Basic Concept of 3-Dimensional Spiral String Theory (3D-SST)

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According to the 3-Dimensional Spiral String Theory (3D-SST), at the core of the universe are two polarized spacetime spiral string entities called *toryces* and *helyces* that form elementary mass and radiation particles respectively. Polarization of toryces is a result of a topological inversion of their spacetimes that enables them to absorb and release energy. Elementary mass particles are created from toryces by following the universal conservation laws. Helyces are created when their parental toryces are transferred from higher to lower quantum energy states. Depending on the type of their parental toryces, the helyces form elementary radiation particles having various frequencies and propagating at either luminal or superluminal velocities. The radiation particles are responsible for exchange of energy and communication between the matter particles. Physical properties of toryces and helyces are directly related to their spacetime properties. The theory requires a new interpretation of zero, number line and trigonometry.

1. Spacetime Parameters of Toryx

Spiral structure of elementary particles was a subject of several serious scientific investigations [1-17]. According to the 3-Dimensional Spiral String Theory (3D-SST) [18-33], at the core of the universe are two polarized spacetime spiral string entities called *toryces* and *helyces* that form elementary mass and radiation particles respectively. Polarization of toryces is a result of a topological inversion of their spacetimes that enables them to absorb and release energy. Elementary mass particles are created from toryces by following the universal conservation laws. Helyces are created when their parental toryces are transferred from higher to lower quantum energy states. Depending on the type of their parental toryces, the helyces form elementary radiation particles having various frequencies and propagating at either luminal or superluminal velocities. The radiation particles are responsible for exchange of energy and communication between the matter particles. Physical properties of toryces and helyces are directly related to their spacetime properties. The theory requires a new interpretation of zero, number line and trigonometry.

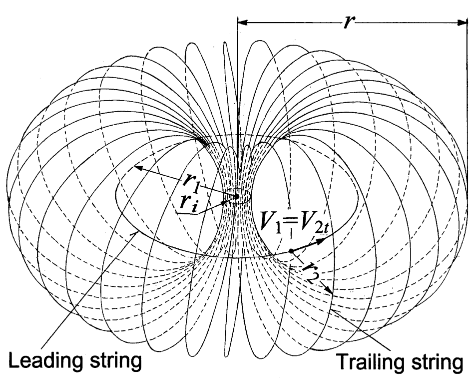

Fig. 1. Spacetime parameters of toryx

Toryx is a spacetime spiral string element containing a double-circular leading string with the radius r_1 and a double-toroidal trailing string with the radius r_2 (Fig. 1). The other spacetime parameters of the toryx shown in Fig. 1 are:

r = toryx outer radius
r_i = radius of real inversion toryx
φ_2 = steepness angle of trailing string
V_1 = spiral (circular) velocity of leading string
V_{2r} = rotational velocity of trailing string
V_{2t} = translational velocity of trailing string
V_2 = spiral velocity of trailing string.

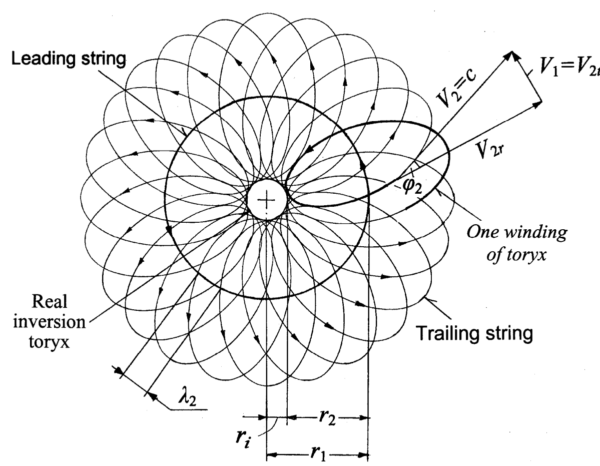

Fig. 2. Plan view of toryx

Length of one winding of trailing string	$L_2 = L_1$	(1)
Inversion radius of real inversion toryx	$r_i = r_1 - r_2 = \text{const}.$	(2)
Spiral velocity of trailing string	$V_2 = \sqrt{V_{2r}^2 + V_{2t}^2} = c = \text{const}.$	(3)

Table 1. Toryx fundamental spacetime equations

When $r_1 = r_i$, toryx reduces to the *real inversion toryx*. This is a circular string (Fig. 2) propagating with the velocity of light c. The toryx spacetime parameters are based on three fundamental equations shown in Table 1. Equation (1) stipulates that the length of one winding of trailing string L_2 is equal to the spiral length of one winding of leading string L_1. Equation (2) establishes that a difference between radii of leading string r_1 and trailing string r_2 is equal to the radius of real inversion toryx r_i that is assumed to be constant. Equation (3) expresses a proposition that the spiral velocity of trailing string V_2 is equal to the velocity of light in the vacuum c that is constant. It is very important to notice that Eq. (3) sets no limits for the values of the two components of the spiral velocity V_2: the rotational velocity V_{2r} and the translational velocity V_{2t}. Any one of them can be superluminal making the other one imaginary to satisfy Eq. (3).

In the diagrams shown in Figure 3 the spacetime parameters of the toryx leading and trailing strings form the sides of right triangles, allowing one to establish the relationships between these parameters by using the Pythagorean Theorem.

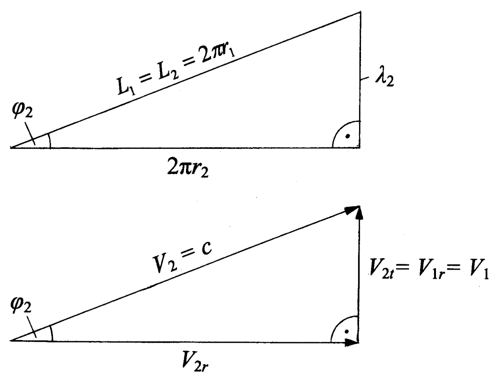

Fig. 3. Spacetime parameters of a toryx

Since the radius of real inversion string r_i and the spiral velocity of trailing string V_2 are constant, we can identify two more parameters of the real inversion string that are also constant. They are the frequency f_i and the cycle time t_i of the real inversion toryx expressed by the equations.

$$f_i = \frac{c}{2\pi r_i} = \text{const}. \tag{4}$$

$$t_i = \frac{2\pi r_i}{c} = \text{const}. \tag{5}$$

Consequently, we can express the toryx spacetime parameters in relative terms in respect to the four constant parameters: r_i, f_i, t_i, and c. Equations (1) – (5) allows one to derive equations for all spacetime parameters of a toryx when the relative radius of its leading string $b_1 = r_1/r_i$ varies from negative to positive infinity.

2. Derivative Spacetime Equations of Toryx

Tables 2 and 3 show derivative equations for relative spacetime parameters of the toryx leading and trailing strings. These parameters correspond to the middle point a of trailing string (Fig. 4).

