

# Plausible Explanation of Quantization of Intrinsic Redshift from Hall Effect and Weyl Quantization

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Using phion condensate model as described by Moffat [1], we consider a plausible explanation of (Tifft) intrinsic redshift quantization as described by Bell [6] as result of Hall effect in rotating frame. We also discuss another alternative to explain redshift quantization from the viewpoint of Weyl quantization, which could yield Bohr-Sommerfeld quantization.

## 1 Introduction

In a recent paper by Moffat [1] it is shown that quantum phion condensate model with Gross-Pitaevskii equation yields an approximate fit to data corresponding to CMB spectrum, and it also yields a modified Newtonian acceleration law which is in good agreement with galaxy rotation curve data. It seems therefore interesting to extend further this hypothesis to explain quantization of redshift, as shown by Tifft *et al.* [2, 6, 7]. We also argue in other paper that this redshift quantization could be explained as signature of topological quantized vortices, which also agrees with Gross-Pitaevskiiian description [3, 5].

Nonetheless, there is remaining question in this quantized vortices interpretation, i. e. how to provide explanation of “intrinsic redshift” argument by Bell [6]. In the present paper, we argue that it sounds reasonable to interpret the intrinsic redshift data from the viewpoint of rotating Hall effect, i. e. rotational motion of clusters of galaxies exhibit quantum Hall effect which can be observed in the form of “intrinsic redshift”. While this hypothesis is very new, it could be expected that we can draw some prediction, including possibility to observe small “blue-shift” effect generated by antivortex part of the Hall effect [5a].

Another possibility is to explain redshift quantization from the viewpoint of Weyl-Moyal quantization theory [25]. It is shown that Schrödinger equation can be derived from Weyl approach [8], therefore quantization in this sense comes from “graph”-type quantization. In large scale phenomena like galaxy redshift quantization one could then ask whether there is possibility of “super-graph” quantization.

Further observation is of course recommended in order to verify or refute the propositions outlined herein.

## 2 Interpreting quantized redshift from Hall effect. Cosmic String

In a recent paper, Moffat [1, p. 9] has used Gross-Pitaevskii in conjunction with his *phion condensate fluid* model to

describe CMB spectrum data. Therefore we could expect that this equation will also yield interesting results in galaxies scale. See also [1b, 1c, 13] for other implications of low-energy phion fluid model.

Interestingly, it could be shown, that we could derive (approximately) Schrödinger wave equation from Gross-Pitaevskii equation. We consider the well-known Gross-Pitaevskii equation in the context of superfluidity or superconductivity [14]:

$$i\hbar \frac{\partial \Psi}{\partial t} = -\frac{\hbar^2}{2m} \Delta \Psi + (V(x) - \gamma |\Psi|^{p-1}) \Psi, \quad (1)$$

where  $p < 2N/(N-2)$  if  $N \geq 3$ . In physical problems, the equation for  $p = 3$  is known as Gross-Pitaevskii equation. This equation (1) has standing wave solution quite similar to solution of Schrödinger equation, in the form:

$$\Psi(x, t) = e^{-iEt/\hbar} \cdot u(x) \quad (2)$$

Substituting equation (2) into equation (1) yields:

$$-\frac{\hbar^2}{2m} \Delta u + (V(x) - E) u = |u|^{p-1} u, \quad (3)$$

which is nothing but a time-independent linear form of Schrödinger equation, except for term  $|u|^{p-1}$  [14]. If the right-hand side of this equation is negligible, equation (3) reduces to standard Schrödinger equation.

Now it is worth noting here that from Nottale *et al.* we can derive a gravitational equivalent of Bohr radius from generalized Schrödinger equation [4]. Therefore we could also expect a slight deviation of this gravitational Bohr radius in we consider Gross-Pitaevskii equation instead of generalized Schrödinger equation.

According to Moffat, the phion condensate model implies a modification of Newtonian acceleration law to become [1, p. 11]:

$$a(r) = -\frac{G_\infty M}{r^2} + K \frac{\exp(-\mu_\phi r)}{r^2} (1 + \mu_\phi r), \quad (4)$$

where

$$G_\infty = G \left[ 1 + \sqrt{\frac{M_0}{M}} \right]. \quad (5)$$

Therefore we can conclude that the use of phion condensate model implies a modification of Newton gravitational constant,  $G$ , to become (5). Plugging in this new equation (5) into a Nottale's gravitational Bohr radius equation [4] yields:

$$r_n \approx n^2 \frac{GM}{v_0^2} \left[ 1 + \sqrt{\frac{M_0}{M}} \right] \approx \chi \cdot n^2 \frac{GM}{v_0^2}, \quad (6)$$

where  $n$  is integer (1,2,3...) and:

$$\chi = \left[ 1 + \sqrt{\frac{M_0}{M}} \right]. \quad (7)$$

Therefore we conclude that — provided the higher order Yukawa term of equation (4) could be neglected — one has a *modified* gravitational Bohr-radius in the form of (6). It can be shown (elsewhere) that using similar argument one could expect to explain a puzzling phenomenon of *receding Moon* at a constant rate of  $\pm 1.5''$  per year. And from this observed fact one could get an estimate of this  $\chi$  factor. It is more interesting to note here, that a number of *coral reef* data also seems to support the same idea of modification factor in equation (5), but discussion of this subject deserves another paper.

