on the parton structure of elementary particles [5], it was shown that such structures can be created by Beltrami-like wave functions. The red curve of Fig. 9 can be compared directly with an experimentally obtained charge distribution of the neutron (Fig. 5 in [5]).

Fig. 10 shows the charge density integral of the field $\mathbf{B}^{(3)}$, which leads to the dipole built from magnetic monopoles as described in [1]. The radial integral over the charge density diverges, but the angular part makes the integral to zero, as is to be expected for dipoles.

As an example of results from the non-diagonal metric (case three), the divergences of the fields $\mathbf{E}^{(0)}$ and $\mathbf{E}^{(3)}$ are graphed in Fig. 11. Obviously, both polarizations lead to different signs for charges near the center. From Table 1, we see that none of four electric polarizations vanish, as is also the case for their curls. The same holds for two of the $\mathbf{B}$ fields. In total, there are six non-vanishing fields and six curls. This allows us to make a connection to the physics of elementary particles. According to the Standard Model, there are three groups ("generations") of quarks with six members each. The most important group is the first group. This group contains three up and three down quarks, which constitute the nucleons of ordinary matter (protons and neutrons). Up quarks have a spin of 1/2 and a charge of 2/3 e, while down

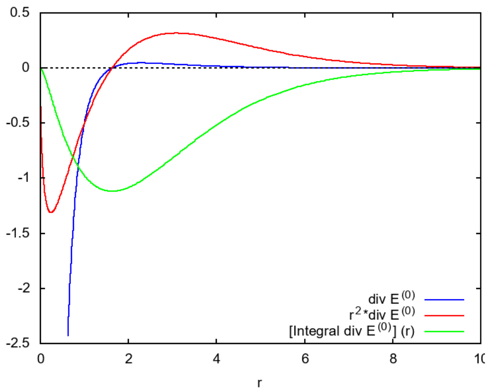

Figure 9: div$(\mathbf{E}^{(0)})$, r^2div$(\mathbf{E}^{(0)})$ and integral of div$(\mathbf{E}^{(0)})$ for a static metric.

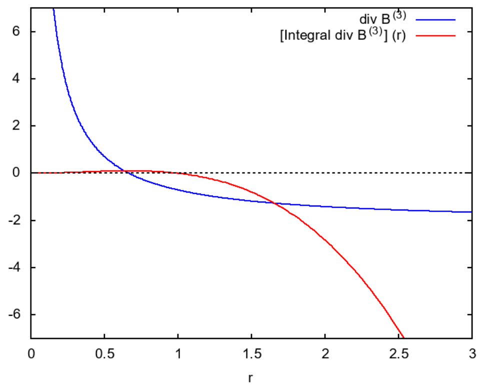

Figure 10: div$(\mathbf{B}^{(3)})$ and integral of div$(\mathbf{B}^{(3)})$ for a static metric.

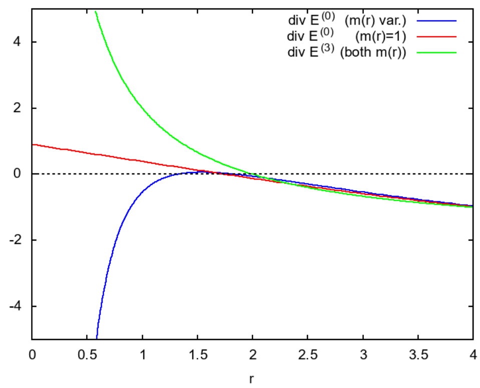

Figure 11: div$(\mathbf{E}^{(0)})$ and div$(\mathbf{E}^{(3)})$ for a non-diagonal rotation metric.

quarks have a spin of -1/2 and a charge of -1/3 e. The quarks do not exist as single particles but only in combinations that give charges of 0 or $\pm e$ and constitute the "strong nuclear force".

All quark groups are classified by symmetry properties. This justifies the assumption that the origin of the charge and spin of elementary particles lies in the geometry. The rotation of a spherically symmetric spacetime creates six basic geometrical forms that are indicated by the structure of the polarization vectors of force fields or, alternatively, their curl vectors.

Quarks cannot be observed directly, but only through the collision of elementary particles and subsequent investigation of their decay products, which are other particles. Therefore, it is reasonable to assume that the origin of the charge and mass of elementary particles lies in the geometry. A single spherically symmetric spacetime cannot be split into fragments. This corresponds to the fact that quarks cannot be observed alone.

The Standard Model for elementary particles is phenomenological, although it is prettied up with a bit of group theory. In contrast to this, all aspects of the centrally symmetric spacetime of ECE theory are completely defined by the unified field. So far, this ECE appraoch is a semiclassical model, since no quantization has been introduced, but the essential results already compare well with the empirical findings. Strong and weak nuclear forces are not required, and gravitation has already been reduced to a special case of electromagnetism in an earlier paper [6]. What is left is the electric charge, and this, the ultimate mystery of physics, is now being shown to be an effect of rotating spacetime, or the aether, itself.

A complete replacement of "quarks" as the building blocks of elementary particles would require the charge that the polarization states create to be determined, and this is not possible analytically because of the complexity of the divergence expressions. The spin of quarks is quantized; therefore, the further development of this theory would require a form of quantization to be introduced. In the ECE UFT papers, we quantized the operators in the wave equation, for example, and interpreted the tetrads as wave functions. The solutions of the wave equation then provided the desired quantum states. In the cases discussed in this paper, the tetrads are known a priori, thus a direct quantization of angular momentum could be possible.

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