THE PRINCIPLE OF EURHYTHMY
A KEY TO THE UNITY OF PHYSICS

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Abstract: The unification of the basic physical laws, from classical physics, quantum physics to gravitic physics seems now possible. The key for this unity is the principle of eurhythmy, literally from the Greek, the principle of the most adequate path. It will be shown that Heron principle of minimum path, Fermat´s principle of minimum time and de Broglie´s guiding principle are no more than mere particular cases of the principle of eurhythmy. Furthermore, it will be shown, with concrete examples, from classical physics, quantum physics to gravitic physics, that all these branches of physics can be unified and understood in a causal way as particular cases of this general principle.

Keywords. Principle of eurhythmy, unity of physics, fundamental physics, Fermat´s principle of minimum time, de Broglie guiding principle.

1. Introduction

The aim of Physics has always been the Unity. This ideal means that physicists look for a very basic principle, from which it would, at last in principle, be possible to derive all particular laws for describing the physical reality at different scales of observation. Presently in physics we are faced with two independent, even opposite, domains, the said classical domain and the quantum realm. The principle of eurhythmy[1] comes from the Greek ***euritmia***, which is the composition of the root *eu* plus *rhythmy*. With *eu* standing for the right, the good, the adequate, and *rhythmy*, for the way, the path, the harmonic motion. The composed word meaning: the adequate path, the good path, the good way, the right way, the golden path, and so on.

In the present work I intend to show that the principle of eurhythmy is, indeed, a basic key for the understanding of the whole physical world.

2. Some basic principles

One of the first principles for understanding the physical world was discovered by Heron of Alexandria back in the first century A.D. In order to explain the refection of light

Fig.1 – Reflection phenomena

and derive the respective law Heron established the principle of the minimum path. This principles states that light coming from a point like source S and going to the observer O, after being reflected by the mirror, from the multiple possible paths follows the shorter one.

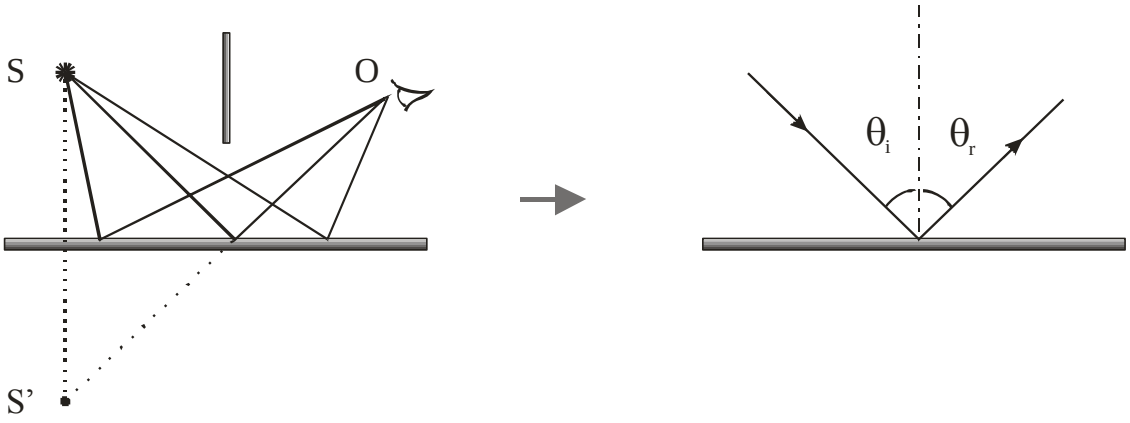

Fig.2 – Heron principle of shortest path

From this principle Heron derived, by geometrical considerations, the reflection law stating that the angle of reflection equals the incident angle, $\theta_i = \theta_r$.

About a millennium and half later, Pierre de Fermat discovered the principle of minimum time. With the help of this principle Fermat was able to derive Snell´s empirical law for the refraction of light. This law describes how light propagates in different optical media. The principle of minimum time states that from all possible paths, from S to O, see Fig. 3, the light follows the path such that the time taken in the whole course is minimum.