Parameter	Equation	
Relative spiral length	$l_1 = \frac{L_1}{2\pi r_i} = b_1$	(6)
Relative radius	$b_1 = \frac{r_1}{r_i}$	(7)
Relative velocity	$\beta_1 = \frac{V_1}{c} = \pm\frac{\sqrt{2b_1 - 1}}{b_1}$	(8)
Relative frequency	$\delta_1 = \frac{f_1}{f_i} = \pm\frac{\sqrt{2b_1 - 1}}{b_1^2}$	(9)
Relative cycle time	$\tau_1 = \frac{t_1}{t_i} = \pm\frac{b_1^2}{\sqrt{2b_1 - 1}}$	(10)

Table 2. Relative spacetime parameters of leading string as a function of the relative radius of leading string b_1

Parameter	Equation	
Relative radius	$b_2 = \frac{r_2}{r_i} = b_1 - 1$	(11)
The number of windings	$w_2 = \frac{b_1}{\sqrt{2b_1 - 1}}$	(12)
Relative volume	$u_2 = \frac{U_2}{2\pi^2 r_i^3} = b_1(b_1 - 1)^2$	(13)
Relative wavelength	$\eta_2 = \frac{\lambda_2}{2\pi r_i} = \pm\sqrt{2b_1 - 1}$	(14)
Relative spiral velocity	$\beta_2 = \frac{V_2}{c} = \sqrt{\beta_{2r}^2 + \beta_{2t}^2} = 1$	(15)
Relative rotational velocity	$\beta_{2r} = \frac{V_{2r}}{c} = \frac{b_1 - 1}{b_1}$	(16)
Relative translational velocity	$\beta_{2t} = \frac{V_{2t}}{c} = \pm\frac{\sqrt{2b_1 - 1}}{b_1}$	(17)
Steepness angle	$\cos u(\phi_2) = \frac{b_1 - 1}{b_1}$	(18)
Relative frequency	$\delta_2 = \frac{f_2}{f_i} = \frac{1}{b_1}$	(19)
Relative cycle time	$\tau_2 = \frac{t_2}{t_i} = b_1$	(20)

Table 3. Relative spacetime parameters of trailing string at a middle point as a function of the relative radius of leading string b_1

In Table 3, $\cos u(\varphi_2)$ is the *universal cosine* that relates to a conventional $\cos(\varphi_2)$ by the equations:

$$\cos u(\phi_2) = \cos(\phi_2) \quad (0^0 < \phi_2 < 180^0) \tag{21}$$

$$\cos u(\phi_2) = \cos^{-1}(\phi_2) \quad (180^0 < \phi_2 < 360^0) \tag{22}$$

The toryx relative outer radii b is equal to:

$$b = 2b_1 - 1 \tag{23}$$

Below is the nomenclature for the parameters of derived equations.

l_1 = relative spiral (circular) length of leading string
l_2 = relative spiral length of trailing string
b_1 = relative radius of leading string
b_2 = relative radius of trailing string
b = toryx relative outer radius
β_1 = relative spiral (circular) velocity of leading string
β_2 = relative spiral velocity of trailing string

β_{2r} = relative rotational velocity of trailing string
β_{2t} = relative translational velocity of trailing string
f_1 = frequency of leading string
f_2 = frequency of trailing string
δ_1 = relative frequency of leading string
δ_2 = relative frequency of trailing string
t_1 = cycle time of leading string
t_2 = cycle time of trailing string
τ_1 = relative cycle time of leading string
τ_2 = relative cycle time of trailing string
w_2 = the number of windings of trailing string
λ_2 = wavelength of trailing string
η_2 = relative wavelength of trailing string
U_2 = volume of trailing string
u_2 = relative volume of trailing string.

Inner velocities *at point a′*	**Outer velocities** *at point a″*
$\beta_{2t}^{in} = \frac{\sqrt{2b_1 - 1}}{b_1^2}$ (24)	$\beta_{2t}^{out} = \frac{(2b_1 - 1)^{3/2}}{b_1^2}$ (25)
$\beta_{2r}^{in} = \frac{\sqrt{b_1^4 - 2b_1 + 1}}{b_1^2}$ (26)	$\beta_{2r}^{out} = \frac{\sqrt{b_1^4 - (2b_1 - 1)^3}}{b_1^2}$ (27)
$\beta_{2t}^{in} > 1$ $0.544 < b_1 < 1.0$	$\beta_{2t}^{out} > 1$ $1.0 < b_1 < 6.222$

Table 4. Relative peripheral velocities of trailing string

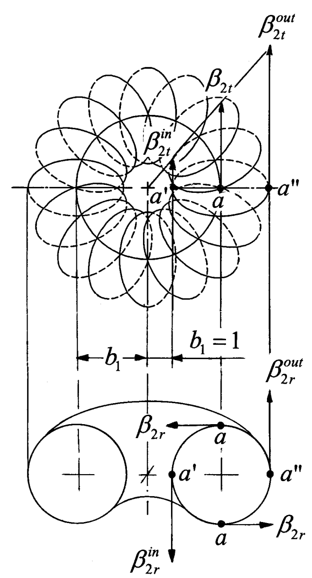

Fig. 4. Trends of translational and rotational velocities of trailing string

To maintain integrity of the toryx, the translational velocity of its trailing string β_{2t} must increase proportionally with the distance from the toryx center as illustrated in Fig. 4. Table 4 shows equations for peripheral velocities of the toryx trailing string. It also shows the ranges of the relative radii of leading string b_1 within which either the relative inner translation velocity β_{2t}^{in} or the relative outer translational velocity β_{2t}^{out} are greater than 1, so their absolute values exceed the velocity of light c and become *superluminal*.

3. Universal Law of Motion

As follows from Eq. (8), the relationship between the relative spiral velocity of leading string β_1 and the relative radius of leading string b_1 is given by the equation:

$$\beta_1 = \frac{V_1}{c} = \frac{\sqrt{2b_1 - 1}}{b_1} \qquad (28)$$

Notably, the toryx leading string follows a more general law of motion than the classical law of motion applied to the planets and atomic electrons. The classical law can be derived from Eq. (28) by assuming that $b_1 >> 1$:

$$\beta_1 = \sqrt{\frac{2}{b_1}} \qquad (29)$$

Figure 5 shows plots of Eqs. (28) and (29). When $b_1 > 20$, the difference between the calculated values of β_1 from the universal and classical laws of motion becomes very small and it continues to decrease as b_1 increases. As b_1 decreases from 20 to 2, this difference progressively increases. According to the classical law of motion, as b_1 decreases from 2 to 0, β_1 sharply increases and approaches the positive infinity $(+\infty)$.

The universal law of motion, however, yields a completely different trend of β_1 within the same range of b_1. Here β_1 initially increases and then, after reaching its maximum value of 1 (corresponding to the velocity of light c) at $b_1 = 1$, it sharply decreases and approaches the positive *infinility* $(+0)$ that is the inverse of positive infinity $(+\infty)$.

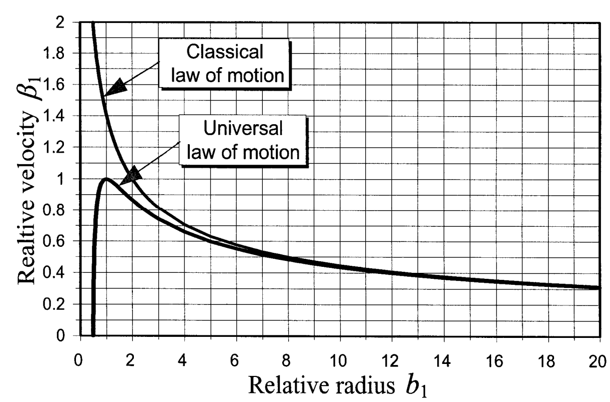

Fig. 5. Universal law of motion versus classical law of motion as a function of the relative radius of leading string b_1.

