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Dark Deformations and Light Pulsations of Cosmic Medium

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Abstract- The suggested constructions are related closely to fluid motion and devoted mainly to get affirmative answers for the known astronomy questions originated in the first half of the last century. As observations continue to evidence, the light, or visible part of universe is not in the void, but is submerged in the invisible dark matter that complements the former up to a general cosmic medium filling all the space. Bellow, such a medium is supposed to be mobile and described with vector field of velocities and matrix fields of fluid deformations and turbulent stresses prevailed in its dark and light parts of universe, respectively.

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Dark Deformations and Light Pulsations of Cosmic Medium

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Abstract- The suggested constructions are related closely to fluid motion and devoted mainly to get affirmative answers for the known astronomy questions originated in the first half of the last century. As observations continue to evidence, the light, or visible part of universe is not in the void, but is submerged in the invisible dark matter that complements the former up to a general cosmic medium filling all the space. Bellow, such a medium is supposed to be mobile and described with vector field of velocities and matrix fields of fluid deformations and turbulent stresses prevailed in its dark and light parts of universe, respectively.

Any dark part is invisible because it's laminar, or it does not produce any turbulent stresses. Moreover, it does not obligated to obey the classical laws of mass, momentum and energy conservation, instead of which the principle of least deformation is assumed to be valid in it. And the latter provides what is known to be a central expansion of medium including the so called Hubble constant and two stagnation points of source and sink.

The light part is visible because its domain contains a turbulent kernel which medium pulsates finely and generates the field of turbulent stresses. And small disturbances of this field when coupled with that of average velocity field propagate throughout the light part in the form of electromagnetic waves.

As this takes place, the visible motion of the light component of cosmic medium is proposed to be relative corresponding to the bulk flow of its dark part, which leads to additional inertial forces.

Keywords: the dark (light) part of universe as a laminar (turbulent) medium, the principle of the least deformation, the turbulent nature of electromagnetic waves.

I. Dark and Light Parts of Matter

Both observations and first analysis for running off, rotation and gravitational lensing of galaxies [1-4] evidence that the visible, or light part of the surrounding matter (including subatomic particles) is not in the void, but it is submerged in the invisible dark matter that complements the universe up to a general cosmic medium filling all the surrounding space.

In what follows, this medium is supposed to be mobile. Its motion is described with vector field of velocities and matrix field of either fluid deformations or turbulent stresses delivered by fluid mechanics [5-8] (in sections 2 or 5 below) and prevailed in dark or light parts, respectively.

In the dark part, the cosmic medium is invisible because it's *laminar*, i.e. it has no turbulent stresses. Moreover, here, it does not obligated to obey the classical laws of mass, momentum and energy conservation [5-8]. Instead of them, in the noted part, the principle of least deformation (theorem 1 in section 3) is assumed to be valid. When being free of physical forces and mass distributions, the latter leads to a central expansion of medium, with the Hubble constant and two stagnation points in the form of source and sink (section 4).

In the light part, the medium is visible because it's *turbulent*, i.e. it finely pulsates and generates the field of turbulent stresses (section 5) approximated by inviscid and incompressible fluid [5–8] and closed on the second order average moments [9–13]. With the precise (not approximate) generation of stresses and approximate diffusion and relaxation to equilibrium [12, 13], the small disturbances of average velocity and turbulent stresses propagate through the light part in the form of electromagnetic waves, as in [14] (section 6).

As this takes place, the visible motion of the light component of cosmic medium is treated to be relative corresponding to the bulk flow of its dark part. Its inertial forces are estimated in the closing section 7. However, let us turn to the necessary details.

II. Fluid Deformations

Given a *smooth* (infinitely differentiable) flow

$$\mathbf{u} = u\mathbf{i} + \upsilon\mathbf{j} + w\mathbf{k} = \mathbf{u}(t,\mathbf{r})$$

depending on *time* $t \geq 0$ in a coordinate system of the unite cube 0ijk including the origin 0, right-oriented orts i, j,k , with cross and point products,

$$\mathbf{i}\times\mathbf{j}=\mathbf{k},\ \ \mathbf{j}\times\mathbf{k}=\mathbf{i},\ \ \mathbf{k}\times\mathbf{i}=\mathbf{j},\ \ \mathbf{i}\cdot\mathbf{j}=\mathbf{j}\cdot\mathbf{k}=\mathbf{k}\cdot\mathbf{i}=0\ \ u\ \ \mathbf{i}\cdot\mathbf{i}=\mathbf{j}\cdot\mathbf{j}=\mathbf{k}\cdot\mathbf{k}=1,$$

and radius-vector

$$\mathbf{r} = x\mathbf{i} + y\mathbf{j} + z\mathbf{k}\ \ (-\infty < x, y, z < \infty),$$

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every point r proves to be mobile,

$$\mathbf{r} = \mathbf{r}^t = x^t\mathbf{i} + y^t\mathbf{j} + z^t\mathbf{k},$$

or taken on a stream line, or trajectory

$$\mathbf{r}' = \mathbf{r}^{t'} = \mathbf{r} + \int_t^{t'} \mathbf{u}\left(s, \mathbf{r}^s\right) ds,$$

so its set in space depends on sets of close points of another trajectories, or, put it in other words, on *fluid*, or *fluid deformations* as spatial derivatives, u_x, υ_x, w_x, ... of velocity components u, υ, w.

As this take place, in fluid mechanics [5–8], the corresponding vectors of ordinary forces (as acting on separate particles, or points) are complemented with matrices of contact forces (as applied to areas of particles), or, here, with *divectors* (from the Greek «διπλός» - «diplos» i.e. «double») to be sums of proportions of direct products of orts, e.g. the *matrix unit*

$$\vec{\mathbf{e}} = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix} = \mathbf{ii} + \mathbf{jj} + \mathbf{kk},$$

the *direct square*

$$\mathbf{uu} = \begin{pmatrix} uu & u\upsilon & uw \\ \upsilon u & \upsilon\upsilon & \upsilon w \\ wu & w\upsilon & ww \end{pmatrix} = \mathbf{u}u\mathbf{i} + \mathbf{u}\upsilon\mathbf{j} + \mathbf{u}w\mathbf{k},$$

the *matrix fluid deformation*

$$\mathbf{u_r} = \begin{pmatrix} u_x & u_y & u_z \\ \upsilon_x & \upsilon_y & \upsilon_z \\ w_x & w_y & w_z \end{pmatrix} = \begin{pmatrix} u_x\mathbf{ii}+ & u_y\mathbf{ij}+ & u_z\mathbf{ik}+ \\ \upsilon_x\mathbf{ji}+ & \upsilon_y\mathbf{jj}+ & \upsilon_z\mathbf{jk}+ \\ w_x\mathbf{ki}+ & w_y\mathbf{kj}+ & w_z\mathbf{kk} \end{pmatrix} = \mathbf{u}_x\mathbf{i} + \mathbf{u}_y\mathbf{j} + \mathbf{u}_z\mathbf{k},$$

and its conjugate, the *matrix flow gradient*

$$\mathbf{u}_\mathbf{r}^* = \begin{pmatrix} u_x & \upsilon_x & w_x \\ u_y & \upsilon_y & w_y \\ u_z & \upsilon_z & w_z \end{pmatrix} = \mathbf{i}\mathbf{u}_x + \mathbf{j}\mathbf{u}_y + \mathbf{k}\mathbf{u}_z = (\nabla u)\mathbf{i} + (\nabla\upsilon)\mathbf{j} + (\nabla w)\mathbf{k} = \nabla\mathbf{u},$$

$$\nabla = \mathbf{i}\partial_x + \mathbf{j}\partial_y + \mathbf{k}\partial_z \qquad (\partial_x = \partial/\partial x),$$

that leads to the *fluid (or convective) acceleration*

$$\mathbf{u}\cdot\nabla\mathbf{u} = u\mathbf{u}_x + \upsilon\mathbf{u}_y + w\mathbf{u}_z = \mathbf{u}_x\mathbf{i}\cdot\mathbf{u} + \mathbf{u}_y\mathbf{j}\cdot\mathbf{u} + \mathbf{u}_z\mathbf{k}\cdot\mathbf{u} = \mathbf{u_r}\cdot\mathbf{u}.$$

