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World as Flow: from Agro-ecological Micrometeorology to Cosmology

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Abstract— **Mathematical model of the turbulent flux is presented using conception of the material point of the second type suggested by the author. The model is applied in two areas: agro-ecologic multi-layer boundary system of green-house gases (GHG) exchange between soil, canopy and atmosphere and in cosmology. Turbulence as an attribute of the any flux is described as a presence of the nonzero vorticity. Generalized advection-diffusion-reaction equation is derived for arbitrary number components in the flux as a universal mechanism to describe energy-mass circulation in Nature. It is shown that taking into consideration vorticity-related component of cosmological motion averts singularity and explains acceleration of the expansion. No mystic matter with dark energy is needed. That energy belongs to the local rotational motion (vorticity). Einstein's idea on static universe occurs to be encompassing conception for the standard cosmology as well as for the emerging new (oscillating) one.**

Index Terms— **Cosmology, material point of the second type, micrometeorology, turbulent flux.**

I. Introduction

One of the most fundamental tendencies of theoretical physics as well as other natural scientific endeavors is presenting Nature by simple but productive model. But, as Einstein but it, the model must be as simple as possible but not simpler. Progress in sciences can be measured by adequateness of the models to reality which, in its turn, can be measured by its prediction might.

From ancient times predicting natural, political and social processes was highly demanded art by political and economic elite performed by very specific circles of the intellectual (astrologic, mystic, theosophical etc.) mind controllers. If we do not have motives to hide historic roots we will see the reminiscent of the traditions of the ancient oracles. One of them is catastrophism.

The largest object scientific research tackles is Universe. The ability of the scientific method to model it, to describe dynamically its past and predict its future is positions science as potentially most effective institute of societies challenging Church, Political and Economic Establishment. Therefore scientific conclusions on the Universe and controlling thought leadership in the sphere goes beyond the pure academic process.

Another smaller but still big object is planet Earth and its fate even closer involved into contemporary hottest debates and, specifically, the role of the anthropologic factor in the climate change. Keeping in mind the emerging carbon quotas trade as an example we recognize that objective knowledge of the complex systems such as climate become tremendous economic component up to political level of importance.

The *smallest* object used in modeling physical reality is material point (particle). As a kind of building block of the not all mathematical models of reality it sets limits of adequateness, advantages and disadvantages of our understanding reality. Therefore it is reasonable to wonder: is this instrument sophisticated enough to serve as the fundament of our crucial models?

II. New Concept of Material Point

In the traditional introductions into flux mechanics, for example into eddy covariance method in measuring green-house gases flux from soil into atmosphere, sensitive area to catch the traces of the anthropological influences onto climate if it ever exist, one of basic primary concepts is an idea of ***fluid parcel*** which "is a very small amount of fluid, identifiable throughout its dynamic history while moving with the fluid flow" (wikipedia). Other close ideas are material point, particle. The author introduced new conception called material point of the second type. The difference of the new conception from the traditional conception of the material point (let us call it material point of the first type) is following. The point of the second type is not characterized by its mass but by density, its motion is a motion of the continuous media – with deformations and torsion. Hereby we have said goodbye to the old sophism "let us call material particle material point and will treat it as a point." Sorry, material point is bit of matter. Therefore it has inalienable ability to be oriented relative to other material objects and the ability to be deformed. And calling it point should not eliminate these objective essential abilities. Treating material point as geometrical point is typical sample of sophism. Description of material point has to include these "new" degrees of freedom.

This revelation brings us to reconsideration of the flux. The geometrical aspect of the model is awareness on necessity of projecting velocity vector V_α to configuration space of radius-vectors R^β to manipulate with velocities Cartesian coordinates:

$$V_\alpha = \mathrm{H}_{\alpha\beta}\mathrm{R}^\beta, \quad (1)$$

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because velocity vector is an object of the different (tangential) space. For the fundamental geometrical aspects of this statement see [7].

