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Gravitation and the Unified Nature of All Kinds of Motion in Non-Empty Space (Part 1)

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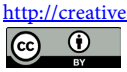


Abstract

The presented work examines the mechanism and conditions of self-motion in bodies as systems of interacting elements. It is shown how the oscillation parameters of these elements determine the mode of motion of the system (body). In this case, the motion is considered as a consequence of symmetry breaking of forces in the systems themselves, and not as a reaction of individual elements to external influences. It is shown that such a violation takes place both in the gravitational field and when the system moves by inertia. Examples of the influence of changes in phase (φ) and frequency (f) parameters of the system elements on the velocity mode of its motion in space are considered. The identity of the causes of self-motion is revealed both in the case of gravitation and inertial motion.

Keywords

Gravitation, Self-Motion, Phase, Frequency, Time Rate, Standing Wave, Potential Well, Standing Wave Node, Momentum, Quantity of Motion

1. Introduction

Despite the many existing theories devoted to gravitation [1], gravitation appears to be a phenomenon, *i.e.*, a phenomenon that is difficult to comprehend. The few reliably established knowledge about gravitation include the effect of gravitational redshift [2], predicted by A. Einstein in 1911, and the results of the Pound and Rebka experiment [3], which in 1960 confirmed the dependence of the position (shift) of spectral lines on the distance from the gravitational source. Further experiments with atomic clocks [4] showed that the gravitational potential affects

the rate of time and, consequently, the rate of all periodic processes in bodies.

Another fact is the reaction of bodies to the presence of a central gravitational field in space. It is believed that it is the gradient of field potentials that forces bodies to move with acceleration. But the question about the mechanism of action of potentials both on the body as a whole and on its separate elements remains open. In other words, how do potentials affect the elements of the body (what do they change) and how does the body transform these changes into motion?

Let us use the method of modeling processes based on the axiomatics of Rhythmodynamics ([5], p. 32) and give examples demonstrating the emergence of driving forces through changes within the system of interacting wave sources.

2. Historical Retrospective

If you know nothing about gravity, the fall of bodies to the surface of the earth looks like *self-motion*[1] without a reason, *i.e.* a miracle. The movement of bodies by inertia, which also occurs as if without a reason and also belongs to one of the types of self-motion, belongs to a similar phenomenon.

Many researchers, starting from ancient times, have thought about the cause of motion of bodies in space. For example, Aristotle: "The *motion of a body in a straight line is realized through the aspiration of its elements to their natural places*!" [6]. For Newton to describe the cause of motion it was enough to have an external action, but he separated numerically equal concepts of "*impulse*" and "*momentum*", intuitively relating *impulse to a* short-term action on the body, and the *momentum to* changes in the body after the action on it. And here a number of questions arise:

1) What are these *natural places* that the elements of the body tend to go?

2) How does the *impulse* differ from *momentum*, and is the *momentum an* absolute *quantity*, if it is somehow fixed in the body?

3) What exactly, in the case of non-empty space, must change in the bodies for these changes to maintain the bodies' velocity?

Modern physics is a set of mathematical models, within the framework of which problems are successfully or not so successfully solved. If a model stops working, it is replaced by another one. Often, something useful is lost in the replacement. So it happened, for example, in the beginning of the 20th century, when the luminiferous Aether was removed from the ideas about the world order and the space turned out to be filled with nothing, *i.e.* empty. But with time this nonsense was eliminated and in later models there appeared physical vacuum, space-time continuum, space-time fabric and other exotic entities, which were endowed with various physical properties.

Some of these properties we will need to describe uniform and accelerated motion. But first, let us use a simplified mathematical modeling, where we consider

[1]Self-Motion—motion having a source and cause in the moving thing itself. The concept of S. opposes the concept of "external push" as the allegedly the only cause of changes occurring in nature. In mechanics, self-movement is considered to be such movement of devices, for example, a cart with a motor which is realized by the forces of the device itself, but with support on the base. In space there is no mechanical base, but there is a non-empty space, which serves as a support for all kinds of motion in it.

the test body and its environment (Figure 2) in *non-empty space*[2] through the prism of gravitational redshift and the Pound-Rebka experiment (Figure 1).

