GEOMETRIZATION OF THE ENERGY-MOMENTUM TENSOR IN A THEORY OF PHYSICAL VACUUM, AN EXOTIC MATTER AND A WARP DRIVE

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Abstract *Ten-dimensional space of events with structure of geometry of an absolute parallelism is examined. Cartan's structural equations are presented as the new vacuum equations generalizing Einstein vacuum equations. Einstein's equations with geometrized energy-momentum tensor of the matter (an Exotic Matter) are obtained. The mass of an object as an Exotic Mass sourced from the torsion of space of an absolute parallelism, can be created by rotation of an usual matter that confirms Cartan's idea. Supported by the new vacuum equations - the present model of the 4D gyroscope confirms the ability of a spacecraft to move in space, due to control and operating of the metrics and curvature of space-time, which was developed and investigated.*

Einstein believed that the main problem in the Unified Field Theory was the geometrization of the energy-momentum tensor of the matter on the right-hand side of his equations

$$R_{ij} - 1/2 g_{ij} R = \kappa T_{ij}.$$

Einstein pointed out at the following issues:

1. The energy-momentum tensor T_{ij} was introduced "manually" and thus had got phenomenological structure.

2. The real energy-momentum tensor T_{ij} mast have a purely field formation and from the beginning it should not contain singularities (point particles).

3. The geometrization of the energy-momentum tensor of matter should result in the geometrization of the matter fields, which they are made of. It means the geometrization of the quantum fields.

How we can solve this problem?

This problem can be solved by using the geometry of absolute parallelism as the space of events and Cartan's structural equations [1]

$$\nabla_{[k} e^{a}{}_{m]} - e^{b}{}_{[k} T^{a}{}_{|b|m]} = 0, \qquad (A)$$

$$R^{a}{}_{bkm} + 2\nabla_{[k} T^{a}{}_{|b|m]} + 2T^{a}{}_{c[k} T^{c}{}_{|b|m]} = 0, \qquad (B)$$

$$i, j, k... = 0, 1, 2, 3, \qquad a, b, c... = 0, 1, 2, 3$$

in this geometry as well as represents the new physical equations.

The claim is :

Equations (A) and (B) are new vacuum equations, generalizing the Einstein's vacuum equations

$$R_{ij} = 0.$$

Why should we use this space of events and equations?

Because [1]:

1. An arbitrarily accelerated four-dimensional reference frame has 10 degrees of freedom: four translational and six rotational.

2. For the description of such frame we require four translational coordinates x_0, x_1, x_2, x_3 and six angular coordinates $\varphi_1, \varphi_2, \varphi_3$, $\theta_1, \theta_2, \theta_3$.

3. Four translational coordinates x_0, x_1, x_2, x_3 are holonomic, and six angular coordinates $\varphi_1, \varphi_2, \varphi_3$, $\theta_1, \theta_2, \theta_3$ are anholonomic.

4. For construction of such ten-dimensional space of events we must use anholonomic geometry.

How can we construct such ten-dimensional space of events ?

1. The simplest generalization of the four-dimensional holonomic Riemann geometry in the case of anholonomity is the geometry of the absolute parallelism constructed in the ten-dimensional manifold. This manifold can conveniently be represented as a vector bundle with a base formed by the manifold of the four translational coordinates

$$x_i, \qquad (i = 0, 1, 2, 3)$$

and a fibre specified at each point x_i by orthonormalized anholonomic tetrad

$$e^a{}_i, \qquad (i = 0, 1, 2, 3), \qquad (a = 0, 1, 2, 3),$$
$$e^a{}_i e^j{}_a = \delta^j_i, \quad e^a{}_i e^i{}_b = \delta^a_b$$
$$e^a{}_{i,j} - e^a{}_{j,i} \neq 0,$$

which has six independent components playing a role of anholonomic rotational coordinates $\varphi_1, \varphi_2, \varphi_3$, $\theta_1, \theta_2, \theta_3$.

What determines six anholonomic rotational coordinates $e^a{}_i$?

