# An explanation of Sedna orbit from condensed matter or superconductor model of the solar system: A new perspective of TNOs

Cite as: AIP Conference Proceedings **2331**, 030014 (2021); https://doi.org/10.1063/5.0041656
Published Online: 02 April 2021

Yunita Umniyati, Victor Christianto, and Florentin Smarandache

# An Explanation of Sedna Orbit from Condensed Matter or Superconductor Model of the Solar System: A New Perspective of TNOs


Yunita Umniyati[1, a)], Victor Christianto[2, b)], and Florentin Smarandache[3, c)]

[1]*Mechatronics Engineering, Swiss German University. Jalur Sutera Barat No. 15, Alam Sutera Tangerang, Banten 15143, Indonesia*
[2]*Malang Institute of Agriculture (IPM), Jl. Soekarno-Hatta, Malang, Indonesia*
[3]*Dept. of Mathematics & Sciences, University of New Mexico, Gallup, USA*

[a)]yunita.umniyati@sgu.ac.id
[b)]Corresponding author: victorchristianto@gmail.com
[c)]smarand@unm.edu



**Abstract.** In a recent paper, we argued in favor of the Gross-Pitaevskii model as a complete depiction of both the close planetary system and winding worlds, particularly considering the idea of chirality and vortices in universes. In this paper, we apply the new model based on Bogoliubov-de Gennes equation correspondence with Bohr-Sommerfeld quantization rules. Then we put forth an argument that from Bohr-Sommerfeld quantization rules, we can come up with a model of quantized orbits of planets in our solar system, be it for inner planets and also for Jovian planets. In effect, we also tried to explain Sedna's orbit in the same scheme.


## INTRODUCTION

A few abbreviations used in this paper: TNO: trans-Neptunian object; KBO: Kuiper-Belt Object. Every once in a while, cosmology and astronomy revelations have opened our eyes that the universe is substantially more entangled than what it appeared in 100-200 years prior. What's more, regardless of all invading fame of General Relativistic augmentation to Cosmology, considering antiquated Greek rationalists' theories, for example, hydor model (Thales) and streaming liquid model (Heracleitus) it appears to be as yet qualified to ask: does it imply that the Ultimate hypothesis that we attempt to discover ought to compare to hydrodynamics or a disturbance hypothesis [1-3].

Meanwhile, in a recent article, we presented some new contentions on the hypothetical small star thought to be an ally to our Sun, known as the Nemesis, which is proposed to clarify an apparent pattern of mass eradications in Earth's history. Some guessed that such a star could influence the circle of articles in the far external close planetary system, sending them on a crash course with Earth. While ongoing cosmic reviews neglected to discover any proof that such a star exists, we layout in this article some hypothetical discoveries including our own, suggesting that such a dwarf star companion of the Sun remains a possibility [4]. And one good indicator for such a dwarf companion of the Sun is Sedna, a planetoid which has been discovered around 2004 by Mike Brown and his Caltech team. Sedna location and eccentric orbit are such that it is not supposed to be there [5-10].

Therefore a physical explanation of why Sedna is located there can be a good start to begin to search the existence and location of the supposedly dwarf companion of the Sun.


*The 2nd Science and Mathematics International Conference (SMIC 2020)*
AIP Conf. Proc. 2331, 030014-1–030014-6; https://doi.org/10.1063/5.0041656
Published by AIP Publishing. 978-0-7354-4075-3/$30.00

# METHOD

Methodology used in this paper: we develop a new conceptual/mathematical model then compare it with the supporting evidences.

## Bohr-Sommerfeld Quantization Rules and Quantized Approach

Here we present Bohr-Sommerfeld quantization rules for planetary circle separations, which brings about a decent quantitative depiction of planetary circle separation in the Solar system [11-14].

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 can be applied to large scale systems like Solar system. (c) In the next section, we suggest another alternative approach, i.e. Eilenberger equation, which reduces to scalar model of Riccati equation [15]. As we have discussed how Riccati equation can be neatly linked to Newton equation, then it seems possible to use this approach too.

## Eilenberger Equation Reduces to Scalar Riccati Equation

In this section, we suggest another alternative approach, i.e. Eilenberger equation, which reduces to scalar model of Riccati equation [15]. As we have discussed how Riccati equation can be neatly linked to Newton equation, then it seems possible to utilized this approach too [15]. Another parametrization of the Eilenberger conditions of superconductivity regarding the answers for a scalar differential condition of the Riccati type is presented. It is indicated that the quasiclassical propagator might be remade, without express information on any eigenfunctions and eigenvalues, by taking care of a straightforward beginning worth issue for the linearized Bogoliubov-de Gennes conditions. The Riccati parametrization of the quasiclassical propagator leads to a stable and fast numerical method to solve the Eilenberger equations [16].