3. The Pound-Rebka Experiment

The experiment is among the brilliant ones, but the results obtained in it can be interpreted from different points of view.

Figure 1 shows the calculation of the relative frequency offset between the source and the receiver in the gravitational field. The result obtained in the experiment shows, among other things, that in the receiver and the source the rate of time, and hence the rate of all periodic processes, depends on their distance from the field source.

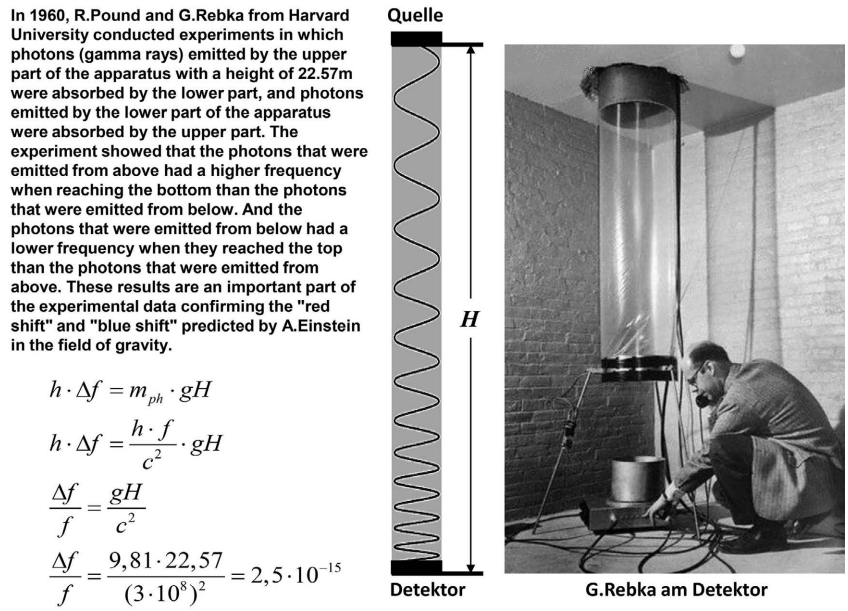


Figure 1. Physicist glenn rebka at harvard university [Corbismedia/Harvard University].

In the Pound-Rebka experiment the distance H was chosen arbitrarily and was equal to 22.57 meters. But inside the bulk test body between its differently distant elements (Figure 2) there is also a difference in frequencies. To evaluate the numerical characteristics and qualitative properties of the object, let's replace the structure of bonds between the elements of the body by a simple model in the form of a wave crystal lattice, the nodes of which are the sources of waves. Let us select a *structural unit of* two sources in the test body and assume the distance between the sources to be equal to one standing wave, *i.e.* $H = \lambda_{st} = c/2f$.

Let the sources (Figure 2) reside in the central gravitational field, *i.e.* in conditions of its unequal potentials. The frequencies of the sources become different. Let us determine the value of the frequency shift Δf between the sources, as well

[2]*Non-empty space* implies the presence of absolute quantities, such as velocity, wavelength, and momentum, considered in a frame of reference tied to the filling of space serving as the reference medium, and relative quantities tied to the frame of reference of some moving object.

as the relation between this shift and the free-fall acceleration g. In the first approximation, the magnitude of the redshift is estimated using the formula:

$$\frac{\Delta f}{f} = \frac{gH}{c^2} \tag{1.01}$$

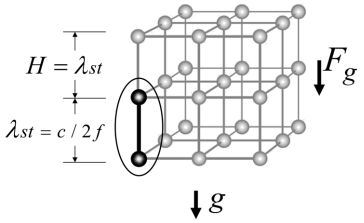


Figure 2. Model of the bulk test body. The sources are represented by material points that respond only to the gravitational potential. In field-free conditions the sources are in-phase.

In our case:

$$H = \frac{c}{2f}. \tag{1.02}$$

Then

$$\Delta f = \frac{g}{2c} \tag{1.03}$$

From here

$$\boxed{g = 2c \cdot \Delta f \left[\mathrm{m/s \cdot Hz}\right]} \tag{1.04}$$

Substituting the numerical values into (1.03): $g = 9.8\ \mathrm{m/s^2}$, $c = 299792458\ \mathrm{m/s}$. we obtain:

$$\boxed{\Delta f = 1.63 \times 10^{-8}\ \mathrm{Hz}} \tag{1.05}$$

From (1.04) it follows that movement of the system under consideration with acceleration g *is* related to (and depends on) the presence of the frequency shift Δf, which is induced by the gravitational field potential gradient.

