

Research Article

Quantum Sound Waves Theory: Application to the Treatment of Quantum Wave's Information by the Brain during a Teaching-Learning Sequence in a Class Room

Ibrahima Sakho

Department of Physics Chemistry, UFR Sciences and Technologies, Iba Der Thiam University, Thies, Senegal
Email: ibrahima.sakho@univ-thies.sn

Received: December 05, 2024

Accepted: December 26, 2024

Published: January 03, 2025

Abstract

A new approach of sound waves named quantum sound waves theory (QSWT) is presented in this paper. Similar to photons, the quantum particles of light, we consider that sound waves are a flux of quantum particles referred to as sonons. Each sonon transport quantum energy equals to $h_s \nu$ with ν the frequency of the sound wave and h_s the quantum sonon constant estimated at $5.842\,487\,81 \times 10^{-28}$ J.s. compared with the Planck's constant $h = 6.63 \times 10^{-34}$ J.s. In the framework of the QSWT, we describe the brain as a quantized biological matter characterized by cervellonic levels. Transitions between these levels by cervellons (cervellonic particles) make it possible to understand the treatment of information by the brain during a teaching-learning sequence in a class room.

Keywords: Quantum Sound Waves Theory (QSWT), Sound Waves, Sonons, Quantum Sonon Constant, Cervellonic Levels, Cervellons, Information, Brain, Teaching-Learning Sequence.

1. Introduction

Phonons are well known to be the quantum particles of sound waves in solids and were the subject of many works [1-6]. For waves sound in air and water, sound can be described as a flux of quantum particles like photons for light. Besides, for two decades, the formalism of quantum mechanics has been successfully used to describe human decision processes after the identification of the presence of quantum structures in human cognition [7-18]. In addition, some studies attempt to demonstrate that consciousness and quantum theory are closely linked [19]. In a recent past, an international team has just confirmed, with brain imaging support, that our thinking follows quantum laws. This study says not that the brain and its billions of neurons are a quantum physical system, but that our thinking, the way we process information, the way we learn and about which choices we make follows quantum logic [20].

In this work, we treat waves sound as a flux of quantum particles like photons for light. These particles referred to as sonons interact with atoms and molecules contained in material (such as air, water, brain, etc.) where waves sound can propagate. In this paper, we assume that the biological matter of the brain is quantized and characterized by cervellonic levels. The treatment of information by the brain is then due to the transitions of cervellons (cervellonic particles) between the preceding levels. This approach makes it possible to understand the treatment of information by the brain during a teaching-learning sequence in a class room. Section 2 presents the theoretical part of the work. We conclude in section 3.

2. Theory

2.1. Definition of Sound

Sound is a physical phenomenon characterized by sound vibrations. The propagation of these vibrations in air or in water generates sounds. Sound is measured in decibels and is characterized by two parameters: its height and its intensity. Pitch (bass, treble) is associated with frequency and is measured in hertz (Hz); the lower a sound, the lower its frequency, the higher it is, the higher its frequency. Frequency is the number of oscillations or the number of periods T per second of a periodic vibratory phenomenon ($\nu = 1/T$). The intensity (strong, weak) is measured in decibel (dB). The decibel noted X_{dB} is a unit defined as ten times the decimal logarithm of the ratio between two powers, that means for P_1 and P_2 ($P_1 \geq P_2$) powers, we obtain X_{dB}

$= 10 \log_{10} (P_1/P_2)$. The average human ear perceives sounds in a certain frequency range, from approximately 20 Hz to 20,000 Hz. Low frequencies range from 20 Hz to 200 Hz, mid or medium frequencies from 201 Hz to 2,000 Hz, and high frequencies range from 2,001 Hz to 20,000 Hz. For a given sound, there are several frequencies including the fundamental frequency f_0 and higher frequencies, called harmonics $2f_0$, $3f_0$, etc. Ultrasound is sound vibration at frequencies above 20,000 Hz. These sound waves cannot be detected by the human ear. However, they are audible to certain animals, such as bats, dolphins and whales [21]. Sound can be pure or complex. Pure sound is made up of only one frequency (the equivalent of a whistle, for example). Complex sounds are natural sounds composed of several sounds that can be separated during spectral analysis. As for noise, it is a set of sounds without harmony. It results from a complex mixture of sounds of different intensities and frequencies. The WHO, for its part, defines noise as an acoustic phenomenon producing an unpleasant or annoying hearing sensation [22].

