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Dialogue between two Chief Worldview Systems on Quantized Orbit Distances as Astrophysics Phenomena

Victor Christianto[1*]

Author's Affiliations:	**Victor Christianto,** [1]Malang Institute of Agriculture (IPM), Jl. Soekarno-Hatta, Indonesia. *Initiator, *Halton Arp Institute*, with affiliation to International Mariinskaya Academy, St. Petersburg.
Corresponding author:	**Victor Christianto,** Malang Institute of Agriculture (IPM), Jl. Soekarno-Hatta, Indonesia E-mail: victorchristianto@gmail.com
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ABSTRACT This is a follow-up to our previous paper, suggesting going toward quantum geophysics and quantum astrophysics. Recently, a colleague asks to this author: "1. What is the quantum interpretation of the astrophysics? 2. What is the quantum explanation of the orbital distances?" This review paper will discuss two chief worldview systems on such quantized orbitdistances as a phenomenon in astrophysics and astronomy. We will discuss in specific way: scale relativity approach of Prof. Laurent Nottale, in comparison with our own approach. This short review is also intended as a response to M. Pitkanen's recent article.[1]We hope this discussion will be found interesting.

KEYWORDS Planetary orbits, macroquantization, quantized orbits, low temperature physics, Nottale

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INTRODUCTION

From time to time, cosmology and astronomy disclosures have opened our eyes that the universe is considerably more entangled than what it showed up in 100-200 years earlier. Additionally, thinking about old-fashioned Greek philosophers' speculations, for instance, *hydor model* (Thales) and *streaming fluid* model (Heracleitus). Historians told us that Thales was able to predict eclipse at May 28th, 585 BCE. It seems, by all accounts, to be at this point we are able to inquire: does it suggest that the Ultimate theory that we endeavor to find should follow with hydrodynamicsmodeling approach?[1]

In this context, in a recent paper, we discuss a data-driven approach to astrophysics, while arguing in favor of going toward quantum geophysics and quantum astrophysics [21]. Recently, a colleague asks:
"1) What is the quantum interpretation of the astrophysics?
2) What is the quantum explanation of the orbital distances?"

Therefore, this short review paper will discuss two chief worldview systems on such quantized orbit distances as a phenomenon in astrophysics and astronomy, in response to aforementioned questions.

We will discuss in a more specific way: *scale relativity* approach of Laurent Nottale, Schumacher *et al*. in comparison to our own approach, based on correspondence between low temperature physics and cosmology.

[1]M. Pitkanen. Three Alternative Generalizations of Nottale's Hypothesis in theTGD framework. *Prespacetime Journal*, June 2021, Volume 12, Issue 2.

The title above is an adaptation to Galilei's book: *Dialogue concerning two chief world systems.*[2] Nonetheless, it does not mean that this author compares his cosmological model with such a figure like Galilei; instead he just thinksthat the discussions on which interpretation to choose for applying quantum mechanical principles to astrophysical phenomena, reminds us to that classic book in astronomy.

We hope this discussion will be found interesting for new readers.

SUMMARY OF NOTTALE'S IDEAS

From what we read from Nottale *et al*.'s [15] papers since 1996 and on, he started with scale relativistic argument, then deriving generalized Schrodinger equation for astrophysics bodies, for fractal spacetime case. His approach is something like Edward Nelson's procedure to derive Schrodinger equation from Newton gravitation equation (it is sometimes dubbed as "*Nelson's mechanics*").[3]

The complicated procedures that Nottale proposed, in the end boil down to a quantized radius equation for planetary orbit distances, as follows:

$$r = \frac{n^2 GM}{v_0^2}, \qquad (1)$$

where r, n, G, M, v_0represent orbit radii (semimajor axes), quantum number ($n = 1,2,3,\dots$), Newton gravitation constant, mass of the nucleus of orbit, and specific velocity, respectively.

One thing to point out here is that Nottale *et al*.[15] keep intact the standard probability interpretation of quantum wave function, *a la* Max Born. As far as this author know, even to Nottale's more recent publications, such a probabilistic interpretation prevents him to predict new planetary orbit beyond Pluto.[4]
That is where we started our new arguments.