Here $H_{\alpha\beta}$ is advection-distortion-vortex tensor (affinor), R^{β} is radius-vector of the material point. Splitting tensor $H_{\alpha\beta}$ into three parts, responsible for expansion $\theta\delta_{\alpha\beta}/3$, shear $\sigma_{\alpha\beta}$ and vorticity $\omega_{\alpha\beta}$ is a novel tool to describe turbulence in the boundary layer agro-meteorology modeling, new degrees of freedom of the particle modeled as a material point of the second type:

$$H_{\alpha\beta} = \theta\delta_{\alpha\beta}/3 + \sigma_{\alpha\beta} - \omega_{\alpha\beta}\,. \quad (2)$$

III. GHG FLUX MODEL EQUATIONS

Hydrodynamic Euler equations split into

$$\frac{d\vartheta}{dt} + \frac{1}{3}\theta^2 + \sigma^2 - \omega^2 = -F_{\alpha\alpha}$$

$$\sigma^2 = \sigma_{\alpha\beta}\sigma_{\alpha\beta}, \omega^2 = \omega_{\alpha\beta}\omega_{\alpha\beta}, \frac{d\rho}{dt} = -\rho\vartheta,$$

(3)

$$\frac{d\sigma_{\alpha\beta}}{dt} + \frac{2}{3}\vartheta\sigma_{\alpha\beta} + \sigma_{\alpha\gamma}\sigma_{\gamma\beta} - \frac{1}{3}\delta_{\alpha\delta}\sigma^2 + \omega_{\alpha\gamma}\omega_{\gamma\beta} + \frac{1}{3}\delta_{\alpha\delta}\omega^2 = -F_{(\alpha\beta)} + \frac{1}{3}\delta_{\alpha\delta}F_{\gamma\gamma}$$

Here $F_{\alpha\beta}$ is a tensor of the external forces gradient. Dynamics of the turbulent flux (3) is much more complex than of laminar flux and flux measurement methods need including turbulence-related terms.

A. *Advection-diffusion-reaction equations*

For a more general description structure (e.g. eddies) formation we get equation of the multi-component reaction-diffusion type

$$\frac{\partial x_i}{\partial t} = f_i(\{x_j\}) + \nabla_k D^k{}_j(r)\nabla^j x_i\,.$$

Substances diffusion and transfer of thermal energy are described by the same class equations. This equation is extremely universal and can be applied in modeling the broad range of processes taking place in agroindustry and in its energetics. The most impressive new application is a thermochemical decomposition of organic material such us agro manure at elevated temperatures without the participation of oxygen (pyrolysis) and production of designed fuels. It goes without saying that migration and generating (reacting) of gases in soil described by this equation.

The geometries of the subsystems are also considered in the modeling of the growth kinetics as a crucial factor. New class of equations called advection-diffusion-reaction (http://arxiv.org/pdf/1210.4091v2.pdf) was derived as following

$$\frac{\partial\rho_i}{\partial t} = -\tfrac{1}{3}H_i\rho_i + f(\{\rho_i\}) + \nabla\left[D_i(\{\rho_i\})\nabla\rho_i\right]\,.$$

This equation describes arbitrary amount of material components with densities ρ_i, parameters H_i - diagonal elements of matrix in (1) - are responsible for an advection change of density, and coefficients of the effective diffusion D_i, generalized and adopted when needed. It may also provide nonlinear evolution scenarios for evolution of the multi-component reacting media in the different systems such as agro-bio-geo fluxes. The nonlinear term $f(\{\rho_i\})$ stands for reactions between the components. The fluxes in the layers are objects for matching requirements on the boundaries between the layers. $\frac{d\omega_{\alpha\beta}}{dt} + \frac{2}{3}\vartheta\omega_{\alpha\beta} + \sigma_{\alpha\gamma}\omega_{\gamma\beta} + \sigma_{\alpha\gamma}\omega_{\gamma\beta} + \omega_{\alpha\gamma}\delta_{\gamma\beta} = -F_{[\alpha\beta]}$. These requirements are fulfilled by appropriate identification of the constants of integration.

One of the new features of the nonlinear dynamic processes described by given equation is the existence of the so called threshold effects. This means that we may expect emergence and ability to long existence of some eddies and grow some of them to scales intensities of tornado before getting destroyed up.

B. *Speed of Sound in Turbulent Flux*

Next aspect in using physical laws in the presence of turbulence is taking into account vorticity in Doppler Effect for measurement of speed of flux. Traditionally eddy covariance theory refers to standard Doppler Effect whereas it is based on consideration of the flux as turbulent. In self-consistent model the basic equation describing (ultra)sound needed to be one for turbulent flux, e.g. Blokhintsev- Howe equation [13, 14]. In the adiabatic approximation the equation holds

$$B = H + v^2/2,\ \frac{D}{Dt} = \frac{\partial}{\partial t} + v\nabla,\ L = \Omega\times v - T\nabla S\,,$$

$$\left\{\frac{D}{Dt}\left(\frac{1}{c^2}\frac{D}{Dt}\right) + \frac{1}{c^2}\frac{Dv}{Dt}\nabla - \nabla^2\right\}B = \operatorname{div}L - \frac{1}{c^2}\frac{Dv}{Dt}L,$$

