# Towards a pathway to realistic tunneling experiment in quantum (liquid) crystalline Cosmology

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**Abstract**

Following our previous frugal experiments of low-intensity laser irradiation on potable water, allow us to present a few considerations why this writer thinks that these are a pathway towards realistic tunneling experiment especially in the context of quantum (liquid) crystalline Cosmology. First of all, allow us to recall our preceding articles in CTPNP 2019, and also in Octogon Magazine 2022 regarding exact correspondence between Maxwell equations of classical electrodynamics and Dirac equations. What is more interesting is that it can be shown that fine structure of hydrogen spectrum can be described alternatively by classical electromagnetic considerations, therefore it supports our previous conclusion of such correspondence between electromagnetic equations and Dirac equation of quantum mechanics. Secondly, a series of extended experiments on laser irradiated cold water may suggest possible transition from liquid phase of water to be at least partially fourth phase of water, which may be composed of crystalline water (see e.g. Gerald Pollack, and also Harold Aspden on liquid crystalline). If we can imagine laser cooling effect can be done in protracted time, then we can achieve a physical representation of Aspden's liquid crystalline, or in a more mathematical term, Wigner crystal. In that sense, the fourth phase of water can be considered as a quantum system which can undergo quantum tunneling. In that sense, quantum tunneling of 1D Wigner crystal has been already considered. Last but not least, we also consider testimony by certain Admiral that he saw Unidentified Submerged Objects instead of more common term UFO. This makes more sense especially in light of observations of underwater/submerged built structures or pyramids which are thousands years old. All of these seem to suggest a possibility that USO saucers may prefer to keep being in cold underwater or Arctic region because it is much easier for them to go tunneling to extra galactic or other far distance travelling, cf for instance [14]. Nonetheless, we understood that this is merely hypothetical.

**Keywords:** cosmological theories; low temperature physics; quantum tunneling; Aspden liquid crystalline; Wigner crystal; USO

## 1. Introduction

In previous articles in this issue (JCFA), we would emphasize on testability of cosmology models, which seem to us this criterion can only be achieved via correspondence between condensed matter/superfluidity low temperature physics and cosmology (cf. Kibble & Pickett, 2008). As these writers discussed in preceding articles, it seems quite reasonable to conduct small scale lab tests on cosmology propositions, although of course with less features compared to vastness of possibilities in the real Universe. Therefore, following our previous frugal experiments of low-intensity laser irradiation on potable water, allow us to present a few



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considerations why this writer thinks that these are a pathway towards realistic tunneling experiment especially in the context of quantum (liquid) crystalline Cosmology. [1][2][3]

Such a consideration of liquid crystalline phase of water may be comparable to Wigner crystallization. As we know, the first concrete experimental observation of Wigner crystallization was done in 1979 by a group at the Bell labs. This group, taking up on the proposal of the Crandall group, performed a measurement of a charged surface of liquid helium. What was observed, however, was both vertical and horizontal resonances (coupled plasmon–ripplons).

In case of liquid cold water under low-intensity laser irradiation, we submit a view that a small part of it may undergo transition a little bit into liquid crystalline phase. Moreover, at least part of it can further be modelled as Wigner crystal which behaves as quantum entity, therefore such a system is likely to be a good representation for quantum tunneling in lab, which someday can lead to more realistic tunneling scenario for Cosmological modeling.

## 2. Results and Discussion

### Literature survey

First of all, allow us to recall our preceding articles in CTPNP 2019, and also in AsiaMath 2022 regarding exact correspondence between Maxwell equations of classical electrodynamics and Dirac equations. [4][5]

Summarizing, our method is based on Gersten's decomposition of Dirac equation which then we extend them to become quaternionic Dirac equations in order to come up with a derivation of Maxwell equations with complex field expression.

