Why does the Impossible Thrust work

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Abstract: Scientific literature refers to a strange observed phenomenon, "impossible" according to traditional physics. The authors have called it an Impulsive Thrust from a Closed Radio-Frequency Cavity in Vacuum. Here we present a possible explanation for the observed thrust based on the conceptual framework of Eurhythmic Physics, a macroscopic non-linear pilot-wave theory.

Keywords: Impossible thrust, nonlinear pilot-wave theory, Eurhythmic Physics, de Broglie waves, pilot waves, Guiding Principle, Principle of Eurhythmy.

1. Introduction

In a rather surprising paper, White *et al.* [1] have reported the occurrence of a mechanical thrust apparently caused by a magnetic resonant field in a cavity and, as the authors put it, «lacking a propellant or other medium with which to exchange momentum». The group engaged in a set of experiences using a copper frustum shaped cavity as a test particle attached to a torsion pendulum with μN resolution, and placed within a vacuum chamber (8×10^{-6} torr). As an RF emitting circuit induced TM212 resonant modes inside the frustum's cavity, its movement was optically registered. Results suggest that for power scans at 40, 60 and 80 W, around 1.937 Ghz, the system consistently performed with a thrust-to-power ratio of $1.2 \pm 0.1 \mathrm{mN/kW}$ under vacuum conditions with the force directed to the narrow end of the frustum.

Several error sources presumably explaining the effect were considered and dismissed (e.g. RF interaction with the surrounding medium, thermal expansion and mechanical vibrations coming from the environment). A macroscopic pilot-wave type theory was then slightly suggested as a possible mean to explain these results. The authors defined a pilot wave theory as a «realist interpretation of quantum mechanics, conjecturing that the statistical nature of the formalism of quantum mechanics is due to an ignorance of an underlying more fundamental real dynamics, and that microscopic particles follow real trajectories over time just like larger classical bodies do» [1].

Before such a bold suggestion, no concrete model was provided and only an indication of a strong resurgence in the last decade favoring these ideas was given. Namely the experimental work pioneered by Couder and Fort [2] with macroscopic bouncing droplets on an oil medium, creating a wave pattern that guides the droplet.

Later identified as a case of a Faraday pilot-wave dynamics studied by Milewski *et al.* [3] and chronicled under the hydrodynamic quantum analogs researched by Bush [4].

As it happens a much more earlier effort to build a general wave interaction theory as the one suggested, has been developed from a nonlinear causal approach to quantum physics [5].

Coming directly from the initial and then late contributions of de Broglie [6], first Andrade e Silva [7] (who was de Broglie's collaborator) and then, J.R. Croca [5] tried to put forward a pilot wave theory offering a realist causal framework for quantum phenomena. By 1927 de Broglie himself was aiming at a quantum theory in which Newton first principle was to be replaced by the *Guidage Principle* or Guiding Principle [8]. Improving upon such ideas, Croca suggested the so-called principle of Eurhythmy [9]. As it stands, the word εὐρυθμία (*euruthmía*) comes from the junction of the two greek words εὖ (*eû*, "well") and ῥυθμός (*rhuthmós*, "symmetry") meaning *rhythmical order* and, in the sense here taken, also *the best path*.

This has a twofold meaning: on one hand, all behaviors are to be understood as the result of rhythmic or undulatory phenomena and, on the other, these undulatory phenomena allow systems to pursuit primarily those behaviors that reinforce their structural stability, thus extending their persistence.

Eurhythmic Physics [9] is thus a general nonlinear pilot wave theory that includes both quantum mechanics and macroscopic physics, that attempts to describe interactions using undulatory dynamics.

Following such a strategy, in what follows we shall present a possible explanation for the results observed by White *et all* [1] paving the way for further improvement on the device.

2. Eurhythmic Physics

Eurhythmic physics is a natural extension of nonlinear quantum physics, which in the linear approach contains, at the predictive level, quantum mechanics.

In eurhythmic physics, quantum waves or more precisely subquantum waves, also named de Broglie waves, pilot waves, theta waves or even vacuum waves, vacuum states, are real physical waves and not mere probability waves as claimed by orthodox quantum mechanics. On the other hand, particles, as discovered by de Broglie [6], are very complex physical entities, composed of a wave, a pilot wave, the θ (theta) wave, practically devoid of energy [10], plus a relatively high energetic part, the corpuscle, corresponding to the kernel of the complex particle ξ, named the acron.