AN EARLY ENDEAVOR TO REDERIVE NOTTALE'S QUANTIZED RADII RECIPE

It all began with a Santa Fe book, edited by Prof. W. Zurek, with title: *Entropy, Complexity and the Physics of Information* (Addison-Wesley Publ., 1990), that I obtained in a book sale in Jakarta around 1995 or 1996. Around the end of 1997, he found an interesting summary of article by Laurent Nottale-Schumacher from Observatoire de Paris-Meudon, describing their finding that Schroedinger equation can be generalized to *large-scale astrophysics systems*. Therefore, around 1999-2000, I tried to find a simpler derivation of Nottale's equation to derive quantizated orbit distances of planetary systems, both in our solar system and also for exo-planets. At the time, he only got a few books, including that Santa Fe book (to abbreviate: WHZ).

After some time, he wrote a draft with title: "*How much does information weigh?*", which he published online in a personal website at early 2000. But unfortunately that piece of article has been vanished in the air.[5]

SUMMARY OF CANTORIAN SUPERFLUID COSMOLOGY

In this section, allow us to tell a story of our next phase of encountering with macroquantum condensate astrophysics. It began by a somewhat "educated guess" (or some readers may call it: *einfuhlung*), when he picked up an old book by Nozieres & Pines (1994), on superfluid Bose liquid.[18] Then he asked: Let us see

[2]G. Galilei. Url: https://rauterberg.employee.id.tue.nl/lecturenotes/DDM110%20CAS/Galilei-1632%20Dialogue%20Concerning%20the%20Two%20Chief%20World%20Systems.pdf
[3]One of these authors once wrote a messsage to Prof. Edward Nelson the late, asking a few questions, just before he passed away.
[4]Interested readers may wish to read Nottale's two recent books: [22][23]. And I should say here, by comparing our result here is meant to be a dialogue, and personally I am deeply grateful to Nottale's effort to describe all things in Nature using his approach of scale relativity, despite I prefer a bit more topological/superfluid low temperature approach to astrophysics.
[5]That early attempt to rederive Nottale's model of generalized Schrodinger was made during spare time, at the time he worked near Borneo island.

what this book can bring to the realm of astrophysics and cosmology. Soon, he found many interesting findings in the literature, from W.H. Zurek to Grigory Volovik etc.

Shortly speaking, that is a beginning of our continued investigations in the past 16-17 years until now, resulting several papers in a series [3-10]. The earliest paper called "*Cantorian superfluid vortex hypothesis*" was published in July 2003 and January 2004, where he submitted a prediction of possible locations of 3 new orbits of planetoids in the outer side of Pluto. (Note: More observations until now have revealed more than 5 planetoids at the outer skirt of solar system, beyond Pluto orbit.)

Then two years later, he published a paper in AFLB [4], where he outlined what are possible explanations of macroquantum effects in astrophysics (such as observed also by Tifft and also Virginia Trimble etc. -- the so-called Tifft's redshift quantization). One of the arguments outlined in that AFLB paper is *macroquantum condensate*, i.e. possible quantum effect induced by BEC or superfluid-type medium.

More recently, he and other colleagues (VC, FS, YU) come up with an argument that observed *cosmological entanglement* may be caused by such a macroquantum effect is real (CTPNP Conf. Proceedings, organized by Malang State University, 2019).

DISCUSSION: ESSENTIAL DIFFERENCES BETWEEN NOTTALE'S SCALE RELATIVITY AND CSV MODEL

As we remark in previous section, it is worthy to note: One thing to point out here is that Nottale *et al.* keep intact the standard probabilistic interpretation of quantum wave function, *a la* Max Born. We don't check yet Nottale's more recent publications, but as far as I know, such a probabilistic interpretation prevents him to predict new planetary orbits beyond Pluto. (It can be mentioned here that until 2002, almost all textbooks on solar system tell us that Pluto is the farthest planet in solar system.)

As far as we know, probabilistic interpretation of quantum wave function is very problematic, and it was rejected by developer of wave mechanics, E. Schrodinger. See for instance, a rather popular book, John Gribbin: "*Schrodinger's kittens: In search of reality*." That is a quite interesting book to start with, if some readers want to know why reality is an elusive dream when it comes to deciphering the physical meaning of wave function in wave mechanics.[6]

And if some readers wish to read a more dense philosophical musing on probable relation between confusions of the *psyche* caused by such an elusive reality in QM and its connection with possible causation of WW II, you can read one or two articles of Derek Dillon's *Moon of Hoa Binh* papers, where he argues against the pedantic Born's interpretation of such a wave function.

