

Review Article

A Review of Schrödinger Equation & Classical Wave Equation

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Abstract

In this paper, I will review some inadequacies of Schrödinger equation. Then I will discuss George Shpenkov's interpretation of classical wave equation and two other authors' wave equations. According to Shpenkov, the classical wave equation is able to derive a periodic table of elements -which is close to Mendeleev's periodic table-, and also other phenomena related to the structure of molecules. It is argued here that one may arrive at new energy methods using this classical wave equation as starting point. It is suggested that Shpenkov's interpretation of classical wave equation can complement Schrödinger equation.

Key Words: Schrödinger Equation, classical wave equation, George Shpenkov, periodic table, element, molecule, new energy.

1. Introduction

George Shpenkov's work is based on [1]: (1) Dialectical philosophy and dialectical logic; (2) The postulate on the *wave nature* of all phenomena and objects in the Universe. He uses the classical wave equation is as follows:

$$\Delta\hat{\Psi} - \frac{1}{c^2} \frac{\partial^2 \hat{\Psi}}{\partial t^2} = 0 \quad (1)$$

This equation is also known as the wave equation of sound or string vibration [18, 22].

In this paper, I will review the inadequacy of spherical solution of Schrödinger's equation to say anything about the structure of molecules. It is a common fact, that the spherical solution of Schrödinger equation is hardly discussed properly in many quantum mechanics textbooks, with an excuse that it is too complicated. Then I will discuss George Shpenkov's interpretation of classical wave equation, where he is able to derive a periodic table of elements -which is close to Mendeleev's periodic table-, and other phenomena related to the structure of molecules, which are elusive dreams from the viewpoint of quantum mechanics.

George Shpenkov claims that his wave equation is able to explain the following:

- a. Derive a periodic table of elements (slightly different from but close to the Mendeleev's periodic law) based on spherical solution of his standing wave equation [9];

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- b. Give a dynamical model of elementary particles [8];
- c. Derive binding energy of deuterium, tritium, helium and carbon [10];
- d. Derive the atom background radiation of hydrogen which corresponds to the observed COBE/CMBR (Cosmic Microwave Background Radiation) [7];
- e. Derive the shell-nodal model of atoms and molecules [11];
- f. Explain anisotropy of graphene [12];
- g. Describe the shell-nodal picture of carbon and grapheme [13];
- h. Describe electron “orbitals”;
- i. Describe electron “spin”;
- j. Derive neutron magnetic moment;
- k. Derive proton magnetic moment;
- l. And other things [14].

Therefore, it seems that Shpenkov’s wave model of particles and molecules may be a promising alternative to complement the standard quantum mechanics.

2. Schrödinger equation

George Shpenkov points out that there are several weaknesses associated with (spherical solution of) Schrödinger’s equation:

- i. Its spherical solution is rarely discussed completely (especially in graduate or undergraduate quantum mechanics textbooks), perhaps because many physicists seem to feel obliged to hide from public that the spherical solution of Schrödinger’s wave equation does not agree with any experiment.
- ii. Schrödinger equation is able only to arrive at hydrogen energy levels, and it has to be modified and simplified for other atoms. For example, physicists are forced to use an approximate approach called Density Functional Theory (DFT) in order to deal with N-body system.¹
- iii. The introduction of variable wave number k in Schrödinger equation, depending on electron coordinates, and the omission of the azimuth part of the wave function, were erroneous [6]. Schrödinger’s variable wave number should be questioned, because the potential function cannot influence the wave speed or consequently the wave number.
- iv. Introduction of the potential function V in the wave equation, which results in dependence of the wave number k on the Coulomb potential, *generates divergences* that do not have a physical justification. They are eliminated in an artificial way.[6, p.27]
- v. Modern physics erroneously interprets the meaning of polar-azimuthal functions in Schrödinger’s equation, ascribing these functions to atomic “*electron orbitals*”. [1, p.5]
- vi. Schrödinger arrived at a “correct” result of hydrogen energy levels using only a radial solution of his wave equation, with one major assumption: the two quantum numbers found in the solution of his wave equation were assumed to be the same with Bohr’s quantum number [2].