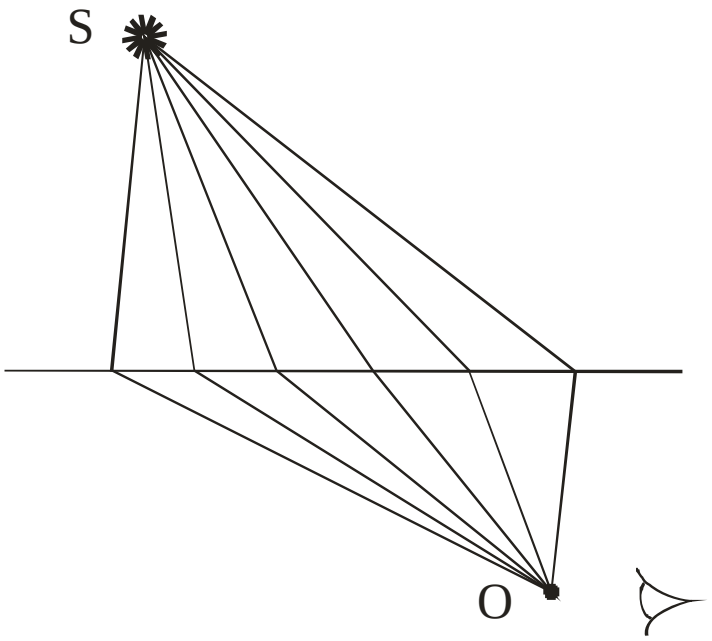

Fig.3 – The principle of minimum time

This principle of minimum time says that the light coming from a point like source, the point S, to reach the observer at point O, after travelling through two different optical media, follows a path such that the time taken in the whole course is a minimum.

That is the light behaves in such a way that it "chooses" from among all possible paths the one that takes less time. From this principle Fermat derived the Snell's law for the transmission of the light in different optical media. The basic idea behind this principle of minimum time is that the light that goes from point S to reach point O, after travelling through different optical media, where it has different velocities follows, from all possible paths, the one that takes less time. In short, this natural entity we call light, "chooses" the best, the most adequate path, that is it follows the principle of eurhythmy.

In these conditions light seems to behave much like the human beings when they have to go from on point to another. Suppose you happen to be in the centre of Lisbon, the Chiado for instance, and want to go to Almada city, at the other side of the Tagus River. The shortest way to go is by the 25 de Abril bridge. Nevertheless, we are in the summer time and too many people want to go to the beaches to enjoy the sea and the sun so, at the moment, there is one of the biggest jams at the 25 de Abril bridge. Aware of these facts, instead of trying to go through the shortest path, by the 25 de Abril bridge, you went by Vasco da Gama bridge. You made this choice because even if this alternative path is three

or four times longer you arrive sooner at you destination, the city of Almada, because you can travel much faster.

In the case of the light it travels the shortest possible path in the medium where its velocity is slower, and the longest path in the medium in which it can travel faster so that, at the end, it takes the less possible time on going from one point to the other.

Naturally, Heron principle of the shortest path is a particular case of Fermat's principle of minimum time. This is easily seen because in the reflection phenomena the light travels always in the same optical medium and with the same velocity. In such conditions, the shortest path is the one that takes less time.

The principle of minimum time of Fermat was soon followed by Maupertuis's principle of least action for classical mechanics. These principles were and are commonly named extreme principles. It was shown[2] that classical mechanics can be derived from these principles of extreme. Since these principles are mere particular formulations of the same basic principle, it is only natural to assume that classical physics is nothing more than a consequence of principle of eurhythmy.

3. Nonlinear quantum physics

At the beginning of the twentieth century physicists were faced with two apparently contradictory ways for the observed behaviour of nature[3]. At the quantum scale of observation things seemed to occur in a different strange way. A quantum entity, such as an electron or so, shows on the one hand corpuscular properties of localization and by the other hand extended wave-like properties.

In order to make things a little concrete and size the real problem let us look briefly at the well-known double slit experiment.

3.1. Double slit experiment

Since the beginning of quantum physics the double slit experiment has played a most important role in the conceptual development of quantum physics. Consequently this experiment has been done and redone many times, with different quantum entities, like electrons, photons, neutrons, atoms, molecules, and so, giving always the same result.

The experiment runs like this: a source of quantum entities, of electrons for instance, emits one at a time. This means that in the whole apparatus only one and only one electron is present at each instant of time. This basic requirement is made in order to avoid any possible interaction with other electrons.