All classical fields like EM fields or even gravitational fields are understood as non-fundamental operative fields corresponding to real theta wave fields existing underneath in the subquantum medium [9]. These theta waves are piloting particles in a nonlinear very complex way and so it may happen that in certain EM regimes certain unexpected effects may arise from those very same theta waves, corresponding to what traditional physics thought to be only EM waves, as in the case for the observed impulsive thrust.

Consequently, since we are in the nonlinear realm it may happen that, in general, action does not equal reaction. This means that in certain specific conditions a minor action may give rise to a huge reaction. This situation is precisely described by de Broglie guiding principle or by its generalization, the principle of eurhythmy. This principle says that the corpuscles, the acra, move preferentially, according to a stochastic nonlinear process, to the regions where the intensity of the field originated by the pilot wave, the theta wave, is more intense,

$$p \propto I = |\theta|^2. \tag{2.1}$$

This expression, adequate for a free wave, or homogeneous field tells us that the probability of finding a corpuscle is proportional to the intensity of the theta wave field in which is immersed. If the wave is confined in a cavity it is the amount of energy per unit volume, energy density, the field intensity, the quantity that matters.

In such conditions, if the field is symmetric, the probability of going in each direction is same so that the average motion of the particle, that is, its mean velocity is zero. In order to have and average velocity different from zero, the particle, the acron, must be immersed in an asymmetric intensity field. The average velocity of a corpuscle in an asymmetric theta wave intensity field may be derived from eurhythmic physics.

Indeed, the organizing principle of eurhythmy allows us to mathematize the complex inter-relational physics between wave and corpuscle to describe and predict the average motion of the acron in an extended theta wave field.

To describe the motion of the corpuscle in the theta wave field we consider the field divided in cells C_i of equal size ℓ_0, and that in each transition the corpuscle has a propensity to remain in the same cell or to move forwards or backwards, as indicated in the next sketch with the respective transition probabilities.

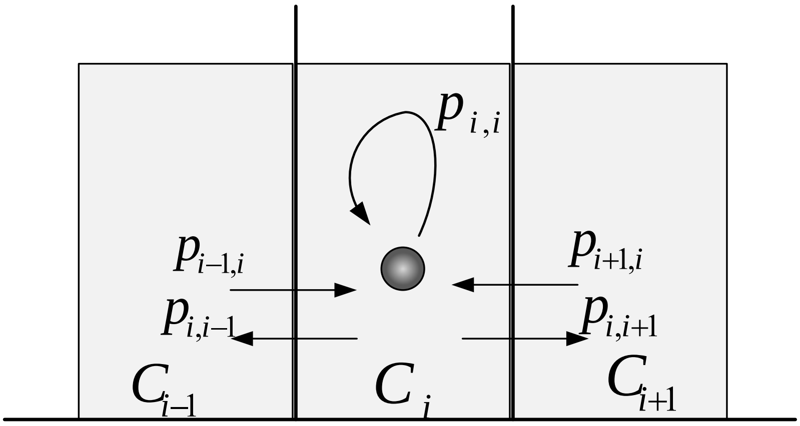

Fig. 2.1 – Corpuscle stochastic motion

In which

$$q_i = p_{i,i-1}; \quad \delta_i = p_{i,i}, \quad p_i = p_{i,i+1} \ , \tag{2.2}$$

And where $q_i = p_{i,i-1}$ represents the probability for the corpuscle to move from cell C_i, to cell C_{i-1}, and successively. The probability conservation equation allows us to write

$$q_i + \delta_i + p_i = 1. \tag{2.3}$$

The form of the transition probabilities being given by

$$\begin{cases} q_i = p_{i,i-1} = \frac{I_{i-1}}{I_{i-1}+I_i+I_{i+1}} \\ \delta_i = p_{i,i} \quad = \frac{I_i}{I_{i-1}+I_i+I_{i+1}} \\ p_i = p_{i,i+1} = \frac{I_{i+1}}{I_{i-1}+I_i+I_{i+1}} \end{cases} \tag{2.4}$$

Here I_i is the average field intensity in the generic cell C_i of size ℓ_0.