A somewhat similar idea has been put forward by Masreliez [18] using the metric:

$$ds^2 = e^{\alpha\beta} [dx^2 + dy^2 + dz^2 - (icdt)^2]. \quad (8)$$

Another alternative of this metric has been proposed by Socoloff and Starobinski [19] using multi-connected hypersurface metric:

$$ds^2 = dx^2 + e^{-2x} (dy^2 + dz^2) \quad (9)$$

with boundaries:  $e^{-x} = \Lambda$ .

Therefore one can conclude that the use of phion condensate model has led us to a form of expanding metric, which has been discussed by a few authors.

Furthermore, it is well-known that Gross-Pitaevskii equation could exhibit *topologically* non-trivial vortex solutions [4, 5], which also corresponds to quantized vortices:

$$\oint p \cdot dr = N_v 2\pi\hbar. \quad (10)$$

Therefore an implication of Gross-Pitaevskii equation [1] is that topologically quantized vortex could exhibit in astrophysical scale. In this context we submit the viewpoint that this proposition indeed has been observed in the form of Tiffit's redshift quantization [2, 6]:

$$\delta r = \frac{c}{H} \delta z. \quad (11)$$

In other words, we submit the viewpoint that Tiffit's observation of quantized redshift implies a quantized distance between galaxies [2, 5], which could be expressed in the form:

$$r_n = r_0 + n(\delta r), \quad (12)$$

where  $n$  is integer (1,2,3,...) similar to quantum number. Because it can be shown using standard definition of Hubble law that redshift quantization implies quantized distance between galaxies in the same cluster, then one could say that this equation of quantized distance (11) is a result of *topological* quantized vortices (9) in astrophysical scale [5]; and it agrees with Gross-Pitaevskii (quantum phion condensate) description of CMB spectrum [1]. It is perhaps more interesting if we note here, that from (11) then we also get an equivalent expression of (12):

$$\frac{c}{H} z_n = \frac{c}{H} z_0 + n \left( \frac{c}{H} \delta z \right) \quad (13)$$

or

$$z_n = z_0 + n(\delta z) \quad (14)$$

or

$$z_n = z_0 \left[ 1 + n \left( \frac{\delta z}{z_0} \right) \right]. \quad (15)$$

Nonetheless, there is a problem here, i. e. how to explain intrinsic redshift related to Tiffit quantization as observed in Fundamental Plane clusters and also from various quasars data [6, 6a]:

$$z_{iQ} = z_f [N - 0.1 M_N] \quad (16)$$

where  $z_f = 0.62$  is assumed to be a fundamental redshift constant, and  $N (= 1, 2, 3 \dots)$ , and  $M$  is function of  $N$  [6a]. Meanwhile, it is interesting to note here similarity between equation (15) and (16). Here, the number  $M$  seems to play a rôle similar to second quantum number in quantum physics [7].

Now we will put forward an argument that intrinsic redshift quantization (16) could come from rotating quantum Hall effect [5a].

It is argued by Fischer [5a] that "Hall quantization is of necessity derivable from a *topological quantum number* related to this (quantum) coherence". He used total particle momentum [5a]:

$$p = mv + m\Omega \times r + qA. \quad (17)$$

The uniqueness condition of the collective phase represented in (9) then leads, if we take a path in the bulk of electron liquid, for which the integral of  $mv$  can be neglected, to the quantization of the sum of a *Sagnac flux*, and the magnetic flux [5a]:

$$\begin{aligned} \Phi &= q \oint A \cdot dr + m \oint \Omega \times r \cdot dr = \\ &= \iint B \cdot dS = N_v 2\pi\hbar. \end{aligned} \quad (18)$$

This flux quantization rule corresponds to the fact that a *vortex* is fundamentally characterised by the winding number  $N$  alone [5a]. In this regard the vortex could take the form of cosmic string [22]. Now it is clear from (15) that quantized vortices could be formed by different source of flux.

After a few more reasonable assumptions one could obtain a generalised Faraday law, which in rotating frame will give in a non-dissipative Hall state the quantization of Hall conductivity [5a].

Therefore one could observe that it is quite natural to interpret the quantized distance between galaxies (11) as an implication of quantum Hall effect in rotating frame (15). While this proposition requires further observation, one could think of it in particular using known analogy between condensed matter physics and cosmology phenomena [10, 22]. If this proposition corresponds to the facts, then one could think that redshift quantization is an imprint of generalized quantization in various scales from microphysics to macrophysics, just as Tifft once put it [2]:

“The redshift has imprinted on it a pattern that appears to have its origin in microscopic quantum physics, yet it carries this imprint across cosmological boundaries”.

