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On Cantorian Superfluid Vortex Cosmology: 14 years later and still in progress

Victor Christianto*[1], Florentin Smarandache[2]

[1]Malang Institute of Agriculture (IPM), Malang, Indonesia.
http://researchgate.net/profile/Victor_Christianto
*Email: victorchristianto@gmail.com. Founder of www.ketindo.com
[2]Dept. Mathematics and Sciences, University of New Mexico, Gallup – USA.
Email: florentin.smarandache@laposte.net

ABSTRACT

Around 14 years ago, one of these authors's early paper was published in Apeiron Journal. The complete paper appeared on January 2004 edition, while a condensed version of CSV has been published earlier at July 2003. Among key ideas in those two papers are: (a) a nonlinear cosmology model based on Navier-Stokes turbulence equations, which then they are connected to superfluid turbulence, and (b) the superfluid turbulence can lead to superfluid quantized vortices, which can be viewed as large scale version of Bohr's quantization rule, and (c) this superfluid quantized vortice interpretation of Bohr's rule allow us to predict quantization of planetary orbits in solar system including new possible orbits beyond Pluto. This paper is intended as a retrospect of what happened after the publication of those papers, and also some related ideas we have developed since that time. The first author (VC) would like to express sincere gratitude to the late Prof. Robert M. Kiehn for spending precious time to read and suggest corrections to our first paper on Cantorian Superfluid Vortex model, during 2002-2003. And also to Mr. Roy Keys from Apeiron for publishing our three papers describing CSV model. It is our hope that the new proposed view will inspire younger physicists and cosmologists to develop more realistic nonlinear cosmology models, and we also hope the ideas presented here can be verified with observation data.

Keywords: nonlinear cosmology, Newtonian cosmology, vortex dynamics, superfluid turbulence, Navier-Stokes equations, spiral galaxy, Ermakov-type equation.

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1. Introduction

Around 14 years ago, one of these authors (VC)'s first paper was published in *Apeiron Journal*, January 2004, while a condensed version of the ideas has been published earlier at July 2003. [6][7]

Among key ideas in those two papers are (a) a nonlinear cosmology model based on Navier-Stokes turbulence equations, which then they are connected to superfluid turbulence, and (b) the superfluid turbulence can lead to superfluid quantized vortices, which can be viewed as large scale version of Bohr's quantization rule, and (c) this superfluid quantized vortices interpretation of Bohr's rule allow us to predict quantization of planetary orbits in solar system including new possible orbits beyond Pluto. Then a follow-up paper was published in July 2004, because VC read about recent discovery of Sedna, which at the time it was the first discovered planetoid at the outer side of Pluto. The discovery by Mike Brown-Trujillo team from Caltech was quite a big news back then. Other discoveries of new planetoids beyond Pluto have been reported since then, which seem to cause IAU to admit in a conference held around 2005: Pluto is no longer the edge of our solar system. Mike Brown also made a hit with his book, depicting himself as "Pluto killer."

As with ourselves, the truth was that one of these authors (VC) was refused to publish more papers in Apeiron. So he decided to send subsequent papers to other journals, like *Annales de la Fondation Louis de Broglie* [8], after kind help by Dr. Valery Dvoeglazov, editor of Apeiron Journal.

After bouncing back and forth with other topics in astrophysics and quantum mechanics, finally VC found back his early interest on Cantorian Vortex turbulence cosmology. In a series of papers published in *Prespacetime Journal* (thanks to Dr. Huping Hu), since 2010 up to 2017, we explored topics like Primordial Rotation of Universe and also Cantorian Navier-Stokes cosmology (minus the superfluid term in 2004 paper), see [18]-[20].

Now, in this paper allow us to summarize a few new findings related to that topic.

In this paper we will discuss a novel Newtonian cosmology model with vortex, which offers wide implications from solar system, galaxy modeling up to large scale structures of the Universe, where we include the vortical-rotational effect of the whole Universe.

We review an Ermakov-type equation obtained by Nurgaliev [1][2], and solve the equation numerically with Mathematica 11.

It is our hope that the new proposed view will lead to more rigorous nonlinear cosmology models, and we also hope the ideas presented here can be verified with observation data.