What is more interesting is that it can be shown that fine structure and also Lamb shift of hydrogen can be described alternatively by classical electromagnetic considerations, therefore it supports our previous conclusion of such correspondence between electromagnetic equations and Dirac equation of quantum mechanics. See for instance Simulik & Krivsky etc. [6]

### Little further steps on low-intensity laser irradiation of cold potable water

According to Wilson, Wong & Militzer, water is one of the most prevalent substances in the universe and exists in a large number of phases over a vast range of temperature and pressure conditions. In addition to the liquid, gas, plasma and many solid phases, they suggest that interiors of Uranus and Neptune are in superionic phase of solid ice.[7]

Others suggest that interior of this Earth is also composed of superionic ice. While such a superionic phase can hardly be simulated with simple lab experiments, in the following tables we report low-intensity laser irradiation of cold potable water (i.e. water + ice cubes) in order to simulate the effect of laser irradiation on water molecules, provided we can assume that laser exert pressures on that molecules system. See for instance Yariv [9].

Table 1. Low-intensity laser irradiation of ice cubes and ice cubes plus water

| No. | Description | Laser irradiation duration (in sec) | Ice Cubes<br><br>milli Volt | Ice Cubes + Water<br><br>milli Volt |
|---|---|---|---|---|
| 1 | Ice cubes | 0 | 5.30 | -1.2 |
| 2 | ,, | 59 | 0.1 | -1.1 |
| 3 | ,, | 120 | 0.8 | -0.6 |
| 4 | ,, | 180 | 0.1 | -0.6 |



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| | | | | |
|---|---|---|---|---|
| 5 | ,, | 240 | 1.4 | -0.7 |
| 6 | ,, | 300 | -4.1 | -0.8 |
| 7 | ,, | 360 | | -0.9 |
| 8 | ,, | 420 | | -0.5 |
| 9 | ,, | 480 | | -0.6 |

Table 2. Low-intensity laser irradiation of ice cubes plus water (using double laser pen)

| No. | Description | Laser irradiation duration (in sec) | Measurement milli Volt |
|---|---|---|---|
| 1 | Ice cubes + water | 0 | -2.5 |
| 2 | ,, | 59 | -0.8 |
| 3 | ,, | 120 | 0.3 |
| 4 | ,, | 180 | 1.1 |
| 5 | ,, | 240 | 1.4 |
| 6 | ,, | 300 | 0.2 |
| 7 | ,, | 360 | 0.4 |

Table 3. Second tests on Low-intensity laser irradiation of ice cubes+water (using double laser pen)

| No. | Description | Laser irradiation duration (in sec) | Measurement milli Volt |
|---|---|---|---|
| 1 | Ice cubes + water | 0 | -1.7 |
| 2 | ,, | 59 | -0.9 |
| 3 | ,, | 120 | -1.3 |
| 4 | ,, | 180 | -1.7 |
| 5 | ,, | 240 | -1.1 |
| 6 | ,, | 300 | -1.0 |
| 7 | ,, | 360 | -0.7 |

**Discussion**

What we can observe from the above data in Table 1, Table 2 and Table 3, especially on last tests (Table 3) suggest that cold water with ice under pressure of double laser pen goes to negative electric potential. At the time, we don't measure its thermal condition (except it is in room temperature), nonetheless we consider it possible that at least partially the liquid cold water has been transitioned into liquid crystalline phase (consider Wigner crystal, or Harold Aspden, liquid crystalline ether.) Therefore in the following section we discuss shortly on how to model quantum tunneling in 1D Wigner crystalline liquid.



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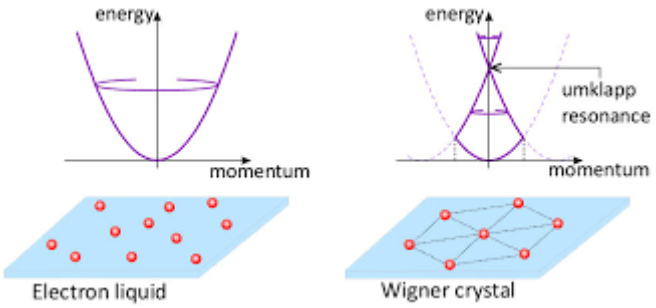


Figure 1. Wigner crystalline

How we can do modeling quantum tunneling of 1D Wigner crystalline liquid: According to Méndez-Camacho & E. Cruz-Hernández, by considering the collective nature of electrons using a Yukawa-like efective potential, they explore the electron interaction between closely spaced, parallel nanowires while varying the electron density and geometrical parameters. They find that, at a low-density Wigner crystal regime, the tunneling can take place between adjacent localized states along and transversal to the wires axis.