III. Motions of Least Deformation

The corresponding value

$$D = \frac{1}{2}\left\|\mathbf{u_r} + \nabla\mathbf{u}\right\|^2 = \frac{1}{2}\left|\mathbf{u}_x + \nabla u\right|^2 + \frac{1}{2}\left|\mathbf{u}_y + \nabla\upsilon\right|^2 + \frac{1}{2}\left|\mathbf{u}_z + \nabla w\right|^2 =$$

$$= 2u_x^2 + 2\upsilon_y^2 + 2w_z^2 + \left(\upsilon_x + u_y\right)^2 + \left(w_y + \upsilon_z\right)^2 + \left(u_z + w_x\right)^2.$$

will be referred to as the *local* (for every point r) *measure* of fluid deformation $\mathbf{u_r}$.

As it can be verified immediately, the measure is reduced to squares of local *norms* of *heterogeneity*

$$A = \sqrt{\left(u_x - \upsilon_y\right)^2 + \left(\upsilon_y - w_z\right)^2 + \left(w_z - u_x\right)^2},$$

shift

$$B = \sqrt{\left(\upsilon_x + u_y\right)^2 + \left(w_y + \upsilon_z\right)^2 + \left(u_z + w_x\right)^2}$$

and *compressibility*

$$C = u_x + \upsilon_y + w_z$$

in the *identity of measure*:

$$3D - 3B = 6\left(u_x^2 + \upsilon_y^2 + w_z^2\right) = 2\left(C^2 + A^2\right)$$

or

$$D = 2A^2/3 + B^2 + 2C^2/3. \qquad (1)$$

It is the identity (1) that evidently delivers both *least* local measure

$$2C^2/3 \le D \tag{2}$$

and related deformation $\mathbf{u_r}$ in the following

Theorem 1 (the principle of least deformation). The least local measure $2C^2/3$ in (2) is realized by the deformation $\mathbf{u_r}$ that is homogeneous,

$$A = 0, \quad or \quad u_x = \upsilon_y = w_z \tag{3}$$

and without shift,

$$B = 0, \; or \; \upsilon_x + u_y = w_y + \upsilon_z = u_z + w_x = 0, \tag{4}$$

or by the flow u reduced to the sum

$$\mathbf{u} = \mathbf{w}(t,\mathbf{r}) = \mathbf{w}^{(i)} + \mathbf{w}^{(ii)} + \mathbf{w}^{(iii)} \tag{5}$$

of translation $w^{(i)}$, rotation $w^{(ii)}$, with angular velocity $\Omega = \Omega = (t)$, and the central expansion (or contraction) $w^{(iii)}$, with a coefficient $H = H(t) \ge 0$ (or $H \le 0$, respectively), and the braking vector $\Theta = \Theta(t)$ such that

$$\mathbf{w}^{(i)} = \mathbf{U}(t), \quad \mathbf{w}^{(ii)} = \mathbf{\Omega} \times \mathbf{r} \;\; and \;\; \mathbf{w}^{(iii)} = H\mathbf{r} - \frac{1}{2}\mathbf{r}\cdot\mathbf{r}\mathbf{\Theta} + \mathbf{r}\cdot\mathbf{\Theta}\mathbf{r}, \tag{6}$$

for any transfer $r \to r - r_0$ (of the origin 0 to an arbitrary point r_0).

Proof. Identity (1) and condition (2) assume equations (3) and (4) which hold true for smooth *u, υ, w* after differentiating,

$$\upsilon_{zx} + u_{yz} = w_{xy} + \upsilon_{zx} = u_{yz} + w_{xy} = 0, \;\; or \;\; u_{yz} = \upsilon_{zx} = w_{xy},$$

so we have zero mixed derivatives,

$$u_{yz} = \frac{1}{2}\left(\upsilon_{zx} + u_{yz}\right) = 0, \quad \upsilon_{zx} = \frac{1}{2}\left(w_{xy} + \upsilon_{zx}\right) = 0, \quad w_{xy} = \frac{1}{2}\left(u_{yz} + w_{xy}\right) = 0$$

re-derivatives,

$$u_{yy} = -\upsilon_{yx} = -u_{xx} = -w_{zx} = u_{zz}, \qquad -\upsilon_{zz} = w_{zy} = \upsilon_{yy} = u_{xy} = -\upsilon_{xx},$$
$$-w_{xx} = u_{xz} = w_{zz} = \upsilon_{yz} = -w_{yy},$$

and derivatives of the third order

$$u_{yyy} = u_{zzy} = \left(u_{yz}\right)_z = 0,$$

further,

$$u_{yyx} = u_{zzx} = -u_{xxx} \quad u \quad u_{yyx} = w_{yyz} = -\upsilon_{yzz} = -u_{xzz} = u_{xxx},$$

hence,

$$u_{yyx} = u_{yyz} = u_{xxx} = 0,$$

and, finally,

$$u_{yxx} = w_{xyz} = \left(w_{xy}\right)_z = 0, \;\; u_{zzz} = -w_{xzz} = -\upsilon_{xyz} = -\left(\upsilon_{zx}\right)_y = 0$$
$$u \quad u_{zxx} = \upsilon_{zyx} = \left(\upsilon_{zx}\right)_y = 0,$$

so

$$u_{yyy} = u_{yyx} = u_{yyz} = u_{yxx} = u_{zzz} = u_{zxx} = u_{xxx} = 0,$$

including analogous derivatives for *υ,w*:

$$\upsilon_{zzz} = \upsilon_{zzy} = \upsilon_{zzx} = \upsilon_{zyy} = \upsilon_{xxx} = \upsilon_{xyy} = \upsilon_{yyy} = 0,$$
$$w_{xxx} = w_{xxz} = w_{xxy} = w_{xzz} = w_{yyy} = w_{yzz} = w_{zzz} = 0.$$