Let us consider this fundamental experiment, sketched in Fig.4.

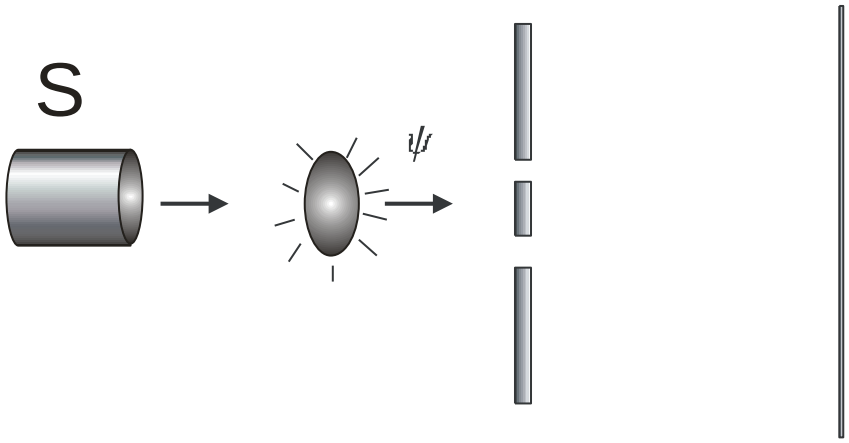

Fig.4 – Double slit experiment.

The electron in its way encounters a screen with two slits. If one places a detector right behind each slit what is to be expected?

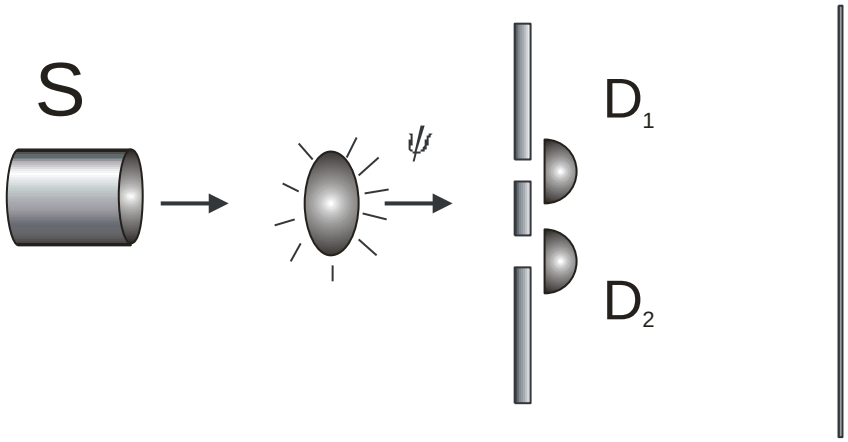

Fig.5 – Double slit experiment with two detectors.

It happens that sometimes one detector is triggered and at other times it is the second detector that is activated. In any case, and here is the point, it never happens that the two detectors are activated at the same time. Naturally, this situation can never be expected to occur since we are dealing with one single electron at a time. In the whole apparatus, for each event, there is only one single quantum particle. If this basic conceptual and practical requirement is not met the experiment is meaningless. Therefore, from this first analysis the observer would conclude that the electron would go through one slit or the other.

Now, if one removes the two detectors from the slits, and places a large array of detectors sufficiently far away in the route of the particles that went through the slits, what is to be expected? What shall be the distribution of impacts of the electrons on the array of detectors?

If one maintains the previous affirmation that the electron went by one or the other of the slits, then one would expect a continuous bell shape gaussian distribution of impacts on the detector.

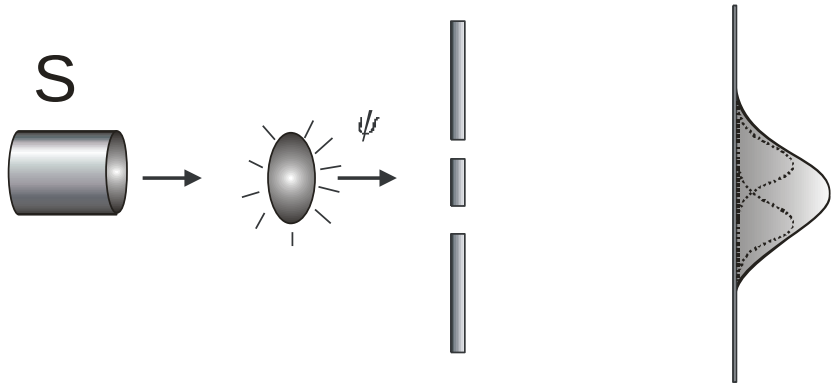

Fig.6 – Double slit experiment with corpuscles.