Now, the stochastic evolution equation can be obtained [9] recalling that the number of corpuscles in cell C_i at instant t +1 is equal to the number of corpuscles remaining in the cell plus the ones entering from right and left cells

$$n_{i,t+1} = p_{i-1}n_{i-1,t} + \delta_i n_{i,t} + q_{i+1}n_{i+1,t} \,. \tag{2.5}$$

In the continuous approach this stochastic difference equation may assume the form:

$$A(x)\frac{\partial^2 n}{\partial x^2}+B(x)\frac{\partial n}{\partial x}+C(x)n=\frac{1}{v_N}\frac{\partial n}{\partial t}\,, \tag{2.6}$$

with

$$A(x)=\frac{1}{2}\ell_0 d,\quad B(x)=\ell_0 d_x-\mu,\quad C(x)=\frac{1}{2}\ell_0 d_{xx}-\mu_x \tag{2.7}$$

and

$$\mu(x)=p(x)-q(x),\qquad d(x)=p(x)+q(x) \tag{2.8}$$

since, ℓ_0 , the size of the cell, is very small. This continuous stochastic equation allows us, in principle, to calculate the distribution of corpuscles in any given theta wave field.

The drift, the average motion or the velocity of the corpuscles is described by the difference between the probabilities to go right or left, $\mu(x)=p(x)-q(x)$.

This transition probabilities may also be written in the continuous form

$$\begin{cases} q(x)=\dfrac{I(x-\ell_0)}{I(x-\ell_0)+I(x)+I(x+\ell_0)} \\ \delta(x)=\dfrac{I(x)}{I(x-\ell_0)+I(x)+I(x+\ell_0)} \\ p(x)=\dfrac{I(x+\ell_0)}{I(x-\ell_0)+I(x)+I(x+\ell_0)} \end{cases} \tag{2.9}$$

By Taylor expanding *I(x)* and making the cutoff at ℓ_0^2, we finally get the average motion of the acron

$$\mu(x)=\frac{2}{3}\ell_0\frac{I_x}{\mathrm{I}} \tag{2.10}$$

which may be generalized to three dimensions resulting

$$\mu=\frac{2}{3}\ell_0\frac{\nabla\mathrm{I}}{\mathrm{I}} \tag{2.11}$$

This expression may also be written

$$\Gamma=\frac{\nabla\mathrm{I}}{\mathrm{I}}, \tag{2.12}$$

in which we put, $\Gamma=3/2\ell_0\mu\propto\mu$.

This expression, translating the eurhythmic motion of a complex particle in interaction with the medium is what we call the genesis formula, since it "generates" motion.

3. Explaining impossible thrust

In the framework of eurhythmic physics, a nonlinear physics, in which action is not in general proportional to reaction and consequently a minute action may, in the adequate conditions, cause a huge reaction, this strange observed phenomenon has an easy and natural explanation.

White *et all* [1] reported that a real thrust was observed in a copper trunked cone in which a stationary standing wave was produced at about 1.937 GHz with two nodes along the axial direction, as shown schematically in the next drawing, Fig.3.1

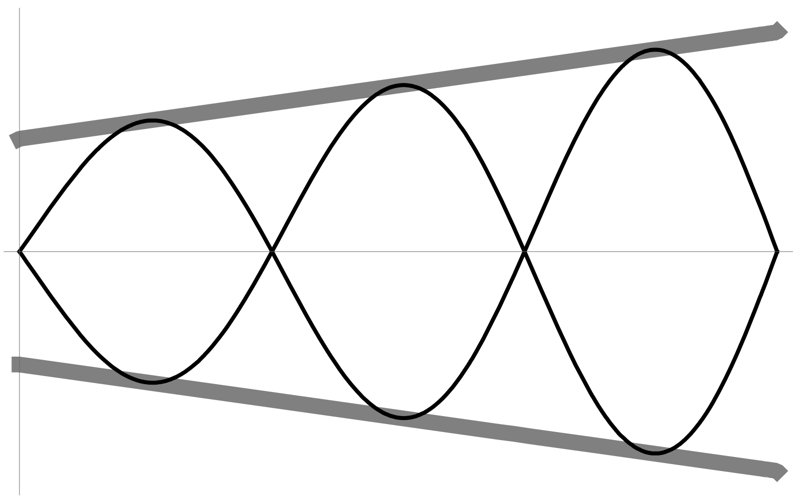

Fig. 3.1 - Axial nodes in the impossible thrust setup. The x-axis runs from left to right, the total length is L, and the nodes occur at intervals of L/3.