4. Two Kinds of Polarization of Toryces

Toryces are polarized by their vorticity and reality. The *toryx vorticity V* is equal to the ratio of the radii of the toryx trailing and leading strings. It is also equal to the relative rotational velocity of trailing string β_{2r} as given by the equation:

$$V = \frac{r_2}{r_1} = \frac{b_1 - 1}{b_1} = \beta_{2r} = \cos u(\phi_2) \qquad (30)$$

Figure 6 uses a circular *universal number line* to present the toryx vorticity V as a function of the steepness angle of trailing string φ_2. Toryces with the positive vorticity V are called *positive* and with the negative vorticity V *negative*.

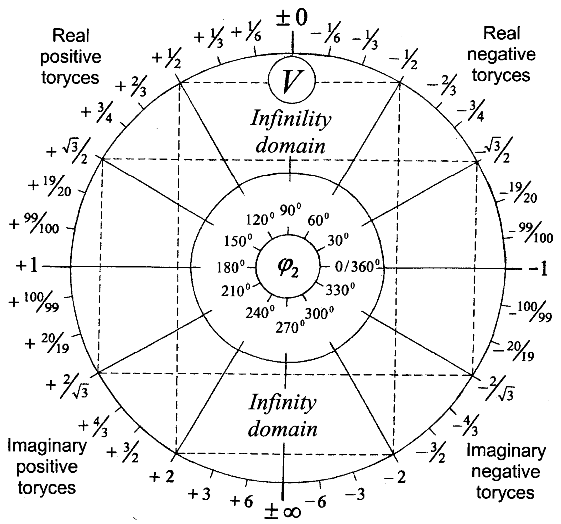

Fig. 6. Toryx vorticity V

Figure 7 uses a circular universal number line to present the toryx reality R as a function of the steepness angle of trailing string φ_2. Toryces with the real reality R are called *real* and with the imaginary reality R *imaginary*.

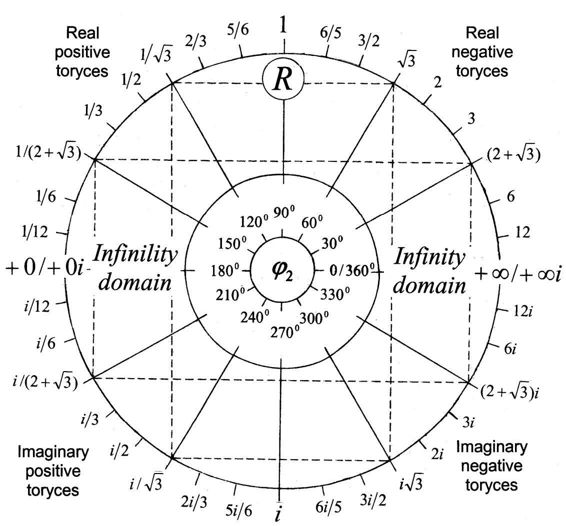

Fig. 7. Toryx reality R.

The toryx reality R defines the reality of the toryx spacetime parameters. In a real toryx all its spacetime parameters related to the middle of its trailing string are expressed with the real numbers, while in the imaginary toryx some of these parameters are expressed with the imaginary numbers. The toryx reality R is equal to the square root of the relative outer toryx radius b as expressed by the equation:

$$R = \sqrt{b} = \sqrt{\frac{1+\cos u(\phi_2)}{1-\cos u(\phi_2)}} \qquad (31)$$

In the universal number line shown in Fig. 6 we can identify two ranges of the toryx vorticity V. The first range, called the *infinility domain*, occupies two top quadrants symmetrical in respect to the infinility (± 0). The second range, called the *infinity domain*, occupies two bottom quadrants symmetrical in respect to the infinity $(\pm\infty)$. We can also identify two similar domains in the universal number line (Fig. 7) representing the toryx reality R. Here the infinility domain occupies two left quadrants symmetrical in respect to the infinility $(+0/+0i)$, while the infinity domain occupies two right quadrants symmetrical in respect to the infinity $(+\infty/+\infty i)$. Remarkable, in both lines the infinity and infinility domains occupy the same space, and the numbers located in different quadrants are either reversely or inversely related to one another.

5. Metamorphoses of Toryx Topology

Figure 8 shows metamorphoses of the toryx topology in a circular diagram as a function of the steepness angle of trailing string φ_2.

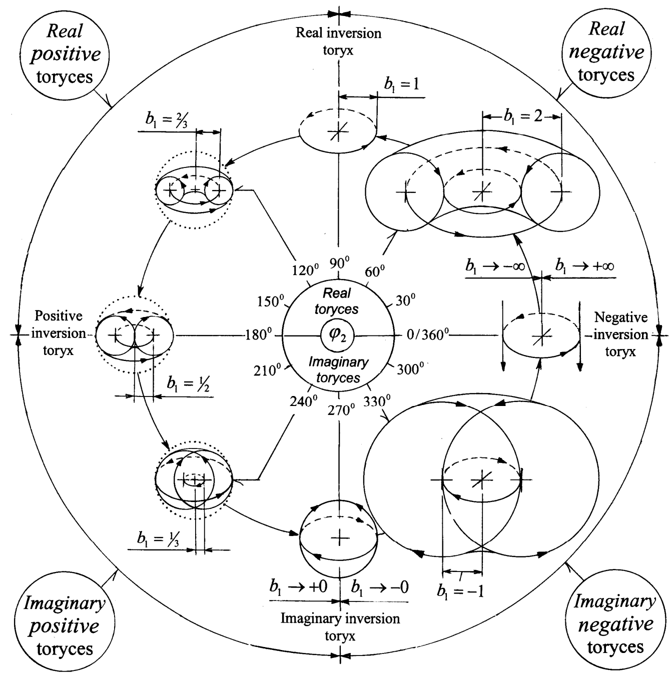

Fig. 8. Metamorphoses of the toryx topology as a function of the steepness angle of trailing string φ_2.

Real negative toryces – These toryces are located at the top right quadrant $(+0<\phi_2<\tfrac{1}{2}\pi)$, $(+\infty > b_1 > 1)$.

- At the beginning of this range the relative radii of leading strings b_1, the relative radius of trailing string b_2 and the number of windings w_2 approach the real positive infinity $(+\infty)$. Consequently, the trailing string appears as two infinitely long straight lines called the *negative inversion toryx*.
- As φ_2 increases and b_1 decreases, the relative radius of trailing string b_2 and the number of windings w_2 decrease. Consequently, the trailing string appears like a toroidal spiral. At the end of the range, the relative radius of trailing string b_2 approaches the real positive infinility (+0) and the number of windings reduces to one ($w_2 \to 1$). Consequently, the trailing string merges with the leading string and the toryx reduces to a circle with the relative radius $b_1 \to 1$, representing the *real inversion toryx*.

Real positive toryces - These toryces are located at the top left quadrant $(\tfrac{1}{2}\pi<\phi_2<\pi)$, $(1 > b_1 > \tfrac{1}{2})$.