In the present paper, Tifft’s remark represents natural implication of topological quantization, which could be formed at any scale [5]. We will explore further this proposition in the subsequent section, using Weyl quantization.

Furthermore, while this hypothesis is new, it could be expected that we can draw some new prediction, for instance, like possibility to observe small “blue-shift” effect generated by the Hall effect from antivortex-galaxies [23]. Of course, in order to observe such a “blue-shift” one shall first exclude other anomalous effects of redshift phenomena [6]. (For instance: one could argue that perhaps Pioneer spacecraft anomaly’s blue-shifting of Doppler frequency may originate from the same effect as described herein.)

One could expect that further observation in particular in the area of low-energy neutrino will shed some light on this issue [20]. In this regard, one could view that the Sun is merely a remnant of a neutron star in the past, therefore it could be expected that it also emits neutrino similar to neutron star [21].

### 3 An alternative interpretation of astrophysical quantization from Weyl quantization. Graph and quantization

An alternative way to interpret the above proposition concerning topological quantum number and topological quantization [5a], is by using Weyl quantization.

In this regards, Castro [8, p.5] has shown recently that one could derive Schrödinger equation from Weyl geometry using continuity equation:

$$\frac{\partial \rho}{\partial t} + \frac{1}{\sqrt{g}} \partial_i (\sqrt{g} \rho v^i) \quad (19)$$

and Weyl metric:

$$R_{\text{Weyl}} = (d - 1)(d - 2) (A_k A^k) - 2(d - 1) \partial_k A^k. \quad (20)$$

Therefore one could expect to explain astrophysical quantization using Weyl method in lieu of using generalised Schrödinger equation as Nottale did [4]. To our knowledge this possibility has never been explored before elsewhere.

For instance, it can be shown that one can obtain Bohr-Sommerfeld type quantization rule from Weyl approach [24, p.12], which for kinetic plus potential energy will take the form:

$$2\pi N \hbar = \sum_{j=0}^{\infty} \hbar^j S_j(E), \quad (21)$$

which can be solved by expressing  $E = \sum \hbar^k E_k$  as power series in  $\hbar$  [24]. Now equation (10) could be rewritten as follows:

$$\oint p \cdot dr = N_v 2\pi \hbar = \sum_{j=0}^{\infty} \hbar^j S_j(E). \quad (22)$$

Or if we consider quantum Hall effect, then equation (18) can be used instead of equation (10), which yields:

$$\begin{aligned} \Phi &= q \oint A \cdot dr + m \oint \Omega \times r \cdot dr = \\ &= \iint B \cdot dS = \sum_{j=0}^{\infty} \hbar^j S_j(E). \end{aligned} \quad (23)$$

The above method is known as “graph kinematic” [25] or Weyl-Moyal’s quantization [26]. We could also expect to find Hall effect quantization from this deformation quantization method.

Consider a harmonic oscillator, which equation can be expressed in the form of deformation quantization instead of Schrödinger equation [26]:

$$\left( \left( x + \frac{i\hbar}{2} \partial_p \right)^2 + \left( p - \frac{i\hbar}{2} \partial_x \right)^2 - 2E \right) f(x, p) = 0. \quad (24)$$

This equation could be separated to become two simple PDEs. For imaginary part one gets [26]:

$$(x \partial_p - p \partial_x) f = 0. \quad (25)$$

Now, considering Hall effect, one can introduce our definition of total particle momentum (17), therefore equation (25) may be written:

$$(x \partial_p - (mv + m\Omega \times r + qA) \partial_x) f = 0. \quad (26)$$

Our proposition here is that in the context of deformation quantization it is possible to find quantization solution of harmonic oscillator without Schrödinger equation. And

because it corresponds to graph kinematic [25], generalized Bohr-Sommerfeld quantization rule for quantized vortices (22) in astrophysical scale could be viewed as signature of “super-graph” quantization.

This proposition, however, deserves further theoretical considerations. Further experiments are also recommended in order to verify and explore further this proposition.

### Concluding remarks

In a recent paper, Moffat [1] has used Gross-Pitaevskii in his “phion condensate fluid” to describe CMB spectrum data. We extend this proposition to explain Tiffit redshift quantization from the viewpoint of topological quantized vortices. In effect we consider that the intrinsic redshift quantization could be interpreted as result of Hall effect in rotating frame.

Another alternative to explain redshift quantization is to consider quantized vortices from the viewpoint of Weyl quantization (which could yield Bohr-Sommerfeld quantization).

It is recommended to conduct further observation in order to verify and also to explore various implications of our propositions as described herein.

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