As a consequence,

$$u_{yyy}=0 \ \ implies \ \ u=y^2a(t,x,z)+yb(t,x,z)+c(t,x,z),$$

$$u_{yyx}=u_{yyz}=0 \ \ implies \ \ a_x=a_z=0, \ or \ \ a=a_1(t),$$

$$u_{yz}=0 \ \ implies \ \ b_z=0, \ or \ \ b=b(t,x),$$

$$u_{yxx}=0 \ \ implies \ \ b_{xx}=0, \ or \ \ b(t,x)=xb_1(t)+e_1(t),$$

$$u_{zzz}=0 \ \ implies \ \ c_{zzz}=0, \ or \ \ c(t,x,z)=z^2d(t,x)+ze(t,x)+f(t,x),$$

$$u_{zz}=u_{yy} \ \ implies \ \ c_{zz}=u_{zz}=u_{yy}, \ or \ \ d(t,x)=a_1(t),$$

$$u_{zxx}=0 \ implies \ \ e_{xx}=0, \ or \ \ e(t,x)=xc_1(t)+f_1(t),$$

$$u_{xxx}=0 \ implies \ \ f_{xxx}=0, \ or \ f(t,x)=x^2g(t)+xd_1(t)+U_1(t),$$

$$u_{xx}=-u_{zz} \ \ implies \ \ f_{xx}=c_{xx}=-u_{zz}, \ or \ \ g=-a_1(t).$$

Evidently, the same is true for υ and w, so

$$u=a_1(t)\left(y^2+z^2-x^2\right)+b_1(t)xy+c_1(t)xz+d_1(t)x+e_1(t)y+f_1(t)z+U_1(t),$$

$$\upsilon=a_2(t)\left(z^2+x^2-y^2\right)+b_2(t)yz+c_2(t)yx+d_2(t)x+e_2(t)y+f_2(t)z+U_2(t),$$

$$w=a_3(t)\left(x^2+y^2-z^2\right)+b_3(t)zx+c_3(t)zy+d_3(t)x+e_3(t)y+f_3(t)z+U_3(t).$$

The repeated substitution *u, υ, w* in (3) and (4) gives us:

$$b_3=c_2=-2a_1=\Theta_1, \ b_1=c_3=-2a_2=\Theta_2, \ b_2=c_1=-2a_3=\Theta_3,$$

$$d_1=e_2=f_3=H \quad (A=0),$$

and

$$d_2=-e_1=\Omega_3, \ e_3=-f_2=\Omega_1, \ f_1=-d_3=\Omega_2 \ (B=0).$$

As a result, we have:

$$u=U_1+\Omega_2z-\Omega_3y+Hx-\frac{\Theta_1}{2}\left(x^2+y^2+z^2\right)+\left(\Theta_1x+\Theta_2y+\Theta_3z\right)x,$$

$$\upsilon=U_2+\Omega_3x-\Omega_1z+Hy-\frac{\Theta_2}{2}\left(x^2+y^2+z^2\right)+\left(\Theta_1x+\Theta_2y+\Theta_3z\right)y,$$

$$w=U_3+\Omega_1y-\Omega_2x+Hz-\frac{\Theta_3}{2}\left(x^2+y^2+z^2\right)+\left(\Theta_1x+\Theta_2y+\Theta_3z\right)z,$$

Putting

$$\mathbf{U}=U_1\mathbf{i}+U_2\mathbf{j}+U_3\mathbf{k}, \ \ \boldsymbol{\Omega}=\Omega_1\mathbf{i}+\Omega_2\mathbf{j}+\Omega_3\mathbf{k}, \ \ \boldsymbol{\Theta}=\Theta_1\mathbf{i}+\Theta_2\mathbf{j}+\Theta_3\mathbf{k},$$

we come to (5) and (6), which completes the proof.

IV. The Stationary Central Expansion

Let us consider the pattern of trajectories for the *stationary central expansion* $\mathrm{w}^{(iii)}$ in (6) when

$$H = const > 0 \quad and \quad \mathbf{\Theta} = \mathbf{const} \neq \mathbf{0}, \quad or \quad \Theta = \sqrt{\mathbf{\Theta}\cdot\mathbf{\Theta}} > 0.$$

In terms of dimensionless variables

$$\tau = Ht, \quad \mathbf{R} = \frac{\Theta \mathbf{r}}{H} = X\mathbf{i} + Y\mathbf{j} + Z\mathbf{k} \quad and \quad \mathbf{W}^{(\mathrm{iii})} = \frac{\Theta \mathbf{w}^{(\mathrm{iii})}}{H^2}, \quad for \quad \frac{\mathbf{\Theta}}{\Theta} = -\mathbf{j},$$

we have:

$$\frac{d\mathbf{R}}{d\tau} = \mathbf{W}^{(\mathrm{iii})} = \mathbf{R} + \frac{1}{2}\mathbf{R}\cdot\mathbf{R}\mathbf{j} - \mathbf{R}\cdot\mathbf{j}\mathbf{R} \quad \left(\frac{d\mathbf{r}}{dt} = \mathbf{r}_t = \mathbf{w}^{(\mathrm{iii})}\right),$$

or

$$\frac{dX}{d\tau} = (1-Y)X, \quad \frac{dY}{d\tau} = Y + \frac{1}{2}\left(X^2 - Y^2 + Z^2\right) \quad u \quad \frac{dZ}{d\tau} = (1-Y)Z.$$

In cylindrical coordinates

$$R = \sqrt{Z^2 + X^2} \quad and \quad \varphi = \mathrm{arctg}\frac{X}{Z} \qquad (or \ Z = R\cos\varphi \quad and \quad X = R\sin\varphi),$$

we obtain three equations:

$$\frac{dR}{d\tau} = \bar{u} = -R\bar{Y}, \qquad \frac{d\bar{Y}}{d\tau} = \bar{\upsilon} = \frac{R^2 + 1 - \bar{Y}^2}{2}, \quad \bar{Y} = Y - 1, \quad and \quad \frac{d\varphi}{d\tau} = 0,$$

where the third one excludes the rotation around the axis $R = 0$. Then, with account for identity

$$\left(\frac{\bar{u}}{R^2}\right)_R + \left(\frac{\bar{\upsilon}}{R^2}\right)_{\bar{Y}} = \frac{\bar{Y}}{R^2} - \frac{\bar{Y}}{R^2} = 0,$$

trajectories of two remaining equations reduce to level lines $\psi(R\bar{Y}) = c$ of the proper first integral

$$\psi\left(R,\bar{Y}\right) = -\frac{R}{2} + \frac{1-\bar{Y}^2}{2R} \quad (\bar{u} = R^2\psi_{\bar{Y}} \quad and \quad \bar{\upsilon} = -R^2\psi_R).$$

Those form a c–family of the circular arcs

$$(R+c)^2 + \bar{Y}^2 = c^2 + 1, \quad -\infty < c = const < \infty,$$

on the $(R,\bar{Y})$ –plane that come from the source, $(0,-1)$ and end in the *sink* as shown in

Fig. 1.