¹ Anonymous, Density Functional Theory for Beginners. URL:
http://newton.ex.ac.uk/research/qsystems/people/coomer/dft_intro.html (accessed at April 28th, 2014)

- vii. Quantum mechanics solutions, in their modern form, contradict reality because on the basis of these solutions, the existence of crystal substances-spaces is not possible. [6, p.26]
- viii. Schrödinger's approach yields abstract phenomenological constructions, which do not reflect the real picture of the micro-world.[2]
- ix. Schrödinger himself in his 1926 paper apparently wanted to interpret his wave equation in terms of vibration of string [3][4]. This is why he did not accept Born's statistical interpretation of his wave equation until he died. Einstein and de Broglie also did not accept the statistical interpretation of quantum mechanics.
- x. The interpretation and the physical meaning of the Schrödinger's wave function was a problem for physicists, and it still remains so, although many researchers understand its conditional character [6].

In the initial variant, the Schrodinger equation (SE) has the following form [2]:

$$\Delta\Psi + \frac{2m}{\hbar^2} \left(W + \frac{e^2}{4\pi\epsilon_0 r} \right) \Psi = 0 \quad (2)$$

The wave function satisfying the wave equation (2) is represented as:

$$\Psi = R(r)\Theta(\theta)\Phi(\varphi)T(t) = \psi(r, \theta, \varphi)T(t) \quad (3)$$

Where $\psi(r, \theta, \varphi) = R(r)\Theta(\theta)\Phi(\varphi)$ is the complex amplitude of the wave function, because

$$\Phi_m(\varphi) = C_m e^{\pm im\varphi} \quad (4)$$

For standard method of separation of variables to solve spherical SE, see for example [20][21].

The Φ , Θ and T equations were known in the theory of wave fields. Hence these equations presented nothing new. Only the R was new. Its solution turned out to be *divergent*. However, Schrödinger together with H. Weyl (1885-1955), contrary to the logic of and all experience of theoretical physics, artificially cut off the divergent power series of the radial function $R(r)$ at a κ -th term. This allowed them to obtain the radial solutions, which, as a result of the cut off operation, actually were the fictitious solutions.[2]

Furthermore, it can be shown that the time-independent SE [20]:

$$\nabla\Psi + \frac{2m}{\hbar^2} (E - V)\Psi = 0, \quad (5)$$

Can be written in the form of standard wave equation [2]:

$$\nabla\Psi + k^2\Psi = 0, \quad (6)$$

Where

$$k = \pm \sqrt{\frac{2m}{\hbar^2} (E - V)}. \quad (7)$$

Or if we compare (6) and (2), then we have [2]:

$$k = \pm \sqrt{\frac{2m}{\hbar^2} \left(W + \frac{e^2}{4\pi\epsilon_0 r} \right)}. \quad (8)$$

This means that the wave number k in Schrödinger's radial wave equation is a quantity that varies continuously in the radial direction. Is it possible to imagine a field where the wave number, and hence the frequency, change from one point to another in the space of the field? Of course, it is not possible. Such wave objects do not exist in Nature.

4. Shpenkov's interpretation of classical wave equation

Now I will introduce the Shpenkov's interpretation of classical wave equation, which can be written simply as follows:

$$\nabla^2 \Psi + \frac{\omega^2}{c^2} \Psi = 0, \quad (9)$$

Where the wave number $k = \frac{\omega}{c}$, is constant, instead of variable [6]. Here, ω denotes the fundamental carrying frequency of the wave field at the corresponding level of space, and c denotes the speed of light. In order to correct the faults of wave mechanics, it is necessary to write down the above wave equation, which meets the conditions: (a) the wave number is constant, and (b) the azimuth factor must be taken into consideration along with radial $R(r)$ and polar factor of the wave-function [6].

In this case, the differential equation for the radial factor $R(r)$ is:

$$\rho \frac{d^2 R_l}{d^2 \rho} + 2\rho \frac{dR_l}{d\rho} + [\rho - l(l+1)] R_l = 0 \quad (10)$$

Where $\rho = kr$ [6].

The value of the fundamental frequency ω determines only the absolute scale of all parameters at the corresponding level of space. At the atomic and subatomic levels, it is equal to: [6, p.27]

$$\omega_e = 1.86916197 \cdot 10^{18} \text{ s}^{-1}. \quad (11)$$

The wave radius corresponding to (11) is:

$$\lambda_e = \frac{c}{\omega_e} = 1.603886998 \cdot 10^{-8} \text{ cm} . \quad (12)$$

As we can see, λ_e is equal to one-half of mean value of the interatomic distance in crystals (in terms of the generally accepted atomic model); therefore it is not a random coincidence. [6, p.27]

The detailed analysis to find spherical solution of equation (9) is discussed in Shpenkov's other papers [9, 11].