Therefore it appears that we can utilize Eilenberger equation which is an alternative to Bogoliubov-De Gennes equation for description of superconductors. According to Schopol, the Eilenberger reduces to Riccati equation:

$$h_{vF}\frac{\partial}{\partial x}b_x + [2\bar{\varepsilon}_n + \Delta(x)b_x] + \Delta^{\dagger}(x) = 0, \tag{1}$$

which after some steps it will yield a system of coupled Riccati ODEs. Interestingly it can be shown that angular momentum conservation combined with power law potentials can be recast into a Riccati ODE:

$$\frac{1}{2}m\dot{r}^2 + \left(\frac{1}{2}+\frac{1}{\epsilon}\right)\frac{1}{mr^2} - \frac{m\ddot{r}r}{\epsilon} - E \;=\; 0. \tag{2}$$

Therefore, our hypothesis is that such a Riccati ODE (2) may be linked to scalar Riccati ODE as a reduction to Eilenberger equation. Numerical solution of equation (2) can be done with Mathematica or other computer algebra softwares.

In retrospect, we can recall the fact that there is a known Pioneer anomaly, which can be interpreted as an anomalous (scalar) acceleration after the Pioneer spacecraft enters the Jupiter's orbit and on. Therefore it can be interpreted as a possible indicator of the existence of scalar effect of Riccati ODE.

# RESULT AND DISCUSSION

The quantization of circulation for nonrelativistic superfluid is given by [5]:

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

where $N, \hbar, m_s$ represent winding number, diminished Planck steady, and superfluid molecule's mass, individually. Also, the all out number of vortices is given by [5]:

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

Also, in light of the above condition (4), Sivaram & Arun [17] can give a gauge of the quantity of cosmic systems known to man, alongside a gauge of the number stars in a universe. In any case, they don't give clarification between the quantization of dissemination (5) and the quantization of rakish energy. As indicated by Fischer [8], the quantization of precise force is a relativistic augmentation of quantization of dissemination, and along these lines it yields Bohr-Sommerfeld quantization rules.

Besides, it was recommended that Bohr-Sommerfeld quantization rules can yield a clarification of planetary circle separations of the Solar framework and exoplanets [1,19]. Here, we start with Bohr-Sommerfeld's guess of quantization of rakish energy. As we probably am aware, for the wavefunction to be all around characterized and remarkable, the momenta must fulfill 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 known simple solution for the orbit radius for any quantum number of the form:

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

or

$$r = \frac{n^2 GM}{v_0^2}, \tag{9b}$$

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 (10), we denote:

$$v_0 = \frac{2\pi}{g} GMm. \tag{10}$$

The value of $m, g$ in equation (10) are adjustable parameters.

Strikingly, we can comment here that condition (9b) is actually the equivalent with what is gotten by Nottale utilizing his Schrodinger-Newton formula [17]. In this manner here we can check that the outcome is the equivalent, it is possible that one uses Bohr-Sommerfeld quantization rules of Schrodinger-Newton condition. The relevance of condition (9b) incorporates that one can anticipate new exoplanets (i.e., extrasolar planets) with noteworthy outcome.

Thusly, one can locate a flawless correspondence between Bohr-Sommerfeld quantization rules and movement of quantized vortices in consolidated issue frameworks, particularly in superfluid helium [1,20]. Here we propose a conjecture that superfluid vortices quantization rules also provide a good description for the planetary orbits in our Sollar System. An idea that given the chemistry composition of Jovian planets are different from inner olanets began around 15 years ago, therefore 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 modelled if we assume that the Jovian planets were originated from a twin star system: the Sun and its companion, using the notion of $\mu = \frac{m_1 m_2}{m_c}$ is the reduced mass.