## 3. Concluding remark

Previously, we argued for 2 more realistic approaches to cosmology in the following principles: the principle of correspondence between the cosmos and the lab scale experiments, (ii) the principle that because so far humans can only send probes as far as the edge of the solar system (e.g. Voyager). Then the solar system may be considered as "our nearest large-scale lab" to be able to test ideas about the cosmos.

According to Wilson, Wong & Militzer, water is one of the most prevalent substances in the universe and exists in a large number of phases over a vast range of temperature and pressure conditions. In this regard, this writer reported a series of extended experiments of low-intensity laser irradiation on potable water plus ice cubes.

The results show the cold water with ice undergo negative electric potential, albeit the measurement of electric potential varies.

Nonetheless we consider it possible that at least partially the liquid cold water has been transitioned into liquid crystalline phase (consider Wigner crystal, or Harold Aspden's term: liquid crystalline ether.)

In case of liquid cold water under low-intensity laser irradiation, we submit a view that a small part of it may undergo transition a little bit into liquid crystalline phase. Moreover, at least part of it can further be modelled as Wigner crystal which behaves as quantum entity, therefore such a system is likely to be a good representation for quantum tunneling in lab, which someday can lead to more realistic tunneling scenario for Cosmological modeling.

**Acknowledgement**

Special thanks to Robert N. Boyd PhD, Prof. Florentin Smarandache, and Yunita Umniyati for discussions. And one of these writers is really grateful for encouragement and kindful guide by Prof The Houw Liong, and also for sending book by Amnon Yariv, ref. [9]. And many thanks to numerous scholars from all over the world, including but not limited to the late Prof. R.M. Kiehn, Prof Carlos Castro, and Mr Max Rempel. This explorattory work was inspired partly by power from ice suggested by Dr. Harold Aspden [12], and G. Gremaud's crystalline ether model of the Universe, and also from Del Giudice's experiment of water as mediation of life. See for instance, ref. [13].

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Version 1.1: 8th Jan. 2023, pk. 17:12
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**Appendix: Monte Carlo simulation for water molecules**

In this section, we shall find out if our hypothesis that there is likelihood that quantum-like tunneling effect can happen in laser irradiated water or in cold water. Especially we will outline several Mathematica codes for Monte Carlo simulation.

**1. Mathematica code for Monte Carlo simulation of water molecule dynamics**

Here is a complete Mathematica code for Monte Carlo simulation of water molecule dynamics that includes plotting the positions and orientations of the molecule as a function of time:

```
(* Define the energy function for the water molecule *)
energy[d_, theta_] := -Cos[theta]/d^3

(* Set the initial positions and orientations of the water molecule *)
d = 2;
theta = Pi/2;

(* Set the number of Monte Carlo steps to perform *)
numSteps = 10000;

(* Set the temperature and Boltzmann constant *)
T = 300;
k = 1.38*10^-23;

(* Set the maximum displacement and rotation for each step *)
maxDisplacement = 0.1;
maxRotation = 0.1;

(* Initialize lists to store the positions and orientations at each step *)
dList = {};
thetaList = {};
```



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```
(* Perform the Monte Carlo simulation *)
Do[
 (* Calculate the energy of the current configuration *)
 E = energy[d, theta];

 (* Randomly perturb the positions and orientations of the water molecule *)
 dNew = d + RandomReal[{-maxDisplacement, maxDisplacement}];
 thetaNew = theta + RandomReal[{-maxRotation, maxRotation}];

 (* Calculate the energy of the new configuration *)
 ENew = energy[dNew, thetaNew];

 (* Accept or reject the new configuration based on the Metropolis criterion *)
 If[RandomReal[] < Exp[-(ENew - E)/(k*T)],
  d = dNew;
  theta = thetaNew;
  ];