Note that Δf cannot be large or even noticeable value, there is a limitation, e.g. cannot be of order $\Delta f = 0.5\ \mathrm{Hz}$ and is typically several order of magnitude less.

We can also consider gravitation through the concept of force. Let's use the well-known inverse square law and also calculate the test body's weight through its gravity mass:

$$F_g = -\gamma \frac{mM}{R^2} \tag{1.06}$$

and

$$F_g = mg \tag{1.07}$$

Equating the above right-hand sides we obtain

$$mg = -\gamma \frac{mM}{R^2} \tag{1.08}$$

$$g = -\gamma \frac{M}{R^2}. \tag{1.09}$$

In our (1.04) case (see **Appendix** for derivation)

$$g = 2c \cdot \Delta f\ . \tag{1.10}$$

So

$$2c \cdot \Delta f = -\gamma \frac{M}{R^2}. \tag{1.11}$$

Hence

$$\Delta f = -\gamma \frac{M}{2cR^2}. \tag{1.12}$$

Substituting the known numerical values:

$$\gamma = 6.67430 \times 10^{-11}\ \mathrm{N \cdot m^2/kg^2}$$

$$M = 5.9722 \times 10^{24}\ \mathrm{kg}$$

$$R = 6378136\ \mathrm{m}$$

$$c = 299792458\ \mathrm{m/s}$$

we obtain

$$|\Delta f| = \frac{6.67430 \times 10^{-11} \times 5.9722 \times 10^{24}}{2 \times 299792458 \times 6378136^2} = 1.63 \times 10^{-8}\ [\mathrm{Hz}] \tag{1.13}$$

The obtained value is the same as (1.05). The same result was obtained by two methods having as a common part the wave model of the test body.

For comparison, let's write down two formulas side by side:

$$F_g = mg\left[\mathrm{kg \cdot m/s^2}\right] \tag{1.14}$$

$$F_g = 2mc \cdot \Delta f\ [\mathrm{kg \cdot m/s \cdot Hz}] \tag{1.15}$$

If in (1.14) we do not see a reference to the cause of the force, then in (1.15) there is such a reference in the form of the frequency shift, indicating that the force acting on the body is proportional to the gradient of frequencies and is essentially internal. By this even in the formal description we demonstrate the origin and action of Gravitation. In other words the gravitational potential gradient is not directly the final cause of the body's motion to the source of the gravitational field. The gradient only determines the character of oscillations of sources, *i.e.* influences on phase and frequency parameters of the system elements. This, in turn, leads to a violation of the balance of internal forces in the body and to a reaction to such a violation by self-motion. The physics of such self-motion has not been considered so far, and this paper is devoted to it.

Let's continue modeling to clarify the question: are the changes inside the bodies a common or single cause for any kind of motion, in particular—the inertial motion?

4. Theory and Experiments

It is known that the frequency shift represents the change of the phase difference in time. This indicates that when a system (structural unit) moves with acceleration,

its instantaneous velocity corresponds to a specific phase shift between the sources.

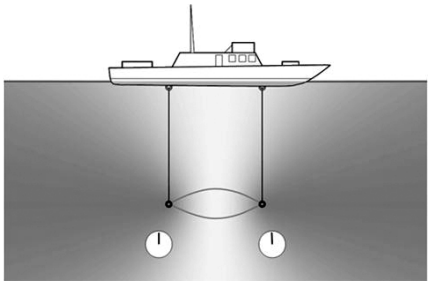
$$a = \Delta V / \Delta t ,$$

$$V_{inst} = a \cdot t ,$$

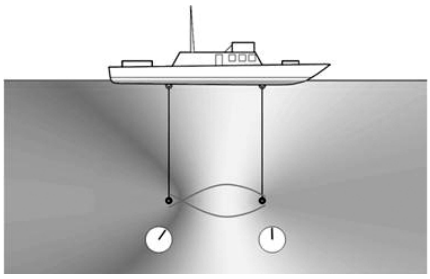
$$V_{inst} = 2c \cdot \Delta f \cdot t = c/\pi \cdot \Delta\varphi$$