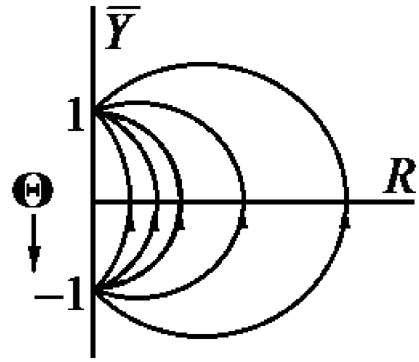

Fig. 1: A pattern of a central expansion with the constant coefficient $H>0$ and the braking vector $\Theta=-\Theta\mathbf{j},\ \Theta>0,$ in the plane $R=\sqrt{Z^2+X^2}$, $\bar{Y}=Y-1$, of dimensionless $X=\Theta x/H,\ Y=\Theta y/H$ and $Z=\Theta z/H$

V. Pulsations of the Light Part

Now, let us turn to an alternative case of flow $\mathbf{u}=\mathbf{u}(t,\mathbf{r})$ of an *ideal* (inviscid) incompressible fluid [5-7] to be a *continuous medium* of a constant mass *density.*

$$\rho = const > 0,$$

submitted to the mass conservation law, or the *continuity equation*

$$\rho_t + \nabla\cdot\rho\mathbf{u} = 0,\ \ or\ \ \ \nabla\cdot\mathbf{u}=0, \tag{7}$$

and, besides, possesses a homogeneous and isotropic field $p\vec{\mathbf{e}}$ of pressure $p=p(t,\mathbf{r})$ which *specific* (as taken per unit mass) *buoyant force of Archimedes*

$$-\frac{1}{\rho}\nabla p = -\frac{1}{\rho}\nabla\cdot p\mathbf{e},$$

balances the *full acceleration*

$$\mathbf{u}_t + \mathbf{u}\cdot\nabla\mathbf{u} = \mathbf{u}_t + u\mathbf{u}_x + \upsilon\mathbf{u}_y + w\mathbf{u}_z$$

in the dynamical law of Newton transferred to continuous media, of the *hydrodynamical Euler equations* [5-7]:

$$\mathbf{u}_t + \mathbf{u}\cdot\nabla\mathbf{u} = -\frac{1}{\rho}\nabla p\ \ (for\ \ \mathbf{u}=u\mathbf{i}+\upsilon\mathbf{j}+w\mathbf{k}), \tag{8}$$

In addition to (8), we take the following agreements:

(i) pressure p and flow u pulsate, or are decomposed into *averages* $\bar{p}$, $\bar{\mathbf{u}}$ and *pulsations* p', $\mathbf{u}'$ [11, 12],

$$p=\bar{p}+p'\ \ and\ \ \mathbf{u}=\bar{\mathbf{u}}+\mathbf{u}'\ \ for\ \ \bar{\bar{p}}=\bar{p}\ \ and\ \ \bar{\bar{\mathbf{u}}}=\bar{\mathbf{u}},\ \ or\ \ \overline{p'}=0\ \ and\ \ \overline{\mathbf{u}'}=\mathbf{0};$$

(ii) the flow u is *turbulent* in the sense that the matrix of *correlations* $\overline{\mathbf{u}'\mathbf{u}'}$ is not zero:

$$\overline{\mathbf{u}'\mathbf{u}'} \neq \vec{\mathbf{0}};$$

(iii) as it usually is [11, 12], at that, the density ρ does not pulsate:

$$\rho = \bar{\rho}\ \ \ (or\ \ \ \rho'=0).$$

Global Journal of Science Frontier Research (A) Volume XVII Issue III Version I Year 2017
50

Then, with account for (7), we have:

$$\nabla \cdot \bar{\mathbf{u}} = \nabla \cdot \mathbf{u}' = 0,$$

and

$$\overline{\mathbf{u}' \cdot \nabla \bar{\mathbf{u}}} = \overline{\mathbf{u}'} \cdot \nabla \bar{\mathbf{u}} = \mathbf{0} \quad and \quad \overline{\bar{\mathbf{u}} \cdot \nabla \mathbf{u}'} = \bar{\mathbf{u}} \cdot \nabla \overline{\mathbf{u}'} = \mathbf{0} \quad (\overline{\mathbf{u}'} = \mathbf{0}),$$

so

$$\mathbf{u} \cdot \nabla \mathbf{u} = \nabla \cdot \left(\bar{\mathbf{u}}\bar{\mathbf{u}} + \mathbf{u}'\mathbf{u}' + \bar{\mathbf{u}}\mathbf{u}' + \mathbf{u}'\bar{\mathbf{u}} \right) = \bar{\mathbf{u}} \cdot \nabla \bar{\mathbf{u}} + \nabla \cdot \mathbf{u}'\mathbf{u}' + \bar{\mathbf{u}} \cdot \nabla \mathbf{u}' + \mathbf{u}' \cdot \nabla \bar{\mathbf{u}},$$

and

$$\overline{\mathbf{u} \cdot \nabla \mathbf{u}} = \bar{\mathbf{u}} \cdot \nabla \bar{\mathbf{u}} + \nabla \cdot \overline{\mathbf{u}'\mathbf{u}'}.$$

As a consequence, the averaged Euler equations (8), or the *first Kelvin-Reynolds equations* [8, 9] are valid:

$$\bar{\mathbf{u}}_t + \bar{\mathbf{u}} \cdot \nabla \bar{\mathbf{u}} + \nabla \cdot \overline{\mathbf{u}'\mathbf{u}'} = -\frac{1}{\rho} \nabla \bar{p}. \tag{9}$$

Then, multiplying the *pulsation* of (8), or difference between (8) and (9),

$$\mathbf{u}'_t + \bar{\mathbf{u}} \cdot \nabla \mathbf{u}' + \mathbf{u}' \cdot \nabla \bar{\mathbf{u}} + \nabla \cdot \left(\mathbf{u}'\mathbf{u}' - \overline{\mathbf{u}'\mathbf{u}'} \right) = -\frac{1}{\rho} \nabla p',$$

by the pulsation of velocity,

$$\overline{u'_t \mathbf{u}' + \mathbf{u}'_t u'} = \overline{\mathbf{u}' u'}_t, \quad \left(\bar{\mathbf{u}} \cdot \nabla u' \right) \mathbf{u}' + \left(\bar{\mathbf{u}} \cdot \nabla \mathbf{u}' \right) u' = \bar{\mathbf{u}} \cdot \nabla \mathbf{u}' u',$$

with account for identities

$$\left(\mathbf{u}' \cdot \nabla \bar{u} \right) \mathbf{u}' + \left(\bar{\mathbf{u}} \cdot \nabla \mathbf{u}' \right) u' = \left(\nabla \bar{u} \right) \cdot \mathbf{u}'\mathbf{u}' + u' \bar{\mathbf{u}} \cdot \nabla \mathbf{u}' = \mathbf{u}'\mathbf{u}' \cdot \nabla \bar{u} + u'\mathbf{u}' \cdot \bar{\mathbf{u}}_{\mathbf{r}},$$

and

$$\overline{\left(\nabla \cdot \left(\mathbf{u}' u' - \overline{\mathbf{u}' u'} \right) \right) \mathbf{u}' + \left(\nabla \cdot \left(\mathbf{u}'\mathbf{u}' - \overline{\mathbf{u}'\mathbf{u}'} \right) \right) u'} = \nabla \cdot \overline{\mathbf{u}'\mathbf{u}' u'},$$

we come to the second *Kelvin-Reynolds equations*

$$\overline{\mathbf{u}'\mathbf{u}'}_t + \bar{\mathbf{u}} \cdot \nabla \overline{\mathbf{u}'\mathbf{u}'} + \overline{\mathbf{u}'\mathbf{u}'} \cdot \left(\bar{\mathbf{u}}_{\mathbf{r}} + \nabla \bar{\mathbf{u}} \right) + \nabla \cdot \overline{\mathbf{u}'\mathbf{u}'\mathbf{u}'} = -\frac{1}{\rho} \overline{\mathbf{u}' \nabla p' + \left(\nabla p' \right) \mathbf{u}'}, \tag{10}$$

where there come into existence the *evolution,* $\overline{\mathbf{u}'\mathbf{u}'_t} + \bar{\mathbf{u}} \cdot \nabla \overline{\mathbf{u}'\mathbf{u}'}$ the *generation* $\overline{\mathbf{u}'\mathbf{u}'} \cdot (\bar{\mathbf{u}}_{\mathbf{r}} + \nabla \bar{\mathbf{u}})$, the *diffusion* $\nabla \cdot \overline{\mathbf{u}'\mathbf{u}'\mathbf{u}'}$ and the relaxation $\frac{1}{\rho} \overline{\mathbf{u}' \nabla p' + (\nabla \rho') \mathbf{u}'}$ of correlations $\overline{\mathbf{u}'\mathbf{u}'}$ [8, 12, 14,15].