2. A few theoretical backgrounds

Some years ago, Matt Visser asked the following interesting questions: How much of modern cosmology is really cosmography? How much of modern cosmology is independent of the Einstein equations? (Independent of the Friedmann equations?) These questions are becoming increasingly germane — as the models cosmologists use for the stress-energy content of the universe become increasingly *baroque*. [5]

In this regard, academician Isaak Khalatnikov mentioned at the 13th Marcel Grossman Conference[1], that Lev Landau suggesting that something is too symmetric in the models yielding singularities, and that this problem is one of the three most important problems of modern physics. The aim of this report is to show that singularities are, indeed,

[1] http://www.icra.it/mg/mg13/

consequences of such an overly "symmetrical approach" in building non-robust (i.e. without structural stability) toy models with singularities. Such models typically apply a synchronous system of reference and "Hubble's law", neglecting not-to-be-averaged-out quadratic terms of perturbations (specifically, differentially rotational velocities, vortexes).[1]

Only by accounting the overlooked factors instead of Einstein's ad hoc introduction of a new entity, which was later declared by him as his "biggest blunder", can we correctly interpret accelerated cosmological expansion, as well as provide possibility of static solution. The common perception of the observed accelerated expansion is that there is need either in modifying the General Relativity or discover new particles with unusual properties. Interestingly enough, both ways are possible depending on what kind of system of reference and corresponding interpretation are chosen, a decision which is usually made depending on the level of *"geometrization*."[1]

Local rotations (vortices) play a role in radical stabilization of the cosmological singularity in the retrospective extrapolation, making possible a static or steady-state (on the average) Universe or local region. Therefore Einstein could "permit" the galaxies to rotate instead of postulating a cosmological constant *ad hoc* in his general-relativistic consideration of a static Universe. Though, it does not necessarily mean that the cosmological constant is not necessary for other arguments.[2]

3. A few historical notes

Since long time ago, there were numerous models of the Universe, dating back to Ptolemaic geocentric model, which was subsequently replaced by Nicolas Copernicus discovery. Copernicus model then was brought into fame after Isaac Newton published his book. But other than Newton, there was a model of Universe as a turbulent fluid (hurricane) brought by a French philosopher and mathematician, R. Descartes. But, this model was almost forgotten. Many physicists rejected Descartes' model because it stood against Newtonian model, but the truth is turbulence model can be expressed in Navier-Stokes equations, and Navier-Stokes equations can be considered as the rigorous formulation of Newtonian laws, especially for fluid dynamics. In other words, we can say that Newtonian turbulence Universe is not in direct contradiction with Newtonian laws. Therefore, in this paper we submit wholeheartedly a proposal that the Universe can be modelled as Newtonian-Vortex based on 3D Navier-Stokes equations. We shall show some implications of this new model in the following sections.

4. Solar System model

In this section, we will review the work which was carried out by VC and FS during the past ten years or so. The basic assumption here is that the Solar System's planetary orbits are quantized. But how do their orbits behave? Do they follow Titius-Bode's law? Our answer can be summarized as follows:[6][7][8]

Navier-Stokes equations → superfluid quantized vortices → Bohr's quantization

Our predictive model based on that scheme has yielded some interesting results which may be comparable with the observed orbits of planetoids beyond Pluto, including what is dubbed as Sedna.[9] And it seems that the proposed model is slightly better compared to Nottale-Schumacher's gravitational Schrödinger model and also Titius-Bode's empirical law.

5. Spiral Galaxy model

In this section, we discuss a simple model of galaxies based on a postulate of turbulence vortices which govern the galaxy dynamics. Abstract of Vatistas' paper told clearly:[10]

> Expanding our previous work on turbulent whirls [1] we have uncovered a similarity within the similarity shared by intense vortices. Using the new information we compress the tangential velocity profiles of a diverse set of vortices into one and thus identify those that belong to the same genus. Examining the Laser Doppler Anemometer (LDA) results of mechanically produced vortices and radar data of several tropical cyclones, we find that the uplift and flattening effect of tangential velocity is a consequence of turbulence. Reasoning by analogy we conclude that turbulence in the interstellar medium could indeed introduce a flattening effect in the galactic rotation curves.