$$\boxed{V = c/\pi \cdot \Delta\varphi} \tag{1.16}$$

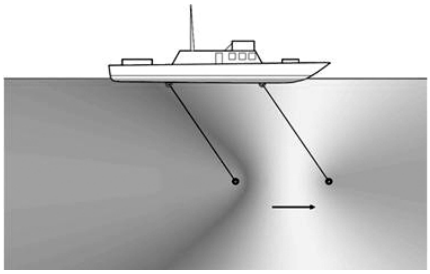
A hydroacoustic experiment (**Figure 3**), was conducted to verify (1.16) and (1.04), where phase and frequency-controlled ultrasonic radiators served as the sources of waves [7]. The necessary condition was that the test system must be open and reside in non-empty space.



(a)



(b)



(c)

Figure 3. The emergence of self-motion of an acoustic system in a non-empty isotropic space (liquid). https://youtu.be/664LAcLZk9Y. (a) The sources are in-phase, $V = 0$, zero momentum $P = 0$, $\lambda_{st} = c/2f$. There is an equilibrium of internal forces. The sources are located in potential wells (in nodes). (b) Phase shift $\Delta\varphi$ leads to the energy asymmetry between the sources. The potential wells are shifted to the right. The system has non-zero momentum $P = mc/\pi \cdot \Delta\varphi$ ($m = 1$). (c) The system has fully restored the equilibrium through movement at speed $V = c/\pi \cdot \Delta\varphi$, and $\lambda'_{st} = \lambda_{st}\left(1 - V^2/c^2\right)$.

5. Description of the Experiment

At $V=0$ only one source is active: due to the absence of gradient there is no directed motion of the system. Figure 3(a) shows that the activation of the second source leads to a coupling between the sources and the formation of the system. The coupling is organized by excitation of the medium and is characterized by the appearance of a standing wave. Between the sources the standing wave creates a system of "potential wells" in the form of nodes and thus the sources in interaction keep each other at a fixed distance. The occurrence of a phase shift or frequency difference between the sources causes the potential wells, or standing wave nodes (Figure 3(b)) to drift, which causes the sources to react. There is a joint directional displacement of the potential wells and sources up to a velocity at which the sources will again be in the potential wells. In other words, the medium remains stationary, but the excitation in the form of a standing wave (nodes and anti-nodes) moves in the medium, displacing the sources. This type of motion is possible only in a system of sources and is not inherent to individual elements. We observe the fact of finding the cause of motion in the moving system itself, which allows us to speak about the self-movement of the system.

As in the gravity example, the frequency difference between the sources will drive the system to move with acceleration, in the in accordance with $a=2c\cdot\Delta f$, which indicates to generality or universality of the above dependencies.

6. Examples of Self-Motion

Self-motion in pure form takes place only in cases when the elements of the already moving system (body) are not affected by any violent or other action affecting the parameters of the elements of this system. Inertial motion is an example of self-motion in its pure form.

Free fall in the gravitational field, although looks like self-motion, is not free from external influence. The reason: the frequency difference between the elements of the system (in the body) appears exclusively and due to the presence of the gravitational field.

The Brownian motion of molecules can probably be attributed to pure self-motion. For example, an oxygen molecule may consist of $O_2=O^{16}+O^{17}$ or $O_2=O^{16}+O^{16}$. In such any simple molecule, even in the absence of external causes, there is always (at least minimal) violation of phase or frequency balance, and there must be a reaction to it. One variant of such a reaction is uniform, or accelerated self-motion. Asymmetry exists also in more complex molecules, e.g. H_2O.