Let us consider now the *turbulent kernel* of the light part of a cosmic medium as a *basic medium* 0 with constant pressure $\bar{\rho}^{(0)} = const$, any average flow $\bar{\mathbf{u}}^{(0)}$ and homogeneous and isotropic turbulence $\overline{\mathbf{u}'\mathbf{u}'}^{(0)} = c^2 \vec{\mathbf{e}}$ with the *character pulsation velocity* c to be the velocity of light in vacuum:

$$c = c_{\mathbf{u}} = c\left[\mathbf{u}'^{(0)} \right] = \frac{1}{3} \sqrt{\overline{\mathbf{u}'^{(0)} \cdot \mathbf{u}'^{(0)}}} = 2.99\ 792\ 458 \ldots 10^8\ \frac{m}{s}.$$

As a consequence, first we have that the value c is *absolute*, i.e. it does not depend on frame of reference, or on the additive average flow $\mathbf{a} = \bar{\mathbf{a}}$:

Global Journal of Science Frontier Research (A) Volume XVII Issue III Version I Year 2017

$$c_{\mathbf{u}+\mathbf{a}} = c\left[\left(\mathbf{u}+\mathbf{a}\right)'^{(0)}\right] = c\left[\mathbf{u}'^{(0)}\right] = c_{\mathbf{u}} \quad since \quad \left(\mathbf{u}+\mathbf{a}\right)' = \mathbf{u}' + \mathbf{a}' = \mathbf{u}' \quad (\mathbf{a} = \overline{\mathbf{a}}).$$

Put it in other words, the *special relativity principle* of Einstein is valid. Taking this into account, we may suppose the turbulent kernel to be at rest in average:

$$\overline{\mathbf{u}}^{(0)} = \mathbf{0}.$$

Further, we take fields $\overline{p}$, $\overline{\mathbf{u}}$ and $\overline{\mathbf{u}'\mathbf{u}'}$ to be small disturbances of $\overline{p}^{(0)}$, $\overline{\mathbf{u}}^{(0)}$ and $\overline{\mathbf{u}'\mathbf{u}'}^{(0)}$, respectively, with zero diffusion and linear *relaxation of Rotta* [12, 13]:

$$\nabla\cdot\overline{\mathbf{u}'\mathbf{u}'\mathbf{u}'} = \vec{\mathbf{0}} \quad and \quad \frac{1}{\rho}\overline{\mathbf{u}'\nabla p' + (\nabla p')\mathbf{u}'} = 4\pi\sigma\left(\overline{\mathbf{u}'\mathbf{u}'} - \overline{\mathbf{u}'\mathbf{u}'}^{(0)}\right), \qquad \sigma = const > 0.$$

Substituting them in equations (9) and (10) and neglecting square members of *small deviations*

$$\zeta = p - p^{(0)}, \quad \boldsymbol{\xi} = \overline{\mathbf{u}} - \overline{\mathbf{u}}^{(0)}, \; \nabla\cdot\boldsymbol{\xi} = 0, \; and \quad \vec{\boldsymbol{\eta}} = \overline{\mathbf{u}'\mathbf{u}'} - \overline{\mathbf{u}'\mathbf{u}'}^{(0)},$$

we can rewrite (9) and (10) as

$$\boldsymbol{\xi}_t + \nabla\cdot\vec{\boldsymbol{\eta}} + \nabla\frac{\zeta}{\rho} = 0 \quad u \quad \boldsymbol{\eta}_t + c^2\left(\boldsymbol{\xi}_{\mathbf{r}} + \nabla\boldsymbol{\xi}\right) + 4\pi\sigma\boldsymbol{\eta} = \vec{\mathbf{0}}.$$

Taking the curl of the first equation in (9-10) and the divergence of second one and accounting for identities

$$\nabla\cdot\nabla\boldsymbol{\xi} = \Delta\boldsymbol{\xi} = -\nabla\times\left(\nabla\times\boldsymbol{\xi}\right) \qquad (\nabla\cdot\boldsymbol{\xi} = 0),$$

we lead to *equations of small disturbances of turbulent kernel* [14]:

$$\nabla\times\boldsymbol{\xi}_t + \nabla\times\left(\nabla\cdot\boldsymbol{\eta}\right) = \mathbf{0} \quad u \quad \nabla\cdot\boldsymbol{\eta}_t - c^2\nabla\times\left(\nabla\times\boldsymbol{\xi}\right) + 4\pi\sigma\nabla\cdot\boldsymbol{\eta} = \mathbf{0}. \tag{11}$$

VI. The Electromagnetic Field

Then, treating the inverse value of the specific charge of electron as the *electrical equivalence* of force,

$$\kappa = 5.68563...10^{-12}\,\frac{kg}{C} \qquad \left(\frac{1}{\kappa} = \; 1.75882...10^{11}\,\frac{C}{kg}\right), \qquad C = 1\,\text{Coulomb},$$

we come to the statement:

Theorem 2 *(waves of turbulent kernel disturbances).* As taken with the electrical equivalent κ, the deviations of small disturbances,

$$\boldsymbol{\xi} = \overline{\mathbf{u}} - \overline{\mathbf{u}}^{(0)}, \quad \overline{\mathbf{u}'\mathbf{u}'} = \overline{\mathbf{u}'\mathbf{u}'}^{(0)} + \vec{\boldsymbol{\eta}} \quad and \quad \zeta = p - p^{(0)}, \quad \nabla\cdot\boldsymbol{\xi} = 0,$$

of turbulent kernel,

$$\overline{\mathbf{u}}^{(0)} = \mathbf{0}, \quad p^{(0)} = const \quad and \quad \overline{\mathbf{u}'\mathbf{u}'}^{(0)} = c^2\mathbf{e},$$

produces the electromagnetic field of components

$$\mathbf{E} = \kappa\nabla\cdot\boldsymbol{\eta} \quad and \quad \mathbf{H} = c\kappa\nabla\times\boldsymbol{\xi}.$$

