MATHEMATICAL CORRELATION BETWEEN DOCTRINE OF DRUG DYNAMIZATION AND QUANTUM MECHANICS

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Abstract:
Homoeopathy is a much perplexing science to unfold its cardinal principles. Doctrine of drug dynamization states that the process of preparation of homoeopathic medicines is mathematico-mechanical. While the mechanical aspect is well established, mathematics still lags. The current study investigates the mathematical aspect of drug dynamization through equations of quantum mechanics. The quantum mechanics offers the probability of finding the particle in the extremely diluted homoeopathic medicines. The Born's statistical interpretation of original Schrodinger's equation helped to calculate the exact of probability of finding the active substance particle between two homoeopathic dilutions when mathematically modelled and simulated in python programing language. Similarly, quantum entanglement is also established using entanglement equations through mathematical model and simulation in python programing language. This study concludes that with the help of quantum mechanics it is very well possible to explain the process of homoeopathic drug dynamization scientifically and mathematically.

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Introduction

Homeopathy is an alternative medical system that was developed in the late 18th century, and it is based on the idea that highly diluted substances can treat various ailments. The preparation of homeopathic remedies involves diluting the original substance many times over, sometimes to the point where not a single molecule of the original substance remains [1]. This raises questions about the effectiveness of such remedies, as well as their safety [2]. Quantum mechanics offers the solution for detection of drug particle at given time through statistical interpretation of the Wave function [3].

Quantum mechanics, on the other hand, is a subfield of physics that deals with the behavior of matter and energy at the smallest scales, such as the scale of atoms and subatomic particles [4]. It is widely accepted by the scientific community as a fundamental theory that accurately describes the physical world and has been confirmed by numerous experiments [5]. The Schrödinger equation is a fundamental and wave equation in quantum mechanics that describes the evolution of a quantum system over time. It is typically interpreted in terms of probability, rather than in terms of actual values of physical quantities. This interpretation is known as the "statistical interpretation" of the Schrödinger equation [6].

The Born rule, named after Max Born, provides a statistical interpretation of the wave function in quantum mechanics. According to the Born rule, the probability of finding a particle at a particular location in space is proportional to the magnitude squared of the wave function at that location [7]. This means that if the wave function at a certain point is large, then the probability of finding the particle at that point is high, and if the wave function is small, the probability of finding the particle at that point is low [8]. The wave function itself can be thought of as a mathematical description of the state of a particle, including its position, momentum, and other properties [9]. The Born rule provides a way to make predictions about the behavior of a particle based on the wave function [10].

Methodology

1) As reported by Mercin Molski et al., (2011) the solvent concentration increases which can be shown through both time dependent as well as time independent Schrodinger equations [3]. And the exponential rise in the solvent could be explained with first and second order equation as stated in the paper.

$$\frac{d}{dt}S(t) - a\frac{\exp(-at)}{1-\exp(-at)}\,\mathrm{S(t)} = 0 \text{……..(1)}$$

$$\frac{d^2}{dt^2}S(t) + a^2\frac{\exp(-at)}{1-\exp(-at)}S(t) = 0 \text{……..(2)}$$

$$\frac{d^2}{d\tau^2}S(\tau) + \frac{\exp(-a\tau)}{1-\exp(-a\tau)}S(\tau) = 0 \text{……..(3)}$$

Similarly, there is exponential decay in the active substance as well,

$$m_A + m_S = M \text{……} (4)$$

$$A(x) + S(x) = \frac{m_A}{M} + \frac{m_S}{M} = 1 \text{……} (5)$$

$$A(x) = 10^{-x} = S(x) = 1 - 10^{-x} \text{……} (6)$$

This was further coded in python program for modelling and simulations as below,

```
import numpy as np
import math


NUM=100#potentization step
Afull=np.zeros(NUM)
Sfull=np.zeros(NUM)
A=1
for ik in range(NUM):
    # active substance of concentration
    A=A/10
    Afull[ik]=A
    # solvent of concentration
    S=1-A
    Sfull[ik]=S
    print(ik,A,S,'\n')
```

2) Quantum mechanics approaches the problem quite differently. In this case what we are looking for is the particle's wave function $\varphi(x,t)$, and we get it by solving the Schrodinger equation [6].

$$ih\frac{\partial\varphi}{\partial t} = -\frac{h^2}{2m}\frac{\partial^2\varphi}{\partial x^2} + V\varphi \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (7)$$

Practically it's impossible to find exact amount of drug substances in extreme homoeopathic dilutions. Quantum mechanics and "wave function" offers a kind of explanation to this.