Some consequences of the solution of the Shpenkov's interpretation of classical wave equation are [6]:

- a. As masses of atoms are multiple of the neutron mass (or hydrogen atom mass), following Haiy's ideas makes it reasonable to suppose that any atom, like the elementary Haiy's molecule, is the neutron (H-atom) molecule;
- b. Therefore, atoms should be considered as neutron (H-atom) quasispherical multiplicative molecules. The word 'multiplicative' means that particles, constituted of these elementary molecules, must be coupled by strong bonds, which we call multiplicative bonds.
- c. Potential polar-azimuthal nodes of spherical shells in stable atoms (nucleon molecules) contain by two coupled nucleons.
- d. Polar potential-kinetic nodes (not filled with nucleons in the most abundant and stable atoms) are ordered along the z axis of symmetry (in spherical coordinate system) of the atoms.
- e. Exchange (interaction) between completed nodes inside (strong) and outside (electromagnetic) of the atoms is realized by exchange charges of nucleon and electron on the fundamental frequency (11).
- f. It is possible to get this method yielding the actual picture of distribution of nodes-extremes, corresponding to Haiy's elementary molecules.
- g. Principal azimuth nodes of the wave space of atoms are marked by ordinal numbers. These numbers coincide with the ordinal numbers of elements of Mendeleev's periodic table. The quantity of neutrons, localized in one node, is equal to or less than two.
- h. Arranging atoms with the same or similar structure of outer shells one under another, one arrives at the *periodic-nonperiodic law of spherical spaces* that constitutes periodic table, slightly differing from the conventional one of Mendeleev.

To be fair, Shpenkov may not be the first person who uses that the classical wave equation to study atoms and particles. There are at least two persons that I can recall here who appear to attempt similar thing: Randell L. Mills and Robert A. Close. Randell Mills calls his theory *Classical Quantum Mechanics*, while Robert Close calls his theory *The Classical Wave Theory of Matter*.

While Randell Mills seems to argue that Maxwell's equations are capable to explain stability of hydrogen [23][24], according to Rathke [25], Mills assumes that the dynamics of the electron are described by a classical wave equation for its charge-density function, $\rho(t,x)$,

$$\left(\nabla^2 - \frac{1}{c^2} \frac{\partial^2}{\partial t^2} \right) \rho(t, x) = 0 \quad (13)$$

Which is similar to equation (1). According to Rathke [25], this equation leads to Euler differential equation which has general solution:

$$f(r) = c_1 + \frac{c_2}{r}, \quad (14)$$

But that is different from the solution given by Mills:

$$f(r) = \frac{1}{r} \delta(r - r_n). \quad (15)$$

Therefore, according to Rathke, Mills's conclusion that there are fractional energy levels of hydrogen (which he calls 'hydrino') is erroneous. [25]

Close takes a similar approach, based on the classical wave equation. Before suggesting his wave equation, he arrives at a conclusion, that if we take the curl of the third of Maxwell equations and combine it with the time derivative of the fourth equation we obtain [26]:

$$\begin{aligned} \nabla^2 E - \frac{1}{c^2} \frac{\partial^2 E}{\partial t^2} &= 0 \\ \nabla^2 B - \frac{1}{c^2} \frac{\partial^2 B}{\partial t^2} &= 0 \end{aligned} \quad (17)$$

Each of these equations is a homogeneous wave equation. In vacuum, both E and B have zero divergence, so these equations have the same form as the conventional equation for shear waves.

Therefore, we find that there exists formal connection between classical wave equation and Maxwell's equations. Such a connection is known as *electrical-mechanical-acoustical analogy*.²

While Close does not give an exact solution of classical wave equation, he finds some interesting points. For example, he is able to find coupled wave equation from factorization of 1-dimensional scalar wave equation [26]. For clarity, we give his factorization procedure for 1-dimensional case of equation (1), which can be written as follows:

$$\partial_t^2 a = c^2 \partial_z^2 a. \quad (18)$$

This equation can be factored:

$$[\partial_t - c \partial_z][\partial_t + c \partial_z] a = 0 \quad (19)$$

The general solution is a superposition of forward and backward propagating waves:

²<http://www.isi.ee.ethz.ch/teaching/courses/ak2/elektro-mechanische-akustische-analogien-english.pdf> (accessed at March 25th, 2014)

$$a(z, t) = a_F(z - ct) + a_B(z + ct) \quad (20)$$

It can be shown that we can reduce the equations for forward and backward waves into a first-order matrix equation [26, p.83]:

$$\left[\partial + \begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix} c \partial_z \right] \Psi = \partial_t \begin{pmatrix} \dot{a}_F(z - ct) \\ \dot{a}_B(z + ct) \end{pmatrix} - c \partial_z \begin{pmatrix} a'_F(z - ct) \\ a'_B(z + ct) \end{pmatrix} = 0 \quad (21)$$

It is also worth noting that solution of wave function of Helmholtz equation has been obtained by Blackledge and Babajanov in [34]. For discussion on the theory of ordinary differential equations, see for example Coddington and Levinson [35].