That is, if the electron behaves only like a corpuscle entity the observed distribution would result from the contribution of electrons that sometimes come from one slit, plus the contribution of the corpuscles that, at other times, come from the other slit.

Still, experimental evidence clearly shows that instead of a continuous gaussian pattern, what in fact is observed is an interferometric pattern as shown in Fig.7.

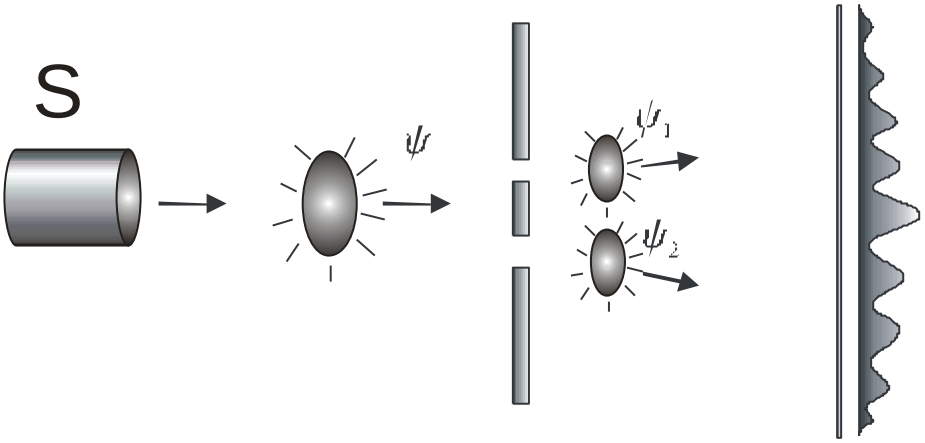

Fig.7 – Double slit experiment.

In order to explain the observed interference pattern one has to assume that the quantum particle, in this case the electron, has somehow gone both ways. An interference pattern is always a result of the superposition of at least two waves. This means that the quantum entity we call electron went through both slits. Under these conditions we have to conclude that the electron must be a wave.

Now we have a problem!

The first experiment, with the detectors placed behind the two slits, indicates that the electron is a kind of localized entity, that is, a corpuscle that went though one slit or through the other.

The second experiment leads us to conclude that the electron is an extended entity, a wave, because it went through both slits at the same time giving origin to an interference pattern.

Therefore the quantum entity we call electron must have a very weird behavior: It has to pass through one slit **or** the other and also must go, at the same time, through **both** slits.

Summarizing: In the single particle double slit experiment the quantum particle must pass:

1 – through one slit **or** the other slit.

2 – through one slit **and** the other slit

How can this be possible! Is it possible to find an explanation for this apparent logical contradiction for the behavior of nature at the quantum level?

3.1.1. Orthodox interpretation

When we have a very tough problem to solve, in general, the first and even the easiest approach evolves a process which, in the whole, is very similar to those used by mankind in all times, since the beginning of history till now. When faced with the very complex problems posed by the everyday life, due to the enormous difficulty in finding a correct natural, causal and rational explanation, the first approach is, in general, to get help from what is usually named, the unknown, the occult, the transcendental, the mysterious and the weird forces of nature. First one looks for some kind of regularities, pattern repetitions then tries to formulate some first rough empirical laws. The next step is finding some kind of justification for them. Most times, as we well know, mainly due to the difficulty in finding a causal rational explanation, or even by an inner desire, these first pseudo-justifications involve Godlike transcendental justifications. If it was found that at a certain place and at a certain epoch of the year it usually rained then it certainly was because that was the will of the Gods or of other similar powerful transcendent entities. Trying to find a causal and rational explanation for the natural phenomena was, in the best case, a pure loss of time because there was nothing more to look for. To solve the problem of the dualism wave-corpuscle posed by nature, at the quantum scale of observation, the first idealistic approach for finding a solution was made much in a similar way.

