

# Solar System Wave Function

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## Abstract

Pluto, Ceres and all planets of Solar system except Neptune, with a high approximation, follow a rule called Titius-Bode rule or Bode rule, which can by no means be considered as a stochastic event. This rule shows that the distance of planets from the sun in the solar system is regulated. Here, I prove that the existence of a standing and cosine wave packet, with the wavelength  $\lambda = 0.6 AU$  ( $AU$  represents the distance of Earth from the Sun) and the phase constant  $\phi = \frac{\pi}{6}$ , in the solar system is the reason for Bode rule. And moreover I prove that this huge wave packet belongs to the sun. Bode rule does not predict the distance of Neptune from the Sun but my wave theory, which believes in the presence of a cosine and standing wave in the solar system, can give us the distance of Neptune. It seems that, based on this article, quantum mechanics will enter a new stage.

**Keywords:** Titius-Bode rule, Solar system, Quantum mechanics

## Introduction

The planets of the solar system move around the sun in elliptical orbits such that the sun is in one of the focal points of these ellipses. These ellipses are very close to the circle, and in fact the orbits of the planets of the solar system are concentric circles. Pluto and Ceres and all planets of Solar system except Neptune, with a high approximation follow a rule known as Bode rule or Titius-Bode rule. According to this rule, the distance of each planet from the Sun is equal to  $a = 0.4 AU + 0.3 AU \times 2^n$ , where  $0.4 AU$  is the distance of Mercury from the Sun (or more precisely the length of the semi-major axis of Mercury's orbit) and  $n = 0,1,2,3, \dots$  [1]. Table. 1 shows the high accuracy of the Bode rule. It was historically based on this rule that Ceres was discovered in 1801 [1]. If this rule was only true for three or four planets, then we could call it a coincidence, but when it is true for seven planets, plus Ceres and Pluto, there is definitely a reason for it. In this article, I will find the reason for the existence of the Bode rule. In fact, I will prove that the presence of a cosine and standing wave packet in the solar system is the reason for existence of Bode rule. and, I will prove that this wave packet belongs to the sun. The Bode rule does not predict the position of Neptune but my wave theory, which believes in the presence of a cosine and standing wave in the solar system, can give us the position of Neptune.

Planet	T-B rule distance (AU)	Semi-major axis (AU)	Deviation from prediction
Mercury	0.4	0.39	-2.5%
Venus	0.7	0.72	+2.8%
Earth	1.0	1.00	0.00%
Mars	1.6	1.52	-4.77%
Ceres	2.8	2.77	-1.16%
Jupiter	5.2	5.20	+0.00%
Saturn	10.0	9.58	-4.45%
Uranus	19.6	19.20	-1.95%
Pluto	38.8	39.48	+1.05%

38 **Table. 1. Planets distances from the Sun and the prediction of Bode rule.** Bode rule cannot predict the distance of  
39 Neptune from the Sun.

#### 40 **Wave Function and Bode Rule**

41 Consider a standing and cosine wave function with a wavelength  $\lambda = 0.6 AU$ ; if we assume that  
42 the first node of this wave is at a distance of  $0.1 AU$  from the Sun the next nodes are at the distances  
43 of  $0.4 AU, 0.7 AU, 1 AU, 1.3 AU, 1.6 AU, \dots 2.8 AU, \dots$  from the Sun. Each node is  $0.3 AU$   
44 ahead of the previous node. If we consider the planets of the solar system in the position of the  
45 nodes of this wave, in such a case, there is no planet on the first node ( $0.1 AU$ ) and Mercury is on  
46 the second node, Venus is on the third node, Earth is on the fourth node, Mars is on the sixth node,  
47 and the position of fifth node ( $1.3 AU$ ) is empty. The seventh, eighth, and ninth nodes are empty,  
48 and Ceres is on the tenth node. Jupiter is placed on the eighteenth node and Saturn is on the thirty-  
49 third node, and Uranus, Neptune, and Pluto are on the nodes farther from the Sun. As you can see,  
50 a wave function, with the wavelength  $\lambda = 0.6 AU$ , easily predicts the position of the planets and  
51 it seems that a huge and standing wave plays a role in determining the position of the planets in  
52 the solar system. Therefore, we can consider the reason for the Bode rule to be the existence of a  
53 large cosine wave in the solar system that oscillates along the axis perpendicular to the plane of  
54 the solar system. In this article I will obtain the equation of this wave function. But what does this  
55 wave belong to? I answer this question in this article. The presence of a huge cosine wave in the  
56 solar system seems strange at first glance, but quantum mechanics eradicates our surprise. Based  
57 on quantum mechanics, a wave packet can be assigned to each object called the ‘associated matter  
58 wave ‘of that object, and this associated wave is the solution of the Schrodinger equation. In this  
59 article I prove that the above standing and cosine wave function is the solution of the Schrodinger  
60 equation and so an object must have created this wave in the solar system; I demonstrate that this  
61 object is the sun. It is the sun that has created a standing wave around itself and provided a definite  
62 orbit for the planets to orbit. In the present article, I show that the de Broglie equation ( $\lambda = h / p$ )  
63 with the Planck constant  $h$  is not suitable on astronomical scale, and we must consider a much  
64 larger constant instead of the Planck constant in the astronomical scale.