In eurhythmic physics the observed thrust may be explained as a natural consequence of the asymmetry of the energetic field intensity density created in the experimental device, acting on the particles forming the conical wall.

The energetic field intensity of a wave in a medium depends, as expected, on the specific setup conditions:

1 - Homogeneous free medium. The energetic field intensity I is proportional to the form of the wave. This situation, the most common, corresponds to an interacting medium without stress in which the energetic field density is distributed homogenously. That means, in this case, that the energy density, the intensity of the field is constant in the region in which is defined. For such a simple type of distribution, the energetic field intensity is, naturally, proportional to the form of the wave that is, $I \propto I_\theta = |\theta|^2$.

2 - Inhomogeneous medium. In this case, due to concrete preparation of the experimental setup, the energetic density of the field is not constant. In such conditions, the intensity of the field distribution is no longer proportional to $|\theta|^2$.

In the present case, in which the cavity has a funnel form, the energetic field intensity may be more concentrated in the narrower part of the funnel. It is thus assumed that the cavity works, for certain experimental conditions, like a kind of energetic field compressor, increasing in this zone the energetic density of the field.

Let us now see concretely what may happen in this experimental setup:

The θ wave field inside the linear funnel geometry device of length L along the axial direction may be described by

$$\theta = A(a+bx)\cos(\omega t)\sin(kx), \quad 0 \leq x \leq L,\ t \geq 0, \tag{3.1}$$

with $L = 3\pi/k$ and A some constant with a and b positive, in general.

The wave intensity, I_θ, being given by

$$I_\theta = |\theta|^2 = A(a+bx)^2\cos(\omega t)^2\sin(kx)^2 \quad 0 \leq x \leq L,\ t \geq 0. \tag{3.2}$$

a) Assuming the simplest case of a homogeneous energetic field density we have simply

$$I \propto I_\theta = |\theta|^2. \tag{3.3}$$

A corpuscle sensitive to this energetic field distribution experiences a drift, using (2.12) given by

$$\mu(x) \propto \frac{I_x}{\mathrm{I}} = \frac{2b}{a+bx} + 2k\cot(kx)\,, \;\; 0 \le x \le L. \tag{3.4}$$

The average drift is

$$\overline{\mu} = \frac{1}{L}\int_0^L \left(\frac{2b}{a+bx} + 2k\cot(kx)\right)dx, \tag{3.5}$$

Giving

$$\overline{\mu} = \frac{2}{L}(\ln(a+bL) - \ln(a)).\,. \tag{3.6}$$

showing that the drift decreases with the size of the device. From this expression one sees that if the device is cylindrical, meaning $b = 0$, there is no average motion for any corpuscle even if they are sensitive to the field and therefore no overall macroscopic thrust created from all corpuscles in the frustum walls acting together.

b) By assuming, on the other hand, that the energetic field density is not homogeneous but rather concentrated inversely in the narrower part of the cavity, we may write as first, direct approach,

$$I \propto A(a+bx)^{-2}\cos(\omega t)^2\sin(kx)^2 \quad 0 \le x \le L,\; t \ge 0. \tag{3.7}$$

For this field intensity distribution, using (2.12) the drift is given by

$$\mu(x) \propto \frac{I_x}{\mathrm{I}} = \frac{-2b}{a+bx} + 2k\cot(kx)\,, \;\; 0 \le x \le L\,. \tag{3.8}$$

The average drift is then

$$\overline{\mu} = \frac{1}{L}\int_0^L \left(\frac{-2b}{a+bx} + 2k\cot(kx)\right)dx, \tag{3.9}$$

Giving

$$\overline{\mu} = -\frac{2}{L}\left(\ln(a+bL) - \ln(a)\right), \tag{3.10}$$

showing that the drift decreases with the size of the device.

This means, that for the same geometry of the cavity, depending on the field preparation, the overall thrust direction may change. In fact this is the thrust direction experimentally observed.

Now we are going to see that by changing the geometry of the experimental device, it is possible to increase the absolute value of the drift and consequently of the thrust.

