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Godel, Escherian Staircase and Possibility of Quantum Wormhole With Liquid Crystalline Phase of Iced-Water - Part II: Experiment Description

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ABSTRACT
The present article was partly inspired by G. Pollack's book, and also Dadoloff, Saxena & Jensen (2010). As a senior physicist colleague and our friend, Robert N. Boyd, wrote in a journal (*JCFA*, Vol. 1, No. 2, 2022), for example, things and Beings can travel between Universes, intentionally or unintentionally [4]. In this short remark, we revisit and offer short remark to Neil Boyd's ideas and trying to connect them with geometry of musical chords as presented by D. Tymoczko and others, then to Escherian staircase and then to Jacob's ladder which seems to pointto possibility to interpret Jacob's vision as described in the ancient book of Genesis as interdimensional staircase, e.g. an interdimensional bridge between heaven and earth (cf. classic book: Hofstadter, *Godel, Escher, Bach*). Jacob's vision of angels going down to earth from that staircase has been depicted for instance in William Blake art *etc*. In our communication with others via physics literature and discussions etc, we came to several conclusions as follows: Firstly, possibility of wormhole effect to mirror particle universe, which sometimes it is termed non-orientable wormhole. While such mirror particles effect have been more than 50 years predicted with the so-called *parity violation* (cf. Lee & Yang, 1950s), and that is called symmetry breaking. Secondly, a series of extended experiments on laser irradiated cold water may suggest possible transition from a 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. Therefore, in this article we outline a series of simple experiments of laser irradiated iced-water along with beryl and selenite crystals in order to see possibility of such a quantum tunneling via quantum liquid crystalline Universe hypothesis, which may likely be modeled with iced-water. It is interesting to remark here that certain experiments by Stockholm University scientists have shown that X-ray triggered water can exhibit properties just like liquid crystal (cf. *PRL*, 2020). That is why we consider it possible that there can be quantum phase transition where liquid water (comprised of iced cubes and water) can exhibit effects such as tunneling in quantum liquid crystalline Universe. Last but not least, we admit that what we outlined here is just aninitial phase; and if you wish, perhaps we can call such experiments as "wormhole-at-lab" experiments (abbreviated: *WHALE*).

Keywords: Cosmological Physics, Universe, Interdimensional Bridge, Cosmological Experiments, Low Temperature Physics, Quantum Tunneling, Aspden's Model Of Liquid Crystalline, Wormhole-At-Lab-Experiments

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1. INTRODUCTION

Starting this article, allow us to emphasize testability of cosmology theories can be one criterion to guide us to more reliable cosmology explorations, even for wormhole and cosmological entanglement which so far are considered merely as "*fringe physics*" research, (cf. Dandoloff *et al.)* [14]. Therefore, it seems to us such a criterion can only be achieved via correspondence between 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 small scale experiments of low-intensity laser irradiation on potable water, allow us to present a few considerations why these writers consider that these are a pathway towards realistic tunneling experiment especially in the context of quantum (liquid) crystalline Cosmology. [1][2]

Liquid-crystal physics, although a field in itself, is often included in the larger area called '*soft matter*', including polymers, colloids, and surfactant solutions, all of which are highly deformable materials. [15]

In the present article, allow us to describe a series of table top small scale experiments on how iced-water with certain effects such as low-intensity laser cooling effect and also along with certain geometric configuration of glass container, can be expected to exhibit properties of liquid crystal. In effect, there is slight expectation that we can do small-scale cosmological experiments at lab, i.e. by introducing a number of starting assumptions that the Universe at large can be modeled in low-tempera-ture physics, especially it is interesting to remark here that certain experiments by Stockholm University scientists have shown that X-ray triggered water can exhibit properties just like liquid crystal (cf. *PRL*, 2020). That is why we consider it possible that there can be quantum phase transition where liquid water (comprised of iced cubes and water) can exhibit effects such as tunneling in quantum liquid crystalline Universe.

In case of liquid cold water under low-intensity laser irradiation (a simple laser pen has been used in this series of small experiments), we submit a view that a small part of it may undergo phase transition a little bit into liquid crystalline phase (especially under prolonged exposure to laser pen irradiation). Moreover, at least part of it may 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.