With densities of charges and conduction currents,

$$\delta = \frac{\kappa}{4\pi}\nabla\cdot\nabla\cdot\vec{\boldsymbol{\eta}} \quad and \quad \mathbf{j} = \sigma\kappa\nabla\cdot\boldsymbol{\eta},$$

and scalar and vector potentials,

$$\varphi = \frac{\kappa\zeta}{\rho}, \quad -\Delta\varphi = -\nabla\cdot\nabla\varphi = 4\pi\delta, \quad and \quad \mathbf{A} = c\kappa\boldsymbol{\xi}, \quad \nabla\times\mathbf{A} = \mathbf{H}, \quad \nabla\cdot\mathbf{A} = 0,$$

it is submitted to the two pairs of Maxwell equations for the Ohm's law:

$$\frac{1}{c}\mathbf{H}_t + \nabla\times\mathbf{E} = 0 \quad and \quad \nabla\cdot\mathbf{H} = 0 \quad (the\ first\ pair) \quad with$$
$$\frac{1}{c}\mathbf{E}_t - \nabla\times\mathbf{H} + \frac{4\pi}{c}\mathbf{j} = \mathbf{0} \quad and \quad \nabla\cdot\mathbf{E} = 4\pi\delta \ (the\ second\ pair) \ for \quad \mathbf{j} = \sigma\mathbf{E}, \tag{12}$$

respectively, and propagated in the form of linear crosswise waves, with the absolute velocity of light $c = \sqrt{\mathbf{u}'^{(0)}\cdot\mathbf{u}'^{(0)}/3}$.

The theorem 2 follows immediately from equations (11) and above definitions of E, H (see also [14, 15]).

VII. Bulk Acceleration

In conclusion, let us touch upon the possibility for detecting of an invisible matter in sections 3 and 4 that is directly adjacent to the initial astronomical observations and analysis mentioned above and alternative to the known search of its elementary constituents [16]. This possibility in hand specifies the mobility of cosmic medium by the following *bulk acceleration* of its dark part.

So, let us take again the *absolute* (motionless) frame of reference related to the unit cube 0ijk , with points, orts and *matrix structure*

$$\mathbf{r} = x\mathbf{i} + y\mathbf{j} + z\mathbf{k}, \quad \mathbf{r}_x = \mathbf{i}, \quad \mathbf{r}_y = \mathbf{j}, \quad \mathbf{r}_z = \mathbf{k} \quad and \quad \mathbf{e} = \mathbf{r}_\mathbf{r} = \mathbf{ii} + \mathbf{jj} + \mathbf{kk},$$

respectively, and suppose that the *local flow*

$$\mathbf{u} = u\mathbf{i} + \upsilon\mathbf{j} + w\mathbf{k} = \mathbf{u}(t,\mathbf{r}),$$

is given with which we can determine the *displacement*

$$\mathbf{r}' = \mathbf{r}^{t'} = \mathbf{r} + \int_t^{t'}\mathbf{u}(s,\mathbf{r}^s)ds$$

of a *moving particle* (point) $\mathbf{r} = \mathbf{r}^t$, then, compute its *internal* (as local, or relative) *velocity*

$$\mathbf{r}_t = \lim_{t'\to t+0}\frac{\mathbf{r}' - \mathbf{r}}{t' - t} = \mathbf{u}(t,\mathbf{r}),$$

and, finally, find out its *rigid* (as solid-state, or translational) *acceleration*

$$\mathbf{u}_t = \partial_t\mathbf{u} = \frac{\partial\mathbf{u}}{\partial t} = \lim_{t'\to t+0}\frac{\mathbf{u}(t',\mathbf{r}) - \mathbf{u}(t,\mathbf{r})}{t' - t} \quad as \ if \quad \mathbf{u}_\mathbf{r} = \mathbf{u}_x\mathbf{i} + \mathbf{u}_y\mathbf{j} + \mathbf{u}_z\mathbf{k} = \mathbf{0},$$

fluid (or convective) *acceleration*

$$\delta_t\mathbf{u} = \frac{\delta\mathbf{u}}{\delta t} = \lim_{t'\to t+0}\frac{\mathbf{u}(t,\mathbf{r}') - \mathbf{u}(t,\mathbf{r})}{t' - t} = \mathbf{u}\cdot\nabla\mathbf{u} = \mathbf{u}_\mathbf{r}\cdot\mathbf{u},$$

and *full acceleration* reduced to preceding ones:

$$d_t\mathbf{u}=\frac{d\mathbf{u}}{dt}=\lim_{t'-t\to+0}\frac{\mathbf{u}(t',\mathbf{r}')-\mathbf{u}(t,\mathbf{r})}{t'-t}=\mathbf{u}_t+\delta_t\mathbf{u}\,.$$

Besides, let the *bulk flow*

$$\mathbf{w}=\mathbf{w}(t,\mathbf{r})$$

is given to transfer particles $\mathbf{r}=\mathbf{r}^{+}\,\mathbf{r}^{+t}$ in new positions

$$\mathbf{r}'^{+}=\mathbf{r}'^{+t'}=\mathbf{r}+\textstyle\int_t^{t'}\mathbf{w}\left(s,\mathbf{r}'^{+s}\right)ds\,,$$

with velocities

$$\mathbf{r}_t^{+}=\mathbf{w}\left(t,\mathbf{r}^{+}\right),$$

and to deform orts of the cube 0ijk into edges

$$\mathbf{i}^{+}=\mathbf{r}_x'^{+}=\mathbf{i}+\textstyle\int_t^{t'}\mathbf{w}_x ds\,,\quad \mathbf{j}^{+}=\mathbf{r}_y'^{+}=\mathbf{j}+\textstyle\int_t^{t'}\mathbf{w}_y ds\,,\quad \mathbf{k}^{+}=\mathbf{r}_z'^{+}=\mathbf{k}+\textstyle\int_t^{t'}\mathbf{w}_z ds\,,$$

of the moving cube, or hexahedron $\mathbf{0i^{+}j^{+}k^{+}}$ with *rates* (velocities)

$$\mathbf{i}_t^{+}=\mathbf{w}_x\,,\quad \mathbf{j}_t^{+}=\mathbf{w}_y\,,\quad \mathbf{k}_t^{+}=\mathbf{w}_z\,,$$

so that the matrix structure $\vec{\mathbf{e}}$ of 0ijk takes the form of structure

$$\vec{\mathbf{e}}^{+}=\mathbf{i}^{+}\mathbf{i}+\mathbf{j}^{+}\mathbf{j}+\mathbf{k}^{+}\mathbf{k}\,,\qquad \mathbf{e}^{+}\Big|_{t'=t}=\mathbf{e}\,,$$

of $\mathbf{0i^{+}j^{+}k^{+}}$, with the rate

$$\vec{\mathbf{e}}_t^{+}=\lim_{t'\to t+0}\frac{\mathbf{e}^{+}-\mathbf{e}}{t'-t}=\mathbf{i}_t^{+}\mathbf{i}+\mathbf{j}_t^{+}\mathbf{j}+\mathbf{k}_t^{+}\mathbf{k}=\mathbf{w}_x\mathbf{i}+\mathbf{w}_y\mathbf{j}+\mathbf{w}_z\mathbf{k}=\mathbf{w}_{\mathbf{r}}\,.$$