- As the relative radius of leading string b_1 becomes less than 1 and continues to decrease, both the negative value of the relative radius of trailing string b_2 and the number of windings w_2 increase.
- At the end of the range, when $b_1 \to 0.5$ and $b_2 \to -0.5$, the inner parts of the toryx opposite windings began to touch one another and the toryx eye disappears. Consequently, the toryx reduces to the *positive inversion toryx.* In this toryx, the number of windings w_2 approaches the real positive infinity (+∞).

Imaginary positive toryces - These toryces are located at the bottom left quadrant $(\pi < \phi_2 < \tfrac{3}{2}\pi)$, $(\tfrac{1}{2} < b_1 < +0)$.

- At the beginning of this range, the number of windings w_2 approaches the imaginary negative infinity (-∞*i*). As soon as the relative radius of leading string b_1 becomes less than 0.5, the opposite parts of windings of trailing string begin to overlap with one another.
- As φ_2 increases and b_1 decreases, the negative value of the relative radius of trailing string b_2 increases and the imaginary number of windings w_2 decreases.
- At the end of the range, the relative radius of leading string b_1 approaches the real positive infinility (+0), the relative radius of trailing string $b_2 \to -1$, and the number of windings w_2 approaches the imaginary negative infinility (– 0*i*). Consequently, the toryx trailing string reduces to a circle called the *imaginary inversion toryx*. The imaginary inversion toryx is located in the plane perpendicular to the plane of the real inversion toryx.

Imaginary negative toryces - These toryces are located at the bottom right quadrant $(\tfrac{3}{2}\pi < \phi_2 < 2\pi)$, $(-0 < b_1 < -\infty)$.

- At the beginning of the range the sign of the relative radius of leading string b_1 becomes negative and the leading string becomes inverted, or turned inside out in respect to the imaginary inversion toryx. Consequently, the toryx appears as the imaginary inversion string in which the relative radius of leading string b_1 approaches the real negative infinility (-0), the relative radius of trailing string b_2 approaches – 1, while the number of windings w_2 approaches imaginary negative infinility (-0*i*).
- As the negative value of the relative radius of leading string b_1 increases, the negative values of the relative radius of trailing string b_2 also increase. The imaginary negative number of windings w_2 also increases.
- At the end of the range, the relative radius of trailing string b_2 approaches the real negative infinity (-∞) and the number of windings w_2 approaches the imaginary negative infinity (-∞*i*). At this point, the toryx reduces to the *negative inversion string.*

6. Physical Properties of Toryces

For the case when the effects of electric forces are negligibly small in comparison with the effects of gravity, the radius of real inversion string r_i and the frequency of the real inversion string f_i are given by the equations:

$$r_i = \frac{Ze_0^2}{8\pi\varepsilon_0 m_0 c^2} \tag{32}$$

$$f_i = \frac{4\varepsilon_0 m_0 c^3}{Ze_0^2} \tag{33}$$

In Eqs. (32) and (33):

Z = atomic number
ε_0 = electric constant
e_0 = elementary charge
m_0 = rest mass of electron

Toryx physical properties are directly related to their space-time properties. Table 5 shows equations for the toryx relative charge and mass as a function of the toryx vorticity V.

Relative toryx charge	$\frac{e}{e_0} = \frac{V}{2}$	(34)
Relative toryx inertial mass	$\frac{m_i}{m_0} = -\frac{V}{2}$	(35)
Relative toryx gravitational mass	$\frac{m_g}{m_0} = \frac{\lvert V\rvert}{2}$	(36)

Table 5. Equations for toryx relative charge and mass

The toryx exchange energy E_x defines the energy that the toryx either absorbs or releases. It is equal to the sum of its relative kinetic and potential energies, and is expressed by the equation:

$$E_x = -m_0 c^2 \frac{(b_1-1)(2b_1-1)}{2b_1^3} \tag{37}$$

Positive sign of E_x corresponds to the absorption of energy, while the negative sign the release of energy by the toryx. Most of toryces are able to perform only one part of a "breathing cycle" that is to either absorb or to release energy. These toryces are called *mutually-sustainable*, because they need partners to complete their breathing cycles. But some toryces, called *self-sustainable*, can do it by themselves. The relative radii of leading string b_1 of these toryces are defined by the equations shown in Table 4.

Table 6 shows equations for the toryx mechanical and magnetic properties. The toryx relative magnetic moments μ/μ_B and μ/μ_n are expressed respectively in respect to the Bohr magneton μ_B and to the nuclear magneton μ_n that are equal to:

$$\mu_B = \frac{e_0^3}{8\pi\alpha\varepsilon_0 m_0 c} \tag{38}$$

$$\mu_n = \frac{e_0^3}{8\pi\alpha\varepsilon_0 m_p c} \tag{39}$$

In Eqs. (38) and (39):

a = fine structure constant
m_p = proton mass

Toryx relative density	$\rho_r = \rho\frac{4\pi^2 r_i^3}{m_0} = \frac{\lvert(b_1-1)\rvert}{b_1^2(b_1-1)^2}$	(40)

Toryx relative Young's modulus of elasticity	$Y_r = Y\dfrac{4\pi^2 r_i^3}{m_0 c^2} = \dfrac{2b_1 - 1}{b_1^4 \lvert b_1 - 1 \rvert}$	(41)
Real toryx relative Bohr magnetic moment	$\mu / \mu_B = \pm\dfrac{Z\alpha(b_1 - 1)\sqrt{2b_1 - 1}}{2b_1}$	(42)
Imaginary toryx relative Bohr magnetic moment	$\mu / \mu_B = \pm\dfrac{iZ\alpha(b_1 - 1)\sqrt{2b_1 - 1}}{2b_1}$	(43)

Table 6. Equations for toryx magnetic properties

7. Classification of Toryces

In previous sections we described four main groups of toryces, including:

- Real negative (outverted) toryces
- Real positive (inverted) toryces
- Imaginary positive (inverted) toryces
- Imaginary negative (outverted) toryces.

We use capital Latin letters for the symbols of toryces. The top superscripts indicate sign (and value wherever possible) of their charges. A "smiling cup" over the toryx symbols identifies the imaginary toryces.

As shown in Fig.9, real negative toryces are divided into the real negative a-toryces A^- and the real negative e-toryces E^-. The real positive toryces are divided into the real positive a-toryces A^+ and the real positive e-toryces E^+. The imaginary positive toryces are divided into the imaginary positive e-toryces $\breve{E}^+$ and the imaginary positive a-toryces $\breve{A}^+$. The imaginary negative toryces are divided into the imaginary negative a-toryces $\breve{A}^-$ and the imaginary negative e-toryces $\breve{E}^-$.

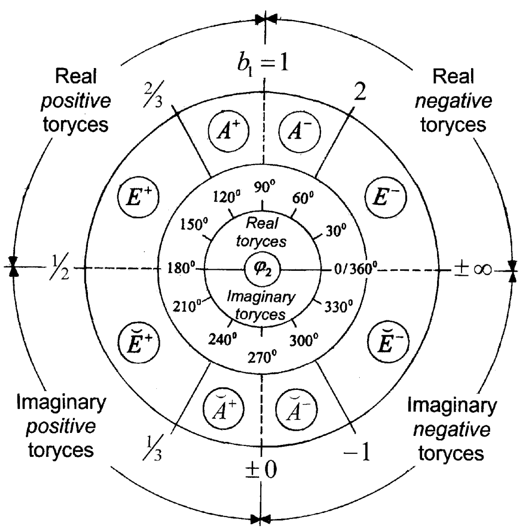

Fig. 9. Eight types of toryces

8. Quantum Energy States of Toryces

Toryces change their energy states in quantum steps by oscillation and excitation (Fig. 10).