The anholonomic tetrad $e^a{}_i$ defines:

1. The Riemannian metric in the base

$$ds^2 = g_{ik}dx^i dx^k = \eta_{ab}e^a{}_i e^b_k, dx^i dx^k \qquad \eta_{ab} = \eta^{ab} = \mathrm{diag}(-1,\, 1,\, 1,\, 1)$$

and the Killing-Cartan metric in the fibre

$$d\chi^2 = -e^a{}_i De^i{}_a = e^i{}_a De^a{}_i = T^a{}_{bk}T^b{}_{an}dx^k dx^n.$$

2. Anholonomic object

$$\Omega^{..i}_{jk} = e^i{}_a e^a_{[k,j]} = \frac{1}{2}e^i{}_a(e^a{}_{k,j} - e^a{}_{j,k}), \qquad (A)$$

which is a torsion of the geometry of absolute parallelism.

3. Connection of the geometry absolute parallelism

$$\Delta^k_{ij} = e^k{}_a e^a{}_{i,j} \qquad \Delta^k_{[ij]} = e^k{}_a e^a{}_{[i,j]} = -\Omega^{..k}_{ij}$$

4. Ricci rotational coefficients - **torsion field**

$$T^i_{jk} = -\Omega^{..i}_{jk} + g^{im}(g_{js}\Omega^{..s}_{mk} + g_{ks}\Omega^{..s}_{mj}) = e^i{}_a \nabla_k e^a{}_j = -e^a{}_j \nabla_k e^i{}_a, \ (T)$$

which is a contorsion tensor in the geometry of absolute parallelism.

The claim is:

1. Connection Δ^i_{jk} can be represented as the sum

$$\Delta^i_{jk} = \Gamma^i_{jk} + T^i_{jk},$$

where Γ^i_{jk} are the Christoffel symbols, and T^i_{jk} are the Ricci rotation coefficients.

2. The curvature tensor of the space of absolute parallelism $S^i{}_{jkm}$ defined in terms of the connection Δ^i_{jk} is equal to zero

$$S^i{}_{jkm} = 2\Delta^i_{j[m,k]} + 2\Delta^i_{s[k}\Delta^s_{|j|m]} = 0,$$

and can be represented as the sum

$$S^i{}_{jkm} = R^i{}_{jkm} + P^i{}_{jkm} = 0, \qquad (B)$$

where

$$R^i{}_{jkm} = 2\Gamma^i_{j[m,k]} + 2\Gamma^i_{s[k}\Gamma^s_{|j|m]}$$

is the Riemann curvature tensor and

$$P^i{}_{jkm} = 2\nabla_{[k}T^i_{|j|m]} + 2T^i_{c[k}T^c_{|j|m]},$$

is the Ricci curvature tensor.

The claim is:

1. From the equations (B) follow 10 equations

$$R_{jm} - \frac{1}{2}g_{jm}R = \nu T_{jm}, \qquad (B.1)$$

similar to the Einstein's equations, but with the geometrized right-hand side, defined as

$$T_{jm} = -\frac{2}{\nu}\{(\nabla_{[i}T^{i}{}_{|j|m]} + T^{i}{}_{s[i}T^{s}{}_{|j|m]})$$

$$-\frac{1}{2}g_{jm}g^{pn}(\nabla_{[i}T^{i}{}_{|p|n]} + T^{i}{}_{s[i}T^{s}{}_{|p|n]})\} \qquad (E)$$

and 10 equations

$$C_{ijkm} + 2\nabla_{[k}T_{|ij|m]} + 2T_{is[k}T^{s}_{|j|m]} = -\nu J_{ijkm} \qquad (B.2)$$

similar to the Yang-Mills equations with a geometrized source given by the tensor current

$$J_{ijkm} = 2g_{[k(i}T_{j)m]} - \frac{1}{3}Tg_{i[m}g_{k]j}$$

The claim is:

