Report

On Primordial Rotation of the Universe, Hydrodynamics, Vortices & Angular Momenta of Celestial Objects

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Abstract

In the present paper, we make some comments on a recent paper by Sivaram & Arun in *The Open Astronomy Journal* 2012, 5, 7-11 with title: 'Primordial rotation of the Universe, Hydrodynamics, Vortices and angular momenta of celestial objects', where they put forth an interesting idea on the origin of rotation of stars and galaxies based on torsion gravity. We extend further their results by hypothesizing the presence of quantized vortices in relation with the torsion vector. If the hypothesis is proven and observed, then it can be used to explain numerous unexplainable phenomena in galaxies etc. The quantization of circulation can be generalized to be Bohr-Sommerfeld quantization rules, which are found useful to describe quantization in astrophysical phenomena, i.e. planetary orbit distances. Further recommendation for observation of the proposed quantized vortices of superfluid helium in astrophysical objects is also mentioned.

Key Words: primordial rotation, Universe, hydrodynamics, vortices, angular momenta, celestial objects.

Introduction

Two recent papers by Sivaram & Arun, one in *The Open Astronomy Journal* 2012, 5, 7-11 [1], and one in arXiv [2] are found very interesting. They are able to arrive at the observed value of effective cosmological constant by considering background torsion in the teleparallel gravity. According to them, "the background torsion due to a universal spin density not only gives rise to angular momenta of all structures but also provides a background centrifugal term acting as a repulsive gravity accelerating the universe, with spin density acting as effective cosmological constant."[1] The torsion is given by [1, p.10]:

$$Q = \frac{4\pi G\sigma}{c^3} \approx 10^{-28} cm^{-1}, \qquad (1)$$

And the background curvature [1, p.10] is given by:

$$Q^2 \approx 10^{-56} cm^{-2}. \qquad (2)$$

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In the meantime, a recent review of dark energy theories in the literature (including teleparallel gravity) has been given in [4], and present problems in the standard model general relativistic cosmology are discussed by Starkman [5]. These seem to suggest that a torsion model of effective cosmological constant based on teleparallel gravity as suggested by Sivaram and Arun (2012) seems very promising as a description of phenomena related to accelerated expansion of the Universe usually attributed to 'dark energy' (as alternative to cosmological constant explantion).

However, Sivaram & Arun do not make further proposition concerning the connection between quantized vortices (Onsager-Feynman's rule) and the torsion vector. It will be shown here, that such a connection appears possible.

Here we present Bohr-Sommerfeld quantization rules for planetary orbit distances, which results in a good quantitative description of planetary orbit distance in the solar system [6][6b][7]. Then we find an expression which relates the torsion vector and quantized vortices from the viewpoint of Bohr-Sommerfeld quantization rules [3].

Further observation of the proposed quantized vortices of superfluid helium in astrophysical objects is recommended.

Bohr-Sommerfeld quantization rules and quantized vortices

The quantization of circulation for nonrelativistic superfluid is given by [1][3]:

$$\oint v dr = N \frac{\hbar}{m_s} \tag{3}$$

Where $N, \hbar, m_s$ represents winding number, reduced Planck constant, and superfluid particle's mass, respectively [3]. And the total number of vortices is given by [1]:

$$N = \frac{\omega . 2\pi r^2 m}{\hbar} \tag{4}$$

And based on the above equation (4), Sivaram & Arun [1] are able to give an estimate of the number of galaxies in the universe, along with an estimate of the number stars in a galaxy.

However, they do not give explanation between the quantization of circulation (3) and the quantization of angular momentum. According to Fischer [3], the quantization of angular momentum is a relativistic extension of quantization of circulation, and therefore it yields Bohr-Sommerfeld quantization rules.

Furthermore, it was suggested in [6] and [7] that Bohr-Sommerfeld quantization rules can yield an explanation of planetary orbit distances of the solar system and exoplanets. Here, we begin with Bohr-Sommerfeld's conjecture of quantization of angular momentum. As we know, for the wavefunction to be well defined and unique, the momenta must satisfy Bohr-Sommerfeld's quantization condition:

$$\oint_{\Gamma} p.dx = 2\pi.n\hbar, \tag{5}$$

for any closed classical orbit Γ. For the free particle of unit mass on the unit sphere the left-hand side is:

$$\int_0^T v^2.d\tau = \omega^2.T = 2\pi.\omega, \tag{6}$$

Where $T = \frac{2\pi}{\omega}$ is the period of the orbit. Hence the quantization rule amounts to quantization of the rotation frequency (the angular momentum): $\omega = n\hbar$. Then we can write the force balance relation of Newton's equation of motion:

$$\frac{GMm}{r^2} = \frac{mv^2}{r}. \tag{7}$$

Using Bohr-Sommerfeld's hypothesis of quantization of angular momentum (6), a new constant g was introduced:

$$mvr = \frac{ng}{2\pi}. \tag{8}$$

Just like in the elementary Bohr theory (just before Schrodinger), this pair of equations yields a known simple solution for the orbit radius for any quantum number of the form:

$$r = \frac{n^2.g^2}{4\pi^2.GMm^2}, \tag{9}$$

or

$$r = \frac{n^2.GM}{v_o^2}, \tag{10}$$

Where r, n, G, M, v_o represents orbit radii (semimajor axes), quantum number (n=1,2,3,…), Newton gravitation constant, and mass of the nucleus of orbit, and specific velocity, respectively. In equation (10), we denote:

$$v_0 = \frac{2\pi}{g} GMm. \tag{11}$$

The value of m and g in equation (11) are adjustable parameters.

Interestingly, we can remark here that equation (10) is exactly the same with what is obtained by Nottale using his Schrodinger-Newton formula [8]. Therefore here we can verify that the result is the same, either one uses Bohr-Sommerfeld quantization rules or Schrodinger-Newton equation. The applicability of equation (10) includes that one can predict new exoplanets (extrasolar planets) with remarkable result.
Therefore, one can find a neat correspondence between Bohr-Sommerfeld quantization rules and motion of quantized vortice in condensed-matter systems, especially in superfluid helium [3]. Here we propose a conjecture that Bohr-Sommerfeld quantization rules also provide a good description for the motion of galaxies, therefore they should be included in the expression of torsion vector. We will discuss an expression of torsion vector of quantized vortices in the next section.

Torsion and quantized vortices

We cite here a rather old paper of Garcia de Andrade & Sivaram, 1998 [9], where they discuss propagation torsion model for quantized vortices. They consider the torsion to be propagating and it can be expressed as derivative of scalar field:

$$Q = \nabla \phi. \tag{12}$$

Therefore $\oint QdS$ can be written as [9]:

$$\oint QdS = \oint \nabla \phi dS = \int \nabla (\nabla \phi) dV \cong \int \nabla^2 \phi dV. \tag{13}$$

Also $\oint QdS$ must have dimensions of length, and thus quantized as [9]:

$$\oint QdS \cong \frac{n\hbar c}{M} \tag{14}$$

Now we invoke a result from the preceding section discussing Bohr-Sommerfeld quantization rules. Assuming that Bohr-Sommerfeld quantization rules also govern the galaxies motion as well as stars motion, then we can insert equation (11) into equation (14), to yield a new expression:

$$\oint QdS \cong \frac{n\hbar c.2\pi Gm}{v_0 g} \tag{15}$$

Therefore, we submit a viewpoint that the torsion vector is also a quantized quantity, and it is a function of Planck constant, speed of light, Newton gravitation constant, vortex particle's mass, a specific velocity and an adjustable parameter, g. It is interesting to find out whether this proposition agrees with observation data or not.

The above proposition (15) connects torsion vector with gravitation constant, which seems to give a torsion description of gravitation. There are numerous other models to describe alternative or modified gravitation theories, for instance Wang is able to derive Newton's second law and Schrodinger equation from fluid mechanical dynamics. [10][11]

In the mean time, for discussion of galaxy disk formation, see [12]. And [13] gives alternative vortices argument for dark matter.

The proposed quantization of circulation as suggested by Sivaram and Arun [1] is based on a conjecture that the universe is formed by superfluid or condensed matter. For models describing further this proposition, see discussion in Brook [14].

Concluding remarks

In the present paper, we make some comments on a recent paper by Sivaram & Arun in *The Open Astronomy Journal* 2012, 5, 7-11 where they put forth an interesting idea on the origin of rotation of stars and galaxies based on torsion gravity. We extend further their results by hypothesizing the presence of quantized vortices relation with the torsion vector. If the hypothesis is proven and observed, then it can be used to explain numerous unexplainable phenomena in galaxies etc. Further recommendation for observation of the proposed quantized vortices of superfluid helium in astrophysical objects is also mentioned.

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