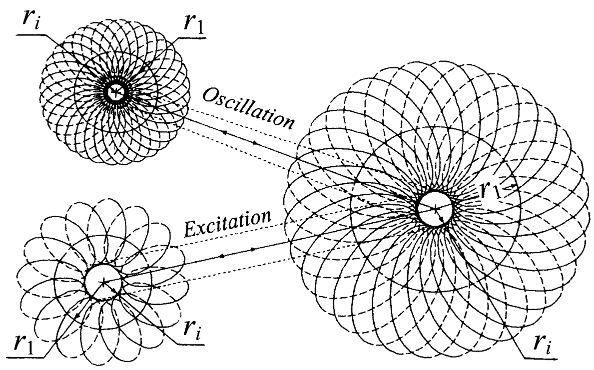

Fig. 10. Excitation and oscillation of toryces

Oscillated toryces - During the oscillation of a toryx the radius of real inversion toryx r_i changes inversely proportional to the *toryx oscillation factor* Q_p defined by the equation below.

$$Q_0 = 1$$
$$Q_p = 3\left(\frac{\Lambda_M}{2(p-1)}\right)^{p-1} = \frac{r_{i0}}{r_{ip}} \tag{44}$$

where p = 1, 2,…toryx oscillation quantum energy state Λ_M = matter level constant.

A plot of Eq. (44) appears as a bell-type curve (Fig. 11). The ratios of the toryx parameters at the oscillation quantum states $p > 0$ and $p = 0$ are given by the equation.

$$Q_p = \frac{r_{i0}}{r_{ip}} = \frac{f_{ip}}{f_{i0}} = \frac{m_{ip}}{m_{i0}} = \frac{m_{gp}}{m_{g0}} = \frac{\mu_0}{\mu_p} \tag{45}$$

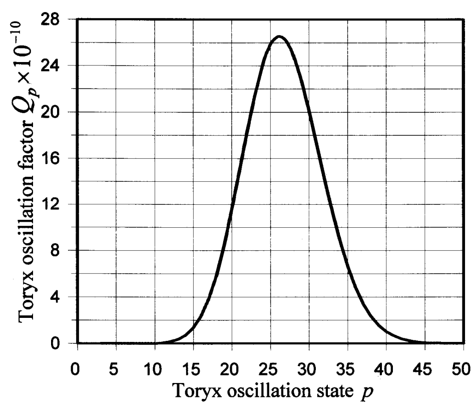

Fig. 11. Toryx oscillation factor Q_p as a function of the toryx oscillation state p

The matter level constant Λ_M is one of the major parameters defining the quantum energy states of excited toryces. It depends on the matter level M = 0, 1, 2,... Notably, for the ordinary matter M = 2. The matter level constant Λ_M is assumed to be related to the matter level M by the series:

$$\begin{aligned}
\Lambda_0 &= 2^0 = 1 \\
\Lambda_1 &= 2^1(1^1 + 2^1) = 6 \\
\Lambda_2 &= 2^2(1^2 + 2^2) + 3^2(2^2 + 3^2) = 137 \\
\Lambda_3 &= 2^3(1^3 + 2^3) + 3^3(2^3 + 3^3) + 4^3(3^3 + 4^3) = 6841
\end{aligned} \tag{46}$$

Excited toryces - During the excitation of a toryx, the radius of real inversion string r_i remains constant while the other toryx parameters change as a function of the radius of leading string r_1. Toryces can be excited either exponentially or harmonically. The relative radii of leading strings of exponentially-excited toryces b_1 are assumed to be a function of the *quantization parameter z*:

$$z = 2(n\Lambda_M)^m \quad (47)$$

where

m = 0, 1,… toryx exponential excitation quantum state
n = 0, 1,… toryx linear excitation quantum state.

In harmonic toryces m = 0. The frequencies of trailing strings of these toryces relate to one another by simple harmonic ratios, explaining their name.

9. Formation of Elementary Particles & Atoms

Each elementary particle, or a *tron*, is made up of two polarized matched toryces. There are two main types of trons, reality-polarized and charge-polarized (Fig. 12). We use the lowercase Latin letters for the symbols of trons.

Charge-polarized trons – Constituent toryces of the charge-polarized trons have opposite charges. Both these toryces can be either real or imaginary.

Reality-polarized trons – In the reality-polarized trons, one of the toryces is real while the other one is imaginary. The total charge of these trons can be either negative or positive.

Tron name	Tron type	Toryx	**Equation**	
Negative e-tron $e^-_{m,n,p}$	Reality-polarized	$E^-_{m,n,p}$	$b_1 = z$	(48)
		$\breve{E}^-_{m,n,p}$	$b_1 = 1 - z$	(49)
Positive e-tron $e^+_{m,n,p}$	Reality-polarized	$E^+_{m,n,p}$	$b_1 = \frac{z}{2z-1}$	(50)
		$\breve{E}^+_{m,n,p}$	$b_1 = \frac{z-1}{2z-1}$	(51)
Real a-tron $a^0_{m,n,p}$	Charge-polarized	$A^-_{m,n,p}$	$b_1 = \frac{z}{z-2}$	(52)
		$A^+_{m,n,p}$	$b_1 = \frac{z}{z+2}$	(53)
Imaginary a-tron $\breve{a}^0_{m,n,p}$	Charge-polarized	$\breve{A}^-_{m,n,p}$	$b_1 = \frac{1}{1-z}$	(54)
		$\breve{A}^+_{m,n,p}$	$b_1 = \frac{1}{1+z}$	(55)

Table 6. Equations for quantum energy states of matched exponentially-excited toryces forming trons

The magnitude of any physical property of a tron is equal to a sum of magnitudes of respective properties of its constituent toryces. Table 6 shows equations for quantum energy states of matched exponentially-excited toryces forming the trons. Figure 11 shows schematically formation of elementary particles e-trons and a-trons.