Here H is enthalpy, $\boldsymbol{\Omega}=\boldsymbol{rot}\boldsymbol{v}$ is vorticity, S - entropy, T - temperature, v is flux speed, c is sound speed, t is time. Note that drag enthalpy B is connected to sound pressure p as $\partial p/\partial t = \rho DB/Dt$ (ρ is mass density of the media). Blokhintsev- Howe equation is derived as a consequence of impulse and mass conservation as well as equation of the state of the ideal gas. LHS of it correspond to the transfer of the sound in the arbitrary non-homogeneous flux and RHS characterizes the sources of the sound connected to character of the flux such as presence of vorticity and entropy gradient. As one can see, sound equation much more complicated than those traditionally used for deriving Doppler Effect in the frame of eddy covariance method.

IV. COSMOLOGIC APPLICATIONS

One can suggest that the cosmologic *singularity* is a consequence of using simplistic expansion law, so called Hubble law, instead of the realistic $V_\alpha = \mathrm{H}_{\alpha\beta}\mathrm{R}^\beta$. $\mathrm{H}_{\alpha\beta}$ can be called distortion velocity tensor (affinor), R^β is radius-vector of galaxies. Excessive symmetric character of the Hubble's law is nothing but *oversimplification* of the cosmological principles of homogeneity and isotropy. The law given above includes distributed rotation which is imperative attribute of cosmological kinematics and has been ignored in the Hubble's law. (Was not the intuitive feeling of the oversimplification of the expansion law the reason for the contradictory attitude to expansion interpretation of redshift-distance correlation by Hubble himself?) Historically, looking a few centuries back, lack of given tensor (affinor) law might be considered the reason for the idea of the Cartesian vortexes to be less popular in comparison to the ideas of Newtonian potential forces. But if to look a few thousand years back, emerging cosmological model was and still is in harmony with oldest world religions and even with the some of the myths to some extent. But new world religions standing on the "beginning" ex nihilo conception (creation camouflaged under scientific terminology), supported "singularizm" and won tender for cooperation with Science on the European scene.

The centrifugal forces acting between particles rotating randomly around each other are shown below to be able to reverse gravitational collapse. It is shown in this report that contribution from vortex ω (anti-symmetric part of $\mathrm{H}_{\alpha\beta}$) provides stabilization of cosmological collapse and induces rotational structure formation. It makes natural to interpret increasing redshift for larger distances as the transverse red shift effect. The exact expression and one for small *RH/c* and *Rω/c*, respectively, hold

$$\frac{\nu}{\nu_0} = \frac{\left[1-\frac{R^2(\omega^2-H^2)}{c^2}\right]^{1/2}}{1-\frac{RH}{c}},$$

therefore, the most natural candidate for acceleration cause is

$$\frac{\nu}{\nu_0} = 1 - \mathrm{RH/c} + \frac{3}{2}(\mathrm{RH/c})^2 - \frac{1}{2}(\mathrm{R}\omega/\mathrm{c})^2,$$

"local rotation" ω>3H which is homogenous and isotropic. *Cosmological Expansion Started from the Big Bounce on Local Rotation.*

Local rotations (vortexes) play the radical stabilization role averting cosmological singularity via the negative *nonlinear* mechanism in the retrospective extrapolation and making static or steady-in-the-average state of the universe (or a local region) possible. Therefore Einstein could "permit" the galaxies to rotate instead of postulating lambda-term ad hoc in the case of general relativistic consideration of static in average Universe. Though, as we know, it does not mean necessarily that the lambda-term is not needed because of other arguments. The further mathematical considerations are done in the frame of the Newtonian formalism shifting from Riemann-Cartan geometry because of the clear purpose: to emphasize that phantom of cosmological singularity is emerged neither because of general relativity (Riemannian character of the space-time), nor because of special relativity (limitedness of the physical velocities), but because of ignoring vorticity. Therefore, averting cosmological singularity happens not necessarily because of involving Cartan torsion but into in proofing in its rights to be counted vorticity. To understand this statement it is enough to know Newtonian hydrodynamics even you are not familiar with advanced geometries.