1. The conservation law for the energy-momentum tensor $T^{(jm)}$ is violated since

$$\nabla_j(R^{jm} - \frac{1}{2}g^{jm}R) = \nu\nabla_j T^{jm} = 0$$

and for symmetrical part of $T^{(jm)}$ we have

$$\nabla_j T^{(jm)} = -\nabla_j T^{[jm]} \neq 0$$

2. A body mass have a purely field formation and appears as a measure unit of **torsion field**

$$M(t) = \int (-g)^{1/2} \rho dV =$$

$$= \frac{2}{\nu c^2} \int (-g)^{1/2} \left\{ g^{jm} \left(\nabla_{[i} T^{i}_{|j|m]} + T^{i}{}_{s[i} T^{s}_{|j|m]} \right) \right\} dV \qquad (M).$$

The claim is:

1. The energy-momentum tensor

$$T_{jm} = -\frac{2}{\nu} \{ (\nabla_{[i} T^{i}{}_{|j|m]} + T^{i}{}_{s[i} T^{s}{}_{|j|m]}) - \frac{1}{2} g_{jm} g^{pn} (\nabla_{[i} T^{i}{}_{|p|n]} + T^{i}{}_{s[i} T^{s}{}_{|p|n]}) \}$$

in the equations (B.1) is the source of the Exotic Matter.

2. The mass (M) is the Exotic Mass, which **can deform the local flat space** by the operated four dimensional rotation of usual mass.

3. The total set of equations of the new theory is:

a) four translational equations of motion

$$\frac{d^2 x^i}{ds^2} + \Gamma^{i}_{jk} \frac{dx^j}{ds} \frac{dx^k}{ds} + T^{i}_{jk} \frac{dx^j}{ds} \frac{dx^k}{ds} = 0,$$

which define four translational coordinates x^i;

b) six rotational equations of motion

$$\frac{de^{i}{}_{a}}{ds} + \Gamma^{i}_{jk} e^{j}{}_{a} \frac{dx^k}{ds} + T^{i}_{jk} e^{j}{}_{a} \frac{dx^k}{ds} = 0,$$

which define six rotational coordinates $e^{a}{}_{k}$;

c) twenty four equations

$$\Omega^{..i}_{jk} = e^{i}{}_{a} e^{a}_{[k,j]} = \frac{1}{2} e^{i}{}_{a} (e^{a}{}_{k,j} - e^{a}{}_{j,k}), \qquad (A)$$

which define twenty four independent components of Ricci torsion;

d) twenty equations

$$R^{a}{}_{bkm} + 2\nabla_{[k}T^{a}{}_{|b|m]} + 2T^{a}{}_{c[k}T^{c}{}_{|b|m]} = 0, \qquad (B)$$

which define twenty independent components of Riemann tensor.

Thus (in general) we have 54 equations for 54 unknown functions.

The claim is:

1. **Torsion field** $T^{a}{}_{bk}$ provides a connection between translational x^k and rotational $\chi_{ab} = -\chi_{ba}$ coordinates

$$d\chi^{a}_{b} = T^{a}{}_{bk}dx^{k}.$$

2. There is a connection between translational and rotational inertia

$$\Omega^{a}{}_{b} = T^{a}{}_{bk}\frac{dx^{k}}{ds},$$

where

$$\Omega_{ab} = \frac{1}{c^2}\begin{pmatrix} 0 & -W_1 & -W_2 & -W_3 \\ W_1 & 0 & -c\omega_3 & c\omega_2 \\ W_2 & c\omega_3 & 0 & -c\omega_1 \\ W_3 & -c\omega_2 & c\omega_1 & 0 \end{pmatrix}.$$

3. Matrix Ω_{ab} describes local **fields of inertia**, created by four dimensional rotation

$$\frac{d^2x^a}{ds^2} + \Omega^{a}{}_{b}\frac{dx^{b}}{ds} = 0.$$

In nonrelativistic limit from these equations we have

$$m\frac{d}{dt}\mathbf{v} = m(-\mathbf{W} + 2[\mathbf{v}\omega]).$$

These equations describe the accelerated motion under action of forces of inertia [1].