2.2. Existence of Waves Sound Particles

Sound waves are vibrations that propagate in air or water and are then picked up by our ears and transmitted to the brain which decodes them. To put into evidence the characteristics of waves sound as a collection of zero rest mass particles (the sonon rest mass may be greater than the photon rest mass admitted to be equal to zero) we call sonons, let us take a concrete example for illustration.

Speech sounds are phonemes. The phoneme is the minimal unit of speech. We cannot divide it, we can only combine it and we recognize this by the fact that, if we change it, the word changes its meaning. "I'm taking a path" takes on, in fact, another meaning if we replace the phoneme /p/ with the phoneme /b/: "I'm taking a bath"». Each phoneme is made up of a spectrum of frequencies, and consonants are made up mainly of high frequencies. In the French alphabet, there are 26 letters including 6 vowels (a, e, i, o, u, y) and 20 consonants (b, c, d, f, g, h, j, k, l, m, n, p, q, r, s, t, v, w, x, z). For illustration, let then consider the sentence

Professor Sakho has got his PhD in atomic and nuclear physics in 2013 at the University Cheikh Anta Diop of Dakar in Senegal. (1)

This sentence is composed of 23 words associated with a lot of number of phonemes. We can first transcribe this sentence in the view point of mathematics. For this, let us put m_i representing a word. So mathematically, sentence (S) can be described as a linear combination of words. So, we can write (1) in the form

$$S = \sum_{i=1}^{23} m_i = m_1 + m_2 + m_3 + \dots + m_{23} \quad (2)$$

With

$m_1 = \text{Professor}$, $m_2 = \text{Sakho}$, $m_3 = \text{has}$,..... $m_{23} = \text{Senegal}$.

Substituting m_i by its meanings, Eq. (2) is written in the shape

$S = \text{Professor} + \text{Sakho} + \text{has} + \text{got} + \text{its} + \text{PhD} + \text{in} + \text{atomic} + \text{and} + \text{nuclear} + \text{physics} + \text{in} + \text{2013} + \text{at} + \text{the} + \text{University} + \text{Cheikh} + \text{Anta} + \text{Diop} + \text{of} + \text{Dakar} + \text{in} + \text{Senegal}$ (3)

In the view point of linguistics (the science of language), the sign "+" in sentence (3) is not pronounced and one hears just the meaning of sentence (1). In the view point of the present quantum wave sound theory (QWST), we associate to each word a wave sound frequency. In addition each word is considered to be a collection of sonons, each sonon carrying the energy $h_s \nu$. The total energy carried by the sentence is then

$$h_s \nu = \sum_{i=1}^{23} h_s \nu_i = h_s \nu_1 + h_s \nu_2 + h_s \nu_3 + \dots + h_s \nu_{23} \quad (4)$$

Eq. (4) is a complex sum of sub-frequencies, each sub-frequency being associated to a phoneme. For example, ν_2 is associated to the word Sakho (here a name is considered as a word) contained five sub-frequencies associated to the phoneme S, a, k, h and o. These sub-frequencies cannot be dissociated as they form a whole frequency ν_2 .

Let us know moving on determining the value of the quantum sonon constant h_s (the subscript "s" is put for sonon). For this purpose, we postulate that, in air or water, sonon propagating with the velocity c_s of sound and photon propagating with the velocity c of light can carry the same energy for the same distance λ . This means

$$\frac{h_s c_s}{\lambda} = \frac{hc}{\lambda} \quad (5)$$

So we get

$$h_s = \frac{c}{c_s} h \quad (6)$$

Using $h = 6.626\,070\,15 \times 10^{-34}$ J·s; $c = 299\,792\,458$ m·s⁻¹; $c_s = 340$ m·s⁻¹, we obtain numerically

$$h_s = 299792458/340 \times 6.62607015 \times 10^{-34} = 5.84248781 \times 10^{-28}$$

So

$$h_s = 5.842\,487\,81 \times 10^{-28} \text{ J·s.} \quad (7)$$

Eq. (5) makes it possible to convert sound waves energy to electromagnetic waves energy and vice versa. Besides, artificial intelligence (AI) can be used to treat communication between people as an exchange (emission by the mouth, reception by the ears, and treatment by the brain) of information incorporated in sonons propagating in air or water with the velocity c_s , each sonon carrying the energy $h_s \nu$. Robots can be used for a test.