Let us consider local imaginary spherical region of the homogeneous and isotropic infinite distribution of gravitating "dust". As Milne and McCrea did, we can ignore the surrounding matter (Birkhoff theorem). But in contrary to Milne and McCrea [6], we do not demand the test particle rest at the contracting sphere marking the boundary of the ball of the constant mass but let it move with the typical peculiar cosmological velocity $\vec{v}_{pecular}$ on the sphere because rotation is a typical motion in the Universe along with well measured expansion, and the galaxies do have peculiar components of their motion. In other words we rehabilitate vorticity, and thereby long time ignored centrifugal cosmological forces as well. $\vec{v}_{pecular}$ is perpendicular to pure Hubble expansion . It is ignored component of the cosmological motion, in particular, in the standard general relativistic Friedman-Lemaitre models as well [3]. In Newtonian cosmology we derive in traditional notations:

$$\dot{\mathrm{H}} + \mathrm{H}^2 = K_1^2\rho^{4/3} - (4\pi\mathrm{G}/3)\rho. \quad (2)$$

Here we have got good surprise. The same functional dependence of ω^2 on R as of energy density and pressure of ultra-relativistic matter (electromagnetic radiation, photons gas), all of them while isotropic, are proportional to $1/\mathrm{R}^4$, and the very same law of conservation of the averaged shear squared σ^2 (the latter causes black "matter" effect along with "black energy" effect of ω^2) remain the functional character of (2) unchanged causing only the re-defining the

constant $K^2 = \Omega^2 - \Gamma^2 - \Sigma^2$, where constants Ω, Γ, Σ stand for vortex, radiation (energy density and pressure) and shear constants in corresponding conservation laws.

Here is the first integral of (2): $H^2/2 = -K^2/2R^4 + GM/R^3 + A/R^2$, where A is a constant of integration. A final integral of the cosmologic equations holds:

For $A \geq 0$ we have:

$t + t_0 = -(2A)^{-1}(2AR^2K + 2GMR - K^2)^{1/2} - GM(2A)^{3/2}\ln(2^{3/2}A^{1/2}(2AR^2 + 2MGR - K^2) + 4AR + 2GM)$; for $A \leq 0$ we have $t + t_0 = (2A)^{-1}(2AR^2K + 2GMR - K^2)^{1/2} - GM(-2A)^{3/2}$ What is exact value of ω^2 in the $\arcsin[(2AR + GM)/(2A^2K^2 + GM^2)^{1/2}]$.

radiation-dominated Einstein static Universe? We have

$\omega^2 = \frac{4\pi G}{3}\rho_{radiation} = \frac{4\pi G}{3c^2}aT^4$, where $a = \frac{\pi^2 k^4}{15\hbar^3 c^3} = 7.56 \times 10^{-16} J/m^3K^4$. Therefore, $\omega^2 = \frac{4\pi^3 Gk^4}{45\hbar^3 c^5}T^4$. Or,

compactly, $\omega^2 = a\chi T^4$, and $\omega^2 = \aleph T^4$, where $\chi = \frac{4\pi G}{3c^2} = 3.1 \times 10^{-27} m/kg$. $\aleph = \frac{4\pi^3 Gk^4}{45\hbar^3 c^5} = 2.11 \times 10^{-41} c^{-2}K^{-4}$ is a new universal

constants combination. The illegally trampled right to rotate is returned to point of matter (particle). For T=2.7K we get that even such a small value as $\omega^2 \approx 1.12 \times 10^{-40}$ rad^2/c^2 could be enough to compensate the radiation contribution to the cosmological contraction preceded to the observed expansion, i.e. less than, supposedly, existing value.

V. Conclusion

Dynamics of the turbulent GHG flux on the boundary layer, as given mathematical model demonstrates, is much complicated in comparison with vortex-free motion. Therefore, eddy covariance method, as an existing broadly accepted successfully working instrument, can experience further development and can bring even more detailed models, accounting vorticity. Vorticity is the phenomenon changing radically many of the scenarios in nature when accounted [9,10]. Therefore we may expect that existing questions in boundary level flux modeling, such as energy balance problem, can be tackled using vortex.

Applying realistic model of the material point of the second type we have given an answer "Thanks, no." to the following hypothesis. In the Universe somebody somehow with the some unknown purpose, at the some mysterious previous stage of its evolution had fine tuned with 100%-precisness zero scattering of each particle around each another. This Entity provided by this fantastic job the delivery all of them to the very same point at the very same time. Sorry, not in this Universe [6-8].

A conclusion section is not required. Although a conclusion may review the main points of the paper, do not replicate the abstract as the conclusion. A conclusion might elaborate on the importance of the work or suggest applications and extensions.

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Author render honors to Indian Physicist Amal Kumar Raychaudhuri (14 September 1923 – 18 June 2005) who is renowned for his famous equation (Raychaudhuri's equation) [17] which is in fact general relativistic version of the first equation of (3). Amal Kumar Raychaudhuri and his highly instrumental equation deserve better establishment and correct interpretation.

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