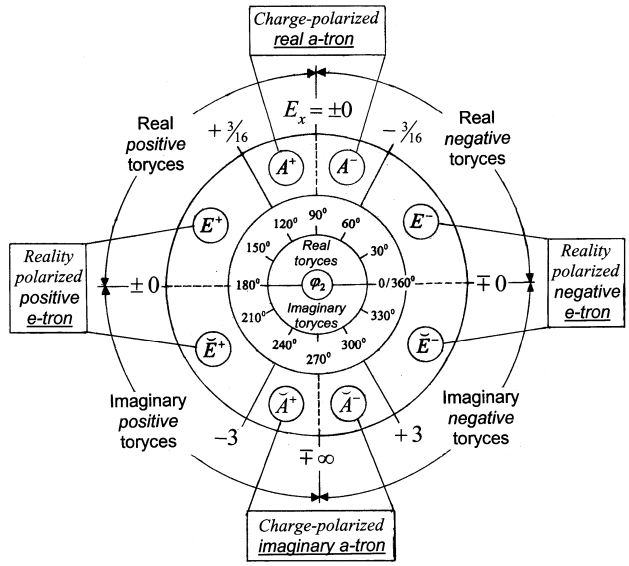

Fig. 12. Formation of e-trons and a-trons

E-trons – Negative and positive e-trons are formed from real and imaginary matched toryces according to the equations:

$$e^{-1}_{m,n,p} = E^-_{m,n,p} + \breve{E}^-_{m,n,p} \quad (56)$$

$$e^{+1}_{m,n,p} = E^+_{m,n,p} + \breve{E}^+_{m,n,p} \quad (57)$$

Negative e-trons reveal themselves as conventional atomic electrons (Fig. 13), while positive e-trons serve as nuclear positrons (Fig. 14). Negative muons and tau can be viewed as oscillated atomic electrons, while positive muons and tau as oscillated atomic antielectrons. Notably, in anti-particles all constituent toryces are topologically inverted inside out in respect the topological state of toryces comprising their opposite particles.

A-trons – Real and imaginary a-trons are formed from negative and positive matched toryces according to the equations:

$$a^0_{m,n,p} = a^-_{m,n,p} + a^+_{m,n,p} \quad (58)$$

$$\breve{a}^0_{m,n,p} = \breve{a}^-_{m,n,p} + \breve{a}^+_{m,n,p} \quad (59)$$

The real a-trons are very light elementary particles that we call *aetherons* (from aether), while the imaginary a-trons are heavy elementary particles that we call *singletrons* (from singularity). At the higher quantum energy states the singletrons and aetherons form *quantum vacuum*. At the lower quantum energy states they form cores of nucleons.

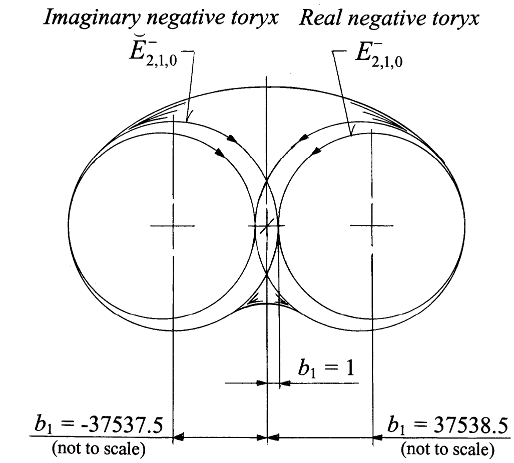

Fig. 13. Negative e-tron $e^{-1}_{2,1,0}$ (atomic electron of hydrogen atom)

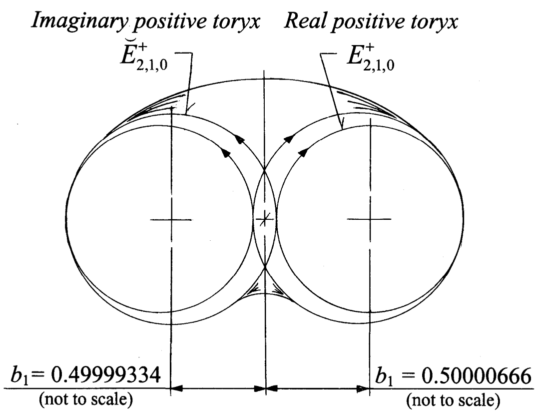

Fig. 14. Positive e-tron $e^{+1}_{2,1,0}$ (nuclear positron)

Harmons – Table 7 shows equations for quantum energy states of harmonic toryces forming *harmons*. Both harmonic toryces and harmons are identified by the letter "*h*" in the first subscripts of their symbols. Reality-polarized harmons serve as free electrons and positrons. Charge-polarized harmons reside in the nucleon shells (Fig. 15).

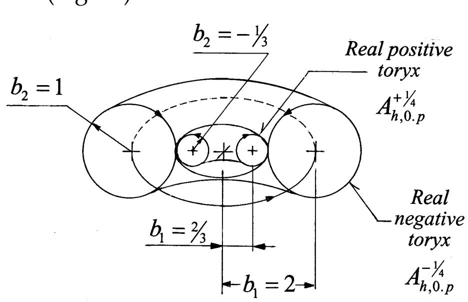

Fig. 15. Real a-harmon $a^0_{h,0,0}$ (a part of a nucleon shell)

Harmon name	Harmon type	Toryx	**Equation**	
Negative e-harmon $e^-_{h,n,p}$	Reality-polarized	$E^-_{h,n,p}$	$b_1 = 2+n$	(60)
		$\breve{E}^-_{h,n,p}$	$b_1 = -(2+n)$	(61)
Positive e-harmon $e^+_{h,n,p}$	Reality-polarized	$E^+_{h,n,p}$	$b_1 = \frac{2+n}{3+2n}$	(62)
		$\breve{E}^+_{h,n,p}$	$b_1 = \frac{2+n}{5+2n}$	(63)
Real a-harmon $a^0_{h,n,p}$	Charge-polarized	$A^-_{h,n,p}$	$b_1 = \frac{2+n}{1+n}$	(64)
		$A^+_{h,n,p}$	$b_1 = \frac{2+n}{3+n}$	(65)
Imaginary a-harmon $\breve{a}^0_{h,n,p}$	Charge-polarized	$\breve{A}^-_{h,n,p}$	$b_1 = -\frac{2+n}{1+2n}$	(66)
		$\breve{A}^+_{h,n,p}$	$b_1 = \frac{2+n}{5+3n}$	(67)

Table 7. Equations for quantum energy states of matched harmonic toryces forming harmons

Spacetime and physical properties of toryces and trons can be calculated by using the equations presented in this paper. Complex particles are made up of trons. Among them are all known hadrons.

Three conservation laws govern formation and existence of atoms.

1. **The law of conservation of charge –** In a stable atom the total sum of charges e of their constituent toryces must be approaching the infinility.

$$\sum_{i=1}^{\infty} e_i \rightarrow \pm 0 \tag{68}$$

2. **The law of conservation of reality –** In a stable atom the total sum of the products of gravitational masses m_g by square of realities R of their constituent toryces must be approaching the infinility.

$$\sum_{i=1}^{\infty} (m_g R^2)_i \rightarrow \pm 0 \tag{69}$$

3. **The law of conservation of energy –** In a stable atom the total sum of exchange energy E_x absorbed and released by all their constituent toryces must be approaching the infinility.

$$\sum_{i=1}^{\infty} E_{xi} \rightarrow \pm 0 \tag{70}$$

10. Spacetime Parameters of Helyx

Helyx is a spacetime spiral string element containing a double-helical leading string with the radius $\tilde{r}_1$ and two helical trailing strings with the radius $\tilde{r}_2$ wound around each branch of leading string. Fig. 16 shows a helyx with only one branch of double-helical leading string. In the diagrams shown in Fig. 17 the spacetime parameters of leading and trailing strings form the sides of right triangles, allowing one to establish the relationships between these parameters by using the Pythagorean Theorem.