2.3. Estimation of the Frequency and the Quantum Sound Energy of a Word or a Sentence

We know that the average human ear perceives sounds for frequencies ranging between 20 Hz to 20,000 Hz. In addition, a frequency standard is a stable oscillator used for frequency calibration or reference. Let us then take as a reference the current reference frequency for tuning musical instruments equals to 440 Hz corresponds to the musical note A4 (LA3) in the central octave of the piano [23]. We associate for each sound the frequency 440 Hz. A word can contain several sounds. Let us apply this assertion to sentence (1) truncated as follows.

Professor Sakho has got his PhD in atomic and nuclear physics (8)

The word "Professor" contains three sounds associated to the sounds "Pro"- "fes- "sor". So the frequency associated to "Professor" is $3 \times 440 = 1\,320$ Hz. PhD is also associated to the frequency 1320 Hz as it consists of three sounds: "P"- "h"- and "d" as one hears "Pi" "ethch" "dee". But the word "got" is associated to only one frequency that means 440 Hz. Table 1 lists the frequencies associated to the words of sentence (8).

Table 1. Frequencies (ν) associated to the words of the sentence "Professor Sakho has got his PhD in atomic and nuclear physics".

Word	Professor	Sakho	got	his	PhD	in	atomic	and	nuclear	physics
ν (Hz)	1 320	880	440	440	1 320	440	1 320	440	1 320	1 320

Using Eq. (7), we can estimate the quantum sound energy (in eV) associated to each word in sentence (8). The results obtained are quoted in Table 2 below.

Table 2. Quantum sound energy ($h_s \nu$, eV) associated to each word in sentence (8). For energy conversion we use: $1 \text{ eV} = 1.6 \times 10^{-19} \text{ J}$; $h_s \approx 5.84 \times 10^{-28} \text{ J·s}$.

Word	Professor	Sakho	got	his	PhD
$h_s \nu (\times 10^{-9} \text{ eV})$	4 818	3 212	1 606	1 606	4 818
Word	in	atomic	and	nuclear	physics
$h_s \nu (\times 10^{-9} \text{ eV})$	1 606	4 818	1 606	4 818	4 818

Artificial intelligence can be used to simulate the data quoted in tables 1 and 2. For instance, a robot can be used to pronounce sentence (8) by only irradiating its quantized artificial brain (in the framework of cervellonic levels) by a quantum sound radiation of energy equals to $5 \times 4\,818 + 3\,212 + 4 \times 1\,606 = 33\,726$ neV with $1\text{ neV} = 10^{-9}\text{ eV}$. It should be mentioned that, no misunderstanding is possible regarding the words associated with the same frequency. For example, the same frequency 4 818 is associated with the words Professor, PhD, atomic, nuclear and physics. But, professor is the first word of sentence (8) and nuclear is the tenth word of this sentence. So, each word will be also associated with its position in the considered sentence. The robot will then associate each frequency to its word along with its position knowing that there are no two words or more associated with the same position in a sentence.

2.4. Treatment of Quantum Wave's Information by the Brain during a Teaching-Learning Sequence in a Class Room

In our recent work [24] we considered that the brain is quantified and thus postulates the existence of biological particles named cervellons. The human brain is thus made up of cervellonic levels. The cervellons are responsible for the exchange of information between the brain (of a learner, for example) and the external environment (teacher, parent of a student, classmates, etc.). Furthermore, by analogy with the processes of generating laser radiation, it would be possible to show that the human brain (made up, among other things, of atoms) is "quantified" and to analyze the processing of information by the brain as processes of "cervellonic" transitions between quantized brain levels. Cervellons are responsible for ensuring the transmission of information throughout the brain. From this perspective, we consider that the cerebral levels of processing and restitution of information are of three types:

- ✓ A ground level of reception of an information (example question asked by a teacher to a learner);
- ✓ An excited level of an information being processing (learner's level of thinking);
- ✓ An intermediate level of restitution of the processed information (answer to the asked question).

