# Positive, Neutral and Negative Mass-Charges in General Relativity

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As shown, any four-dimensional proper vector has two observable projections onto time line, attributed to our world and the mirror world (for a mass-bearing particle, the projections posses are attributed to positive and negative mass-charges). As predicted, there should be a class of neutrally mass-charged particles that inhabit neither our world nor the mirror world. Inside the space-time area (membrane) the space rotates at the light speed, and all particles move at as well the light speed. So, the predicted particles of the neutrally mass-charged class should seem as light-like vortices.

## 1 Problem statement

As known, neutrosophy is a new branch of philosophy which extends the current dialectics by the inclusion of neutralities. According to neutrosophy [1, 2, 3], any two opposite entities <A> and <Anti-A> exist together with a whole class of neutralities <Neut-A>.

Neutrosophy was created by Florentin Smarandache and then applied to mathematics, statistics, logic, linguistic, and other branches of science. As for geometry, the neutrosophic method expanded the Euclidean set of axioms by denying one or more of them in at least two distinct ways, or, alternatively, by accepting one or more axioms true and false in the same space. As a result, it was developed a class of Smarandache geometries [4], that includes Euclidean, Riemann, and Lobachevski-Gauss-Bolyai geometries as partial cases.

In nuclear physics the neutrosophic method theoretically predicted "unmatter", built on particles and anti-particles, that was recently observed in CERN and Brookhaven experiments (see [5, 6] and References there). In General Relativity, the method permits the introduction of entangled states of particles, teleportation of particles, and also virtual particles [7], altogether known before in solely quantum physics. Aside for these, the method permits to expand the basic space-time of General Relativity (the four-dimensional pseudo-Riemannian space) by a family of spaces where one or more space signature conditions is permitted to be both true and false [8].

In this research we consider another problem: mass-charges of particles. Rest-mass is a primordial property of particles. Its numerical value remains unchanged. On the contrary, relativistic mass has "charges" dependent from relative velocity of particles. Relativistic mass displays itself in only particles having interaction. Therefore theory considers relativistic mass as mass-charge.

Experimental physics knows two kinds of regular particles. Regular mass-bearing particles possessing non-zero rest-masses and relativistic masses (masses-in-motion). Massless light-like particles (photons) possess zero rest-masses, while their relativistic masses are non-zeroes. Particles of other classes (as virtual photons, for instance) can be considered as changed states of mass-bearing or massless particles.

Therefore, following neutrosophy, we do claim:

Aside for observed positively mass-charged (i. e. mass-bearing) particles and neutrally mass-charged (light-like) particles, there should be a third class of "negatively" mass-charged particles unknown in today's experimental physics.

We aim to establish such a class of particles by the methods of General Relativity.

## 2 Two entangled states of a mass-charge

As known, each particle located in General Relativity's space-time is characterized by its own four-dimensional impulse vector. For instance, for a mass-bearing particle the proper impulse vector $P^\alpha$ is

$$P^\alpha = m_0 \frac{dx^\alpha}{ds}\,, \quad P_\alpha P^\alpha = 1\,, \quad \alpha = 0,1,2,3\,, \tag{1}$$

where $m_0$ is the rest-mass of this particle. Any vector or tensor quantity can be projected onto an observer's time line and spatial section. Namely the projections are physically observable quantities for the observer [9]. As recently shown [10, 11], the four-dimensional impulse vector (1) has two projections onto the time line*

$$\frac{P_0}{\sqrt{g_{00}}} = \pm\, m\,, \qquad \text{where } m = \frac{m_0}{\sqrt{1 - \mathrm{v}^2/c^2}}\,, \tag{2}$$

and solely the projection onto the spatial section

$$P^i = \frac{m}{c}\,\mathrm{v}^i = \frac{1}{c}\,p^i, \quad \text{where } \mathrm{v}^i = \frac{dx^i}{d\tau}\,, \quad i = 1,2,3\,, \tag{3}$$

where $p_i$ is the three-dimensional observable impulse. Therefore, we conclude:

*Where $d\tau = \sqrt{g_{00}}\,dt + \frac{g_{0i}}{c\sqrt{g_{00}}}\,dx^i$ is the properly observed time interval [9, 12].

> Any mass-bearing particle, having two time projections, exists in two observable states, entangled to each other: the positively mass-charged state is observed in our world, while the negatively mass-charged state is observed in the mirror world.