In order to conciliate the two apparently contradictory affirmations resulting from the complex quantum behavior, Niels Bohr developed in 1927 his famous principle of complementarity. This principle assumes that a quantum particle has two dual and opposite natures. Sometimes quantum entities show the undulatory extended nature, other times the corpuscular localized properties. The two properties never showing at the same time. According to the experiment some times we observe the corpuscular localized properties other times undulatory extended properties. These two opposite properties are a direct consequence of Fourier ontology[4]. This ontology claims that only the infinite in time and space harmonic plane waves do have a well definite frequency. All other finite waves are necessarily a composition of infinite harmonic plane waves. In this conditions the more a quantum entity is localized de more harmonic plane waves are necessary to build it. In the limit when the position of a quantum entity is known with absolute precision, the number of harmonic plane waves necessary to make that structure is infinite. This means that if we know the position of a quantum particle without error them, the same very single particle

has a infinite number of frequencies and consequently all possible energies. Inversely, if the energy of the particle is known without error, we are in the other extreme. Therefore only one single harmonic plane wave is necessary to describe it. In such conditions the position of the quantum particle is completely unknown because it indeed occupies all space and time.

So in this idealistic approach, in the double slit experiment those two opposite properties of quantum systems manifest clearly one at a time:

a) When the detectors are placed in front of the slits and only one of the two is fired the quantum particle exhibits its corpuscular nature.

b) With the detectors removed, the electron passes through both the two slits showing the undulatory characteristic in order to produce the observable interference pattern.

Therefore in the Copenhagen, or Borhean, interpretation of the quantum physics the double slit experiment can be interpreted in a general idealistic conceptual framework in the following way:

The quantum particle is to be described by a probability wave, containing all information on the quantum system. This wave goes in direction of a screen with two slits. There the initial wave splits into two probability waves one coming from slit one the other from slit two. These two waves, coming from the slits, are directed to the detection region where they overlap. The detection region is usually composed of a large array of detectors. When the composite wave, which is the sum of the two, arrives at the detection zone one small detector from the array is triggered. The distribution of the clicks, corresponding to the successive arrivals of electrons, follows an interference pattern distribution given by the squared modulus of the total probability wave.

Therefore in order to explain and predict the result from the double slit experiment Bohr denies the very existence of the objective reality. Before measurement the entity we call electron, does not exists really. What exists is only a bunch of two potential electrons, one coming from slit one the other from slit two. One of these potential electrons can eventually be made real by the act of measurement. The whole conceptual orthodox theoretical construction is made upon these idealistic ideas.

3.1.2. Causal interpretation

Even if it seems difficult to understand the apparent strange behaviour of the quantum entities a causal, rational, beautiful and intuitive, explanation for the apparent logical contradiction posed by the double slit experiment is possible.

Contrary to the Borhean proposal this explication starts from the basic assumption that there is an objective reality from which the observer is a part. In order to coherently follow this causal program it is necessary, from the very beginning, to deny Fourier ontology. In these circumstances we accept as natural that a finite wave, after all al real waves are finite, may have a well definite frequency. So a single quantum particle which position is known with good precision can, consequently, have a single value for the

energy. The mathematical tool that allows us to build this causal model only recently was developed and is called local analysis by wavelets[5].
It was the great physicist Louis de Broglie, in the twenties of the XX century, the one who advanced the first rational explication for the riddle posed by the double slit experiment. De Broglie proposed that the thing we call a quantum particle, implicitly assumed to be a single point like structure is indeed a very complex entity. In his view a real quantum particle is composed of an extended, yet finite, part, the wave, plus a very localized and indivisible structure, the corpuscle. Later[3] this early model was developed and the quantum particle is now mathematically described by a wavelet solution to a nonlinear master equation that describes both extend and localized properties.

Commonly, this wave is named theta wave and the localized structure singularity or the corpuscle. The following drawing, Fig.8, tries to picture a causal quantum particle.

Fig.8 – Graphic representation of a quantum particle.

For all practical purposes the energy of the quantum particle is the one of the singularity. The energy of the theta wave is so small that the common detectors are unable to see it. Now a question arises! How are the wave and the singularity related?