A relaxation process (elimination of all wrong answers) would occur between the cerebral level of information processing and the cerebral level of emission of the processed information. This implicitly opens up avenues of research with a view to concrete applications of quantum physics in education. Let us consider the particular case of the interaction between a teacher asking a question to a student. The question asked consists of a radiation of information emitted from the mouth (transmitter) of the teacher. This informational radiation propagates in the form of sound waves and arrives at the ear (receiver) of the student. Subsequently, the acoustic vibrations of the eardrum cause the birth of an informational nerve flow which excites the brain at the fundamental level of reception of information. The cervellons pass to the higher level of information processing. Then, after treatment, nonradioactive cervellonic transitions occur (elimination by the brain of any information not compatible with the right answer) towards the intermediate level of information restitution. Subsequently, radiative transitions (restitution of the processed information) take place towards the ground level of reception of information. Figure 1 schematically illustrates the envisaged information radiation-brain interaction process. Note that informational radiation is made up of packets of information.

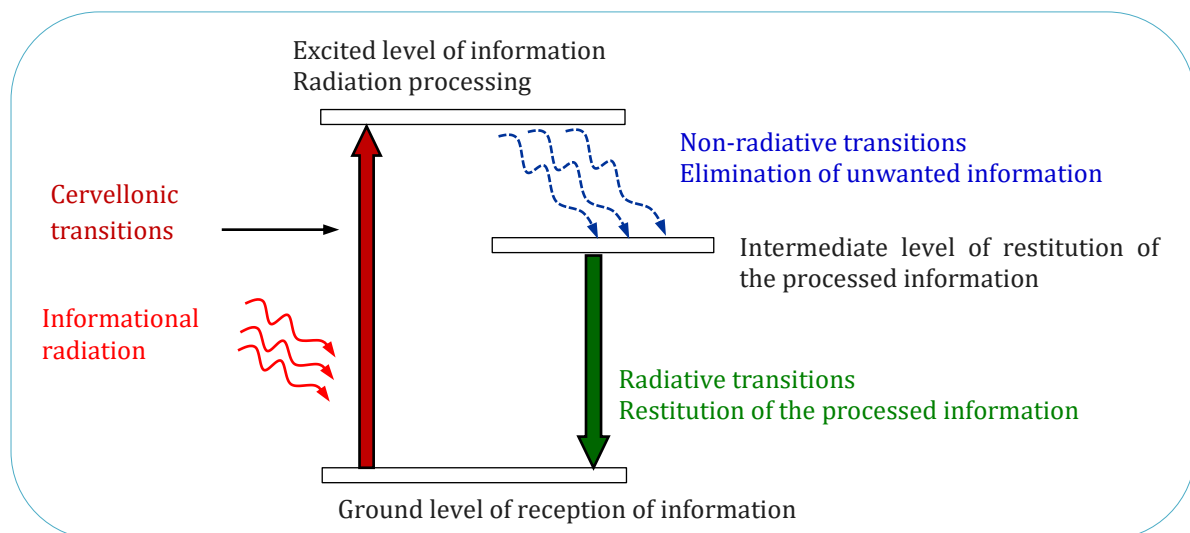


Figure 1. Illustration of informational radiation-brain interaction process. We distinguish the three quantized levels allowing thought to propagate in the brain. Note that the levels considered are contained in intelligence bands made up of a very large number of discrete levels.

Let us give a concrete example of informational radiation-brain interaction in the case of a teaching-learning sequence in a classroom.

- ✓ Informational radiation (question): four times two equals how much? Or $4 \times 2 = ?$;
- ✓ Absorption of informational radiation (ground level): cervellonic transitions;
- ✓ Processing the content of informational radiation: thinking step;
- ✓ Non-radiative transitions: elimination of results like four plus two, four minus two, etc.;
- ✓ Radiative transitions: answer to the question asked: four times two equals eight (it can also be wrong for a student who has not mastered the multiplication table by 4).

Figure 2 illustrates the informational radiation-brain interaction process (question answer) envisaged (the interaction is described in mathematical language). Intermediate level of restitution of the processed information (result after thinking).