4. Some possible applications of Shpenkov's wave model

a. Application in molecular vibration

A possible test of the Shpenkov's model of atom and molecule based on the classical wave equation is fundamental ground tone vibration of H₂, HD, and D₂. It may open new experiments on how the Shpenkov's wave model can be compared to QED prediction.[27] It is noted here that Shpenkov is also able to derive Lamb shift of hydrogen using his wave model. [28] There also exists plenty of information on water vibration.³

b. Application in cosmic microwave background radiation

Kreidik & Shpenkov [7] derive microwave background radiation of hydrogen atom based on Shpenkov's interpretation of classical wave equation. They conclude that the Microwave Background Radiation, observed in Cosmos, apparently is the zero-level (background) radiation of all atoms in the Universe. Following their dynamic model, the H-atom is a paired dynamic system with the central spherical microobject of a complicated structure (proton) and the orbiting electron. The electron in H-atom under the wave motion exchanges the energy with the proton constantly at the fundamental frequency ω_e . This exchange process between the electron and proton has the dynamically equilibrium character. It is represented by a system of radial standing waves, which define "zero level exchange" in a dynamically stable state of the atom. At $p=0$, they obtain $\lambda=0.106267$ cm, then they can find an estimate of the absolute temperature of zero level of radiation:

$$T = \frac{0.290 \text{ cm} \cdot K}{\lambda} = 2.7289 K \approx \Delta K \quad (22)$$

Where $\Delta=2\pi.lge=2.7288$ is the measure of the fundamental period (fundamental quantum measures). The temperature obtained coincides with the temperature of "relict" background measured by NASA's Cosmic Microwave Background Explorer (COBE) satellite to four significant digits ($2.725 \pm 0.002 K$).[7] The concept of zero level radiation of H-atoms questions

³ URL: <http://www1.lsbu.ac.uk/water/vibrat.html> (accessed at March 25th, 2014)

quantum mechanical probabilistic model, which excludes an electron's orbital motion *along a trajectory* as matter of principle.[7]

c. Application in cosmology

Neven Bilić studied sound wave propagation in a relativistic perfect fluid with a non-homogeneous isentropic flow. [29] The sound wave equation turns out to be equivalent to the equation of motion for a massless scalar field propagating in a curved space-time geometry. Among other things, he obtained that the free classical wave equation (1) is a simplest case of the generalized wave equation [29]:

$$\partial_{\mu} \left\{ \frac{n}{w} \sqrt{-g} \left[g^{\mu\nu} - \left(1 - \left(\frac{n}{w} \frac{\partial w}{\partial n} \right)^{-1} \right) u^{\mu} u^{\nu} \right] \right\} \partial_{\nu} \phi = 0 \quad (23)$$

The above wave equation (23) can be rewritten as [29]:

$$\partial_{\mu} f^{\mu\nu} \partial_{\nu} \phi = 0. \quad (24)$$

And then he used this form of the acoustic wave equation to construct the acoustic metric. It is known that acoustic metric may have application in astrophysics and early cosmology.

d. Application in graphene [12]

Graphene, one-atom-thick layers of graphite, having a two dimensional hexagonal lattice, gives us a new unique possibility for the direct verification of some predictions, originated from the solutions of classical wave equation (9). According to modern notions, a two dimensional hexagonal lattice of graphene is regarded as having crystallographic symmetry of a six order. Hence, electrical conductivity of graphene in a hexagonal plane perpendicular to this axis must be isotropic, in full agreement with the basic symmetry theory as having more than two-fold symmetry. This is why an examination of feasible conductivity anisotropy in pristine unstrained graphene has never been undertaken till now, and a question about such studies has never been raised among researchers. For this reason, a talk about an existence of natural conductivity anisotropy in graphene seemed nonsensical. However, according to the shell-nodal structure of the carbon atom originated from said solutions, graphene has two-fold axis of symmetry. Accordingly, it makes sense to undertake efforts (experiments) to verify that. The tests are not so complicated, but obtained result can change many things in physics.