The claim is:

In the local (tetrad) indices the equations (A) and (B) has the form

$$\nabla_{[a}e^{k}_{\ b]} = -T^{c}_{\ [ba]}e^{k}_{\ c}, \qquad (A)$$

$$R^{a}_{\ bcd} = -2\nabla_{[c}T^{a}_{\ |b|d]} - 2T^{a}_{\ f[c}T^{f}_{\ |b|d]}. \qquad (B)$$

Using the 1+3 splitting of the local spacetime [3], we will have from (T) and (B)

$$\nabla_{b}e^{0}_{\ a} = -T^{c}_{\ ab}e^{0}_{\ c} = \nabla_{b}u_{\ a} = -T^{c}_{\ ab}u_{\ c}, \qquad (A')$$

or

$$\nabla_{b}u_{a} = -W_{a}u_{b} + \omega_{ab} + \sigma_{ab} + \frac{1}{3}\Theta h_{ab}, \qquad (A'^{1+3})$$

and

$$R^{d}_{\ abc} = 2W_{a}(\omega_{bc} - W_{[b}u_{c]})u^{d} + 2\nabla_{[c}W_{|a|}u_{b]}u^{d} -$$
$$-2\nabla_{[c}\omega_{|a|b]}u^{d} - 2\nabla_{[c}\sigma_{|a|b]}u^{d} - \frac{2}{3}\Theta_{,[c}h_{b]a}u^{d} + \frac{2\Theta}{3}[u_{a}\omega_{bc} -$$
$$-u_{a}W_{[b}u_{c]} + \omega_{a[c}u_{b]} + \sigma_{a[c}u_{b]} + \frac{\Theta}{3}h_{a[c}u_{b]}]u^{d}, \qquad (B^{1+3})$$

where $u_{a} = dx_{a}/d\tau$ - the timelike local 4- velocity vector, so that $u_{a}u^{a} = -1$, $g_{ab} = u_{a}u_{b} - h_{ab}$, $ds^{2} = g_{ab}dx^{a}dx^{b} =$

$(u_a u_b - h_{ab})dx^a dx^b = d\tau^2 - dl^2$, h_{ab} - metric tensor of a 3D surface, orthogonal to the unit vector u_a,

$$\omega_{ab} = \nabla_{[b} u_{a]} + W_{[a} u_{b]}, \qquad (V)$$

- vorticity,

$$\sigma_{ab} = \nabla_{(b} u_{a)} + \frac{Du_{(a}}{d\tau} u_{b)} - \frac{1}{3}\Theta h_{ab}, \qquad (S)$$

- shear,

$$\Theta = \nabla_a u^a, \qquad (E)$$

-expansion (or contraction) and

$$W_a = u_b \nabla_b u_a = \frac{Du_a}{d\tau} \qquad (W)$$

- the local 4- acceleration vector.

The claim is:

All fields (V)-(W) define the local fields of inertia and are expressed through the irreducible parts of the torsion $\Omega^{i}_{\cdot jk}$, which can be represented as the sum of three irreducible parts as follows

$$\Omega^{i}_{\cdot jk} = \frac{2}{3}\delta^{i}{}_{[k}\Omega_{j]} + \frac{1}{3}\varepsilon^{n}{}_{jks}\hat{\Omega}^{\hat{s}} + \bar{\Omega}^{i}_{\cdot jk},$$

where

$$\Omega^{i}_{\cdot jk} = g^{im} g_{ks} \Omega^{\cdot\cdot s}_{mj},$$

and the vector Ω_j, the pseudovector $\hat{\Omega}_j$ and the traceless part of torsion $\bar{\Omega}^{\ i}_{\cdot jk}$ are given by

$$\Omega_j = \Omega^{i}_{\cdot ji},$$

$$\hat{\Omega}_j = \frac{1}{2}\varepsilon_{jins}\Omega^{ins},$$
$$\bar{\Omega}^s_{.js} = 0, \quad \bar{\Omega}_{ijs} + \bar{\Omega}_{jsi} + \bar{\Omega}_{sij} = 0,$$

where ε_{ijkm} is a fully skew-symmetrical Levi-Civita symbol. Manipulating by torsion $\Omega^{\cdot\cdot i}_{jk}$ we can change fields (V)-(W) and, accordingly, curvature (B^{1+3}) of the space.