In our first submitted paper on Cantorian superfluid cosmology model, I had a quite long discussion over the meaning of Nottale's method and also meaning of wave function in QM. The reviewer was the late Prof. Robert M. Kiehn from University of Houston. VC's early draft actually tried to derive Nottale's quantized radius equation from a quite similar gravitational-Schrodinger equation, but with different assertion to meaning of wave function. In this interpretation, I wrote that the wave function in QM should be interpreted as "tendency to make structures." And Prof. Kiehn agreed with that interpretation, partly because it allows more substantial attribution, rather than abstract probabilistic argument of Born. (Prof/ Kiehn also wrote elsewhere on mathematical correspondence between 2D Schrodinger equation and Navier-Stokes equation.)

Nonetheless, the late Prof. Kiehn later on suggested a simpler and more elegant approach, i.e. in order to argue in favor of Old QM theory of Bohr to interpret quantization of planetary orbit distances and improving Titius-Bode Law.

The essence of derivation based on Bohr-type arguments, after some improvements, is as follows:[7]

[6] John R. Gribbin. Url: https://www.publishersweekly.com/978-0-316-32838-8

[7] The aformentioned arguments based on Bohr-type quantization instead of complicated gravitational-Schrodinger equation, has been presented in SMIC conference, 2020, and it has been published in *AIP Proceeding Series*, 2021. See : Yunita Umniyati, Victor Christianto, Florentin Smarandache. An explanation of Sedna orbit from condensed matter or superconductor model of the solar system: A new perspective of TNOs. *AIP Conference Proceedings* 2331, 030014 (2021); https://doi.org/10.1063/5.0041656

Here we present Bohr-Sommerfeld quantization rules for planetary orbit distances, which result in a good quantitative description of planetary orbit distance in the Solar System[1].

First of all, let us point out some motivations for utilization of Bohr-Sommerfeld quantization rules: (a) the neat correspondence between Bohr-Sommerfeld quantization rules and topological quantization as found in superfluidity, and (b) there is neat correspondence between Bogoliubov-de Gennes and generalized Bohr-Sommerfeld quantization; in turn it can be applied to large scale systems like Solar system.

Sonin's preface in his book can be paraphrased as follows[4]:

"The movement of vortices has been a region of study for over a century. During the old style time of vortex elements, from the late 1800s, many fascinating properties of vortices were found, starting with the outstanding Kelvin waves engendering along a disconnected vortex line (Thompson, 1880). … The circumstance changed after crafted by Onsager (1949) and Feynman (1955) who uncovered that turning superfluids are strung by a variety of vortex lines with quantized dissemination. With this revelation, the quantum time of vortex elements started."

The quantization of circulation for non=relativistic superfluid is given by [3]:

$$\oint v dr = N \frac{\hbar}{m_s} \quad (1)$$

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

$$N = \frac{\omega\, 2\pi r^2 m}{\hbar} \quad (2)$$

And based on the above equation (2), Sivaram & Arun [16] 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 and the quantization of angular momentum. According to Fischer [17], 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 that Bohr-Sommerfeld quantization rules can yield an explanation of planetary orbit distances of the Solar system and exoplanets [1-15]. 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:

$$\oint_\Gamma p dx = 2\pi n\hbar, \quad (3)$$

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

$$\int_0^T v^2 d\tau = \omega^2 T = 2\pi\omega, \quad (4)$$

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:

$$\frac{GMm}{r^2} = \frac{mv^2}{r}. \quad (5)$$

Using Bohr-Sommerfeld's hypothesis of quantization of angular momentum (4), a new constant g was introduced:

$$mvr = \frac{ng}{2\pi}. \quad (6)$$

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

$$r = \frac{n^2 g^2}{4\pi^2 GMm^2}, \quad (7a)$$

or

$$r = \frac{n^2 GM}{v_0^2}, \quad (7b)$$

where r, n, G, M, v_0 represent orbit radii (semimajor axes), quantum number ($n = 1,2,3, \ldots$), Newton gravitation constant, mass of the nucleus of orbit, and specific velocity, respectively. In equation (7b), we denote:

$$v_0 = \frac{2\pi}{g} GMm. \quad (8)$$

The value of m, g in equation (8) are adjustable parameters.