It's difficult to implement the Schrodinger's equation in its pure form but to find the probability of the particles in homoeopathic dilution we have answer as Born's statistical interpretation of the wave function, which says that $|\varphi(x,t)|^2$ gives the probability of finding the particle at point *x*, at time *t* as follows:

$$\int_a^b |\varphi(x,t)|^2\,dx = \{probability\ of\ finding\ the\ particle\ between\ a\ and\ b, at\ time\ t.\} \ldots..(8)$$

Probability is the area under the graph of $|\varphi|^2$.

The above mathematical equation was coded in python programing language and multiple simulations were run for the said mathematical model to obtain the precision and extend the applicability to all the homoeopathic dilution levels.

The programming code for mathematical model using Born's statistical interpretation of the wave function for calculating the probability of finding particle in a given homoeopathic dilution is as below:

```
import numpy as np
import matplotlib.pyplot as plt
from matplotlib.patches import Polygon


"""
#Solvent
def Inte2(x):
    return (1-10**(-x))

x=np.linspace(1, 10,num=10)
y=Inte2(x)

print(y)
"""


def Inte(x):
    return (10**(-x))

#a,b= 2,3 #integral limits
from decimal import *
getcontext().prec = 100000000
a=Decimal(input('Enter the values of a:  '))
b=Decimal(input('Enter the values of b:  '))

x= np.linspace(1, 10,num=10)
y= Inte(x)


Auc=(((10**(-2*a))-(10**(-2*b))))/2
print('Area Under curve is:',Auc)
fig,ax = plt.subplots()
ax.plot(x,y,linewidth=2, linestyle= "--", color='r', marker='o')
plt.xlabel("Dilution")
plt.ylabel("Active Substance")

plt.title('PLOT')
ax.set_ylim(bottom=0)
```

```
# Make the shaded region
ix = np.linspace(int(a), int(b),num=(int(b)-int(a)))
iy = Inte(ix)

verts = [(a, 0), *zip(ix, iy), (b, 0)]
poly = Polygon(verts, facecolor='0.9', edgecolor='0.5')

ax.add_patch(poly)

#ax.text(0.5 * (a + b), 30, r"$\int_a^b f(x)\mathrm{d}x$", horizontalalignment='center', fontsize=20)

fig.text(0.9, 0.05, '$x$')
fig.text(0.1, 0.9, '$y$')

ax.spines.right.set_visible(False)
ax.spines.top.set_visible(False)
ax.xaxis.set_ticks_position('bottom')

ax.set_xticks([a, b])
ax.set_xticklabels(('$a$',  '$b$'))
ax.set_yticks([])


plt.show()
```

3) Though the quantum mechanics talks only about the probability of particular outcome in an experiment (whereas classical mechanics predicts the outcome of an experiment deterministically), still quantum mechanics remains the most successful theory as of now [6]. We assume that the particles of active drug substance and solvent are entangled with each other irrespective of the distance.

The below mathematical model was used to prove the assumption of entanglement.

$$|\varphi(1,2)\rangle = \frac{1}{\sqrt{2}}[|\propto_z\rangle 1|\beta_z\rangle 2 - |\beta_z\rangle 1|\propto_z\rangle 2] \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (9)$$

$$|\varphi(1,2)\rangle = \frac{1}{\sqrt{2}}[|\propto_x\rangle 1|\beta_x\rangle 2 - |\beta_x\rangle 1|\propto_x\rangle 2] \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (10)$$

$$|\varphi(1,2)\rangle = \frac{1}{\sqrt{2}}[|\propto_y\rangle 1|\beta_y\rangle 2 - |\beta_y\rangle 1|\propto_y\rangle 2] \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (11)$$