7. Discussion

Modern established physical paradigm, whether Newton's classical mechanics, or electrodynamics, and quantum mechanics, considers the motion of bodies in space from a phenomenological point of view, without paying attention to the internal mechanism of starting and maintaining of motion, *i.e.* does not take into

account changes in the interaction of structural units of matter when changing the mode of their motion. Usually a descriptive approach is used, limiting the possibilities of controlling the motion of bodies to well known two options: pushing and pulling or, in space, repulsion from the propellant of a rocket engine. The way of describing motion presented in this paper draws attention to a forgotten "something" that fills space and is endowed with specific physical properties. Known properties include the property of "something" to carry wave perturbations by means of itself and the property to resist the acceleration of bodies. And if "something" is capable of resisting acceleration (note that it is not the body that resists, but the "void" that tries to hinder), then we are dealing with a substance that can support. The presence of such a supporting substance was shown in an experiment with a homodyne-type interferometer [8], which was subjected to motion with acceleration. The presence of a support provides a basis for obtaining a driving force in a seemingly empty space. To date, such an understanding of the processes of motion is not generally accepted. But it has already been developed under the general name of Rythmodynamics[3] (RD) [5], considering physical phenomena in the framework of Euclidean geometry and phase-frequency relations within the bodies under study.

The results of consideration of processes from the point of view of Rhythmodynamics allow us to demonstrate the difference between impulse and momentum. Impulse is what acts on the body from outside, and the momentum is what has changed and remains inside the body after the action on it. Formally it looks as follows:

$$P_1 = F \cdot \Delta t \quad \text{(impulse from the acting object)} \tag{1.16}$$

$$V = c/\pi \cdot \Delta\varphi \quad \text{(velocity of the system)} \tag{1.17}$$

$$P_2 = mc/\pi \cdot \Delta\varphi \quad \text{(the amount of movement inside the body)} \tag{1.18}$$

$$P_2 = P_1$$

(1.18) shows the momentum in the system after the action on it (1.16), and the phase shift formed between the elements, which is further preserved and maintains the new velocity of the system (1.17). Note that in a moving system the equilibrium of internal forces is always established.

8. Future Prospects and Goals

It is shown theoretically and in experiments that by artificially controlling the frequencies and phases of the active elements of the system (of a body or a technical device) with support of the all-penetrating *non-empty space*, it is possible to change the velocity mode of the system. Moreover, the motion can be controlled from inside the system, *i.e.*, without going beyond its limits. From outside it will

[3]Rythmodynamics (RD), is a branch of science that studies the influence of periodic processes on the formation of natural phenomena and their properties. ([5] p.10]. The basis of RD is the geometry of Euclid, supplemented by the missing axiom in it, called—the axiom of Foundation ([5], p. 27). Rhythmodynamics is not a dogma, but an invitation to reconsider the views on the world around us.

be seen that "the system moves itself". And it is not a paradox, because invisible for an external observer, but *excited reference medium is* hidden (located) inside the tested system. It is the medium with that the elements of the system interact and rely upon.

Space cannot be left aside, when the only way to obtain the driving force is considered to be interaction with the working body (propellant). Now the situation has changed and it is possible to develop a substitute for the rocket engines. Yes, from the engineering point of view, the problem is difficult, but solvable. The solution of this and other tasks of similar complexity will inevitably lead to the emergence of techniques and technologies of another level, which means that new opportunities will open up. It's a matter of small things—to set big goals and to form new, decent image of the future.

9. Conclusions

This article reveals the main thing—all types of motion of material bodies in space have a single, universal phase-frequency cause. It also became possible to take a deeper look at such important characteristics of bodies as mass, inertia, centrifugal force and others. This is also important because movement in one form or another is present in all natural phenomena and processes, in all models of modern physics, and therefore is a fundamental integral element of ideas about the world being studied. In fairness, it should be noted that the identity of the causes of self-motion, found both in the case of gravity and in the case of the movement of bodies by inertia, is another important confirmation of Einstein's equivalence principle. Further analysis and modeling using the Rhythmodynamics method can be useful in terms of understanding and explaining the causality of both already known phenomena and new ones that have not yet been discovered.

In addition, the results of our experiments indicate the possibility of creating previously unknown technical devices. One of the directions is the development of phase-frequency methods of moving in space without using a working fluid.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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About Rhythmodynamics

"*Everything that exists has a basis for its existence*!"