Interestingly, we can remark here that equation (7b) is *exactly the same* with what is obtained by Nottale using his Schrodinger-Newton formula [16]. Therefore here we can verify that the result is the same, either one uses Bohr-Sommerfeld's quantization rules of Schrodinger-Newton equation. The applicability of equation (7b) includes that one can predict new exoplanets (i.e., extrasolar planets) with remarkable result.

Therefore, one can find a neat correspondence between Bohr-Sommerfeld's quantization rules and motion of quantized vortices in condensed-matter systems, especially in superfluid helium [1,21]. Here we propose a conjecture that superfluid vortices quantization rules also provide a good description for macro objects such as in cosmology (cf. G. Voloovik) and also for planetary orbits in our Solar System.

Correspondingly, an idea that the chemistry composition of Jovian planets are different from inner planets began around 15 years ago, which suggests that it is likely both series of planets have different origin. By assuming inner planets orbits have different quantum number from Jovian planets, here by using "*least square difference*" method in order to seek the most optimal straight line for Jovian planets orbits in a different quantum number; then it came out that such a straight line can only be modeled if we assume that the Jovian planets were originated from a binary *star system: the Sun and its companion*, using the notion of $\mu = \frac{m_1 m_2}{m_c}$as the reduced mass. Although based on statistical optimization [21,22], it yields new prediction of possible orbits of 3 planetoids in the outer skirt beyond Pluto, from which prediction, Sedna was discovered later by Mike Brown *et al.* (2004).

SOME IMPLICATIONS TO COSMOLOGY MODELING

After some years, in a recent paper we began to draw implications of such a Bohr-type gravitational superfluid explanation of planetary orbit distances to cosmology. In essence, instead of agreeing with asymmetric cosmology as we are taught in standard cosmology model, we would prefer a *symmetric cosmology*, by allowing negative masses at large scale to exist.

In the previously mentioned segments [19], we set forth a contention for low temperature physics model of nearby planetary group, specifically utilizing Bogoliubov-de Gennes conditions which are typically used for superconductors.

While this makes the model somewhat less difficult and understandable, one may ask: what are different confirmations accessible to legitimize the BdG model for the Solar system framework? In this respect, let us submit three supporting confirmations which appear to compare to the calculated result as we illustrated previously:[19]

* Pairing of Pluto-Charon and other TNOs/KBOs seem to be attributable to the BCS/BdG pairing condition;
** pointing to low temperature physics model of Solar System;
*** Solar interior has superfluid inner structure (Oliver K. Manuel *et al.*); see for instance [19-20].

Moreover, with regards to hypothesized twin partner of the Sun (that we call NMS = negative mass star), some literatures also argue that G1.9 is a remnant of supernovae, but others argue that G1.9 cannot be supernovae; instead it is more plausible to argue that G1.9 is a *brown dwarf star*.

Now, we refer to paper by Boney and also by Heald, who argue that

(a) Dirac-Feynman-Stueckelberg's interpretation of Dirac equation symmetry as requiring that antimatter is just an ordinary matter going backward in time, that is not the only possibility.

Quote from Heald:

"If rest mass energy is not a real scalar quantity buta potential imaginary energy, then the rest mass of antimatter will have negative potential energy. Accordingly, it would follow that the total relativistic energy of a matter or antimatter particle can be described by a complex vector summing the real kinetic and imaginary rest mass energies and Newton's law of gravitation will remain valid for antimatter. Theorems of quantum physics and general relativity have shown that antimatter has negative gravitational mass, and so matter and antimatter bodies will exert mutual gravitational repulsion.[20]"

Boney also suggests that it is also equally possible to interpret antimatter as having negative mass. He wrote: "Unfortunately, it seems there is no imperative to imagine antimatter moves backwards in time, at least from the Dirac equation, if you allow negative mass solutions. [20]" The notion of negative mass is admittedly quite strange and counter-intuitive for solar physics or cosmology, but it is well accepted in solid state physics and condensed matter physics. Similarly, H. Choi & P. Rudra argue in favor of pair creation originated from positive-negative energy [28].