Indeed, let us assume that the device instead of a funnel linear geometry has a trumpet geometry described by an exponential variation as shown in next sketch, Fig.3.2

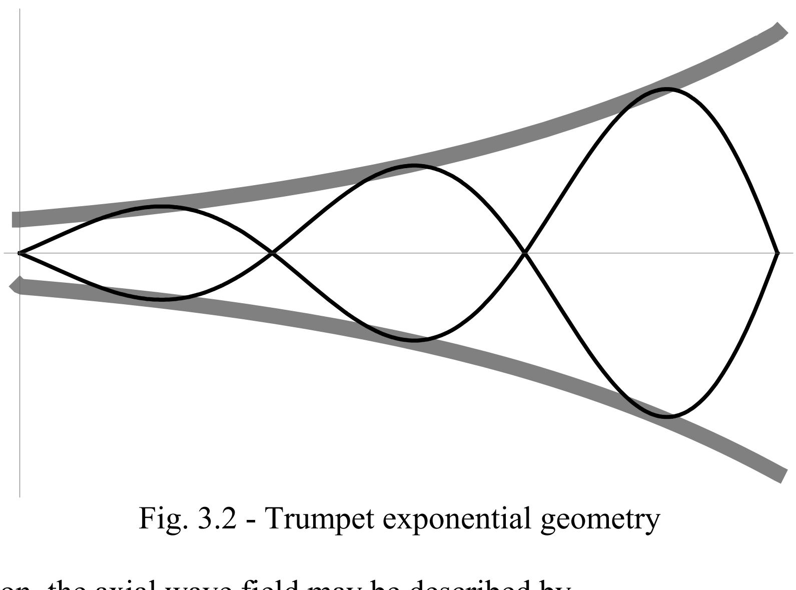

Fig. 3.2 - Trumpet exponential geometry

In this situation, the axial wave field may be described by

$$\theta = A\, e^{\alpha x}\cos(\omega t)\sin(kx), \quad 0 \le x \le L,\ t \ge 0. \tag{3.11}$$

Again, for determining the energetic field intensity distribution we assume:

a) Homogeneous energetic field density.

In such a case, the energetic field intensity is simply given by

$$I \propto I_{\theta} = Ae^{2\alpha x}(\cos(\omega t)\sin(kx))^{2}, \quad 0 \leq x \leq L, \ t \geq 0, \tag{3.12}$$

and the drift for this geometry is then

$$\mu(x) \propto \frac{I_x}{\mathrm{I}} = 2\alpha + 2k\cot(kx)\,, \ \ 0 \leq x \leq L\,. \tag{3.13}$$

This expression tells us that the drift, for this case, apart from the oscillatory part, is constant, not depending on the size of the device. In this situation, the average drift is simply

$$\overline{\mu} = 2\alpha. \tag{3.14}$$

b) Let us now assume that the energetic field density is not homogeneous but inversely concentrated on the narrower region of the cavity.

In such an approximation, the energetic field intensity may be given by

$$I = Ae^{-2\alpha x}(\cos(\omega t)\sin(kx))^{2}, \quad 0 \leq x \leq L, \ t \geq 0, \tag{3.15}$$

giving for the drift

$$\mu(x) \propto \frac{I_x}{\mathrm{I}} = -2\alpha + 2k\cot(kx)\,, \ \ 0 \leq x \leq L\,. \tag{3.16}$$

As before, the average drift, representing the medium behavior of the overall structure, due to the joined movement of all particles in the frustum walls, will occur towards the narrower end thus generating a nonlinear self-pushing effect.

For this geometry, the average drift will be

$$\overline{\mu} = -2\alpha. \tag{3.17}$$

Just as for the previous cavity, with a funnel geometry, the direction of the impulsive thrust does depend on the density distribution of the energetic field.

4. Conclusion

Using what can be classified as a nonlinear pilot wave theory, from which macroscopic overall effects can be previewed and explained, dismissing Newton's third law, we have analyzed an impulsive thrust. This was shown to depend on the geometry of the resonating cavity and further on the homogeneity or inhomogeneity of the EM field, related to a pilot-wave inside the cavity. From this first basic analysis it is further reasonable to assume that using other geometries for the cavity it is possible, in principle, to improve the overall thrust behavior of the system.

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