The result of his model equation can yield prediction which is close to observation (without invoking dark matter hypothesis), as shown in the following diagram:

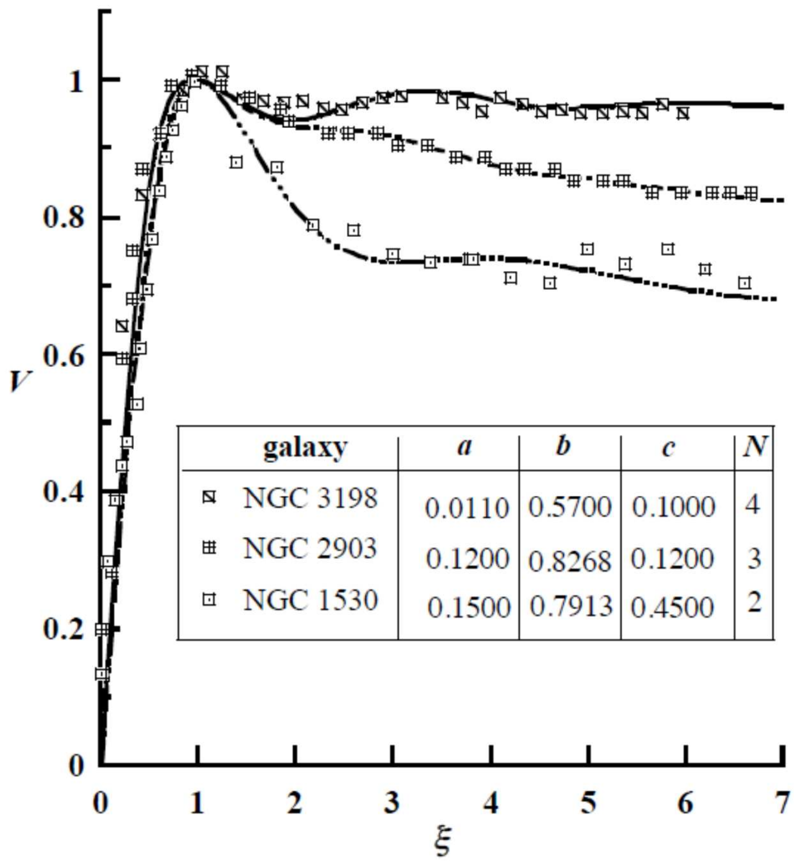

Diagram 1. From Vatistas [10]

Therefore it appears possible to model galaxies without invoking numerous *ad hoc* assumptions, once we accept the existence of turbulent interstellar medium. The model is also governed by Navier-Stokes equations.[10]

6. Deriving Ermakov-type equation for Newtonian Universe with vortex

It has been known for long time that most of the existing cosmology models have *singularity* problem. Cosmological singularity has been a consequence of excessive symmetry of flow, such as “Hubble’s law”. A more realistic one is suggested, based on

Newtonian cosmology model but here we include the vortical-rotational effect of the whole Universe.

In this section, we will derive an Ermakov-type equation following Nurgaliev [1]. Then we will solve it numerically using Mathematica 11.

After he proceeds with some initial assumptions, Nurgaliev obtained a new simple local cosmological equation:[2]

$$\dot{H} + H^2 = \omega^2 + \frac{4\pi G}{3}\rho, \tag{1}$$

where $\dot{H} = dH/dt$. Here, H, G, ω and ρ stand for Hubble constant, Newtonian gravitational constant, angular speed, and density, respectively.

The angular momentum conservation law ωR^2 = const = K and the mass conservation law $(4\pi/3)\rho R^3$ = const = M makes equation (1) solvable:[2]

$$\dot{\mathrm{H}} + \mathrm{H}^2 = \frac{K^2}{R^4} - \frac{\mathrm{GM}}{\mathrm{R}^3}, \tag{2}$$

or

$$\ddot{R} = \frac{K^2}{R^3} - \frac{GM}{R^2}. \tag{3}$$

Equation (3) may be written as Ermakov-type nonlinear equation as follows;

$$\ddot{R} + \frac{GM}{R^2} = \frac{K^2}{R^3}. \tag{4}$$

Nurgaliev tried to integrate equation (3), but now we will solve the above equation with Mathematica 11. First, we will rewrite this equation by replacing GM=A, K^2=B, so we get:

$$\ddot{R} + \frac{A}{R^2} = \frac{B}{R^3}. \tag{5}$$

As with what Nurgaliev did in [1][2], we also tried different sets of A and B values, as follows:

a. A and B < 0

```
A=-10;
B=-10;
ODE=x''[t]+A/x[t]^2-B/x[t]^3==0;
sol=NDSolve[{ODE,x[0]==1,x'[0]==1},x[t],{t,-10,10}]
Plot[x[t]/.sol,{t,-10,10}]
```