The programming code for mathematical model was done using python programing language.

```
import numpy as np


VAL=10
NUM=10#potentization step

Afull=np.zeros(NUM)
Sfull=np.zeros(NUM)
A=1
Tim=np.zeros(NUM)
for ik in range(NUM):
    Tim[ik]=ik+1
    # active substance of concentration
    A=A/10
    Afull[ik]=A
    # solvent of concentration
    S=1-A
    Sfull[ik]=S

    #print(ik,A,S,'\n')

Psifull=np.zeros(NUM)
TIMn=[]
TIMn.append('Psi-0')
for ik in range(VAL):
    ind=ik+1
    if ik>=1:
        print('-----------------------------------------------------------------------\n')

        PS0=1
        PS1=ik+1
        print('Estimating for potentization step: ',PS0,'-->',PS1)
        a1=Afull[PS0-1]
        a2=Afull[PS1-1]
        s1=Sfull[PS0-1]
        s2=Sfull[PS1-1]
        print('a1: ',a1,'  ','a2: ',a2,'  ','s1: ',s1,'  ','s2: ',s2,'  ',)
        als2=(PS0*PS1)+(a1*s2)
        a2s1=(PS0*PS1)+(a2*s1)
        print('als2 :',als2,'   ','a2s1 :',a2s1)
        Psi12=(1/np.sqrt(2))*(als2-a2s1)
```

```
        #Psil2= float("{:.5f}".format(Psil2))
        print('psil2 :',Psil2)
        Psifull[ik]=Psil2
        TIMn.append('Psi'+str(PS0)+'-'+str(PS1))



import matplotlib.pyplot as plt

plt.plot(Tim,Afull,linestyle = '--',color = 'r',marker='o')
plt.xlabel("TIME")
plt.ylabel("A ")
plt.grid(color = 'green', linestyle = '--', linewidth = 0.5)
plt.title('PLOT of A')
plt.axis([1, 10, np.min(Afull),np.max(Afull)]);
for ik in range(len(Psifull)):
    plt.text(Tim[ik],Afull[ik],Afull[ik],rotation='vertical')
plt.show()


plt.plot(Tim,Sfull,linestyle = '--',color = 'g',marker='*')
plt.xlabel("TIME")
plt.ylabel("S")
plt.grid(color = 'green', linestyle = '--', linewidth = 0.5)
plt.title('PLOT of S')
plt.axis([1, 10,np.min(Sfull),np.max(Sfull)]);
for ik in range(len(Psifull)):
    plt.text(Tim[ik],Sfull[ik],Sfull[ik],rotation='vertical')
plt.show()


######################3

Tim=Tim[:VAL]
Afull=Afull[:VAL]
Sfull=Sfull[:VAL]
Psifull=Psifull[:VAL]
Psifull=Psifull[1:]
Tim=TIMn[1:]
plt.plot(Tim,Psifull,linestyle = '--',color = 'b',marker='s')
```

```
plt.xlabel("STEP")
plt.ylabel("Psi")
plt.grid(color = 'green', linestyle = '--', linewidth = 0.5)
plt.title('PLOT of Psi')
plt.axis([0, 10,np.min(Psifull),np.max(Psifull)]);
for ik in range(len(Psifull)):
    plt.text(Tim[ik],Psifull[ik],Psifull[ik],rotation='vertical')
plt.show()
```

Results

1) During the process of homoeopathic dilution there is rise in the solvent concentration:

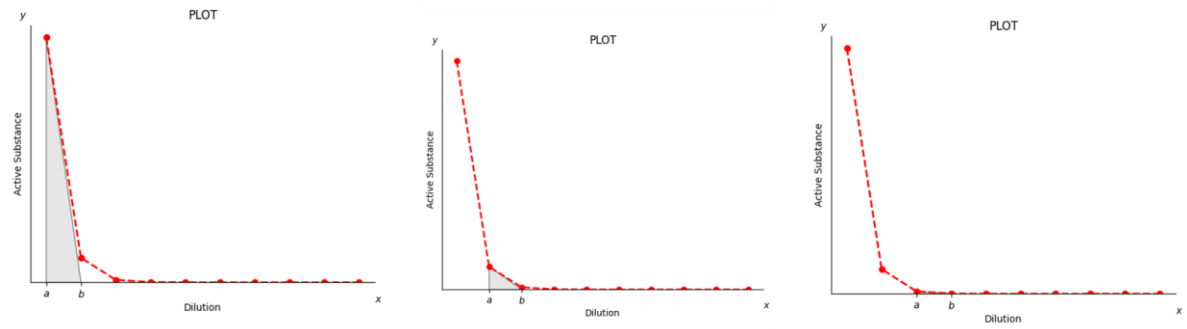
There is an exponential rise in solvent and decrease in active substance can be evident through Table. 1 after running the mathematical model, programmed in python. In the following Table 1. Six iterations of dilution levels are only presented but the model is capable of giving output till infinitesimal dilution (iteration) as also stated in homoeopathic doctrine of drug dynamization.

Table 1: Exponential rise in the solvent and systematic decay in the solute (drug substance)

Dilution level	Solute (concentration)	Solvent (concentration)
1	0.1	0.9
2	0.01	0.99
3	0.001	0.999
4	0.0001	0.9999
5	0.00001	0.99999
6	0.000001	0.999999

2) Probability of finding the particle of original drug substance in the homoeopathic dilution:
After running the mathematical model based on Born's statistical interpretation of Schrodinger's equation the following results were obtained. Area under the curve is calculated based on above mathematical model between potencies mentioned in Fig.1.

Figure 1: Area Under the Curve (AUC): Probability of finding the particle



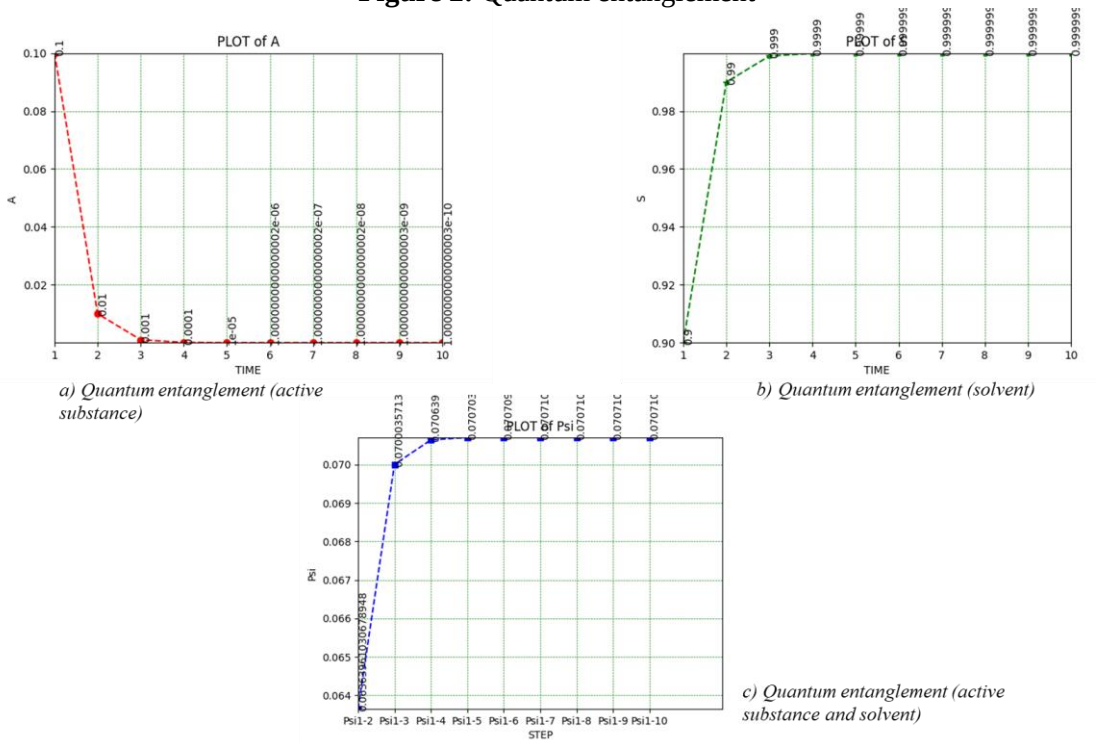
a) Probability of finding the particle: (0.00495) between 1st and 2nd dilution.

b) Probability of finding the particle: (0.0000495) between 2nd and 3rd dilution.

c) Probability of finding the particle: (4.95*10-7) between 3rd and 4th dilution.