Graphene anisotropy explains also the fact that graphene nanotubes, rolled-up form of graphene, have either conductivity, metallic or semiconducting. The rolling-up of graphene is realized mainly along two crystallographic directions: along the major axis (we called it the Z-axis) and in perpendicular to it direction. Nanotubes obtained have the minimal energy of state in these crystallographic directions. The rolling-up of graphene sheets runs spontaneously at the high temperature conditions; it is not yet controlled process. The rolling-up in other directions is thermodynamically unfavorable unstable process and, therefore, is not going on spontaneously.

e. Application in water as fuel (ultrasonic electrolysis of water) [30]

One possible application of the atomic vibration model outlined here is the *ultrasonic electrolysis* of water. When an electrical current passes through water, the hydrogen and oxygen become separated and escape as gasses. This process is referred to as electrolysis. You can

demonstrate a simple form of electrolysis by holding the connection end of a nine-volt battery in a glass of water. Tiny bubbles will begin to form on each electrode, oxygen on one and hydrogen on the other. Higher electrical current will cause the gas to form much more rapidly. These facts indicate that it may be possible to build a motor that runs on water. A battery would be used as a source of electrical energy which would separate the hydrogen/oxygen into gases. The gasses would then fuel an internal combustion engine, which would power a generator to continuously recharge the battery as well as deliver useable mechanical energy. If this sort of motor can be made to work, the energy crisis on this planet will be over forever.

Whether or not this device would produce more energy than that required separating the gasses, and thus produce useful work, depends upon the efficiency of the gas separation process. It has been demonstrated that in addition to electrical current passing through water, ultrasonic vibrations and radio waves are also capable of breaking the molecular bonds in water to release the hydrogen and oxygen.

The resonant frequency of water is $\sim 42.7\text{kHz}$. When water molecules vibrate at this frequency they tend to become unstable.

It should be noted that there have been reports of large explosions when water is physically disassociated using ultrasonic vibrations. The explosive force reported is substantially greater than can be accounted for by the chemical burning of the hydrogen (in one case this was 29,000 pounds of pressure from 3 drops of water). Experimenters constructing this ultrasonic electrolysis device should use appropriate caution.

f. Application in Condensed Matter Nuclear Science (CMNS)

Another possible use of resonance and vibration theory is to understand mechanism in CMNS. There are many theories which have been proposed in order to understand CMNS/Cold fusion, one of them is the Selective Resonant Tunneling Model proposed by Li et al. [31]. Selectivity of the resonant tunneling can be learnt from the electronic harmonic circuit. It is known that at the low energy, the Coulomb barrier is thick and high; hence, the incident deuteron wave in the nuclear well is very weak due to the Coulomb barrier. The amplitude of weak penetrating wave may be enhanced by the resonance effect when the phase of the reflected wave inside the nuclear well is same as that of the incident wave. This is the resonant tunneling. The damping in resonant tunneling of the Coulomb barrier is just the fusion reaction itself, because the deuteron wave function disappears due to fusion reaction. Thus, this fusion reaction rate cannot be very fast, otherwise the fast damping will stop the resonant effect.[31] It is worth mentioning here that this Li's model is able to provide explanation of HuiZenga's three miracles of cold fusion, therefore it may be useful to look at CMNS from this viewpoint.

6. Correspondence between classical wave equation and quantum mechanics

a. Ward & Volkmer's derivation of Schrödinger equation from wave equation

My viewpoint is that there is connection between classical and quantum mechanics, see also [17][19]. Therefore it seems possible to find theoretical correspondence between classical electromagnetic wave equation and Schrödinger equation. Such a correspondence has been discussed by David Ward & Sabine Volkmer [32]. They give a simple derivation of the Schrödinger equation, which requires only knowledge of the electromagnetic wave equation and the basics of Einstein's special theory of relativity.