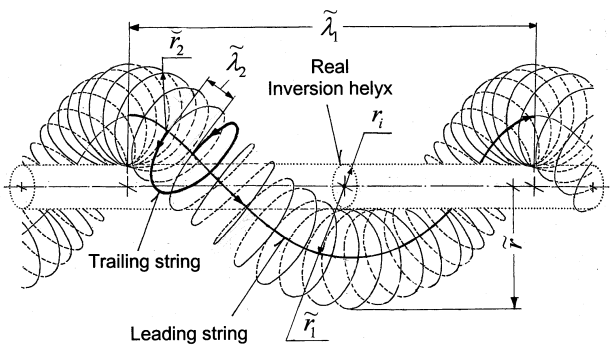

Fig. 16. Helyx

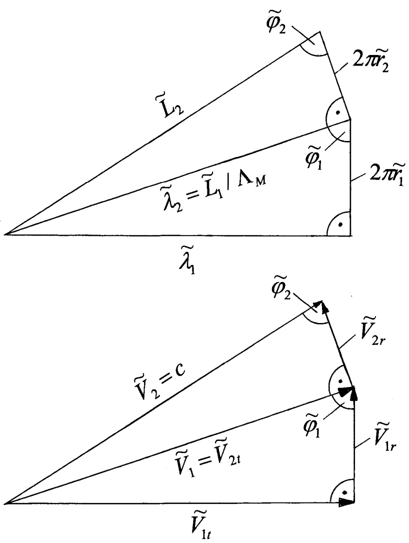

Fig. 17. Spacetime parameters of a helyx

The helyx spacetime parameters shown in Figures 16 and 17 are:

- $\tilde{r}$ = helyx outer radius
- r_i = radius of real inversion helyx
- $\tilde{r}_1$ = radius of leading string
- $\tilde{r}_2$ = radius of trailing string
- $\tilde{L}_1$ = spiral length of leading string
- $\tilde{L}_2$ = spiral length of trailing string
- $\tilde{V}_1$ = spiral velocity of leading string
- $\tilde{V}_{1t}$ = translational velocity of leading string
- $\tilde{V}_{1r}$ = trotational velocity of leading string
- $\tilde{V}_2$ = spiral velocity of trailing string
- $\tilde{V}_{2t}$ = translational velocity of trailing string
- $\tilde{V}_{2r}$ = trotational velocity of trailing string
- $\tilde{\phi}_1$ = steepness angle of leading string
- $\tilde{\phi}_2$ = steepness angle of trailing string
- $\tilde{\lambda}_1$ = wavelength of leading string
- $\tilde{\lambda}_2$ = wavelength of trailing string.

Spacetime properties of helyx are governed by four fundamental equations shown in Table 8. One can clearly see some similarity between the fundamental spacetime equations for helyx and toryx (Table 1). Equations for the radius of real inversion string r_i of toryx and helyx are identical. Similarly to the toryx, the spiral velocity of helyx trailing string $\tilde{V}_2$ is equal to the ultimate string velocity c. Adding to the similarities between the helyx and the toryx is the fact that for both of them the radius r_i and the frequency f_i of real inversion string are respectively expressed by the same equations.

Parameter	Equation	
Radius of real inversion string	$r_i = \tilde{r}_1 - \tilde{r}_2$	(72)
Wavelength of trailing string	$\tilde{\lambda}_2 = \dfrac{\tilde{L}_1}{\Lambda_M}$	(73)
Steepness angle of trailing string	$\sin u(\tilde{\phi}_2) = \dfrac{\tilde{r}_2}{\tilde{r}_1}$	(74)
Spiral velocity of trailing string	$\tilde{V}_2 = \sqrt{\tilde{V}_{1t}^2 + \tilde{V}_{1r}^2 + \tilde{V}_{2r}^2} = c$	(75)

Table 8. Helyx fundamental spacetime equations

Helical trailing strings of the helyx propagate along their helical paths in synchrony with helical leading strings, so, the translational velocity of trailing string $\tilde{V}_{2t}$ is equal to the spiral velocity of leading string $\tilde{V}_1$. As we have done in application to the toryx, we can take advantage of the constancy of the radius r_i, the ultimate string velocity c, and the frequency f_i to express the spacetime parameters of a helyx in relative terms. Helyx fundamental equations (72) – (75) allows one to derive equations for all spacetime parameters of a toryx when the relative radius of its leading string $\tilde{b}_1 = \tilde{r}_1 / r_i$ varies from negative to positive infinity (see Tables 9 and 10).

Parameter	Equation	
Relative radius	$\tilde{b}_1 = \dfrac{\tilde{r}_1}{r_i}$	(76)
Steepness angle	$\cos u(\tilde{\phi}_1) = \dfrac{\tilde{b}_1\sqrt{2\tilde{b}_1 - 1}}{(\tilde{b}_1 - 1)^2 \Lambda_M}$	(77)
Relative Wave-length	$\tilde{\eta}_1 = \dfrac{\tilde{\lambda}_1}{2\pi r_i} = \sqrt{\dfrac{(\tilde{b}_1 - 1)^4 \Lambda_M^2 - \tilde{b}_1^2(2\tilde{b}_1 - 1)}{2\tilde{b}_1 - 1}}$	(78)
Relative length of one winding	$\tilde{l}_1 = \dfrac{\tilde{L}_1}{2\pi r_i} = \dfrac{(\tilde{b}_1 - 1)^2 \Lambda_M}{\sqrt{2\tilde{b}_1 - 1}}$	(79)
Relative transla-tional velocity	$\tilde{\beta}_{1t} = \dfrac{\tilde{V}_{1t}}{c} = \dfrac{\sqrt{(\tilde{b}_1 - 1)^4 \Lambda_M^2 - \tilde{b}_1^2(2\tilde{b}_1 - 1)}}{\tilde{b}(\tilde{b}_1 - 1)\Lambda_M}$	(80)
Relative rotational velocity	$\tilde{\beta}_{1r} = \dfrac{\tilde{V}_{1r}}{c} = \dfrac{\sqrt{2\tilde{b}_1 - 1}}{(\tilde{b}_1 - 1)\Lambda_M}$	(81)
Relative spiral velocity	$\tilde{\beta}_1 = \dfrac{\tilde{V}_1}{c} = \dfrac{\tilde{b}_1 - 1}{\tilde{b}_1}$	(82)
Relative frequency	$\tilde{\delta}_1 = \dfrac{\tilde{f}_1}{f_i} = \dfrac{\sqrt{2\tilde{b}_1 - 1}}{\tilde{b}_1(\tilde{b}_1 - 1)\Lambda_M}$	(83)

Table 9. Spacetime parameters of helyx leading string as a function of the relative radius of leading string $\tilde{b}_1$