#### 65 **Wave Equation of the Solar System**

66 As I have mentioned, a cosine and standing wave function, with the wavelength of  $\lambda = 0.6 AU$   
67 ( $k = \frac{2\pi}{\lambda} = \frac{10\pi}{3}$ ), can predict the position of the planets in the solar system. First I want to derive

68 the phase constant of this wave function. It has been stated that Mercury is on the second node of  
 69 the wave function (the second node corresponds to the phase  $\frac{3\pi}{2}$ ).

$$70 \quad x_{Mercury} = 0.4 \text{ AU} \Rightarrow \psi(x_{Mercury}) = 0 \Rightarrow \cos(kx + \phi) = 0 \Rightarrow kx + \phi = \frac{3\pi}{2} \Rightarrow \phi = \frac{\pi}{6}$$

71 Having  $k$  and  $\phi$ , we can easily find the position of the other planets using the equation  
 72  $kx + \phi = \frac{\pi}{2}, \frac{3\pi}{2}, \frac{5\pi}{2}, \dots, \frac{(2m-1)\pi}{2}$  (Where  $m$  is the node number). For example

$$74 \quad kx_{Venus} + \phi = \frac{5\pi}{2} \Rightarrow \frac{10\pi}{3}x_{Venus} + \frac{\pi}{6} = \frac{5\pi}{2} \Rightarrow x_{Venus} = 0.7 \text{ AU}$$

73 or

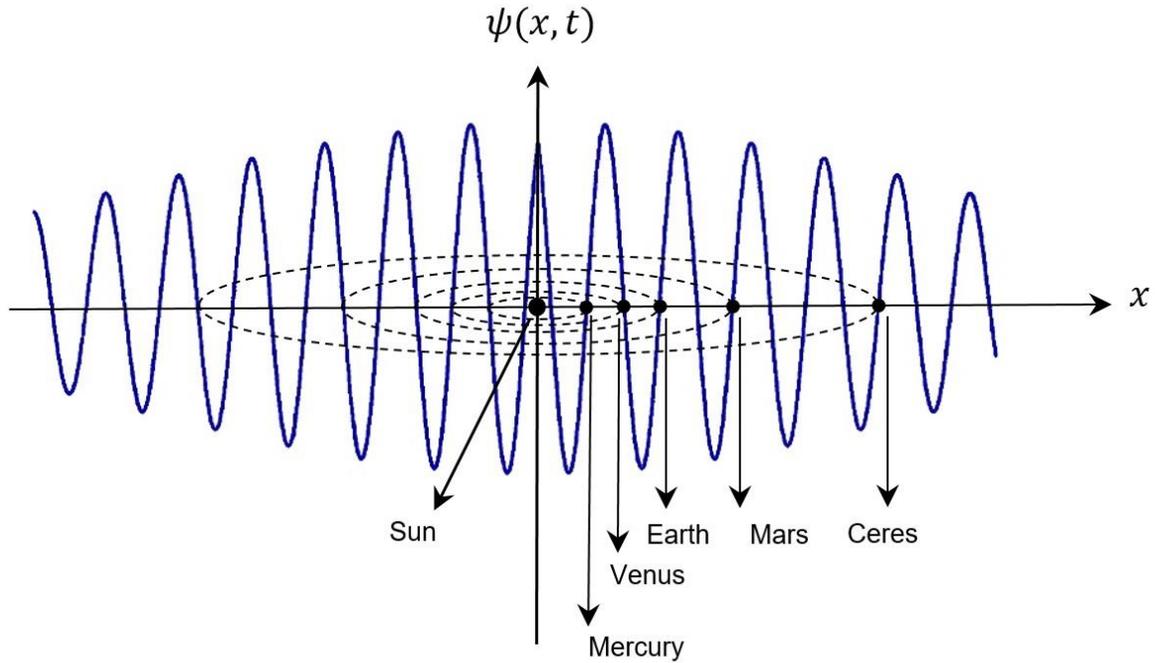
$$75 \quad kx_{Earth} + \phi = \frac{7\pi}{2} \Rightarrow \frac{10\pi}{3}x_{Earth} + \frac{\pi}{6} = \frac{7\pi}{2} \Rightarrow x_{Earth} = 1 \text{ AU}$$