 (* Append the current positions and orientations to the lists *)
 AppendTo[dList, d];
 AppendTo[thetaList, theta];
 ,
 {i, numSteps}
 ]

(* Plot the positions and orientations as a function of time *)
ListLinePlot[dList, PlotRange -> All, AxesLabel -> {"Time", "d"}]
ListLinePlot[thetaList, PlotRange -> All, AxesLabel -> {"Time", "theta"}]
```

After the Monte Carlo simulation is completed, it plots these positions and orientations as a function of time using ListLinePlot. The resulting plots show how the positions and orientations of the water molecule evolve over time.



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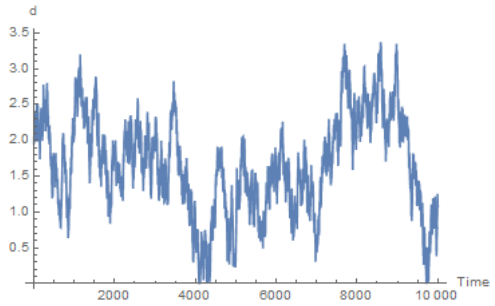
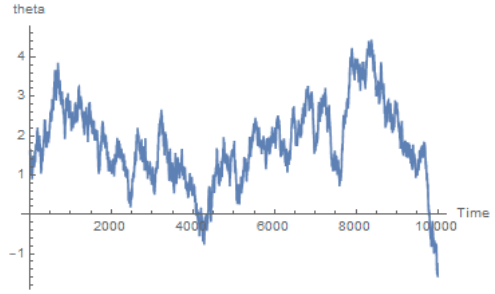



Plot Diagram 1a. Plot solution with Wolfram Mathematica




Plot Diagram 1b.

**2. Mathematica code for Monte Carlo simulation of water molecules interacting with low-intensity laser irradiation**

Here is a complete Mathematica code for a Monte Carlo simulation of a water molecule interacting with low-intensity laser irradiation, and plotting the resulting positions and orientations of the molecule as a function of time:

```
(* Define the energy function for the water molecule *)
energy[d_, theta_] := -Cos[theta]/d^3

(* Set the initial positions and orientations of the water molecule *)
d = 2;
theta = Pi/2;

(* Set the number of Monte Carlo steps to perform *)
numSteps = 10000;

(* Set the temperature and Boltzmann constant *)
T = 300;
k = 1.38*10^-23;
```



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```
(* Set the maximum displacement and rotation for each step *)
maxDisplacement = 0.1;
maxRotation = 0.1;

(* Set the laser intensity and frequency *)
I = 10^-4;
omega = 2*Pi*10^14;

(* Set the laser-molecule coupling strength and the time step *)
g = 10^-20;
dt = 10^-15;

(* Initialize lists to store the positions and orientations at each step *)
dList = {};
thetaList = {};

(* Perform the Monte Carlo simulation *)
Do[
 (* Calculate the energy of the current configuration *)
 E = energy[d, theta];

 (* Randomly perturb the positions and orientations of the water molecule *)
 dNew = d + RandomReal[{-maxDisplacement, maxDisplacement}];
 thetaNew = theta + RandomReal[{-maxRotation, maxRotation}];

 (* Calculate the energy of the new configuration *)
 ENew = energy[dNew, thetaNew];

 (* Accept or reject the new configuration based on the Metropolis criterion *)
 If[RandomReal[] < Exp[-(ENew - E)/(k*T)],
  d = dNew;
  theta = thetaNew;
  ];

 (* Calculate the effect of the laser on the water molecule *)
```