The claim is:

Using the equations (B.1) and the energy-momentum tensor (E) with the structure $T_{ab} = \rho c^2 u_a u_b$, we have for the matter energy density

$$\rho = \frac{1}{c^2}T_{ab}u^a u^b = \frac{1}{\nu c^2}(\nabla_a W^a + 2\omega^2 - 2\sigma^2 - \frac{d\Theta}{d\tau} - \frac{1}{3}\Theta^2)$$

and for the mass (M)

$$M = \frac{1}{\nu c^2}\int(-g)^{1/2}(\nabla_a W^a + 2\omega^2 - 2\sigma^2 - \frac{d\Theta}{d\tau} - \frac{1}{3}\Theta^2)dV, \quad (M^{1+3})$$
$$\omega^2 = \omega_{ab}\omega^{ab}, \quad \sigma^2 = \sigma_{ab}\sigma^{ab}.$$

The mass (M^{1+3}) describes the general case for Alcubierre's version of the warp bubble [4]. From (M^{1+3}) follows, that the null energy condition obeys, when $\nu \geq$ and

$$\nabla_a W^a + 2\omega^2 - 2\sigma^2 - \frac{d\Theta}{d\tau} - \frac{1}{3}\Theta^2 \geq 0.$$

The claim is:

We can operate by mass (M^{1+3}) , i.e. angular velocity (vorticity ω_{ab}) of rotation of masses which mass (M^{1+3}) consists of, it will

lead us to the creation of an inertial propulsion system of an essentially new type, that will move in space [2] like Alcubierre's buble [4]. The elementary scientific model of such propulsion system - 4D gyroscope was created by Shipov Gennady in Thailand (fig.1) and the patent for the vacuum torsion propulsion system representing a warp drive was granted.

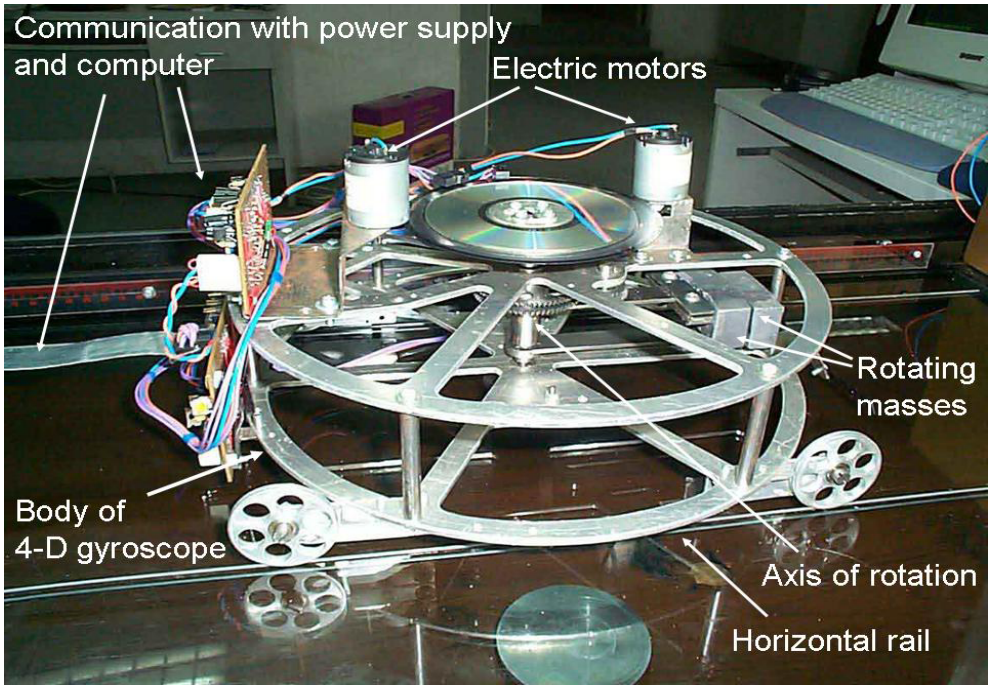

Figure 1: 4D gyroscope

The claim is :