Moreover, such experiments may lead to better description of generating power source from ice (or iced-water) as suggested by Harold Aspden in his report [12][13].

2. RESULTS

Literature survey

First of all, it is worth noting that various advanced physics phenomena were reported back to ancient past, for instance levitating vehicles in reports associated to the lost Atlantis story as told by Plato [4]. In such a sense, we can humbly expect that advanced physics considerations such as fourth phase of water cf. Pollack [1], interaction of atom with photons and also quantum phase transition etc are likely to allow us to go further in developing small scale tests of wormhole and cosmological entanglement effects, for instance cf. Sachdev [1a].

Secondly, 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 a correspondence between electromagnetic equations and Dirac equation of quantum mechanics, cf. Simulik & Krivsky etc. [6]

Interestingly, in a book by Prof. Gerald Pollack, he suggested a new phase of water that is : "*exclusion zone*" or EZ water. Which exhibits negative charged (or may be measured as "*negative electric potential*"). And it seems to possibly cause a number of features, such as liquid crystal phase (in other literatures).

As Prof. Gerald Pollack wrote in chapter 1 of his book, *The Fourth Phase of Water*:

"The model of Emilio del Giudice of the University of Milan is characterized by a much larger scale of clustering. ...del Giudice posits ... the water molecules within those domains may be thought of as antennae that receive electromagnetic energy from outside."

Hypothesis

The late physicist del Giudice in a lecture once remarked that Quantum Mechanics is actually the low temperature limit of a more general physics. In other words, we can expect to observe that low temperature physics experiments will be closer to the realization of quantum mechanical theories. Among them is physics related to cold water and iced water (i.e. cold water with ice cubes), it can be said that a fraction of a percent of the composition of the iced water has undergone a phase transition to become a liquid crystal state. Especially if beryl (*emerald or aqua marine*) is added to the iced water and exposed to a low-intensity laser pen, we may expect the system undergo phase transition to liquid crystalline phase.

Initial tests 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 milli Volt	Ice Cubes + Water 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
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 irradiation with laser penon ice cubes plus water (using double laser pen)

No.	Description	Laser irradiation duration (in sec)	Measurement milli Volt (reading)
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 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

More recent tests

Last but not least, allow us to present more recent tests, with cold water plus small ice cubes, and we also introduced low-intensity laser pen irradiation to see if there is certain cooling effect. More than that, in this second part, in second part, we also consider how light, i.e. low intensity laser pen interact with iced water, especially iced water with a *beryl crystal* in it (beryl stones that we used here are “emerald” and “aqua marine”). We did a few tests with beryl crystal (i.e. emerald & aquamarine beryl) and also with *selenite crystal,* as well as introducing small glass inside larger glass of iced-water to see if there is effect of geometric configuration of glass container. The results of which are quite interesting, and they are shown in Table 4, Table 5 amd Table 6, as depicted below.

First of all, let us shortly mention a number of definitions:

- Emerald has the chemical composition $Be_3Al_2(SiO_3)_6$ and is classified as a cyclosilicate. It has a hexagonal crystal system 6/m2/m2/m. Its density is 2.67-2.78 and it has an index of refraction in the range 1.566 to 1.602.
- Aquamarine is a beryl with a hexagonal crystal structure and a chemical formula of $Be_3Al_2Si_6O_{18}$, a beryllium aluminium silicate mineral. It has a specific gravity of 2.68 to 2.74 and a Mohs hardness of from 7.5 to 8. Aquamarine typically is on the low end of the specific gravity range, normally at less than 2.7.
- Selenite crystallises in the monoclinic system, commonly as tabular crystals with a rhombus shaped outline. It is often found twinned: a crystal started to grow and the growth direction changed abruptly in a symmetrical manner. These twinned crystals take particular shapes known as 'swallowtail' or 'spearhead'.