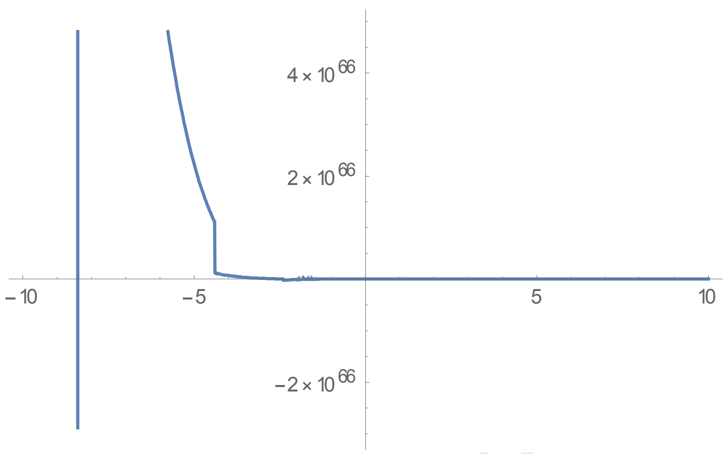

Diagram 2. Plot of numerical solution of Ermakov-type equation for A<O, B<0

b. A > 0, B < 0

```
A=1;
B=-10;
ODE=x''[t]+A/x[t]^2-B/x[t]^3==0;
sol=NDSolve[{ODE,x[0]==1,x'[0]==1},x[t],{t,-10,10}]
Plot[x[t]/.sol,{t,-10,10}]
```

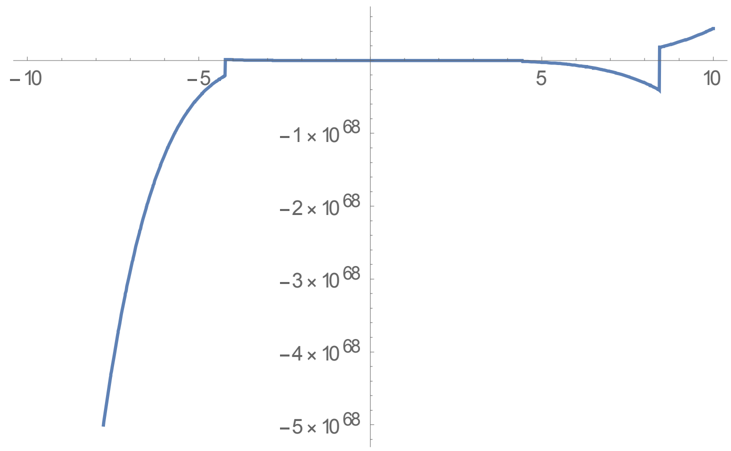

Diagram 3. Plot of numerical solution of Ermakov-type equation for A>O, B<0

From the above numerical experiments, we conclude that the evolution of the Universe depends on the constants involved, especially on the rotational-vortex structure of the Universe. This needs to be investigated in more detailed for sure.

One conclusion that we may derive especially from Diagram 3, is that our computational simulation suggests that it is possible to consider that the Universe has existed for long time in prolonged stagnation period, then suddenly it burst out from *empty and formless* (Gen. 1:2), to take its current shape with observed "accelerated expansion."

As an implication, we may arrive at a precise model of flattening velocity of galaxies without having to invoke *ad-hoc* assumptions such as dark matter.

Therefore, it is perhaps noteworthy to discuss briefly a simple model of galaxies based on a postulate of turbulence vortices which govern the galaxy dynamics. The result of Vatistas' model equation can yield prediction which is close to observation, see section 5 above.

7. Plausible medicine application: modelling virus with 3D Navier-Stokes equations

Although virus is widely known to significantly affect many biological form of life, its physical model is quite rare. In a paper, L.H. Ford wrote:

> "Two simple models for the particle are treated, a liquid drop model and an elastic sphere model. Some estimates for the lowest vibrational frequency are given for each model. It is concluded that this frequency is likely to be of the order of a few GHz for particles with a radius of the order of 50nm." [21]

Such an investigation on acoustic vibration of virus particles may resonate with other reports by Prof. Luc Montagnier [23][24] and also our own hypothesis [25][26], on *wave character of biological entities* such as DNA, virus, water etc.

In this regard, there are studies on the mechanical properties of (biology) materials based on experiments on the acoustic vibrations of elastic nanostructures in fluid media, where the medium surrounding the nanostructure is typically modeled as a Newtonian fluid.

In this section we will also discuss a Newtonian fluid, i.e. 3D Navier-Stokes equations.