4. The principle of eurhythmy

The answer to the last question is given by the principle of eurhythmy. Initially, the relation between the theta wave and the singularity was named by de Broglie as the guiding principle. Meaning that the singularity is guided, through a nonlinear process, preferentially to the regions where the theta wave has higher intensity. Still this name does not give full

account of the complex physical process involved. What really happens is that the singularity, or the corpuscle, necessarily immersed in the theta wave field when moving randomly from one point follows, in average, the best possible path. The best possible path is the one where the theta wave has higher intensity. So, in reality it is not a simple action of guiding. The theta wave naturally guides the corpuscle, but this guiding action is of a very special kind. The theta wave, in reality, guides the singularity to the best possible path, the average path where the intensity of the theta wave is greater. The singularity avoids the regions where the intensity of the theta field is null because in these regions its very existence is in danger, in the sense that in such zones the corpuscle needs to regenerate the surrounding field at the expenses of its own energy. Therefore the motion of the corpuscle in the theta wave field follows always the best possible path, the most adequate path, that is, the average motion follows the principle of eurhythmy. It is assumed, of course, that any corpuscle, as long as it keeps existing, has an inner energy of its own and furthermore keeps always in motion with a natural velocity. The corpuscle moves incessantly, in the theta field, with an instantaneous huge velocity, called the natural velocity. Nevertheless, due to the chaotic nature of the subquantum field the average velocity, which is the observed velocity, can go from zero to the natural velocity.

In these circumstances the principle of eurhythmy unifies by the one hand the principle of minimum time of Fermat and the guiding principle of de Broglie, by the other hand it gives them their true natural deep meaning.

Let us now see briefly how the principle of eurhythmy explains in a clear and beautiful way the double slit experiment.

Fig.9 sketches the experiment where, as always, the source emits a single quantum particle composed, as we have seen, of a wave plus the corpuscle.

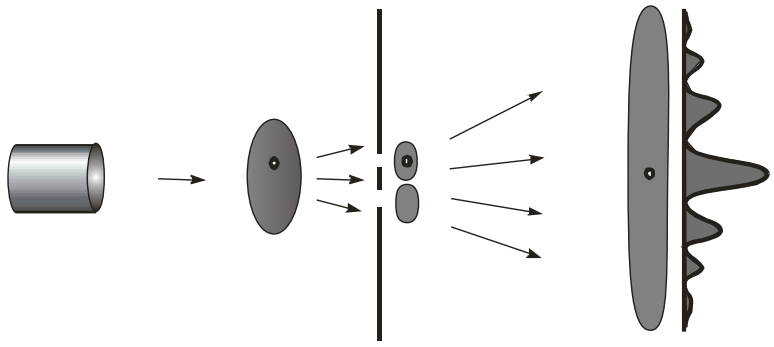

Fig.9 – Double slit experiment explained by the principle of eurhythmy

When the particle arrives at the screen with the slits the extended theta wave field crosses the two slits simultaneously. The very much localized and indivisible corpuscle follows through one slit or the other going immersed in one theta wave or in the other. These two theta waves, one with the corpuscle, the other without it, in theirs natural courses spread in such a way that they overlap, giving origin to a total single theta wave in which the corpuscle is immersed. This total theta wave, being the composition of the two individual theta waves coming from the slits has, as we well know, a distribution of intensity with an interferential form.

Now, the principle of eurhythmy tells us that the corpuscle, among all possibilities, chooses to be localized preferentially at the regions of the space where the intensity of the theta field, the total theta wave, has higher intensity. In these conditions, the first corpuscle arrives at the detection region giving origin to a single click. The position of the click follows naturally the principle of eurhythmy, that is, is localized preferentially in the regions where the intensity of the total theta wave is greater. The following arriving corpuscle follows precisely the same principle. The next do the same. So, as the time goes, the distribution of clicks in the target detector starts gradually getting a net form. In such conditions, at the end, a clear and stable interference pattern becomes perfectly visible. This interferometric pattern is, of course, a perfect copy of the form of the total theta wave intensity field.

In this way, the apparent logical contradiction faced by physicists at the first quarter of the twentieth century for the quantum particle needing to pass by:

1 – One slit **or** the other
2 – One slit **and** the other

is satisfactorily solved in a most clear way.