Leibniz

Any phenomenon or property is based on the processes which form them. It's a general practice in science to regard phenomena and their properties inherent until a theory and instruments are created with the help of which such processes can be discovered. For example, until the emergence of rhythmodynamics the notion of "gravitation" was explained by the curvature of space or the flow of ether toward matter. We understand that this could well be so, but we want explanations to the curvature of space and ether flow. If they cannot be explained, *i.e.* regarded as a "fact", a hierarchy of hypotheses emerges in which the unknown is explained by something yet more unknown. Which, in science, is looked upon as a "mauvais ton".

Another example is motion, *i.e.* the bodies' ability to move in space by inertia. Such motion is regarded as inherent, *i.e.* something basic and preordained and therefore requiring no explanations. And how about matter as a philosophical category? How about physical fields as a special kind of matter, or rather special kind of philosophical category?

With the emergence of mathematics (all kinds of mathematics are based of arithmetic) it became possible to determine correlations between the facts of micro and macro worlds. Somehow this came to be regarded as a true physics. For example, the rectilinear motion by inertia is characterized by speed speed is determined by a ratio of a distance passed in a unit of time. The question is what is the cause of motion? The answer is the cause of motion is in the force which has been applied to the body!

Such answer doesn't reveal anything because the question referred not to the cause which triggered motion, but to the cause of motion as a process, *i.e.* thanks to what exactly the body moves in space in uniform and rectilinear way, what originates and facilitates such motion? The modern physics doesn't answer this seemingly simple question.

In such case how should one treat the now fashionable physical hypotheses about creation of the universe, if we still do not know the origin of motion (there's no matter without motion…)? Here it is appropriate to recall Aristotle: "*Since nature is the beginning of all motion, and the subject of our study is nature, then it is impossible to leave unexplained what motion is*: *after all, ignorance of motion necessarily entails ignorance of nature*".

The modern interpretation of the main fundamental phenomena and properties sounds more like a system of ritual chants rather than scientific explanations. Many researchers are not content with this. They are forced to conduct their own independent research so as to solve the problems which physics avoids to solve. As a result of such research Rhythmodynamics emerged with the help of which model analogies were created of those phenomena under study. If anyone succeeds in creating a simpler way and means of explanation than I've created I'll be much obliged to this man.

Yuri N. Ivanov

Appendix

As a model of matter, let us consider the simplest one-dimensional system (Figure A1) of two interacting wave sources moving in a wave medium with speed V. The natural state of this system is that the sources are located at the nodes of a standing wave created by their joint radiation.

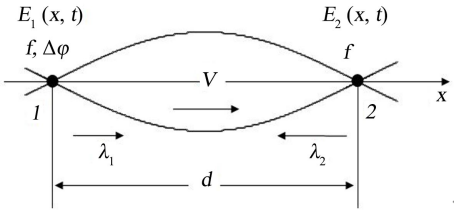

Figure A1. Distance between the sources is d.

Let us determine the distance d between the sources and the phase shift $\Delta\varphi$ between them.

To do this, let's write down expressions for the fields they emit, with left source *1* emitting in the positive direction of the x-axis, source 2 in the negative direction. The sources have the same frequency f, source *1* has a phase shift $\Delta\varphi$ relative to source 2.

$$E_1(x,t) = \cos(\omega t - k_1 x + \Delta\varphi), \tag{A1}$$

$$E_2(x,t) = \cos(\omega t - k_2(x-d)), \tag{A2}$$

where

$$\omega = 2\pi f .$$

The wavelengths emitted by the sources will be different. This is due to the motion of the system in a wave medium with a velocity V:

$$\lambda_1 = \frac{c-V}{f}, \tag{A3}$$

$$\lambda_2 = \frac{c+V}{f}. \tag{A4}$$

The corresponding wave numbers will be

$$k_1 = \frac{2\pi}{\lambda_1} = 2\pi\frac{f}{c-V} = \frac{\omega}{c-V}, \tag{A5}$$

$$k_2 = \frac{2\pi}{\lambda_2} = 2\pi\frac{f}{c+V} = \frac{\omega}{c+V}. \tag{A6}$$

Since the sources are located at the nodes of the standing wave, we have:

$$E_1(0,t) = -E_2(0,t), \tag{A7}$$

$$E_1(d,t) = -E_2(d,t). \tag{A8}$$

This is ensured when the arguments of the cosines differ by an odd number of π:

$$k_2\left(x-d\right)+k_1x-\Delta\varphi=\left(2m+1\right)\pi, \tag{A9}$$

m—integer.