3) Quantum entanglement
The Fig. 2 demonstrates the entanglement between active drug substance and solvent and within active substance and solvent. Quantum entanglement (*Ψ)* increases with the serial successive dilution.

Figure 2: Quantum entanglement



a) Quantum entanglement (active substance)

b) Quantum entanglement (solvent)

c) Quantum entanglement (active substance and solvent)

Discussion

At the core of quantum mechanics is Schrödinger's equation, a mathematical relation that describes the behavior of quantum systems over time. The equation, formulated by physicist Erwin Schrödinger in the 1920s, is a key foundation in the field of quantum physics [9]. Specifically, it provides a description of how the wave function, or quantum state, of a physical system evolves over time [10].

The wave function, often denoted as ψ, embodies the most radical departure from classical physics. Unlike classical descriptions which can precisely pinpoint the location and momentum of a particle, the wave function offers a probabilistic description. When squared, it provides the probability of finding a particle in a particular state or location [9]. It's a mathematical representation of the quantum state of an entire system [11].

Another intriguing phenomenon in quantum physics is quantum entanglement. This refers to the intimate connection that can exist between two or more particles, even when separated by vast distances. When particles become entangled, the state of one particle immediately influences the state of the other, no matter the distance between them [12]. This phenomenon puzzled even Albert Einstein, who referred to it as "spooky action at a distance"[10].

Weak quantum theory (WQT) is a generalized form of quantum theory. It's less about the specifics of particles and more about the general principles, such as complementarity and entanglement, without referring to a specific Hilbert space representation [13]. Some researchers have explored its implications outside the realm of strict physics, such as in psychology and even in alternative medicine [14] [15].

The field of homeopathy posits that substances diluted in water to extreme degrees can still exert a therapeutic effect. Some proponents of homeopathy have pointed to quantum physics, and especially quantum entanglement, as a possible explanation for the purported efficacy of these ultra-dilute solutions [15] [16] [17] [18].

The present investigation conducted to see the correlation between doctrine of homoeopathic drug dynamization and quantum mechanics. The primary objective was to find the probability of finding the particle in given homoeopathic dilution while secondary objective was to investigate the quantum entanglement between these particles.

Molski et al, already hypothesized that there is increase in the solvent concentration during homoeopathic dynamization process namely triturations and succussions through quasi quantum model of potentization [3]. We have further mathematically modelled and simulated the equation to confirm the observations given by author in a more pragmatic and evidence-based approach.

This study demonstrated the probability of finding particle between two different dilutions of homoeopathic medicine as illustrated in results based on the Borne's statistical interpretation of Schrodinger's equation. The area under the curve was calculated for the probability for each homoeopathic dilution using this model programed in the python language.

Similarly, the quantum entanglement was derived within and between the active substance particles as well as solvent particles for individual homoeopathic dilutions based on the equations for quantum entanglement when modelled and simulated in python programing language. It has been observed that quantum entanglement increases with every successive dilution.

Conclusion

While quantum mechanics, as described by Schrödinger's equation and its resultant wave function, offers a robust and mathematically rigorous framework for understanding the probability of finding the particle even in the infinitesimal dilution. Quantum entanglement, as fascinating as it is, provide a bridge to understand how the particles of active substance and solvents are entangled with each other to possibly carry the medicinal information and thereby exert the clinical effect. Engaging critically with these ideas is essential for advancing both the understanding of quantum physics and its potential applications in homoeopathy.

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Conflict of Interest

Author declares that there is no conflict of interest.

Disclosure

The methodology mentioned in this study have received a copy right registration from Copy right office, Govt. of India under the name of 'Homoeopathic Dilution Code'. [Registration no: SW-16597/2023]. Copyright has been awarded to

the primary author [Tejas Gosavi] of this manuscript [13 January 2013].

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