1. Space of events of 4D gyroscope consist from coordinates

$$x_0 = ct,\ x_1 = x_c,\ x_2 = r\phi.$$

2. Metric tensor is

$$g_{ij} = \begin{pmatrix} 0 & 1 - 2k^2r^2U(\phi)/c^2 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & -k^2(1 - k^2\sin^2\phi) \end{pmatrix},$$

where "potential"

$$U(\phi) = \int \phi_{\phi_0} N d\phi$$

is created by angular acceleration

$$N = L/2mr^2.$$

3. The motion equations of center of mass

$$\frac{d^2x^i}{ds^2} + \Gamma^i_{jk}\frac{dx^j}{ds}\frac{dx^k}{ds} + T^i_{jk}\frac{dx^j}{ds}\frac{dx^k}{ds} = 0, i, j, k = 0, 1, 2,$$

where

$$\Gamma^0_{02} = \Gamma^0_{20} = -\frac{k^2rN}{c^2 - 2k^2r^2\int N d\phi}, \quad \Gamma^2_{00} = -\frac{rN}{c^2(1 - k^2\sin^2\phi)},$$

$$\Gamma^2_{22} = -\frac{k^2\sin\phi\cos\phi}{r(1 - k^2\sin^2\phi)}.$$

4. Torsion of the space

$$\Omega^1_{02} = -\Omega^1_{20} = k^2\Phi/2c, \quad \Omega^2_{01} = -\Omega^2_{10} = -\frac{\Phi}{2c(1 - k^2\sin^2\phi)},$$

and contorsion

$$T^1_{20} = -k^2\Phi/c, \quad T^2_{10} = \frac{\Phi}{c(1 - k^2\sin^2\phi)}.$$

5. Riemann tensor

$$R_{00} = -\frac{r^2k^2U^2_\phi}{c^2g(c^2 - 2k^2r^2U)} - \frac{k^2U_\phi\sin\phi\cos\phi}{c^2g^2} - \frac{U_{\phi\phi}}{c^2g},$$

$$R_{22} = -\frac{k^2c^2g}{c^2 - 2k^2r^2U}R_{00},$$

$$R = \frac{2c^2}{c^2 - 2k^2r^2U}R_{00}.$$

6. Ricci tensor created by local torsion $\Omega^i{}_{jk}$

$$P = \frac{k^2\Phi^2}{2g(c^2 - 2k^2r^2U)},$$

where

$$\Phi(t) = 2\sqrt{\frac{N\sin\phi\cos\phi}{1 - k^2\sin^2\phi} + \frac{N_\phi}{k^2}}, \quad N_\phi = \frac{\partial N}{\partial\phi}.$$

7. The force of inertia acting on the center of mass

$$F_{in} = 2(M + 2m)B\omega\sqrt{\frac{N\sin\phi\cos\phi}{1 - k^2\sin^2\phi} + \frac{N_\phi}{k^2}}.$$

This force is created by local torsion of the space and changes the velocity of the center of mass (fig.2)

The movement of the 4D gyroscope under the action of the artificial created forces of inertia- torsion fields it is possible to see on the Youtube.