Let us consider the location of sources at the nearest nodes within the same standing wavelength, while $m=-1$, $m=0$.

Expressions (A7) and (A8) will take the form:

$$-k_2d-\Delta\varphi=\pm\pi, \tag{A10}$$

$$k_1d-\Delta\varphi=\pm\pi. \tag{A11}$$

Considering that wave numbers $k_1,k_2>0$, solutions to system (A10), (A11) exist only for a certain choice of sign, namely:

$$-k_2d-\Delta\varphi=-\pi, \tag{A12}$$

$$k_1d-\Delta\varphi=+\pi. \tag{A13}$$

Subtracting (A12) from (A13) we get:

$$\left(k_1+k_2\right)d=2\pi, \tag{A14}$$

$$d=\frac{2\pi}{k_1+k_2}=\frac{\pi c}{\omega}\left(1-\frac{V^2}{c^2}\right)=\frac{c}{2f}\left(1-\frac{V^2}{c^2}\right), \tag{A15}$$

Then

$$d=\frac{c}{2f}\left(1-\frac{V^2}{c^2}\right). \tag{A16}$$

Or at $V=0$ $d=\lambda_{st}$, at $V>0$ $d=\lambda'_{st}$

Then

$$\boxed{\lambda'_{st}=\lambda_{st}\left(1-\frac{V^2}{c^2}\right)} \tag{A16.1}$$

In (A16), we determined the distance between the sources when the system moves in a wave medium with speed V in the longitudinal direction, thus revealing the dependence of the length of the standing wave (A16.1) on the speed of the system in which it is formed.

Summing up (A12) and (A13) we get:

$$\left(k_1-k_2\right)d-2\Delta\varphi=0, \tag{A17}$$

$$\Delta\varphi=\frac{\left(k_1-k_2\right)d}{2}.$$

Substituting the corresponding d from (A16) we get:

$$\Delta\varphi=\frac{1}{2}\left(\frac{\omega}{c-V}-\frac{\omega}{c+V}\right)\frac{\pi\left(c-V\right)\left(c+V\right)}{\omega c},$$

$$\Delta\varphi=\frac{\pi}{c}\cdot V. \tag{A18}$$

This means that the speed of the system in the medium is related to the phase

shift between the sources located at adjacent nodes of the standing wave as follows:

$$\boxed{V = \frac{c}{\pi} \cdot \Delta\varphi} \tag{A19}$$

Now let's consider the issue of the system moving with acceleration based on the relation (A19) we have identified. If the phase shift $\Delta\varphi$ changes in time, the system we are considering will change its speed in space in order to restore a wave configuration characterized by the coincidence of the localization of sources and nodes of a standing wave. Let us assume that there is a frequency shift between the sources, *i.e.* the frequency of the first source:

$$f_1 = f + \Delta f \ . \tag{A20}$$

In this case, the phase shift of source oscillations is:

$$\Delta\varphi = 2\pi\Delta f \cdot t \ , \tag{A21}$$

where t—time.

Let us differentiate (A19), because the time derivative of V is the acceleration of the system by definition:

$$\frac{\mathrm{d}V}{\mathrm{d}t} = a = \frac{c}{\pi}\frac{\mathrm{d}(\Delta\varphi)}{\mathrm{d}t} = \frac{c}{\pi} \cdot 2\pi\Delta f = 2c \cdot \Delta f \ , \tag{A22}$$

or

$$\boxed{a = 2c \cdot \Delta f} \ . \tag{A23}$$

We have obtained a connection between the difference in the frequencies of the sources and the acceleration experienced by the elementary system. During acceleration, there is a constantly increasing phase shift, which is equivalent to the presence of a frequency difference between the sources.

An elementary system (structural unit) consists of two active sources and a standing wave between them. Let us describe the algorithm for the occurrence of movement and some other reactions of the system to changes in conditions (**Figure A2**).