The mirror world is almost the same that ours with the following differences:

1. The particles bear negative mass-charges and energies;
2. "Left" and "right" have meanings opposite to ours;
3. Time flows oppositely to that in our world.

From the viewpoint of an observer located in the mirror world, our world will seem the same that his world for us.

Because both states are attributed to the same particle, and entangled, both our world and the mirror world are two entangled states of the same world-object.

To understand why the states remain entangled and cannot be joined into one, we consider the third difference between them — the time flow.

Terms "direct" and "opposite" time flows have a solid mathematical ground in General Relativity. They are connected to the sign of the derivative of the coordinate time interval by the proper time interval . The derivative arrives from the purely geometrical law that the square of a unit four-dimensional vector remains unchanged in a four-dimensional space. For instance, the four-dimensional velocity vector

$$U^{\alpha}U_{\alpha} = g_{\alpha\beta}\, U^{\alpha}U^{\beta} = 1\,, \qquad U^{\alpha} = \frac{dx^{\alpha}}{ds}\,. \tag{4}$$

Proceeding from by-component notation of this formula, and using $\mathrm{w} = c^2(1-\sqrt{g_{00}})$ and $v_i = -c\frac{g_{0i}}{\sqrt{g_{00}}}$, we arrive to a square equation

$$\left(\frac{dt}{d\tau}\right)^2 - \frac{2v_i\mathrm{v}^i}{c^2\left(1-\frac{\mathrm{w}}{c^2}\right)}\frac{dt}{d\tau} + \\ + \frac{1}{\left(1-\frac{\mathrm{w}}{c^2}\right)^2}\left(\frac{1}{c^4}\,v_i v_k \mathrm{v}^i\mathrm{v}^k - 1\right) = 0\,, \tag{5}$$

which solves with two roots

$$\left(\frac{dt}{d\tau}\right)_{1,2} = \frac{1}{1-\frac{\mathrm{w}}{c^2}}\left(\frac{1}{c^2}\,v_i\mathrm{v}^i \pm 1\right). \tag{6}$$

Observer's proper time lows anyhow directly $d\tau > 0$, because this is a relative effect connected to the his viewpoint at clocks. Coordinate time $t$ flows independently from his views. Accordingly, the direct flow of time is characterized by the time function $dt/d\tau > 0$, while the opposite flow of time is $dt/d\tau < 0$.

If $dt/d\tau = 0$ happens, the time flow stops. This is a boundary state between two entangled states of a mass-charged particle, one of which is located in our world (the positively directed time flow $dt/d\tau > 0$), while another — in the mirror world (where the time flow is negatively directed $dt/d\tau < 0$).

From purely geometric standpoints, the state $dt/d\tau = 0$ describes a space-time area, which, having special properties, is the boundary space-time membrane between our world and the mirror world (or the mirror membrane, in other word). Substituting $dt/d\tau = 0$ into the main formula of the space-time interval $ds^2 = g_{\alpha\beta}\,dx^{\alpha}dx^{\beta}$

$$ds^2 = c^2dt^2 + 2g_{0i}c\,dt\,dx^i + g_{ik}\,dx^i dx^k, \tag{7}$$

we obtain the metric of the space within the area

$$ds^2 = g_{ik}\,dx^i dx^k. \tag{8}$$

So, the mirror membrane between our world and the mirror world has a purely spatial metric which is also stationary.

As Kotton showed [13], any three-dimensional Riemannian space permits a holonomic orthogonal reference frame, in respect to which the three-dimensional metric can be reduced to the sum of Pythagorean squares. Because our initially four-dimensional metric $ds^2$ is sign-alternating with the signature $(+---)$, the three-dimensional metric of the mirror membrane between our world and the mirror world is negatively defined and has the form

$$ds^2 = -H_1^2(dx^1)^2 - H_2^2(dx^2)^2 - H_3^2(dx^3)^2, \tag{9}$$

where $H_i\,(x^1, x^2, x^3)$ are Lamé coefficients (see for Lamé coefficients and the tetrad formalism in [14]). Determination of this metric is connected to the proper time of observer, because we mean therein.