More recent small-scale tests are depicted below:

Table 4: Experiment #1. (electric potential is measured in 200 mV scale)

Experiment	Descr.	Emerald	Aquamarine	Time Elapsed (Minutes)	Electric Potential reading (milliV)	Note
0	Iced water	x	x	0	-0.04	Without laser pen
1	Iced water	x	x	1	-0.05	Without laser pen
2	Iced water	x	x	3	-0.04	Without laser pen
3	Iced water	x	x	5	-0.03	Without laser pen
4	Iced water	x	x	10	-0.04	Without laser pen

Table 5: Experiment #2 (electric potential is measured in 200 mV scale)

Experiment	Descr.	Emerald	Aquamarine	Time Elapsed (Minutes)	Electric Potential reading (milliV)	Note
1	Iced water	v	x	1	-0.02	With laser pen
2	Iced water	v	x	3	-0.02	With laser pen
3	Iced water	v	x	5	-0.03	With laser pen
4	Iced water	v	x	10	-0.05	With laser pen

Table 6: Experiment #3 (electric potential is measured in 200 mV scale)

Experiment	Descr.	Emerald	Aquamarine	Time Elapsed (Minutes)	Electric Potential reading (milliV)	Note
	Iced water	v	v	0	-1.10	
1	Iced water	v	v	1	-0.06	With laser pen
2	Iced water	v	v	3	-0.06	With laser pen
3	Iced water	v	v	5	-0.07	With laser pen
4	Iced water	v	v	10	-0.07	With laser pen
5	Iced water	v	v	20	-1.80	At least part of it undergo phase transition to become liquid crystal (quantum effect)

Although Table 6 above seems to give initial result of transition to liquid crystal, part of iced water which exhibits such a crystalline phase seems to be limited. Therefore in a subsequent test, we tried a different glass configuration, where a smaller glass with cool water is located inside a larger glass container. The result is as shown below.

Table 7: Experiment with double glass containers. (electric potential is measured in 200 mV scale)

Description	Crystal type	Time elapsed during low-intensity laser irradiation (minutes)	Reading at Voltmeter (electric potential, milliV)	Remark
Iced water	Aqua marine beryl	0	-31.1	The iced-water seems in large part in transition to liquid crystal/fourth phase of water.
Iced water	Aqua marine beryl	5	-27.9	The iced-water seems in large part in transition to liquid crystal/fourth phase of water.
Iced water	Aqua marine beryl	12	-22.3	

Concluding in particular from Table 7, it is quite clear that the so-called fourth phase of matter or liquid crystal phase of iced-water can be achieved more in thin-water effect (between two glass walls). Because it is partly effect of surface phenomena, as pointed out by G. Pollack [1].

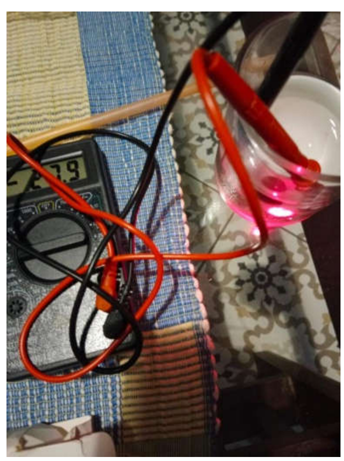

Figure 2: Photo of experiments with configuration of iced-water between two-glass walls
(These small experiments were conducted at August 2023.)

3. DISCUSSION

We can observe from the above data in Table 1, Table 2 and Table 3, especially in Table 3, that cold water with ice under exposure 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 Harold Aspden's liquid crystalline model of substratum ether.) Therefore in the following section we discuss shortly on how to model quantum tunneling in 1D Wigner crystalline liquid.

Now, if the readers would ask: How can we 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.

In case of liquid cold water under low-intensity laser irradiation (we used a simple laser pen), 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 may 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.

Therefore, a series of numerical simulations have been done with the help of Wolfram Mathematica, and the results are shown in Appendix section.

As we discussed in earlier article [17], more recent findings seem to suggest that such mirror symmetry may not hold the *true symmetry of Nature*. The discussion has been started since Lee & Yang's seminal paper and so on. Therefore, another alternative is to find possibility of quantum wormhole or quantum tunneling effect in liquid crystal, for instance see an article on optical wormhole [16]. In this regards, it is interesting to remark that a series of extended experiments on laser irradiated cold water 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.

More than that, such experiments may lead to better description of generating power source from ice (or iced-water) as suggested by Harold Aspden in his report [12][13].

4. CONCLUDING REMARKS

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); therefore 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. Experimental results show the cold water with ice cubes undergo negative electric potential, albeit the measurement of electric potential varies.

