Coherent Waves in water:

a De Broglie-Bohm formulation

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Abstract

In this essay, I propose to use the De Broglie-Bohm pilot wave theory to formulate a very simple model to represent the emission of electromagnetic waves by biological matter in high aqueous dilution, triggered by an ambient background of very low frequency.

Introduction

It has been observed [1] that low frequency electromagnetic waves (500 to 3000 Hz) can be induced by biological matter in high aqueous dilution, triggered by an extremely low frequency EM field (typically in the range of the Schumann modes of the geomagnetic field: 8 to 34 Hz [2]). This phenomenon has been explained by the fact that Coherent Domains are generated, in which water molecules happen to oscillate in phase, thus generating a trapped stationary EM wave [3,4].

In this essay, I propose to formulate this phenomenon using the De Broglie-Bohm Quantum (DBQ) theory [5,6] in the framework of a very simple model. As is well known, DBQ theory assumes a non local pilot wave, supposed to guide deterministic particle dynamics.

Beyond the general benefits of DBQ theory (quantum deterministic theory, non locality), the advantage to use it for this phenomenon could be its relative simplicity.

Modelisation

Let-us consider N coherent oscillators of equal mass m, regularly positioned on a straight line, thus restricting our attention to a 1D model. The oscillators common frequency ω is supposed to be generated by a trigger field of this same frequency.

Furthermore, an external probe particle is supposed to be on the same line at position x_{N+1}.

The pilot wave is therefore N+1 dimensional in space. Let-us look for such a possible expression for it:

$$\psi(x_n, x_{N+1}, t) = e^{i(-\Omega t + k x_{N+1})} e^{i\frac{S(x_n,t)}{\hbar}} \qquad \text{n=1,... N} \qquad (1)$$

Clearly the probe particle is thus associated with a plane wave of frequency Ω.

The oscillators positions at time t are given by:

$$x_n = n x_0 + \xi_0 e^{i(\omega t + \varphi_n)} \qquad \text{n=1,... N} \qquad (2)$$

And, according to DBQ theory, there velocities are given by:

$$v_n = i\omega(x_n - nx_0) = \frac{1}{m}\frac{\partial S}{\partial x_n} \quad (3)$$

(they are supposed to have the same mass m).

The same process applied to the probe particle allows to deduce its velocity:

$$v_{N+1} = \frac{\hbar k}{m} \quad (4)$$

Pilot-wave resolution

Now, the pilot wave must satisfy the Schrödinger equation:

$$i\hbar\frac{\partial\psi}{\partial t} = -\frac{\hbar^2}{2m}\sum_n \nabla_n^2\psi + V\psi \quad (5)$$

For each oscillator, the potential is:

$$V_n = \frac{m\omega^2}{2}(x_n - nx_0)^2 \quad (6)$$

And the external probe particle is supposed to be free, since the radiated EM field due to the oscillators does not generate a potential on their line.

From (3), $S(x_n, t)$ has the form:

$$S(x_n, t) = \sum_n im\omega\left(\frac{{x_n}^2}{2} - nx_0x_n\right) + \mathrm{f(t)} \quad (7)$$

Then, Schrodinger eq. (5) leads to:

$$i\hbar\left(-i\Omega + \frac{i}{\hbar}\frac{\partial S}{\partial t}\right) = -\frac{\hbar^2}{2m}\left\{\frac{i}{\hbar}\sum_n\left(\frac{\partial^2 S}{\partial {x_n}^2} + \frac{i}{\hbar}\left(\frac{\partial S}{\partial x_n}\right)^2\right) - k^2\right\} + \sum_n\frac{m\omega^2}{2}(x_n - nx_0)^2 \quad (8)$$

(the oscillators are supposed to be sufficiently far away from each other, so as not to interfere thru crossed potentials).

From (7) and (8), the time evolution f(t) must satisfy:

$$\hbar\Omega - f'(t) = \frac{k^2\hbar^2}{2m} - \frac{i\hbar}{2m}\sum_n\left[im\omega - \frac{im^2\omega^2}{\hbar}(x_n - nx_0)^2\right] + \sum_n\frac{m\omega^2}{2}(x_n - nx_0)^2 \quad (9)$$

which reduces to the following time evolution:

$$f'(t) = \hbar\Omega - \frac{k^2\hbar^2}{2m} - \frac{\hbar}{2}N\omega \quad (10)$$

Knowing that, in the real experience, the CD formation tends to track the global EM field, we look for a stationary solution $f'(t) = 0$, which means that:

$$\hbar\Omega = \frac{k^2\hbar^2}{2m} + \frac{N}{2}\hbar\omega \quad (11)$$

Or, introducing the probe particle velocity (4):

$$\hbar\Omega = \frac{m{v_{N+1}}^2}{2} + \frac{N}{2}\hbar\omega \quad (12)$$

And, from (7) and (12), the final solution for the pilot wave is:

$$\psi(x_n, x_{N+1}, t) = e^{i\left[-\left(\frac{m{v_{N+1}}^2}{2\hbar} + \frac{N}{2}\omega\right)t + kx_{N+1}\right]}e^{-\sum_n\frac{m\omega}{2\hbar}({x_n}^2 - 2nx_0x_n)} \quad (13)$$

Since

$$x_n^2 - 2nx_0x_n = (x_n - nx_0)^2 - n^2x_0^2 \quad (14)$$

the last term in (13) represents the gaussian spatial positioning of the pilot wave above each oscillator. Furthermore, according to (12) and (13), the frequency of the wave (corresponding to our probe particle in terms of DBQ) has been increased by the sum of half oscillator frequencies. The presence of the oscillators has generated this up-graded frequency or, equivalently, the initial wave energy has been increased, due to the coherent oscillators.

Conclusion

We have thus shown that the pilot wave does encode the initially envisioned “triggered frequency enhancement”, as if the coherent oscillators should cooperate to increase the global initial energy.

Of course, our analysis remains purely formal, since the pilot wave is not directly representative of the EM field itself. The pilot wave remains a theoretical tool, defined in the theoretical “phase space”. However, it just describes what happens in space-time where matter stands, and this remark can be considered to enhance its potential “reality”.

To better approach the EM field, a more sophisticated study should be developed using quantum field theory [7]. Nevertheless, our simple essay gives encouragement to further proceed with this DBQ approach, in order to get more direct, simple and global expression of this kind of phenomenon.

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References

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