It is our hope that the new proposed method can be verified with experiments.

In 2015, Vahe Galstyan, On Shun Pak and Howard A. Stone published a paper where they discuss breathing mode of an elastic sphere in Newtonian and complex fluids.[22] They consider the radial vibration of an elastic sphere in a compressible viscous fluid, where the displacement field of the elastic fluid medium is governed by the Navier equation in elasticity. This spherically symmetric motion is also called the *breathing mode*.

They use a linearized version of Navier-Stokes equations, as follows:[22]

$$\rho_v \frac{\partial v}{\partial t} = -\nabla p + \eta \nabla^2 v + \left(\kappa + \frac{\eta}{3}\right)\nabla, \qquad (1)$$

where ρ_v is the density of the fluid, η is the shear viscosity, κ is the bulk viscosity, and p is the thermodynamic pressure.

There are other authors who work on linearized NS problem, here we mention a few of them: Foias and Saut [27]; Thomann & Guenther [28]; A. Leonard [29].

In fluid mechanics, there is an essential deficiency of the analytical solutions of non-stationary 3D Navier–Stokes equations. Now, instead of using linearized NS equations as above, we will discuss a numerical solution of 3D Navier-Stokes equations based on Sergey Erhskov's papers [13][14].

The Navier-Stokes system of equations for incompressible flow of Newtonian fluids can be written in the Cartesian coordinates as below (under the proper initial conditions):[13]

$$\nabla.\vec{u} = 0, \quad (2)$$

$$\frac{\partial \vec{u}}{\partial t} + (\vec{u} \cdot \nabla)\vec{u} = -\frac{\nabla p}{\rho} + \nu \cdot \nabla^2 \vec{u} + \vec{F}. \quad (3)$$

Where u is the flow velocity, a vector field, ρ is the fluid density, p is the pressure, v is the kinematic viscosity, and F represents external force (per unit mass of volume) acting on the fluid.[13]

In ref. [13], Ershkov explores new ansatz of derivation of non-stationary solution for the Navier–Stokes equations in the case of incompressible flow, where his results can be written in general case as a mixed system of 2 coupled-Riccati ODEs (in regard to the time-parameter t). But instead of solving the problem analytically, we will try to find a numerical solution with the help of computer algebra package of Mathematica 11.

The coupled Riccati ODEs read as follows:[13]

$$a' = \frac{w_y}{2} \cdot a^2 - (w_x \cdot b) \cdot a - \frac{w_y}{2}(b^2 - 1) + w_z \cdot b, \quad (4)$$

$$b' = -\frac{w_x}{2} \cdot b^2 + (w_y \cdot a) \cdot b + \frac{w_x}{2}(a^2 - 1) - w_z \cdot a. \quad (5)$$

First, equations (4) and (5) can be rewritten in the form as follows:

$$x(t)' = \frac{v}{2} \cdot x(t)^2 - (u \cdot y(t)) \cdot x(t) - \frac{v}{2}(y(t)^2 - 1) + w \cdot y(t), \quad (6)$$

$$y(t)' = -\frac{u}{2} \cdot y(t)^2 + (v \cdot x(t)) \cdot y(t) + \frac{u}{2}(x(t)^2 - 1) - w \cdot x(t). \quad (7)$$

Then we can put the above equations into Mathematica expression:[3]

```
v=1;
u=1;
w=1;
{xans6[t_], vans6[t_]}=
{x[t],y[t]}/.Flatten[NDSolve[{x'[t]==(v/2)*x[t]^2-(u*y[t])*x[t]-(v/2)*(y[t]^2-1)+w*y[t], y'[t]==-
(u/2)*y[t]^2+(v*x[t])*y[t]+(u/2)*(x[t]^2-1)-w*x[t], x[0]==1,y[0]==0}, {x[t],y[t]},{t,0,10}]]

graphx6 = Plot[xans6[t],{t,0,10}, AxesLabel->{"t","x"},PlotStyle->Dashing[{0.02,0.02}]];
Show[graphx6,graphx6]
```

The result is as shown below:[3]