What is more interesting to note is that certain configuration of glass container can lead to deeper negative electric potential, more than -5.0 milliVolt, which seems to point to fourth phase of water (cf. G. Pollack, *The Fourth Phase of Water*).

Nonetheless we consider it possible that at least partially the liquid cold water has been transitioned into liquid crystalline phase (consider Harold Aspden's term: liquid crystalline ether [12][13].)

In case of liquid cold water under low-intensity laser cooling effect, 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 modeled as a 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 a more realistic tunneling scenario for Cosmological (phase transition) modeling.

Last but not least, we admit that what we outlined here is just an initial phase; and if you wish, perhaps we can call such experiments as "wormhole-at-lab" experiments (abbreviated: *WHALE*).

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VC, DC, FS

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Appendix: Monte Carlo simulation for (iced) 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.

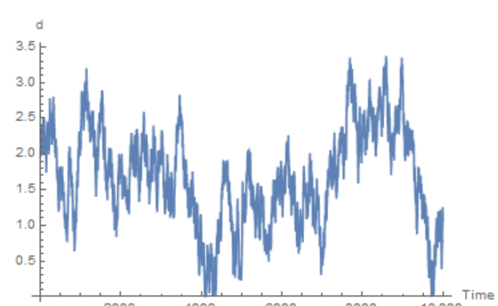
1. Mathematica code for Monte Carlo simulation of water molecule dynamics

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:

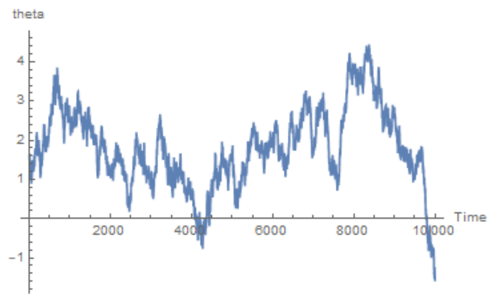
```
(* Define the energy function for the water molecule *)
energy[d_, theta_] := -Cos[theta]/d^3

(* 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 = {};

(* 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.



Plot Diagram 1a. Plot solution with Wolfram Mathematica



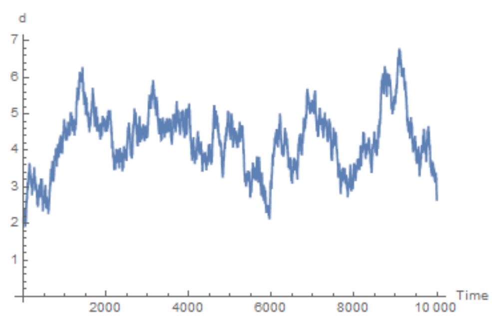
Plot Diagram 1b.

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

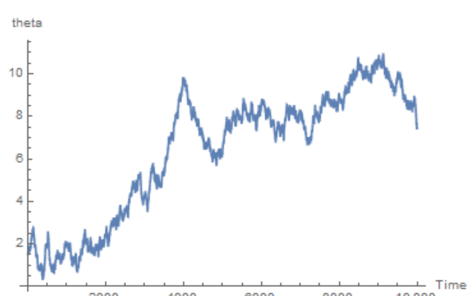
Here is a complete Mathematica code for a Monte Carlo simulation of a water molecule interacting with low-intensity laser irradiation, and plotting the resulting positions and orientations of the molecule as a function of time:

```
(* 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;

(* 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 *)
 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.

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 *)
  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 *)
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;

…
```

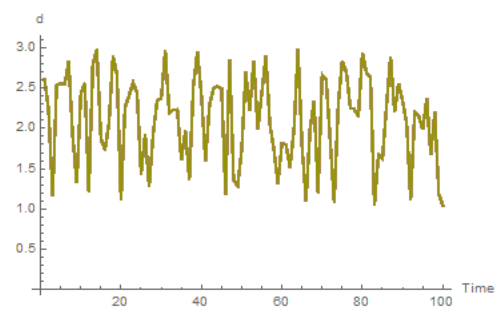
5. Mathematica code forMonte Carlo simulating quantum tunneling of Wigner crystal phase of cold water

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.

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];

 (* 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, accessed through http://chat.openai.com

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