This natural explanation, beautiful and intuitive, can be summarized in the following way:

1 – The indivisible corpuscle passes through -- One slit **or** the other.
2 – The extended theta wave passes through -- One slit **and** the other.

As we have seen it is perfectly possible to comprehend the apparent mystery posed by nature at the quantum level of description without any need to get help from transcendental or mystical forces and furthermore without any necessity of denying the existence of the objective reality. What was necessary, to solve the problem, was imagination and above all the believe that mankind can, progressively, unfold the apparent mysteries posed by nature.

5. The principle of eurhythmy and gravitation

Even before the time of Newton[4] many efforts were made with the aim of explaining the gravitic interaction. Namely, the early efforts made by Kepler, and later by Descartes who assumed that planets were carried by vortex (tourbillons) of a celestial fluid. Huygens was the first to propose a mechanism for the gravitation that was supported by calculation. Nicholas Fatio, a friend of Newton, who proposed, in 1690, to the Royal Society of London a corpuscular theory of gravity. Nevertheless it was Georges-Louis Le Sage (1724-1803) who proposed the most developed theory to explain gravity.

We must point out that the laws for describing **how** gravity forces act were known mainly due to the work of Newton. Now the problem to solve was the **why** of these forces. That is, what was behind the known observed behaviour of such natural forces?

Le Sage tried to explain the forces of gravity in terms of his ultramundane corpuscles filling all space and striking the gravitic bodies impinging on it a pushing force. An isolated body would not move, see Fig. 10,

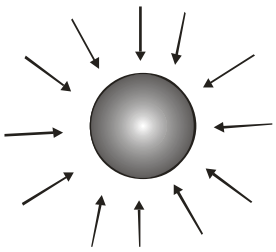

Fig.10 – An isolated body does not move due to the conjugated action of the pushing force

due to the symmetric conjugated action of equal and opposite pushing forces of the ultramundane corpuscles. Nevertheless two bodies, Fig.11

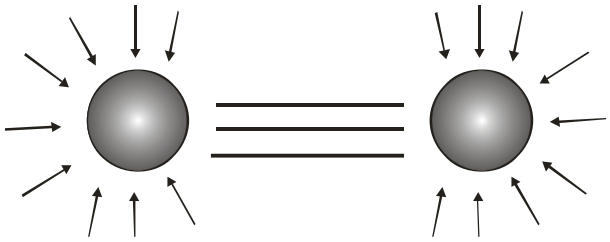

Fig.11 – Two bodies approach due to the mutual shielding action

each one making a kind of shield to each other so that at the end the net effect was that they approach each other. It is possible to show that this overall pushing force acts according to Newton attraction law of the inverse of the square of the distance. This theory of Le Sage knew a certain amount of success till the late XIXth century. Then, it was shown, using statistical physics, that this theory had a big problem with the principle of conservation of energy. In the second half of the twentieth century there were made various attempts of revival of Le Sage pushing theory using either corpuscles or waves. Still, all those attempts had problems with the principle of conservation of energy, even if some authors tried to devise ingenious ways of overcoming the problem. In reality none of those gravitational theories based on a crude force impinging on the gravitic bodies worked well. To make the thing worse all those theories lacked a unitary approach for explaining physical reality.

Now thanks to the principle of eurhythmy the route for understanding the gravitational phenomena is open.

The basic idea is very simple. Just like in nonlinear quantum physics the concept of quantum particle means a multifaceted body, in gravitic physics the fundamental gravitic particle is also a very complex entity. The concept of particle in this new unitary physics involves implicitly a chaotic interaction between the singularity and the theta wave described by the principle of eurhythmy. The gravitic basic particle also shares the same fundamental nature. Thus the fundamental gravitic particle is composed of a wave plus a singularity, the graviton. The gravitic corpuscle being immersed in the field of the theta wave is subject to a permanent chaotic motion. This motion proceeds according to the

principle of eurhythmy. That is, the graviton chooses to be preferentially at the points where the theta gravitic field has higher intensity. In this conditions an isolated single graviton immersed in its gravitic theta wave, due to the radial symmetry of the field in all directions, has also equal probability of moving in all directions, therefore its mean velocity is equal to zero. Even if the graviton moves with a huge instantaneous velocity in each chaotic jump, its mean velocity is, nonetheless, zero, see Fig.12.