As this takes place, the *moving* frame of reference related to $\mathbf{0i^{+}j^{+}k^{+}}$, transfers the radius-vector r,

$$\mathbf{e}^{+}\cdot\mathbf{r}=\mathbf{i}^{+}x+\mathbf{j}^{+}y+\mathbf{k}^{+}z\,,\qquad \mathbf{r}=x\mathbf{i}+y\mathbf{j}+z\mathbf{k}=\vec{\mathbf{e}}\cdot\mathbf{r}=\mathbf{r}\cdot\vec{\mathbf{e}}\,,$$

with the rate

$$\mathbf{w}_{\mathbf{r}}\cdot\mathbf{r}=\vec{\mathbf{e}}_t^{+}\cdot\mathbf{r}=\lim_{t'\to t+0}\frac{\vec{\mathbf{e}}^{+}\cdot\mathbf{r}-\mathbf{r}}{t'-t}$$

that complements the internal, or local velocity u up to the *external* (or absolute) velocity as

$$\boldsymbol{\upsilon}=\lim_{t'\to t+0}\frac{\vec{\mathbf{e}}^{+}\cdot\mathbf{r}'-\mathbf{r}}{t'-t}=\left(\vec{\mathbf{e}}^{+}\cdot\mathbf{r}\right)_t=\vec{\mathbf{e}}^{+}\Big|_{t'=t}\cdot\mathbf{r}_t+\vec{\mathbf{e}}_t^{+}\cdot\mathbf{r}=\mathbf{u}+\mathbf{w}_{\mathbf{r}}\cdot\mathbf{r}\,.$$

As applied to a particle r, the specific external force turns out by Newton the *full external acceleration*

$$d_t^+\mathbf{\upsilon} = \frac{d^+\mathbf{\upsilon}}{dt} = \lim_{t'\to t+0} \frac{\vec{\mathbf{e}}^+ \cdot \mathbf{\upsilon}\left(t', \vec{\mathbf{e}}^+ \cdot \mathbf{r}'\right) - \mathbf{\upsilon}(t,\mathbf{r})}{t'-t},$$

that reduces in its turn to the sum

$$d_t^+\mathbf{\upsilon} = \mathbf{\upsilon}_t^+ + \delta_t^+\mathbf{\upsilon},$$

of rigid and fluid components as

$$\mathbf{\upsilon}_t^+ = \lim_{t'\to t+0} \frac{\vec{\mathbf{e}}^+ \cdot \mathbf{\upsilon}\left(t', \vec{\mathbf{e}}^+ \cdot \mathbf{r}\right) - \mathbf{\upsilon}(t,\mathbf{r})}{t'-t} = \lim_{t'\to t+0} \frac{\vec{\mathbf{e}}^+ \cdot \mathbf{\upsilon}\left(t', \vec{\mathbf{e}}^+ \cdot \mathbf{r}'\right) - \mathbf{\upsilon}(t,\mathbf{r}')}{t'-t}$$

and

$$\delta_t^+\mathbf{\upsilon} = \lim_{t'\to t+0} \frac{\mathbf{\upsilon}\left(t, \vec{\mathbf{e}}^+ \cdot \mathbf{r}'\right) - \mathbf{\upsilon}(t,\mathbf{r})}{t'-t},$$

respectively, computed as vectors:

$$\mathbf{\upsilon}_t^+ = \mathbf{u}_t + 2\mathbf{w}_\mathbf{r}\cdot\mathbf{u} + 2\mathbf{w}_\mathbf{r}\cdot(\mathbf{w}_\mathbf{r}\cdot\mathbf{r}) + \mathbf{w}_{t\mathbf{r}}\cdot\mathbf{r} + (\mathbf{w}_{\mathbf{rr}}\cdot\mathbf{r})\cdot(\mathbf{w}_\mathbf{r}\cdot\mathbf{r})$$

and

$$\delta_t^+\mathbf{\upsilon} = \mathbf{u}_\mathbf{r}\cdot(\mathbf{u} + 2\mathbf{w}_\mathbf{r}\cdot\mathbf{r}) + (\mathbf{w}_\mathbf{r} + \mathbf{w}_{\mathbf{rr}}\cdot\mathbf{r})\cdot\mathbf{u} + 2(\mathbf{w}_\mathbf{r} + \mathbf{w}_{\mathbf{rr}}\cdot\mathbf{r})\cdot(\mathbf{w}_\mathbf{r}\cdot\mathbf{r}).$$

Together with the external acceleration $d_t^+\mathbf{\upsilon}$, the specific internal, or *inertial force*

$$d_t\mathbf{u} - d_t^+\mathbf{\upsilon} = \mathbf{u}_t - \mathbf{\upsilon}_t^+ + \delta_t\mathbf{u} - \delta_t^+\mathbf{\upsilon},$$

comes into existence in the moving frame of reference as the sum of *rigid* one,

$$\mathbf{u}_t - \mathbf{\upsilon}_t^+ = -2\mathbf{w}_\mathbf{r}\cdot\mathbf{u} - 2\mathbf{w}_\mathbf{r}\cdot(\mathbf{w}_\mathbf{r}\cdot\mathbf{r}) - \mathbf{w}_{t\mathbf{r}}\cdot\mathbf{r} - (\mathbf{w}_{\mathbf{rr}}\cdot\mathbf{r})\cdot(\mathbf{w}_\mathbf{r}\cdot\mathbf{r})$$

acting on a particle of rigid or fluid medium, and *fluid* complement

$$\delta_t\mathbf{u} - \delta_t^+\mathbf{\upsilon} = -2\mathbf{u}_\mathbf{r}\cdot(\mathbf{w}_\mathbf{r}\cdot\mathbf{r}) - (\mathbf{w}_\mathbf{r} + \mathbf{w}_{\mathbf{rr}}\cdot\mathbf{r})\cdot\mathbf{u} - 2(\mathbf{w}_\mathbf{r} + \mathbf{w}_{\mathbf{rr}}\cdot\mathbf{r})\cdot(\mathbf{w}_\mathbf{r}\cdot\mathbf{r}),$$

acting on a particle of fluid medium, such that

$$\mathbf{u}_t - \mathbf{\upsilon}_t^+ - \left(\delta_t\mathbf{u} - \delta_t^+\mathbf{\upsilon}\right) = (\mathbf{w}_{\mathbf{rr}}\cdot\mathbf{r} - \mathbf{w}_\mathbf{r})\cdot\mathbf{u} + 2\mathbf{u}_\mathbf{r}\cdot(\mathbf{w}_\mathbf{r}\cdot\mathbf{r}) - \mathbf{w}_{t\mathbf{r}}\cdot\mathbf{r} + (\mathbf{w}_{\mathbf{rr}}\cdot\mathbf{r})\cdot(\mathbf{w}_\mathbf{r}\cdot\mathbf{r}).$$