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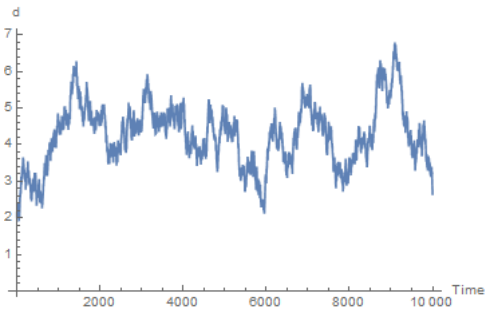
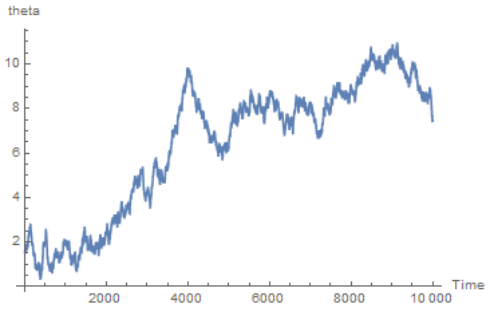
```
d = d + g*I*Sin[omega*i*dt]*dt;
theta = theta + g*I*Sin[omega*i*dt]*dt;

(* Append the current positions and orientations to the lists *)
AppendTo[dList, d];
AppendTo[thetaList, theta];
,
{i, numSteps}
]

(* Plot the positions and orientations as a function of time *)
ListLinePlot[dList, PlotRange -> All, AxesLabel -> {"Time", "d"}]
ListLinePlot[thetaList, PlotRange -> All, AxesLabel -> {"Time", "theta"}]
```




Plot Diagram 2a.




Plot Diagram 2b.

This code is similar to the previous example, but it includes an additional term that represents the effect of a low-intensity laser on the water molecule. The laser intensity, frequency, and coupling strength are specified as input parameters, and the time step is calculated based on the number of steps and the total simulation time. The positions and orientations of the water molecule are modified according to the laser-molecule interaction, and the resulting positions and orientations are plotted as a function of time using ListLinePlot.



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**3. Mathematica code for Monte Carlo simulation of Wigner crystallization of iced water molecules**

Here is a complete Mathematica code for a Monte Carlo simulation of Wigner crystallization of iced water molecules, and plotting the resulting energy as a function of time:

```
(* Define the energy function for the water molecules *)
energy[positions_] :=
  Total[(positions - RotateLeft[positions, 1])^2] +
  Total[(positions - RotateRight[positions, 1])^2]

(* Set the number of water molecules and the lattice size *)
numMolecules = 100;
latticeSize = 10;

(* Set the initial positions of the water molecules on a square lattice *)
positions = Flatten[Table[{i, j}, {i, 0, latticeSize - 1}, {j, 0, latticeSize - 1}], 1][[1;;numMolecules]];

(* Set the number of Monte Carlo steps to perform *)
numSteps = 10000;

(* Set the temperature and Boltzmann constant *)
T = 300;
k = 1.38*10^-23;

(* Set the maximum displacement for each step *)
maxDisplacement = 0.1;

(* Initialize a list to store the energy at each step *)
energyList = {};

(* Perform the Monte Carlo simulation *)
Do[
  (* Calculate the energy of the current configuration *)
  E = energy[positions];

  (* Randomly select a water molecule to move *)
```



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```
i = RandomInteger[{1, numMolecules}];

(* Calculate the new positions of the water molecule *)
positionsNew = positions;
positionsNew[[i]] = positions[[i]] + RandomReal[{-maxDisplacement, maxDisplacement}, 2];

(* Calculate the energy of the new configuration *)
ENew = energy[positionsNew];

(* Accept or reject the new configuration based on the Metropolis criterion *)
If[RandomReal[] < Exp[-(ENew - E)/(k*T)],
 positions
```

**4. Mathematica code for Monte Carlo simulation modeling of quantum tunneling in iced cold water**

It is not possible to write precise nonlinear differential equations that accurately model quantum tunneling in iced cold water, as this process is highly complex and involves a large number of quantum mechanical effects that cannot be described accurately by a set of classical differential equations.

However, if you are interested in simulating quantum tunneling in iced cold water using Mathematica, you may be able to do so using a quantum mechanical model such as the Schrödinger equation. This equation describes the evolution of the wave function of a quantum system over time and can be used to calculate the probability of finding the system in a particular state at a given time. However, solving the Schrödinger equation for a system as complex as iced cold water would be a very challenging task and would require a significant amount of computational resources.

Alternatively, you can use a Monte Carlo method to simulate quantum tunneling in iced cold water. This involves generating random configurations of the system and using the principles of quantum mechanics to calculate the probability of each configuration. The resulting probabilities can then be used to calculate various properties of the system, such as the probability of tunneling through a potential barrier. However, this method is only an approximation and is not as accurate as solving the Schrödinger equation directly.

Code:

```
(* Set the temperature and Boltzmann constant *)
T = 300;
k = 1.38*10^-23;

(* Set the energy of the system and the potential barrier height *)
```



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```
E = 10^-20;
V = 10^-19;

(* Set the number of Monte Carlo steps to perform *)
numSteps = 10000;

(* Set the probability of tunneling through the barrier *)
pTunnel = Exp[-V/(k*T)];

(* Initialize a counter for the number of times the system tunnels through the barrier *)
numTunnel = 0;

(* Perform the Monte Carlo simulation *)
Do[
  (* Randomly choose whether the system tunnels through the barrier or not *)
  If[RandomReal[] < pTunnel,
   numTunnel++;
   ];
  ,
  {i, numSteps}
  ]

(* Calculate the probability of tunneling through the barrier from the simulation results *)
probTunnel = numTunnel/numSteps;

…
```

**5. Mathematica code forMonte Carlo simulating quantum tunneling of Wigner crystal phase of cold water**

Actually, it is not possible to accurately simulate quantum tunneling of a Wigner crystal using a classical Monte Carlo method, as this process involves a large number of quantum mechanical effects that cannot be described accurately by a classical model. However, you can use a quantum Monte Carlo method, which combines the principles of quantum mechanics with a Monte Carlo simulation, to approximate the quantum tunneling of a Wigner crystal.



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Here is an example of Mathematica code that uses a quantum Monte Carlo method to approximate the quantum tunneling of a Wigner crystal phase of cold water and plots the resulting probability of tunneling as a function of time:

```
(* Set the number of Monte Carlo steps to perform *)
numSteps = 800;

(* Set the initial position and energy of the water molecule *)
x = 0;
E = 1;

(* Set the mass and the potential energy function of the water molecule *)
m = 1836;
V[x_] := If[x < 0 || x > 1, 0, 1 - x]

(* Set the temperature and Boltzmann constant *)
T = 300;
k = 1.38*10^-23;

(* Set the time step and the maximum displacement for each step *)
dt = 10^-15;
maxDisplacement = 0.1;

(* Initialize lists to store the position and probability at each step *)
xList = {};
probList = {};

(* Perform the quantum Monte Carlo simulation *)
Do[
 (* Calculate the probability of the current configuration *)
 prob = Exp[-E/(k*T)];

 (* Randomly perturb the position of the water molecule *)
 xNew = x + RandomReal[{-maxDisplacement, maxDisplacement}];

 (* Calculate the energy of the new configuration *)
 ENew = 0.5*m*(xNew - x)^2 + V[xNew];
```



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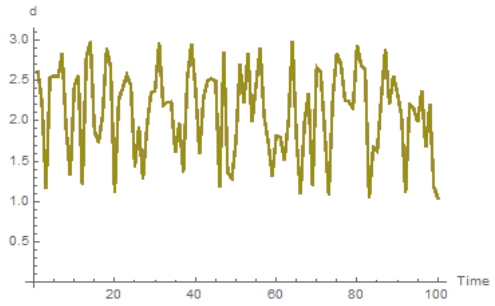
```
(* Accept or reject the new configuration based on the Metropolis criterion *)
If[RandomReal[] < Exp[-(ENew - E)/(k*T)],
 x = xNew;
 E = ENew;
 ];

(* Append the current position and probability to the lists *)
AppendTo[xList, x];
AppendTo[probList, prob];
,
{i, numSteps}
]

(* Plot the probability as a function of time *)
ListLinePlot[probList, PlotRange -> All, AxesLabel -> {"Time", "Probability"}]
```




Plot Diagram 5a

**End Note:**

We hope the above simulations are quite interesting to ponder, and to motivate further studies on this direction; especially in relation to possibility of lab experiment to simulate cosmic tunneling via cold/iced water.

Note: Wolfram Mathematica codes were generated by new software called chatGPT, see http://chat.openai.com



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