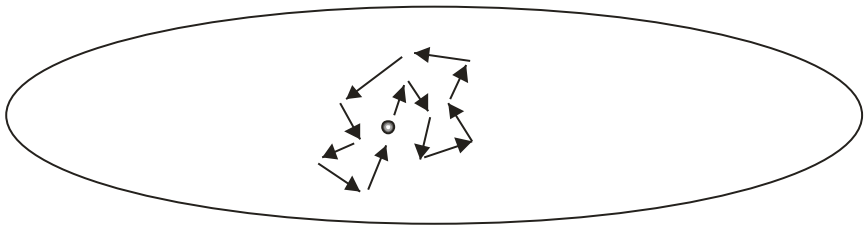

Fig.12 – Gravitic particle. The singularity moves chaotically in the theta wave field preferentially to the points of higher intensity following the principle of eurhythmy.

When we have two gravitic particles, occupying partly the same region of space, their respective theta waves overlap, see Fig.13.

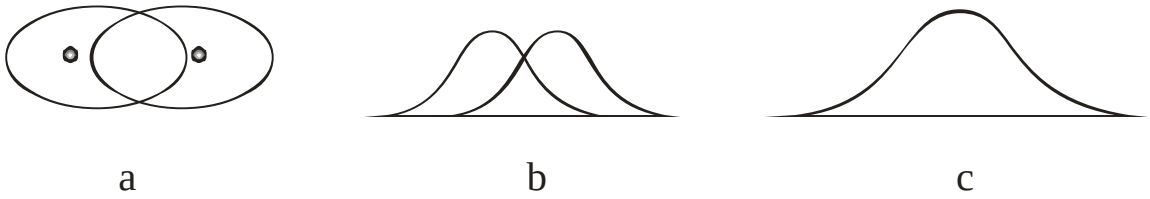

Fig.13 – Overlapping of two single gravitic particles, a). Section of the radial average intensity of the individual theta waves, b). Overall average intensity of the theta field resulting from the composition of the two theta fields, c).

The average theta field is the result of the composition of the two single theta fields. In such circumstances, the two gravitons, immersed in the total theta field, each one moves preferentially to the points where the field has higher intensity, according to the principle of eurhythmy. Consequently due to the distribution of the total theta field, which is a composition of the two individual theta waves, the two gravitons, approach each other. The form of the total theta field, as can be seen from the drawing Fig.13, c), has intensity greater along the line connecting the two single theta waves. Using the old classical language we would say the two gravitons attract each other. That is, due to the nature of the resulting theta wave field, in average the gravitons move in a direction that leads them to approach each other.

The common gravitic bodies are no more than a huge composition of many gravitic particles. The composition of this large number of individual theta waves gives rise to a total theta wave field where the gravitons, the gravitic singularities, move according to the principle of eurhythmy. In fact, assuming that the total average theta field has

approximately a linear variation in the neighbourhood of the Earth, it is possible to derive the law of Galilee. This law says that a body falls to the Earth in such a way that the travelled spaces are proportional to the squares of the time taken.

6. Conclusion

It was shown that the principle of eurhythmy is indeed the very basic conceptual tool for the understanding of the whole physical world in a natural way. In reality this basic principle promotes the very unity of all branches of physics. All physical theories, classical physics, including electromagnetism, quantum physics, and gravitic physics, are only particular cases of the application of the principle of eurhythmy. Still, we ought to be aware that the principle of eurhythmy does not in any way goes against the principle of conservation of energy, on the contrary. Yet this principle is a step ahead in the comprehension of the natural phenomena. There is a much more fundamental and important level of order in Nature described precisely by the principle of eurhythmy.

In this natural causal physics, valid at the diverse scales of observation, united by the principle of eurhythmy, there is a kind of average determinism. Nevertheless and in reality, this does not stand for a complete determinism. At the level of single individual, or even few, physical entities there are always an omnipresent unpredictable chaotic motion. Therefore, as a natural consequence, at the level of the single or few entities there is no determinism. We can not predict the behaviour of the single entities. What we can predict is simply the overall behaviour of a large multiplicity of physical entities.

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