For example, the rotation with constant angular velocity

$$\mathbf{w} = \mathbf{w}^{(\mathbf{ii})} = \mathbf{\Omega}\times\mathbf{r}, \quad \mathbf{\Omega} = \mathbf{const} \quad (\mathbf{w}_{\mathbf{r}t} = \mathbf{w}_{\mathbf{rr}}\cdot\mathbf{r} = \vec{\mathbf{0}}),$$

hence, with deformation matrix $\mathbf{w}_\mathbf{r} = \mathbf{\Omega}\times\mathbf{\varepsilon}$, transfer velocity $\mathbf{w}_\mathbf{r}\cdot\mathbf{r} = \mathbf{\Omega}\times\mathbf{r}$, *Coriolis* and *centrifugal accelerations*, $2\mathbf{w}_\mathbf{r}\cdot\mathbf{r} = 2\mathbf{\Omega}\times\mathbf{r}$ and

$$2\mathbf{w}_\mathbf{r}\cdot(\mathbf{w}_\mathbf{r}\cdot\mathbf{r}) = 2\mathbf{\Omega}\times(\mathbf{\Omega}\times\mathbf{r}) = 2(\mathbf{\Omega}\mathbf{\Omega}\cdot\mathbf{r} - \mathbf{\Omega}\cdot\mathbf{\Omega}\mathbf{r}) = \nabla\left((\mathbf{\Omega}\cdot\mathbf{r})^2 - |\mathbf{\Omega}|^2|\mathbf{r}|^2\right) = -\nabla|\mathbf{\Omega}\times\mathbf{r}|^2,$$

are detected by specific inertial forces,

$$\mathbf{u}_t - \boldsymbol{\upsilon}_t^+ = 2\mathbf{u}\times\boldsymbol{\Omega} + \nabla|\boldsymbol{\Omega}\times\mathbf{r}|^2 \quad or \quad d_t\mathbf{u} - d_t^+\boldsymbol{\upsilon} = 3\mathbf{u}\times\boldsymbol{\Omega} + 2\nabla|\boldsymbol{\Omega}\times\mathbf{r}|^2 - 2(\boldsymbol{\Omega}\times\mathbf{r})\cdot\nabla\mathbf{u},$$

Acting on rigid or fluid particles, respectively.
Finally, for the stationary central expansion

$$\mathbf{w} = \mathbf{w}^{(\mathbf{iii})} = H\mathbf{r} - \frac{1}{2}\mathbf{r}\cdot\mathbf{r}\boldsymbol{\Theta} + \mathbf{r}\cdot\boldsymbol{\Theta}\mathbf{r},\ H_t = 0,\ \ \boldsymbol{\Theta}_t = \mathbf{0},$$

with account for identities

$$\mathbf{w}_{\mathbf{r}} = (H + \mathbf{r}\cdot\boldsymbol{\Theta})\mathbf{e} \vec{+} \mathbf{r}\boldsymbol{\Theta} - \boldsymbol{\Theta}\mathbf{r} \quad and \quad \mathbf{w}_{\mathbf{rr}} = (\mathbf{w}_{\mathbf{r}})_{\mathbf{r}} = \mathbf{e}\vec{\boldsymbol{\Theta}} - \boldsymbol{\Theta}\mathbf{e} \vec{+} \mathbf{i}\boldsymbol{\Theta}\mathbf{i} + \mathbf{j}\boldsymbol{\Theta}\mathbf{j} + \mathbf{k}\boldsymbol{\Theta}\mathbf{k},$$

we find that

$$\mathbf{u}_t - \boldsymbol{\upsilon}_t^+ = -2(H + \boldsymbol{\Theta}\cdot\mathbf{r})\mathbf{u} + 2(\boldsymbol{\Theta}\times\mathbf{r})\times\mathbf{u} + \mathbf{r}\cdot\mathbf{r}(5H + 6\boldsymbol{\Theta}\cdot\mathbf{r})\boldsymbol{\Theta} -$$
$$-2\left(\left(H + \frac{5}{2}\boldsymbol{\Theta}\cdot\mathbf{r}\right)^2 - \frac{6|\boldsymbol{\Theta}|^2 + (\boldsymbol{\Theta}\cdot\mathbf{r})^2}{4}\right)\mathbf{r}$$

and

$$\mathbf{u}_t - \boldsymbol{\upsilon}_t^+ - \left(\delta_t\mathbf{u} - \delta_t^+\boldsymbol{\upsilon}\right) = -H\mathbf{u} + 2\left((H + 2\boldsymbol{\Theta}\cdot\mathbf{r})\mathbf{r} - \mathbf{r}\cdot\mathbf{r}\boldsymbol{\Theta}\right)\cdot\nabla\mathbf{u} +$$
$$+\left(2H\boldsymbol{\Theta}\cdot\mathbf{r} - |\boldsymbol{\Theta}|^2 + 4(\boldsymbol{\Theta}\cdot\mathbf{r})^2\right)\mathbf{r} - \mathbf{r}\cdot\mathbf{r}(H + 2\boldsymbol{\Theta}\cdot\mathbf{r})\boldsymbol{\Theta}.$$

References Références Referencias

1. Hubble E. A relation between distance and radial velocity among extra-galactic nebulae //Proc.Nat. Acad.Sci. 1929. V. 15. P.168-173.
2. *Zwicky F.* On the masses of nebulae and of clusters of nebulae //The Astrophysical Journal. 1937. V. 86. No. 3. P. 217-246.
3. *Rubin V.C., Ford W.K.* Rotation of the Andromeda Nebula from a Spectroscopic Survey of Emission Regions // Astrophysical Journal. 1970. Vol. 159. P. 379.
4. *Massey R., Rhodes J., Ellis R., Scoville N., Leauthaud A., Finoguenov A, Capak P., Bacon D., Aussel H., Kneib J., Koekemoer A., McCracken H., Mobasher B., Pires S., Refregier A., Sasaki S., Starck J., Taniguchi Y., Taylor A., Taylor J.* Dark matter maps reveal cosmic scaffolding // Nature 2007. V. 445 (7125). P. 286–290.
5. *Loitsyanskii L. G.,* Mechanics of Liquids and Gases. - Oxford, London, Edinburgh, New York, Toronto, Paris, Frankfurt: Pergamon, 1966. 481 p.
6. *Batchelor G.K.* An introduction to fluid dynamics. – Cambridge: Univ. Press, 1967. 615 p.
7. *Landau L.D., Lifschitz E.M.* Fluid mechanics. 2nd ed. - Oxford, London, Edinburgh, New York, Toronto, Paris, Frankfurt: Pergamon, 1987. 539 p.
8. *Mase* G.E. Theory and problems of continuum mechanics. NY, London: McGraw-Hill Book Company, 1970. 319 p.
9. *Thomson W.* On the propagation of laminar motion through a turbulently moving inviscid liquid // Phil. Mag.1887. Ser.5.V.24.Iss.149. P.342–353.
10. *Reynolds O.* On the Dynamical theory of incompressible viscous fluids and the determination of the criterion // Phil. Trans. Roy. Soc. London Ser. A. 1894. V. 186. P. 123–164.
11. *Monin A.S., Yaglom A.M.* Statistical fluid Mechanics. Volume I: Mechanics of turbulence. – Cambridge: The MIT Press. 1st ed., 1971. 769 p.
12. *Frost U., Moulden T., editors.* Handbook of Turbulence. Volume 1. Fundamentals and Applications. – NY, London: Plenum Press, 1977. 497 p.
13. *Rotta J. C.* Turbullente Strömungen.- Stuttgart: Teubner, 1972. 267 S.
14. *Troshkin O. V.* On wave properties of an incompressible turbulent fluid // Phys. A. 1990. V. 168. P. 881–899.
15. *Troshkin O.V.* Nontraditional Methods in Mathematical Hydrodynamics. Translation of Mathematical Monographs. US – Rhode Island – Providence: American Mathematical Society. 1995. V.144. 197 p.
16. *Hecht J.* What's the matter? // Nature 2016. V. 537. P. 194–197.