(b) Meanwhile, Anastopoulos-Hu argue that Newton-Schrodinger equation which is quite common in somemodels for AQT (alternative quantum theory), especially for macroquantumphysics, is quite problematic [20].

To summarize, provided argument (a) and (b) above can be accepted, then we suggest to consider symmetry between ordinary matter and antimatter (negative masses) should be considered from the beginning of physical modelling. With regards to experimental vindications of such a negative mass particle, allow us to refer to: (a) M.A. Khamehchi et al reported finding on Negative mass hydrodynamics in a spin-orbit–coupled Bose-Einstein condensate [26], and (b) Kai-Qiang Lin et al. published their experimental finding on negative mass particle, *Nature Communications* [27].

As such, that is why we consider Bogoliubov-De Gennes equations instead of Newton-Schrodinger equation, i.e. BdG equations are essentially coupled Schrodinger equations, reflecting those pairs of particles. In addition, we may also consider symmetric Dirac-Milne cosmology model, which is essentially a generalized Newtonian cosmology which admits negative gravitational mass. There are growing interests to Dirac-Milne model in recent years. [20]

This appears to support our suggestion of conceivable twofold buddy of the Sun as negative mass star (NMS) as we considered in a prior paper [1]. Similarly, as with expected area to discover the bantam friend of the Sun, we can specify here that since 2017, there is an article named as Gliesse G1.9 which was seen around 60-66 AU (around Pluto/Kuiper Belt). In this manner it very well may be a decent begin to see if the G1.9 is surely the binary partner of the Sun that we're searching for [19].

Moreover, further investigations are needed to extend Dirac Milne model towards *symmetric Quantum Liquid Dirac Milne* (QLDM), implicated by our superfluid dynamics model.

CONCLUDING REMARKS

In this review article, we discuss several essential differences between Nottale *et al.'s* [15] interpretation and approach to derive generalized gravitational Schrodinger equation, in order to explain planetary orbit distances, and our approach which was based more on phenomenological approach of superluidity dynamics as observed in lab.

In essence, it is worthy to note that Nottale *et al*. [15] keep intact the standard probabilistic interpretation of quantum wave function, *a la* Max Born. As far as I am aware of, up to Nottale's more recent publications, his approach based on such a probabilistic interpretation of wave function, prevents him to predict new planetary orbit beyond Pluto.

As far as we know, probabilistic interpretation of quantum wave function is very problematic, and it was rejected by developer of wave mechanics, E. Schrodinger (see his famous remark around 1955, while he was in Dublin/DIAS).

On the contrary, our approach to quantized orbit distances as astrophysics phenomena was based on superluid quantization known in low temperature physics, by assuming that superfluid vortices quantization is equivalent to Bohr-type quantization.

We hope that this review paper would be found useful in suggesting that time has come to consider "quantum astrophysics," especially considering such quantization of planetary orbit distances. See our other paper in this journal [21].

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This author wishes to thank to many physicist and scientist fellows for discussions and insights, especially Prof. Florentin Smarandache and Robert Neil Boyd. Interested readers may wish to read Nottale's two recent books: [22][23]. And I should say here, by comparing our results here is meant to be a dialogue, and personally I am deeply grateful to Prof. L. Nottale's effort to describe *all things in Nature* using his approach of scale relativity, despite I prefer a bit more topological/superfluid low temperature physics approach to astrophysics and cosmology. His approach to generalize Schrodinger equation to macro scale objects did much to motivate me to enter this quantum astrophysics study over all these years.

This author also wishes to extend sincere gratitude to numerous physicists who have discussed this theme of macroquantization and related issues, including: the late R.M. Kiehn, the late Antun Rubcic(Zagreb Univ.), Pavel Pintr, Carlos Castro Perelman (Clark Atalanta Univ.), Slobodan Nedic (Serbia), Sergey Ershkov, Yunita Umniyati, Arno Gorgels, and others. I am also really grateful for insights of Prof. The Houw Liong for suggesting to look at Jayant Narlikar's paperson VMH. And special thanks goes to Eny Latifah (Chair of Conference, CTPNP, 2019, held at Universitas Negeri Malang, Indonesia) and also Mutia Delina (Chair of Conference, SMIC, 2020, held at Universitas Negeri Jakarta, Indonesia).
However, this paper is our sole responsibility.

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