4D gyroscope on the glass surface
http://www.youtube.com/watch?v=IrJ79rZKTp4

"UFO" on a glass surface
http://www.youtube.com/watch?v=IeWk5vIEIbo

"UFO" on the oiled glass surface

http : *//www.youtube.com/watch?v* = $SXOKT3\_SPS0$
28.01.2009

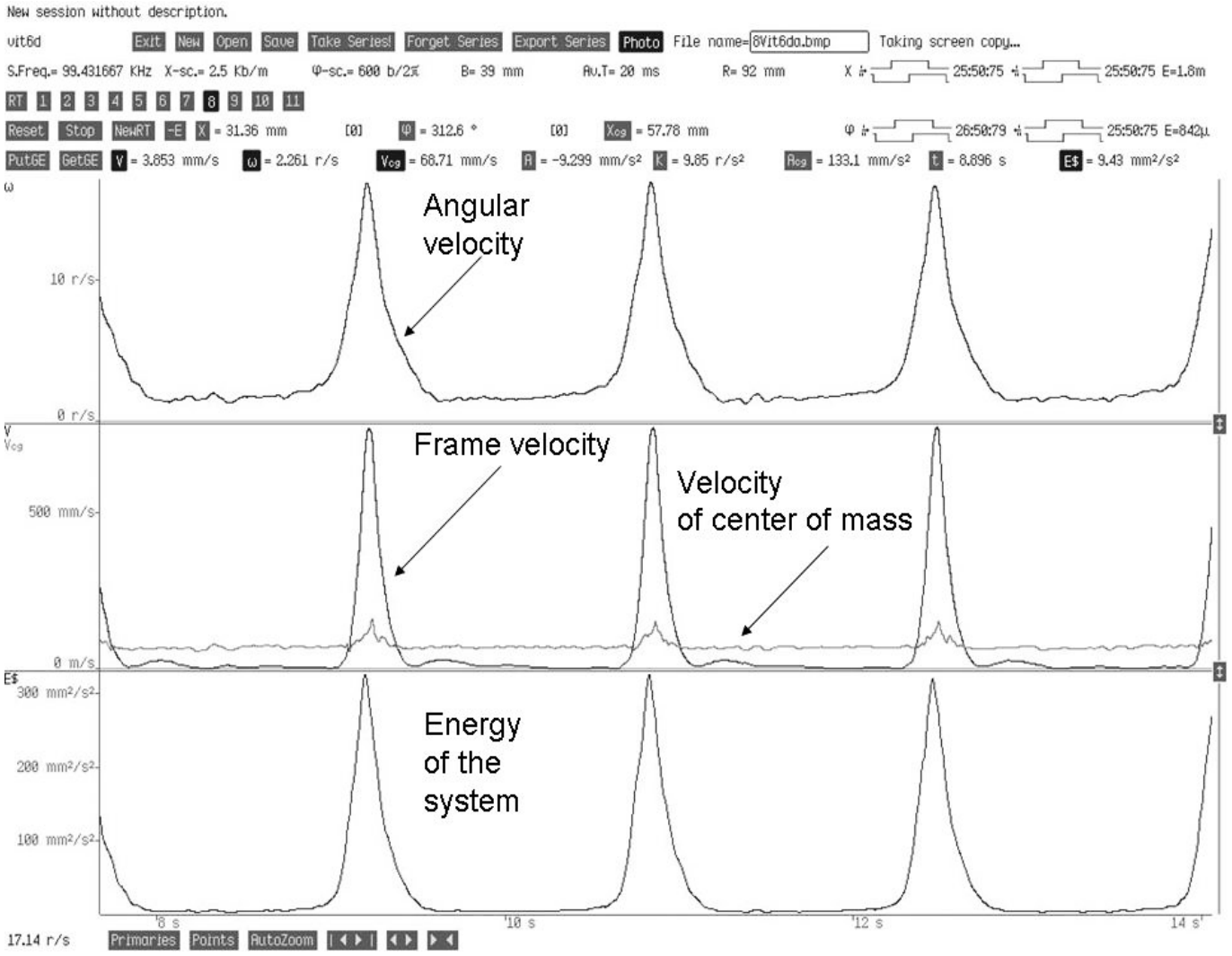

Figure 2: Experimental data

References

[1] *Shipov G.I.* // A Theory of Physical Vacuum. A New Paradigm, Moscow, ZAO "GART", 1998, 312 p.

[2] *Shipov G.I.*// 4-D gyroscope in Descartesian mechanics, Moscow, Cyrillics, 2006. 73 p.

[3] *Raychaudhuri A.*// Relativistic cosmology I., Phys.Rev.1955 Vol.98. P.1123.

[4] *Alcubierre M.*// Class.Quant.Grav. 1994 Vol.11.L73-L75.