Some (basic) formulas of Rhythmodynamics

1) Dependence of the standing wave length on the velocity of the system in non-empty space:

$\lambda'_{st} = \frac{\vec{\lambda} \cdot \bar{\lambda}}{\vec{\lambda} + \bar{\lambda}}$, or $\lambda'_{st} = \frac{c}{2f} \cdot \frac{1-\beta^2}{\sqrt{1-\beta^2\sin^2\theta}}$, where $\frac{c}{2f} = \lambda_{st}$, θ—orientation angle to the direction of movement. λ'_{st} —the harmonic mean value.

2) The velocity of movement of a system (structural unit) consisting of two equally-frequency interacting oscillators and a standing wave between them, by inertia:

$V = \frac{c}{\pi} \cdot \Delta\varphi$, where $\Delta\varphi$ —phase shift between the oscillators of the system.

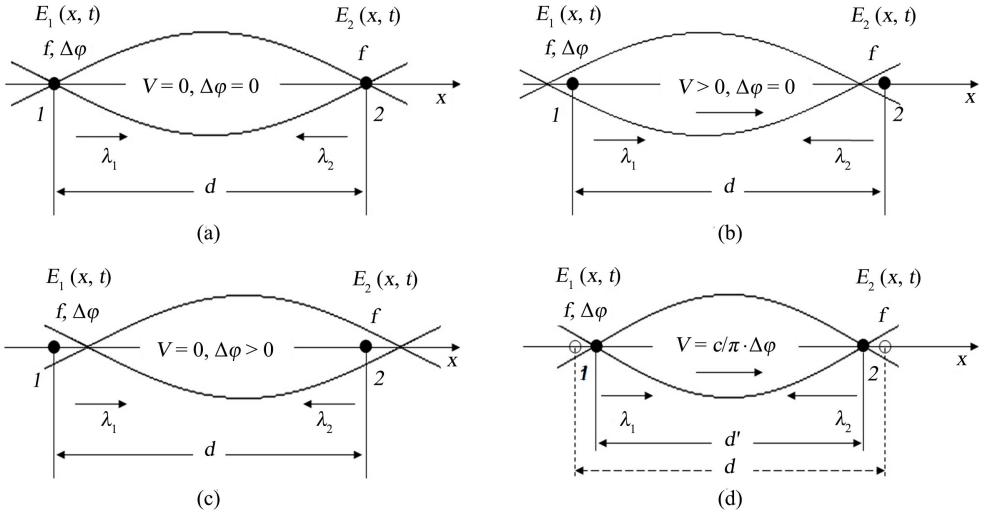

Figure A2. Reaction of the system to changes in speed and parameters of its elements. (a) The sources are in phase and the system is at rest in a wave medium. The positions of the sources and potential wells coincide. The system is in a state of equilibrium. (b) The system with its sources in phase is forced to move to the right with $V = const$. Potential wells lag behind the sources and this slows down the system. The system will resist its own movement in the wave medium, *i.e.* show inertia. (c) If there is a phase difference in the system, the sources are forcibly retained, and the potential wells are shifted to the right. The sources tend to follow the potential wells (beyond their natural places) and the system has a tendency to move in the form of momentum. Such a system will exert an action (constant pressure) on the obstacle. (d) There is a phase difference between the sources of the system and the system is not limited in degrees of freedom. The movement of the system along the x-axis will be its reaction to phase asynchronism. As the system moves, the distance between the sources will decrease ((16.1) will decrease). Obviously, the change in the phase difference over time is equivalent to the frequency difference, which will determine the speed of the system. The system will move with acceleration.

3) Movement of a structural unit (body) with acceleration:

$a = 2c \cdot \Delta f$, where Δf —frequency difference between oscillators.

4) Force of action, momentum and amount of movement:

$F = 2mc \cdot \Delta f$, where $m = 1$—quantitative characteristic

$P_1 = F \cdot \Delta t$—impulse

$P_2 = mc/\pi \cdot \Delta\varphi$—amount of movement (an impulse inside the body)

$P_2 = P_1$

5) The average speed of light (along a closed path: source-mirror-source) in a moving system:

$c' = \dfrac{2\vec{c} \cdot \vec{c}}{\vec{c} + \vec{c}}$, where c'—the harmonic mean value. For more information, see [5] and at the Internet address:

http://rhythmodynamics.com/index_files/presentanion.htm.