Although based on statistical optimization [20,21], it yields new prediction of 3 planetoids in the outer orbits beyond Pluto, from which prediction, Sedna. A table as shown below shows how our simple model based on large-scale quantization inspired by Bohr-Sommerfeld rule obtains a remarkably good prediction compared to observation:

**TABLE 1.** Comparison of prediction and observed orbit distance of planets in Solar system (in 0.1 AU unit) [22]

| Object | No. | Titius | Nottale | CSV | Observ. | Δ, % |
|---|---|---|---|---|---|---|
| | 1. | | 0.4 | 0.43 | | |
| | 2. | | 1.7 | 1.71 | | |
| Mercury | 3. | 4 | 3.9 | 3.85 | 3.87 | 0.52 |
| Venus | 4. | 7 | 6.8 | 6.84 | 7.32 | 6.50 |
| Earth | 5. | 10 | 10.7 | 10.70 | 10.00 | -6.95 |
| Mars | 6. | 16 | 15.4 | 15.4 | 15.24 | -1.05 |
| Hungarias | 7. | | 21.0 | 20.96 | 20.99 | 0.14 |
| Asteroid | 8. | | 27.4 | 27.38 | 27.0 | 1.40 |
| Camilla | 9. | | 34.7 | 34.6 | 31.5 | -10.00 |
| Jupiter | 2. | 52 | | 45.52 | 52.03 | 12.51 |
| Saturn | 3. | 100 | | 102.4 | 95.39 | -7.38 |
| Uranus | 4. | 196 | | 182.1 | 191.9 | 5.11 |
| Neptune | 5. | | | 284.5 | 301 | 5.48 |
| Pluto | 6. | 388 | | 409.7 | 395 | -3.72 |
| 2003EL61 | 7. | | | 557.7 | 520 | -7.24 |
| Sedna | 8. | 722 | | 728.4 | 760 | 4.16 |
| 2003UB31 | 9. | | | 921.8 | 970 | 4.96 |
| Unobserv. | 10. | | | 1138.1 | | |
| Unobserv. | 11. | | | 1377.1 | | |

Source: *Apeiron*, vol. 23, July 2004 [23]

## Further Evidences: Superfluidity of Solar Interior and Pairing of TNO Objects

In the aforementioned sections, we put forth an argument in favor of low temperature physics model of solar system, in particular using Bogoliubov-de Gennes equations which are normally utilized for superconductors. While this makes the model a bit simpler and comprehensible, one may ask: what are other evidences available to justify the BdG model for the Solar system. In this regards, allow us to submit three supporting evidences which seem to correspond to the conceptual model as we outlined above:

- Pairing of Pluto-Charon and other TNOs/KBOs seem to be attributed to the BCS/BdG pairing condition → pointing to low temperature physics model of Solar System.
- Solar interior has superfluid inner structure [24].
- Some literatures argue that G1.9 is remnant of supernovae, others argue that G1.9 cannot be supernovae, instead it is more plausible to argue that G1.9 is brown dwarf star.

First, the BdG model can be related to pairing of electrons, and as it has been discussed for instance in [25], when it is stated, which can be paraphrased as follows:

> "It is indicated that the Bogoliubov-de Gennes conditions pair the electrons in states which are direct blends of the typical states. For a homogeneous framework, we bring up that the part of the self-consistency condition got from the Bogoliubov-de Gennes conditions should be obliged by the BCS matching condition."

In this regard, we can point out that Pluto and Charon seem like evidences related to this pairing condition. Furthermore, Sedna also has a pair planetoid. We can expect that planetoids found around Kuiper Belt (or may be dubbed as TNOs) can take place in pairs.

Second, we can point out the Solar interior which has superfluid inner structure as another evidence [24-27].

Other hint for physical evidence of superconductor/superfluidity nature of solar system may be found in icy dwarf nature of some planetoids and other TNOs objects and other objects beyond Kuiper Belt.

As with potential location to find the dwarf companion of the Sun, we can mention briefly here that since 2017, there is an object dubbed as G1.9 which was observed around 60-66 AU (around Pluto/Kuiper Belt). We can also note here: while some literatures argue that G1.9 is remnant of supernovae [22,25,28], others argue that G1.9 cannot be a supernovae, instead it is more plausible to argue that G1.9 is brown dwarf star. Therefore it can be a good start to find out whether the G1.9 is indeed the dwarf companion that we're looking for all along. See Fig. 1 below.

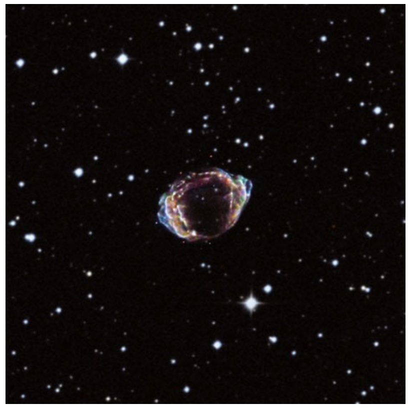

**FIGURE 1.** Gliese G1.9, a candidate of brown dwarf companion of the Sun [28-28a]

## CONCLUSION

In this paper, we present an argument that Bohr-Sommerfeld quantization condition can be linked to Bogoliubov-de Gennes equations, and thus it tends to be indicated that such a Bohr-Sommerfeld quantization can be connected to huge scope structure quantization, for example, our nearby planetary group in Solar system.