$$76 \quad kx_{Mars} + \phi = \frac{11\pi}{2} \Rightarrow \frac{10\pi}{3}x_{Mars} + \frac{\pi}{6} = \frac{11\pi}{2} \Rightarrow x_{Mars} = 1.6$$

77 The distances of the other planets can also be calculated in the same way, which is quite consistent  
 78 with experience. According to the above equation, Neptune is on the ninety-eighth node, which  
 79 corresponds to the phase  $\frac{195\pi}{2}$ . Contrary to the Bode rule, which is not able to predict the distance  
 80 of Neptune, our wave theory predicts the position of Neptune. Therefore, a cosine and standing  
 81 wave function with  $\phi = \frac{\pi}{6}$  and  $k = \frac{10\pi}{3}$  can be attributed to the solar system. But what is the  
 82 general equation of this wave function? The equation of the solar system must contain a component  
 83 with the equation  $\cos(\frac{10\pi}{3}x + \frac{\pi}{6})$  and on the other hand, this wave must be standing so that the  
 84 position of the nodes (planets) does not change. Any wave in which the variables  $x$  and  $t$  are  
 85 entered as a combination of  $kx \pm \omega t$  is a traveling wave [2]. For example, the equation  
 86  $\sin(kx - \omega t + \phi)$  shows a traveling wave. Therefore, the form of our wave function must be either  
 87  $\cos(\delta\omega t) \cos(\frac{10\pi}{3}x + \frac{\pi}{6})$  or  $\sin(\delta\omega t) \cos(\frac{10\pi}{3}x + \frac{\pi}{6})$ . Due to the symmetry of the solar system  
 88 around the sun we choose the equation  $\cos(\delta\omega t) \cos(\frac{10\pi}{3}x + \frac{\pi}{6})$  and then we will show that our  
 89 choice has been correct ( $\delta$  is a constant number that we will derive its value). Since the solar system  
 90 has a certain size and is not infinitely wide, its wave equation must also be localized (a wave  
 91 packet). If we consider an expression in the form  $e^{-\gamma x^2}$  (which is a Gaussian function and plays  
 92 the role of a wave envelope) in the final equation, in such a case, the final equation is a localized  
 93 wave or a wave packet, (the value of  $\gamma$ , which is a positive number, is obtained in the following)  
 94 thus, the primary form of the wave function of the solar system is as follows (equation 1) and the  
 95 planets are on the nodes of this wave function (Fig. 1):

$$96 \quad \begin{cases} \psi(x, t) = C \cos(\delta\omega t) \cos(\frac{10\pi}{3}x + \frac{\pi}{6}) e^{-\gamma x^2} & x \geq 0 & (1-a) \\ \psi(x, t) = C \cos(\delta\omega t) \cos(\frac{10\pi}{3}x - \frac{\pi}{6}) e^{-\gamma x^2} & x \leq 0 & (1-b) \end{cases} \quad (1)$$

97 In equation 1,  $\gamma$ ,  $C$  and  $\delta$  are constant values and we obtain their values in this article.



98

99 **Fig. 1. Solar system standing wave packet with  $\lambda = 0.6 AU$  and  $\phi = \frac{\pi}{6}$ .** Diagram of  $\psi(x, t)$  at the moment  $t = 0$ . The  
100 value of  $\psi(0,0)$  is equal to  $\frac{\sqrt{3}C}{2}$ . This diagram is drawn by a certain value of  $C$  and  $\gamma$  in equation 1, which we will  
101 obtain their value at the end of the article. As you can see, the planets are on the nodes of the wave function. Jupiter,  
102 Saturn, Uranus, Neptune, and Pluto are on the nodes farther from the Sun.