Substituting $dt = 0$ into the time function (6), we obtain the physical conditions inside the area (mirror membrane)

$$v_i\,dx^i = \pm c^2 d\tau\,. \tag{10}$$

Owning the definition of the observer's proper time

$$d\tau = \sqrt{g_{00}}\,dt + \frac{g_{0i}\,dx^i}{\sqrt{g_{00}}} = \left(1-\frac{\mathrm{w}}{c^2}\right)dt - \frac{1}{c^2}\,v_i dx^i, \tag{11}$$

and using $dx^i = v^i d\tau$ therein, we obtain: the observer's proper state $d\tau > 0$ can be satisfied commonly with the state $dt = 0$ inside the membrane only if there is*

$$v_i\mathrm{v}^i = -c^2 \tag{12}$$

thus we conclude:

> The space inside the mirror membrane between our world and the mirror world seems as the rotating at the light speed, while all particles located there move at as well the light speed. So, particles that inhabit the space inside the membrane seem as light-like vortices.

*Here is a vector product of two vectors $v_i$ and $\mathrm{v}^i$, dependent on the cosine between them (which can be both positive and negative). Therefore the modules may not be necessarily imaginary quantities.

| Class of mass-charge | Particles | Energies | Class of motion | Area |
|---|---|---|---|---|
| Positive mass-charges, $m > 0$ | mass-bearing particles | $E > 0$ | move at sub-light speeds | our world |
| Neutral mass-charges, $m = 0$ | massless (light-like) particles | $E > 0$ | move at the light speed | our world |
| | light-like vortices | $E = 0$ | move at the light speed within the area, rotating at the light speed | the membrane |
| | massless (light-like) particles | $E < 0$ | move at the light speed | the mirror world |
| Negative mass-charges, $m < 0$ | mass-bearing particles | $E < 0$ | move at sub-light speeds | the mirror world |

This membrane area is the "barrier", which prohibits the annihilation between positively mass-charged particles and negatively mass-charged particles — the barrier between our world and the mirror world. In order to find its mirror twin, a particle should be put in an area rotating at the light speed, and accelerated to the light speed as well. Then the particle penetrates into the space inside the membrane, where annihilates with its mirror twin.

As a matter of fact, no mass-bearing particle moved at the light speed: this is the priority of massless (light-like) particles only. Therefore:

> Particles that inhabit the space inside the membrane seem as light-like vortices.

Their relativistic masses are zeroes $m = 0$ as those of massless light-like particles moving at the light speed. However, in contrast to light-like particles whose energies are non-zeroes, the particles inside the membrane possess zero energies $E = 0$ because the space metric inside the membrane (8) has no time term.

The connexion between our world and the mirror world can be reached by matter only filled in the light-like vortical state.

## 3 Two entangled states of a light-like matter

As known, each massless (light-like) particle located in General Relativity's space-time is characterized by its own four-dimensional wave vector

$$K^\alpha = \frac{\omega}{c}\frac{dx^\alpha}{d\sigma}\,, \qquad K_\alpha K^\alpha = 0\,, \tag{13}$$

where $\omega$ is the proper frequency of this particle linked to its energy $E = \hbar\omega$, and $d\sigma = \left(-g_{ik} + \frac{g_{0i}g_{0k}}{g_{00}}\right)dx^i dx^k$ is the measured spatial interval. (Because massless particles move along isotropic trajectories, the trajectories of light, one has $ds^2 = 0$, however the measured spatial interval and the proper interval time are not zeroes.)

As recently shown [10, 11], the four-dimensional wave vector has as well two projections onto the time line

$$\frac{K_0}{\sqrt{g_{00}}} = \pm\,\omega\,, \tag{14}$$

and solely the projection onto the spatial section

$$K^i = \frac{\omega}{c}\,c^i = \frac{1}{c}\,p^i, \quad \text{where } c^i = \frac{dx^i}{d\tau}\,, \tag{15}$$

while $c^i$ is the three-dimensional observable vector of the light velocity (its square is the world-invariant $c^2$, while the vector's components $c^i$ can possess different values). Therefore, we conclude:

> Any massless (light-like) particle, having two time projections, exists in two observable states, entangled to each other: the positively energy-charged state is observed in our world, while the negatively energy-charged state is observed in the mirror world.