As with potential location to find the dwarf companion of the Sun, we can mention briefly here that since 2017, there is an object dubbed as G1.9 which was observed around 60-66 AU (around Pluto/Kuiper Belt). Therefore it can be a good start to find out whether the G1.9 is indeed the dwarf companion that we're looking for all along.

## REFERENCES


1. V. Christianto, *Apeiron* **11** (1), pp. 112-152 (2004).
2. I. S. Nurgaliev, *Gravitation and Cosmology* **16** (4), pp. 313-315 (2010).
3. A. Ifa, H. Louati, and M. Rouleux, *J. Math. Sci. Univ. Tokyo*. **25**, pp. 91-127 (2018).
4. V. Christianto and F. Smarandache, *Prespacetime J*. **11** (1), (2020).
5. V. Christianto, F. Smarandache, and Y, Umniyati, *Prespacetime J*. **9** (7), (2018).
6. V. Christianto, *Annales de la Fondation Louis de Broglie* **31** (1), (2006).
7. V. Christianto, D. L. Rapoport, and F. Smarandache, *Prog. In Phys*. **2**, pp. 9-11 (2007).
8. V. Christianto and F. Smarandache, *Prog. In Phys*. **1**, (2008).
9. V. Christianto, *Prespacetime J*. **6** (7), (2015).
10. V. Christianto, F. Smarandache, and Y. Umniyati, *Prespacetime J*. **11** (3), (2020).
11. E. B. Sonin, *Dynamics of quantized vortices in superfluids* (Cambridge University Press, Cambridge, 2016).
12. K. Huang, *A superfluid Universe* (World Scientific Publishing, Singapore, 2016).
13. R. H. Enns and G. C. McGuire, *Nonlinear Physics with Mathematica for Scientists and Engineers* (Birkhauser, Berlin, 2001).
14. S. Hassani, *Mathematical Methods using Mathematica: For Students of Physics and Related Fields* (Springer-Verlag New York, New York, 2003).
15. M. Nowakowski and H. C. Rosu, *Phys. Rev. E*. **65**, (2002).
16. A. Ifa and M. Rouleux, *J. Phys: Conf. Series.* **1194**, (2019). doi:10.1088/1742-6596/1194/1/012049.
17. C. Sivaram, and K. Arun, *The Open Astronomy J*. **5**, pp. 7-11 (2012).
18. U. Fischer, *Ann Phys*. **278**, pp. 62-85 (1999).
19. L. Nottale, *Astron. Astrophys*. **327**, pp. 867-889 (1997).
20. Least square. [Online]. Available from: https://web.williams.edu/Mathematics/sjmiller/public_html/brownClasses/54/handouts/MethodLeastSquares.pdf
21. Least square optimization. [Online]. Available from: https://www.cns.nyu.edu/~eero/NOTES/leastSquares.pdf
22. K. J. Borkowski, *et al.*, *The Astrophysical Journal Letters*. [Online]. Available: https://arxiv.org/abs/1305.7399v1
23. F. Smarandache and V. Christianto, *Prog.In Phys.* **2**, pp. 5-12 (2006).

24. O. K. Manuel, B. W. Ninham, and S. E. Friberg, *J. Fusion Energy*. **21**, pp. 193-198 (2002).
25. M. Z. Pavlovic, *MNRAS 000*, pp. 1–16 (2017). Available: https://arxiv.org/abs/1702.07418v2
26. O. Manuel and S. Friberg, *Proc. 2002 SOHO 12, Local and Global Helioseismology: The Present and Future,* pp. 345-348 (2003).
27. O. Manuel, *Proc. The Third Int. Conf. on Beyond Standard Model Phys*., pp. 307-316 (2003).
28. S. Reynolds, *et al.* THE YOUNGEST GALACTIC SUPERNOVA REMNANT: G1.9+0.3, url: https://arxiv.org/abs/0803.1487v2; see also [18a] Nemesis, brown dwarf start has been discovered. url: https://www.youtube.com/watch?v=Ev7YhmKv_80