103 In Fig. 1, the wave oscillates along the  $\psi$  axis over time. But the nodes and the anti-nodes do not  
104 move relative to each other along the  $x$ -axis. This does not mean that the wave packet is stationary  
105 in the space; it is just like passengers sitting on a train who do not move relative to each other but  
106 the train is moving relative to the rails. In the same way, the solar system wave packet is a standing  
107 wave that rotates, along with the solar system, around the center of the galaxy. As you can see,  
108 Equation (1) can easily predict the position of planets. This equation is the "wave equation of the  
109 solar system". In the continuation of the article, we will prove that this equation is the Real part of  
110 a solution of Schrodinger equation<sup>1</sup> and that's why we can assign it to an object like the sun.

111

112

### 113 Associated Wave Packet of Sun

114 In quantum mechanics, in order to build a wave packet from a set of infinite number of flat matter  
115 waves  $A_0 e^{i(kx - \omega t)}$  that move in one direction, we sum them together based on the superposition

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<sup>1</sup> As you know, the solutions of Schrodinger equation have two parts: Real and Imaginary.

116 principle [3],[4]. In this case, the net wave is a wave packet, and this wave packet is the solution  
 117 of Schrodinger equation. But this wave packet is a traveling wave packet, and now we want to see  
 118 if it is possible to make a standing wave packet from the sum of the infinite number of flat matter  
 119 waves. To obtain this standing wave packet, we proceed as follows.

120 Schrodinger wave equation for a free particle in one dimension is as follows:

$$121 \quad i\hbar \frac{\partial}{\partial t} \psi(x, t) = -\frac{\hbar^2}{2m} \Delta \psi(x, t) \quad (2)$$

122 Where  $\Delta$  is the Laplace operator. This equation clearly has the following solutions [3].

$$123 \quad \psi(x, t) = A(x, t) = A_0 e^{i(kx \pm wt \pm \emptyset)} = A_0 e^{i(kx \pm \emptyset)} e^{\pm iwt} \quad (3)$$

124 On the condition that  $k$  and  $w$  satisfy the relation below:

$$125 \quad w = \frac{\hbar k^2}{2m} \quad (4)$$

126  $A_0 e^{i(kx - wt \pm \emptyset)}$  represents the matter wave propagating in the positive direction of the x-axis<sup>2</sup>, and  
 127  $A_0 e^{i(kx + wt \pm \emptyset)}$  represents the matter wave propagating in the negative direction of x-axis. Equation  
 128 4 is obtained by combining the Planck equation  $E = \hbar w$  and de Broglie equation  $p = \hbar k$ .

129 The flat wave with equation 3 represents an associated wave with a matter particle whose  
 130 probability of presence is uniform throughout all space<sup>3</sup>. But real matter particles are not extensive  
 131 throughout space, they are localized, and in quantum we are seeking the description of localized  
 132 matter particles. So we have to use the equation of a wave packet instead of equation 3. The  
 133 equation of a matter wave packet is obtained from the superposition of (sum of) the waves of  
 134 Equation 3. And we know from the principle of superposition that this net wave is also the solution  
 135 of the Schrodinger equation (Equation 2).

136 In order to obtain an equation for a 'standing wave packet', we must calculate the superposition  
 137 of a set of infinite numbers of flat matter waves which move in opposite directions to each other.  
 138 The net wave is a standing wave packet, which is the solution of the Schrodinger equation.

139 First we calculate the superposition of the waves moving in the positive direction of the x-axis and  
 140 add this net wave to the superposition of the waves moving in the negative direction of the x-axis.  
 141 Consider a set of infinite numbers of flat matter waves  $A_0 e^{i(kx - wt + \emptyset)}$ , which move in the positive  
 142 direction of the x-axis, and suppose that the angular frequency of these waves is equal to  $w_0$  and  
 143 the wave number of these waves is around the median of  $k_0$  and between  $k_0 + \Delta k/2$  and

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<sup>2</sup> The sign  $\pm$  behind  $\emptyset$  means that both  $A_0 e^{i(kx - wt - \emptyset)}$  and  $A_0 e^{i(kx - wt + \emptyset)}$  are the solution of Schrodinger equation.