Because along massless particles' trajectories $ds^2 = 0$, the mirror membrane between the positively energy-charged massless states and their entangled mirror twins is characterized by the metric

$$ds^2 = g_{ik}\,dx^i dx^k = 0\,, \tag{16}$$

or, expressed with Lamé coefficients $H_i\,(x^1, x^2, x^3)$,

$$ds^2 = -H_1^2(dx^1)^2 - H_2^2(dx^2)^2 - H_3^2(dx^3)^2 = 0\,. \tag{17}$$

As seen, this is a particular case, just considered, the membrane between the positively mass-charged and negatively mass-charge states.

## 4 Neutrosophic picture of General Relativity's world

As a result we arrive to the whole picture of the world provided by the purely mathematical methods of General Relativity, as shown in Table.

It should be noted that matter inside the membrane is not the same as the so-called zero-particles that inhabit fully degenerated space-time areas (see [15] and [8]), despite the fact they posses zero relativistic masses and energies too. Fully degenerate areas are characterized by the state $\mathrm{w} + v_i u^i = c^2$ as well as particles that inhabit them*. At first, inside the membrane the space is regular, non-degenerate. Second. Even in the absence of gravitational fields, the zero-space state becomes $v_i u^i = c^2$ that cannot be trivially reduced to $v_i u^i = -c^2$ as inside the membrane.

*Here $u^i = dx^i/dt$ is so-called the coordinate velocity.

Particles inside the membrane between our world and the mirror world are filled into a special state of light-like vortices, unknown before.

This is one more illustration to that, between the opposite states of positively mass-charge and negatively mass-charge, there are many neutral states characterized by “neutral” mass-charge. Probably, further studying light-like vortices, we’d find more classes of neutrally mass-charged states (even, probably, an infinite number of classes).

### References


1. Smarandache F. Neutrosophy/neutrosophic probability, set, and logic. American Research Press, Rehoboth, 1998.
2. Smarandache F. A unifying field in logic: neutrosophic logic. Neutrosophy, neutrosophic set, neutrosophic probability. 3rd ed., American Research Press, Rehoboth, 2003.
3. Smarandache F. and Liu F. Neutrosophic dialogues. Xiquan Publishing House, Phoenix, 2004.
4. Iseri H. Smarandache manifolds. American Research Press, Rehoboth, 2002.
5. Smarandache F. A new form of matter — unmatter, composed of particles and anti-particles. *Progress in Physics*, 2005, v. 1, 9–11.
6. Smarandache F. and Rabounski D. Unmatter entities inside nuclei, predicred by the Brightsen Nucleon Cluster Model. *Progress in Physics*, 2006, v. 1, 14–18.
7. Rabounki D., Borissova L., Smarandache F. Entangled particles and quantum causality threshold in the General Theory of Relativity. *Progress in Physics*, 2005, v. 2, 101–107.
8. Rabounki D., Smarandache F., Borissova L. Neutrosophic methods in General Relativity. Hexis, Phoenix (Arizona), 2005.
9. Zelmanov A. L. Chronometric invariants and co-moving coordinates in the general relativity theory. *Doklady Acad. Nauk USSR*, 1956, v. 107(6), 815–818.
10. Borissova L. and Rabounski D. Fields, vacuum, and the mirror Universe. Editorial URSS, Moscow, 2001, 272 pages (2nd rev. ed.: CERN, EXT-2003-025).
11. Rabounski D. D. and Borissova L. B. Particles here and beyond the Mirror. Editorial URSS, Moscow, 2001, 84 pages.
12. Landau L. D. and Lifshitz E. M. The classical theory of fields. GITTL, Moscow, 1939 (ref. with the 4th final exp. edition, Butterworth-Heinemann, 1980).
13. Kotton E. Sur les variétés a trois dimensions. *Ann. Fac. Sci. Toulouse* (2), v. 1, Thése, Paris, 1899.
14. Petrov A. Z. Einstein spaces. Pergamon, Oxford, 1969.
15. Borissova L. and Rabounski D. On the possibility of instant displacements in the space-time of General Relativity. *Progress in Physics*, 2005, v. 1, 17–19; Also in: *Physical Interpretation of Relativity Theory* (PIRT-2005), Proc. of the Intern. Meeting., Moscow, 2005, 234–239; Also in: *Today’s Take on Einstein’s Relativity*, Proc. of the Confer., Tucson (Arizona), 2005, 29–35.