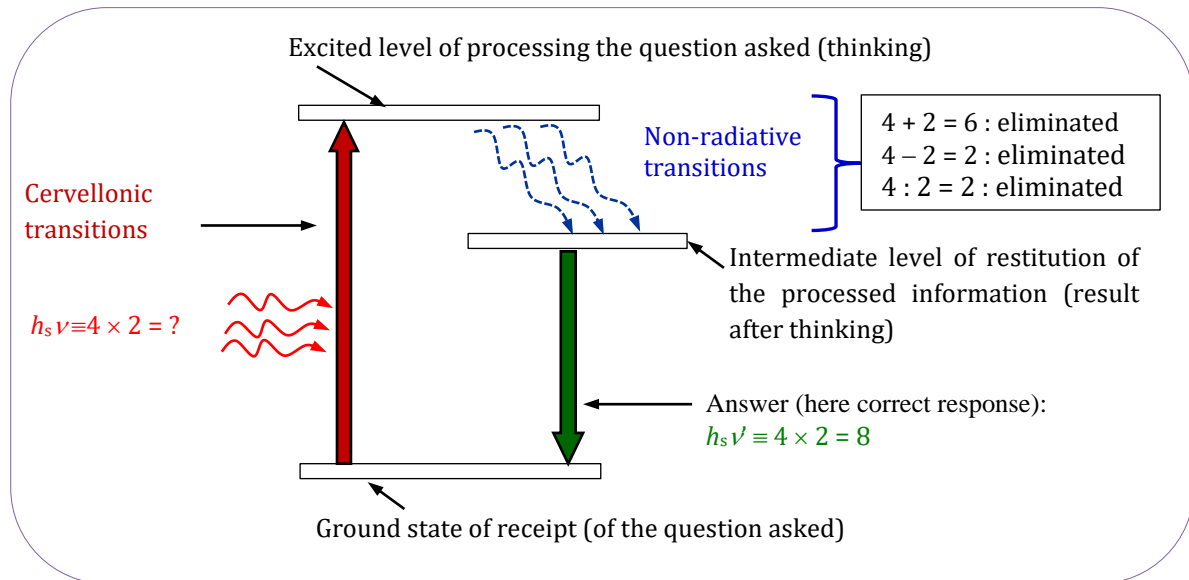


Figure 2. Illustration of the information radiation-brain interaction process (question asked by the teacher and answer provided by the student).

3. Conclusion

In this paper, we have presented a new QSWT of waves sound considered as a flux of sonons, each sonon carrying the energy $h_s \nu$, with $h_s = 5.842\,487\,81 \times 10^{-28}$ J.s. the quantum sonon constant equivalent to the Planck's constant for photons. Application of our QSWT in the particular case of the treatment of information by the brain during a teaching-learning sequence in a classroom open implicitly avenues of research with a view to concrete applications of quantum physics in education. As stated by Koch and Hepp [26], the relation between quantum mechanics and higher brain functions, including consciousness, is often discussed, but is far from being understood. Physicists, ignorant of modern neurobiology, are tempted to assume a formal or even dualistic view of the mind-brain problem. Meanwhile, cognitive neuroscientists and neurobiologists consider the quantum world to be irrelevant to their concerns and therefore do not attempt to understand its concepts. What can we confidently state about the current relationship between these two fields of scientific inquiry? In addition, there has been speculation for decades about the role of quantum mechanics in the relationship between mind and matter. Far from the nonsense on the subject of the New Age or so-called quantum therapies, researchers are beginning to propose experiments which would, perhaps, one day soon allow us to prove that part of our brain functions like a quantum computer. This is the case of renowned American physicist Matthew Fisher, who has just received funding of more than a million euros for this [25]. This may indicate that the present work can play in great role for applying quantum mechanics in the purpose to understand human being behaviour.

Declarations

Acknowledgments: The author is thankful to the UFR Sciences and Technologies of Iba Der Thiam University for financial support.

Author Contribution: Definition of intellectual content, literature survey, prepared first draft of manuscript, implementation of study protocol, data collection, data analysis, manuscript preparation, and manuscript revision.

Conflict of Interest: The author declares no conflict of interest.

Consent to Publish: The author agrees to publish the paper in International Journal of Recent Innovations in Academic Research.

Data Availability Statement: Data are contained within the article.

Funding: This research received funding from the UFR Sciences and Technologies of Iba Der Thiam University.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Research Content: The research content of manuscript is original and has not been published elsewhere.

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Citation: Ibrahima Sakho. 2025. Quantum Sound Waves Theory: Application to the Treatment of Quantum Wave's Information by the Brain during a Teaching-Learning Sequence in a Class Room. *International Journal of Recent Innovations in Academic Research*, 9(1): 1-7.

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