<sup>3</sup> According to the uncertainty principle  $\Delta x \cdot \Delta p \geq \hbar$  and the formula  $p = \hbar k$ , when  $k$  has a certain value then we have  $\Delta p = 0$  and therefore, the value of  $\Delta x$  is infinite.

144  $k_0 - \Delta k/2$ <sup>4</sup>. In such a case, the resultant of these waves, using the superposition principle, is a  
 145 wave packet with equation 5 [3][4].

146 
$$\psi_{total}(x, t) = A_{total}(x, t) = \int A_0(k)e^{i(kx-w_0t+\phi)}dk \quad (5)$$

147 Where  $k$  means  $k_x$ . In equation 5,  $A_0(k)$  is a Gaussian and symmetric function.

148 
$$A_0(k) = e^{-\alpha(k-k_0)^2} \quad (6)$$

149 In equation 6,  $\alpha$  is a constant with a positive value and shows the width of the bell-shaped function  
 150 of  $A_0(k)$ . Since equation 5 is derived from the superposition principle, it is the solution of  
 151 Schrodinger equation.

152 To obtain  $\psi_{total}(x, t)$  from equation 5, we calculate the superposition of all of the waves in one  
 153 moment, which we consider to be the origin of time ( $t = 0$ )<sup>5</sup>, and then we can obtain the net wave  
 154 at any other time. We have:

155 
$$\psi(x, 0) = \int A_0(k)e^{i(kx+\phi)}dk \quad (7)$$

156 The above equation is the momentary image of the net wave. Multiply equation 7 by  $e^{ik_0x-ik_0x}$ .  
 157 We have:

158 
$$\psi(x, 0) = e^{i(k_0x+\phi)} \int A_0(k)e^{i(k-k_0)x}dk \quad (8)$$

159 Considering  $k' = k - k_0$ , we have:

160 
$$\psi(x, 0) = e^{i(k_0x+\phi)} \int e^{-\alpha k'^2} e^{ik'x} dk' \quad (9)$$

161 Using the variable transformation  $k' - \frac{ix}{2\alpha} = q$  (this variable transformation can be explained based  
 162 on the theory of complex variables [4]) and the Gaussian integral  $\int_{-\infty}^{\infty} dq e^{-\alpha q^2} = \sqrt{\frac{\pi}{\alpha}}$ , equation  
 163 9 can be calculated. After placement and simplification, we reach the following final solution [4]:

164 
$$\psi(x, 0) = \sqrt{\frac{\pi}{\alpha}} e^{i(k_0x+\phi)} e^{-\frac{x^2}{4\alpha}} \quad (10)$$

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<sup>4</sup> In the Electromagnetic waves we cannot consider one  $w_0$  for two or many waves in which their  $k$  is different from each other, because for all of the EM waves we have:  $w = ck$  where  $c$  is the speed of light. But for matter waves the issue is different. In the matter waves we have  $w = \frac{\hbar k^2}{2m}$ . As you can see  $w$  is the function of  $k$  and  $m$ . Therefore, it is possible to choose one value of  $w_0$  for the waves in which their  $k$  is different from each other.

<sup>5</sup> It is like taking photo from the wave function with equation 5 in a moment of time, in such a case, the resulting image is the picture of the net wave packet in a moment of time.

165 This equation shows us the form of a traveling wave packet at a point in time. But how are the  
 166 time variations of Equation 10? As we have mentioned, we consider  $w$  for each wave is equal to  
 167  $w_0$ , We have

$$168 \quad \psi(x, t) = \int A_0(k) e^{i(kx - w_0 t + \phi)} dk = \int e^{-\alpha k^2} e^{i(kx - w_0 t + \phi)} dk$$

169 We put  $e^{ik_0 x - ik_0 x}$  in the equation:

$$170 \quad \psi(x, t) = e^{i(k_0 x + \phi) - iw_0 t} \int e^{-\alpha k^2} e^{ikx} dk'$$