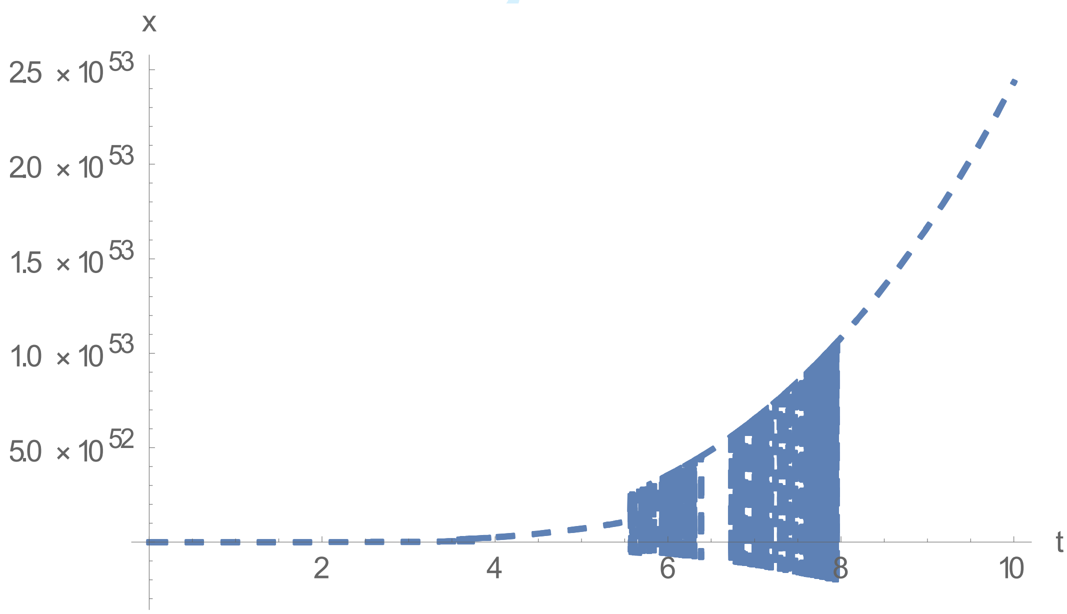

DIAGRAM 4. Graphical plot of solution for case v=u=w=1. See [3]

Concluding remarks

Around 14 years ago, one of these authors's early paper was published in Apeiron Journal. The complete paper appeared on January 2004 edition, while a condensed version of CSV has been published earlier at July 2003. This paper is intended as a retrospect of what happened after the publication of those papers, and also a number of new findings that we have developed since that time.

In the meantime, it has been known for long time that most of the existing cosmology models have singularity problem. Cosmological singularity has been a consequence of excessive symmetry of flow, such as “Hubble’s law”. More realistic one is suggested, based on Newtonian cosmology model but here we include the vortical-rotational effect of the whole Universe. We discuss a plausible model for describing planetary quantization in Solar system and also flattening velocity observed in numerous galaxies. We also review a Riccati-type equation obtained by Nurgaliev, and solve the equation numerically with Mathematica 11.

We also discuss medicine application of this approach for virus modelling, i.e. how to solve 3D Navier-Stokes equations numerically. It is our hope that the above numerical solution of 3D Navier-Stokes equations can be found useful, especially in computational nanomedicine.

The solutions obtained here opens up new ways to interpret existing solutions of known 3D Navier-Stokes problem in physics, astrophysics, cosmology and engineering/medicine fields, especially those associated with nonlinear hydrodynamics and turbulence modelling.

It is our hope that the new proposed Newtonian Cosmology model with vortex can be verified with more extensive observation data.

Acknowledgment

The first author (VC) dedicates this paper to the late Prof. Robert M. Kiehn for spending precious time to read and suggest corrections to early draft of his paper on Cantorian Superfluid Vortex model, back in 2002-2003. And also to Dr. Valery Dvoeglazov and Mr. Roy Keys from Apeiron Journal for publishing our 3 papers on CSV.
VC also gratefully appreciates discussions with many senior physicists since 2002, such as with Prof. Carlos Castro, Prof. Matt Pitkanen, Prof. Akira Kanda, Prof. Michael Fil'chenkov (RUDN), Prof. Alexander P. Yefremov (RUDN), Prof. Vladimir Ivashchuk (RUDN), Prof. Vladimir Kassandrov (RUDN), Prof. Yury P. Rybakov (RUDN), and numerous others who are too many to mention here. Recent discussions with Prof. Bambang Hidayat, Prof. Thee Houw Liong and Prof. Like Wilardjo are also gratefully acknowledged. And special thanks to younger colleagues: Sergey Ershkov from Lomonosov's Moscow State University and Dr. Yunita Umniyati from SGU. Nonetheless, this paper is solely our responsibility.

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