They begin with electromagnetic wave equation (16) in one dimensional case:

$$\frac{\partial^2 E}{\partial x^2} - \frac{1}{c^2} \frac{\partial^2 E}{\partial t^2} = 0. \quad (25)$$

This equation is satisfied by plane wave solution:

$$E(x, t) = E_0 e^{i(kx - \omega t)}, \quad (26)$$

Where $k = \frac{2\pi}{\lambda}$ and $\omega = 2\pi\nu$ are the spatial and temporal frequencies, respectively. Substituting equation (26) into (25), then we obtain:

$$\left(\frac{\partial^2}{\partial x^2} - \frac{1}{c^2} \frac{\partial^2}{\partial t^2} \right) E_0 e^{i(kx - \omega t)} = 0 \quad (27)$$

Or

$$\left(k^2 - \frac{\omega^2}{c^2} \right) E_0 e^{i(kx - \omega t)} = 0 \quad (28)$$

Solving the wave vector, we arrive at dispersion relation for light in free space: $k = \frac{\omega}{c}$. Note that this is similar to wave number k in equation (9).

Then, recall from Einstein and Compton that the energy of a photon is $\mathcal{E} = h\nu = \hbar\omega$ and the momentum of a photon is $p = \frac{h}{\lambda} = \hbar k$. We can rewrite equation (26) using these relations:

$$E(x, t) = E_0 e^{\frac{i}{\hbar}(px - \mathcal{E}t)}, \quad (29)$$

Substituting this equation into (25) we find:

$$-\frac{1}{\hbar^2} \left(p^2 - \frac{\mathcal{E}^2}{c^2} \right) E_0 e^{\frac{i}{\hbar}(px - \mathcal{E}t)} = 0 \quad (30)$$

Then we get an expression of relativistic total energy for a particle with zero rest mass:

$$\mathcal{E}^2 = p^2 c^2. \quad (31)$$

We now assume with de Broglie that frequency and energy, and wavelength and momentum, are related in the same way for classical particles as for photons, and consider a wave equation for non-zero rest mass particles. So we want to end up with:

$$\varepsilon^2 = p^2 c^2 + m^2 c^4. \quad (32)$$

Inserting this equation (32) into equation (30), it is straightforward from (27), that we get:

$$\left(\nabla^2 - \frac{m^2 c^2}{\hbar^2} \right) \Psi = \frac{1}{c^2} \frac{\partial^2 \Psi}{\partial t^2} \quad (33)$$

which is the Klein-Gordon equation for a free particle [32]. Now we want to obtain Schrödinger equation, which is non-relativistic case of (33). The first step is to approximate $\varepsilon^2 = p^2 c^2 + m^2 c^4$, as follows:

$$\varepsilon = mc^2 \sqrt{1 + \frac{p^2}{m^2 c^2}} \approx mc^2 + \frac{p^2}{2m} \approx mc^2 + T. \quad (34)$$

After some approximation steps, then Ward & Volkmer obtained the Schrödinger equation starting from (34) and (33):

$$-\frac{\hbar^2}{2m} \nabla^2 \phi = i\hbar \frac{\partial \phi}{\partial t}, \quad (35)$$

Where the non-relativistic wave function Φ is also constrained to the condition that it be normalizable to unit probability.

While we can conclude that there exists formal connection between classical wave equation and Schrödinger equation, but it still requires some assumptions and approximations. Therefore we can consider that Shpenkov's interpretation of classical wave equation (9) is more realistic for atomic and molecular modeling.

b. Sound wave analogy with quantum mechanics

Hilbert and Batelaan [33] explores equivalence between the quantum system and the acoustic system. They find that the analytic solution to the quantum system exhibits level splitting as does the acoustic system. A simple physical system is discussed that mirrors the quantum mechanical infinite square well with a central delta well potential. They compare the acoustic resonances in a closed tube and the quantum mechanical eigenfrequencies of an infinite square well. They find that the acoustic displacement standing wave is:

$$\xi(x) = \xi_{\max} \sin\left(\frac{n\pi x}{2a}\right), \quad (36)$$

For the n th resonance. Equation (36) is the same shape as the quantum mechanical wave function. Their approach to find analogy between sound wave and quantum mechanics may be useful to be investigated further.

7. Concluding remarks

We have discussed some weaknesses of Schrödinger equation for description of atom and molecules. Then we discuss Shpenkov's wave model of atom and molecules based on classical wave equation. It is shown that his model is able to arrive at a periodic table of elements which is close to Mendeleev's periodic law. Some possible applications of this interpretation of classical wave equation are also discussed, and future research in energy applications may be found fruitful.

While we emphasize that a wave equation should be able to model atom and molecule in realistic way, our view is that there can be possible correspondence between classical mechanics and quantum mechanics. Further investigations in this direction are recommended, in particular using Shpenkov's interpretation of classical wave equation.

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