171 This integral is similar to integral 9, which led to  $\psi(x)$  (Equation 10). Therefore, the output wave  
 172 equation of a set of the infinite number of waves  $A_0(k) e^{i(kx - w_0 t + \phi)}$ , which are moving in the  
 173 positive direction of the  $x$ -axis, is equal to [4];

$$174 \quad \psi_1(x, t) = \sqrt{\frac{\pi}{\alpha}} e^{i(k_0 x + \phi - w_0 t)} e^{-\frac{x^2}{4\alpha}} \quad (11)$$

$$175 \quad e^{i\theta} = \cos\theta + i\sin\theta \Rightarrow \text{Re } \psi_1(x, t) = \sqrt{\frac{\pi}{\alpha}} \cos(k_0 x - w_0 t + \phi) e^{-\frac{x^2}{4\alpha}} \quad (12)$$

176 Due to the presence of the factor  $k_0 x - w_0 t$ , Equation 12 represents a traveling wave packet that  
 177 propagates in the positive direction of the  $x$ -axis [2]. This means that the location of the nodes is  
 178 not known.

179 Similarly, we use the recent trend to obtain the superposition of flat waves traveling in the negative  
 180 direction of the  $x$ -axis, i.e.  $A_0(k) e^{i(kx + w_0 t + \phi)}$ . If we do this, we get to Equation 13.

$$181 \quad \psi_2(x, t) = \sqrt{\frac{\pi}{\alpha}} e^{i(k_0 x + \phi + w_0 t)} e^{-\frac{x^2}{4\alpha}} \quad (13)$$

$$182 \quad \text{Re } \psi_2(x, t) = \sqrt{\frac{\pi}{\alpha}} \cos(k_0 x + w_0 t + \phi) e^{-\frac{x^2}{4\alpha}} \quad (14)$$

183 This equation shows a traveling wave packet that propagates in the negative direction of  
 184 the  $x$ -axis.

185 Now we sum up the two equations 14 and 12 together to get the final wave.

$$186 \quad \text{Re } \psi_{total}(x, t) = \text{Re } \psi_1 + \text{Re } \psi_2$$

187 Thus:

$$188 \quad \text{Re } \psi_{total}(x, t) = \sqrt{\frac{\pi}{\alpha}} e^{-\frac{x^2}{4\alpha}} [\cos(k_0 x - w_0 t + \phi) + \cos(k_0 x + w_0 t + \phi)] \quad (15)$$

189 Using the equation  $\cos\alpha + \cos\beta = 2\cos\frac{1}{2}(\alpha + \beta)\cos\frac{1}{2}(\alpha - \beta)$  and  $\cos(\theta) = \cos(-\theta)$  we  
 190 obtain the equation of a standing wave packet.

191 
$$\begin{cases} \alpha = k_0x - w_0t + \emptyset \\ \beta = k_0x + w_0t + \emptyset \end{cases} \Rightarrow Re \psi(x, t) = 2\sqrt{\frac{\pi}{\alpha}} e^{-\frac{x^2}{4\alpha}} \cos(k_0x + \emptyset) \cos(w_0t) \quad (16)$$

192 There is not the structure of  $kx \pm wt$  in Equation 16 so the net wave is a standing wave. As  
 193 observed, Equation 16 is exactly the same as equation 1-a. By comparing these two equations, we  
 194 have

195 
$$\delta = 1, \quad \gamma = \frac{1}{4\alpha} \quad \text{and} \quad C = 2\sqrt{\frac{\pi}{\alpha}}$$

196 If we put the values  $\emptyset = \frac{\pi}{6}$  and  $k_0 = \frac{10\pi}{3}$  in Equation 16, then we get the final equation of the solar  
 197 system wave function for  $x \geq 0$ .

198 
$$Re \psi(x, t) = 2\sqrt{\frac{\pi}{\alpha}} \cos(w_0t) \cos\left(\frac{10\pi}{3}x + \frac{\pi}{6}\right) e^{-\frac{x^2}{4\alpha}} \quad x \geq 0 \quad (17)$$

199 Equation 17 is obtained by calculating the superposition of a set of infinite number of waves of  
 200  $A_0(k) e^{i(kx-w_0t+\emptyset)}$  and  $A_0(k) e^{i(kx+w_0t+\emptyset)}$  that move in opposite directions to each other (pay  
 201 attention to the + sign behind  $\emptyset$ ). Now if we sum a set of infinite number of flat wave functions  
 202 with the formula  $A_0(k) e^{i(kx-w_0t-\emptyset)}$  and  $A_0(k) e^{i(kx+w_0t-\emptyset)}$  (pay attention to the – sign behind  
 203  $\emptyset$ ) together, by following the path we have taken from equation 5 to equation 17, we reach the  
 204 following relationship;