Parameter	Equation	
Relative radius	$\tilde{b}_2 = \tilde{b}_1 - 1$	(84)
Steepness angle	$\sin u(\tilde{\phi}_1) = \dfrac{\tilde{b} - 1}{\tilde{b}_1}$	(85)
Relative wavelength	$\tilde{\eta}_2 = \dfrac{\tilde{\lambda}_2}{2\pi r_i} = \dfrac{(\tilde{b}_1 - 1)^2}{\sqrt{2\tilde{b}_1 - 1}}$	(86)
Relative length of one winding	$\tilde{l}_2 = \dfrac{\tilde{L}_2}{2\pi r_i} = \dfrac{\tilde{b}_1(\tilde{b}_1 - 1)}{\sqrt{2\tilde{b}_1 - 1}}$	(87)
Number of windings	$\tilde{w}_2 = 1$	(88)
Relative translational velocity	$\tilde{\beta}_{1t} = \dfrac{\tilde{V}_{1t}}{c} = \dfrac{\tilde{b} - 1}{\tilde{b}_1}$	(89)
Relative rotational velocity	$\tilde{\beta}_{1r} = \dfrac{\tilde{V}_{1r}}{c} = \dfrac{\sqrt{2\tilde{b}_1 - 1}}{\tilde{b}_1}$	(90)
Relative spiral velocity	$\tilde{\beta}_2 = \dfrac{\tilde{V}_2}{c} = 1$	(91)
Relative frequency	$\tilde{\delta}_2 = \dfrac{\tilde{f}_2}{f_i} = \dfrac{\sqrt{2\tilde{b}_1 - 1}}{\tilde{b}_1(\tilde{b}_1 - 1)}$	(92)

Table 10. Spacetime parameters of helyx trailing string as a function of the relative radius of leading string $\tilde{b}_1$

11. Physical Properties of Helyces

Similarly to the toryces, physical properties of helyces are expressed as a function of the helyx vorticity $\tilde{V}$ that the relative rotational velocity of the helyx trailing string β_{2r} .

$$\tilde{V} = \beta_{2r} = \frac{\sqrt{2\tilde{b}_1 - 1}}{\tilde{b}_1} \quad (93)$$

Table 11 shows the equations for the helyx relative charge and mass as a function of the helyx vorticity $\tilde{V}$.

Relative helyx charge	$\dfrac{e}{e_0} = \dfrac{\tilde{V}}{2}$	(96)
Relative helyx inertial mass	$\dfrac{m_i}{m_0} = -\dfrac{\tilde{V}}{2}$	(97)
Relative helyx gravitational mass	$\dfrac{m_g}{m_0} = \dfrac{\lvert\tilde{V}\rvert}{2}$	(98)

Table 11. Equations for helyx relative charge and mass

12. Creation of Helyces

Helyces are created when their parental toryces are transferred from higher to lower quantum energy states. Let us consider a general case of creation of a helyx when the excitation quantum energy state of its parental toryx change from higher state $n = k$ to a lower energy state $n = j$ (Fig. 18).

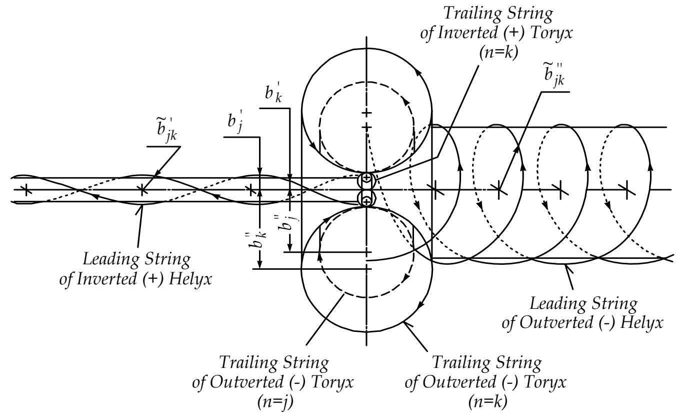

Fig. 18. Emission of helyces

Simultaneously, the oscillation quantum energy state of this toryx changes from a higher energy state $p = k$ to a lower energy state $p = j$ with the respective toryx oscillation factors Q_k and Q_j. Let b_{1k} and b_{1j} be the respective relative radii of the toryx leading strings corresponding to these quantum energy states. According to the law of conservation of energy, the energy of emitted helyx must be equal to a difference between the toryx exchange energy E_{xk} and E_{xj} corresponding to the quantum energy states k and j. Consequently, the frequency of trailing strings of emitted helyx $\tilde{f}_{jk}$ is equal to:

$$f_{jk} = -\frac{Z\alpha f_i}{4}\left(Q_k \frac{(b_{1k} - 1)(2b_{1k} - 1)}{b_{1k}^3} - Q_j \frac{(b_{1j} - 1)(2b_{j1} - 1)}{b_{1j}^3} \right) \quad (94)$$

For the case when the helyces are emitted solely due to the oscillation of toryces, Eq. (99) reduces to the form:

$$f_{jk} = -Z\alpha f_i \frac{(b_1 - 1)(2b_1 - 1)}{4b_1^3}(Q_k - Q_j) \quad (b_1 = b_{1j} = b_{1j}) \quad (95)$$

13. Creation of Radiation Particles

The radiation particles are composed of reality-polarized and charge-polarized matched helyces. The names of the radiation particles are similar to the names of their parental elementary particles responsible for the creation of the helyces. The radiation particles are responsible for exchange of energy and communication between their parent elementary particles. Depending on a type of the toryx quantum energy state which change produced a helyx, the helyces are called either the *excited helyces* or the *oscillated helyces* as shown in Table 12.

Parental elementary particles	Types of radiation particles	
	Excited	Oscillated
Electron	Electon	Electrino
Positron	Positon	Positrino
Aetheron	Aetherton	Aethertrino
Singletron	Singleton	Singletrino

Table 12. Types of radiation particles

Remarkably, the radiation particles originated from electrons, positrons and aetherons propagate at the velocity of light. More precisely, in the reality-polarized radiation particles of this kind the velocities of real helyces are slightly less than the velocity of light, while the velocities of imaginary helyces slightly exceed the velocity of light. In the charge-polarized radiation particles of this kind both positive and negative helyces propagate slightly slower than the velocity of light. The velocities of propagation of singletons and singletrinos are much greater than the velocity of light.

14. Conclusion

1. All elementary particles are made up of polarized spacetime spiral string entities called *toryces.*
2. Toryces are polarized in two ways, by their *vorticity* (with positive and negative charge) and by their *reality* (real and imaginary). The polarization involves topological inversion of their spacetimes.
3. Toryces exist at two types of quantum energy states called *excitation* and *oscillation*.
4. Toryces form elementary matter particles called *electrons*, *positrons*, *aetherons* and *singletrons*.
5. Constituent toryces of stable elementary particle provide balanced absorption and release of energy.
6. The magnitudes of properties of elementary matter particles vary from infinity to *infinility* (the inverse of infinity) and depend on both the types and the levels of quantum energy states of toryces.
7. Polarized spacetime spiral string entities called *helyces* are created when their parental toryces are transferred from higher to lower quantum energy states.
8. Helyces form elementary radiation particles. The helyces created by excited toryces are called *electons, positons, aetherons* and *singletons*. The helyces created by oscillated toryces are called *electrinos, positrinos, aethertrinos* and *singletrinos.*
9. Elementary radiation particles are responsible for the exchange of energy and communication between their parental elementary mass particles.
10. All elementary radiation particles, except for singletrons and singletrinos, propagate at velocity of light. The singletons and singletrinos propagate at superluminal velocities.
11. Spacetime properties of toryces and helyces are based on seven fundamental equations. Their physical properties are directly related to their spacetime properties.
12. Creation and existence of stable atoms is governed by the laws of conservation of charge, reality and energy. In stable atoms the total magnitude of these three parameters must be approaching the infinility.
13. The theory requires a new interpretation of zero, number line and trigonometry.

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