205 
$$Re \psi(x, t) = 2\sqrt{\frac{\pi}{\alpha}} \cos(w_0t) \cos\left(\frac{10\pi}{3}x - \frac{\pi}{6}\right) e^{-\frac{x^2}{4\alpha}}$$

206 Which is in the form of equation 1 for  $x \leq 0$ . Therefore, the final form of the solar system wave  
 207 function (Equation 1) is as follows:

208 
$$\begin{cases} Re \psi(x, t) = 2\sqrt{\frac{\pi}{\alpha}} \cos(w_0t) \cos\left(\frac{10\pi}{3}x + \frac{\pi}{6}\right) e^{-\frac{x^2}{4\alpha}} & x \geq 0 \\ Re \psi(x, t) = 2\sqrt{\frac{\pi}{\alpha}} \cos(w_0t) \cos\left(\frac{10\pi}{3}x - \frac{\pi}{6}\right) e^{-\frac{x^2}{4\alpha}} & x \leq 0 \end{cases} \quad (18)$$

209 In this equation, the larger the  $\alpha$ , the more the width of wave packet is, along the x-axis. We drew  
 210 Fig. 1 by  $\alpha = 6$ .

211 Thus we demonstrated here that Solar system wave equation (equation 1) is the real part of a  
 212 solution of Schrodinger equation. So we can assign it to an object like the sun. The closest star to  
 213 the solar system is at a distance of 4.8 light-years. Therefore, the wave function of the solar system  
 214 (equation 18) can only belong to the sun (it seems that quantum mechanics has entered a new  
 215 phase or stage). But, according to the very large mass of the sun, using the de Broglie equation  
 216 ( $\lambda = \frac{h}{mv}$ ) the wavelength of 0.6 AU will not obtain. So instead of Planck constant we have to  
 217 choose another value for celestial objects. We call this new value the Planck constant in Astronomy  
 218 ( $h_{Astronomy}$ ) abbreviated as  $h_A$  and we have:  $\lambda_A = \frac{h_A}{p}$ . Based on a clever conjecture in his 1924

219 dissertation, de Broglie hypothesized that the equation  $\lambda = \frac{h}{p}$ , which is true for photons, could also  
220 be applied to matter particles [5]. Here, too, we assume that there is a relation in the form of  
221  $\lambda_A = \frac{h_A}{p}$  on the scale of astronomy, according to the existence of a huge wave in the solar system.  
222 In such a case, the Schrodinger equation on the astronomical scale can be written as follows:

$$223 \quad i\hbar_A \frac{\partial}{\partial t} \psi(x, t) = -\frac{\hbar_A^2}{2m} \Delta \psi(x, t) \quad (19)$$

224 If we follow the path of proving the Schrodinger wave equation and put the value  $\hbar_A$  instead of  $\hbar$ ,  
225 we reach equation 19. The Davisson–Germer experiment [6] can be considered as the confirmation  
226 of the de Broglie relationship and the Schrodinger equation at the atomic scale, and the Regularity  
227 of the distances of the planets from the sun can confirm equation 19 and the formula  $\lambda_A = \frac{h_A}{p}$ . For  
228 the celestial wave packet we also have  $w = \frac{\hbar_A k^2}{2m}$ .

## 229 **Conclusion**

230 In this article, by investigating the distances of the planets of the solar system from the sun, we  
231 concluded that a huge, cosine, and standing wave packet surrounds our solar system. Using  
232 quantum mechanics calculations, it was proved that this wave packet belongs to the sun. Finally,  
233 I obtained the Schrodinger equation in astronomy, which describes the behavior of huge  
234 astronomical wave packets. Wave theory predicts the distances of all of the planets (including  
235 Neptune), plus Ceres and Pluto, but as we have seen, the Bode rule does not predict the distance  
236 of Neptune. Describing the distances of the planets by a quantum wave packet can be another  
237 confirmation of the validity of quantum theory. In addition to the astronomical scale, in the atomic  
238 scale, according to this article, it is very likely that electrons are located on the nodes of the  
239 associated wave packet of the atom nucleus. This issue can be discussed and investigated in future  
240 studies.

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