The Unity of Physis

José Nunes Ramalho Croca [1]
(Departamento de Física, Faculdade de Ciências,
Centro de Filosofia das Ciências, Universidade de Lisboa)

1. Introduction

In this paper, a sketch of proposal for a global, epistemic, unifying vision of physics is advanced. It aims to present a new way of looking at nature, the *Physis*, based on the organizational genetic principle of eurhythmy. In this perspective, traditional physics — quantum physics, relativistic physics and classical physics — can all be seen as a particular operational case of the new relational nonlinear physics of the complex. Moreover, New Physics — the eurhythmic physics — also aims to establish a deep interconnection between the commonly labeled hard sciences and the soft sciences dealing with complex systems. Among these so-called soft sciences, we may mention humanities, psychology, sociology, economics, etc. In these sciences, which essentially deal with complex systems, the whole is in general quite different from the sum of its constituent parts. In these conditions, they are not generally liable to a reasonable treatment within the traditional simplistic Cartesian linear conceptual framework.

Nature – that is, *Physis* – is one, so the main objective of natural philosophers, or physicists working on foundational issues, has always been the search for this hidden Unity. This objective underwent a great leap

[1] jncroca@fc.ul.pt

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between the sixteenth and the eighteenth centuries due principally to the work of great thinkers. From these we may point out, Giordano Bruno[1], Galilee[2], Descartes[3], Newton[4] and many others. This great conceptual and experimental effort gave place to a change in the way we looked at nature, thus giving origin to the emergence of the mechanical paradigm.

Nevertheless, at the beginning of the twentieth century, experimental evidence clearly showed that this first approach needed to be improved. From the large amount of experimental evidence, gathered in the diverse fields of physics, the mechanic paradigm seemed inadequate to treat those situations. The problems appeared mainly at very short time scales and spatial scales. In very short time scales, related with great velocities, namely the velocity of light, it was seen that the linear additive law for velocities no longer hold. In order to deal with these difficulties special relativity was born[5]. The experimental problems raised at very short spatial scale, in the domain of microphysics, gave origin to the development of quantum mechanics[6].

Still, and here lies the important point, the basic goal, the unity of physics, was in a certain sense broken. In fact, quantum mechanics and relativity are opposite theories.

Relativity is a causal theory which gives primacy to time and space or more precisely to their intimate relationship, spacetime. Quantum mechanics, traditional quantum mechanics, is a non-causal indeterministic theory in which space and time do not play a significant role.

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[1] Giordano Bruno, *La Cena de le Ceneri*, a cura di Giovanni Aquilecchia, Torino: Einaudi, 1955.

[2] Galileo Galilei, *Dialogues Concerning Two New Sciences*, translated by Henry Crew and Alfonso de Salvio (originally published in 1914), New York: Dover Publications, 1954.

[3] René Descartes (1626) *Règles utiles et claires pour la direction de l'esprit en la recherche de la vérité*, la Haye: Martinus Nijhoff, 1977; *Idem, Discours de la Méthode pour bien conduire la raison et chercher la vérité dans les sciences*, s.l.: French & European Pub., 1990.

[4] Isaac Newton (1726), *Philosophie Naturalis Principia Mathematica,* English trans. I. Bernard Cohen and Anne Whitman, "The *Principia*. Mathematical Principles of Natural Philosophy, A New Translation" [Principia - ed. Cohen], Berkeley and Los Angeles: University of California Press, 1999.

[5] Albert Einstein, *On the electrodynamics of moving bodies*, translation from *Zur Elektrodynamik bewegter Körper*, in *Annalen der Physik*. 17 (1905):891, in *The Principle of Relativity*, Methuen and Company, Ltd. of London, 1923.

[6] Niels Bohr, *Nature*, 14 (1928):580; *Como Lectures, Collected Works*, Vol. 6, Amsterdam: North-Holland, 1985.

Nevertheless, even with all its conceptual contradictions, these two fields of physics were applied, with relative success, during all the twentieth century.

Happily, the end of the last century and the beginning of the twenty-first century gave rise to a new hope for a more general epistemic unification, not only of physics but also of all sciences. Recent results, coming from very accurate and rigorous experiments, have shown to evidence the supreme need of a new paradigm. In the field of relativity, the discovery of superluminal velocities[7] indicates clearly the necessity of change. On the other hand, in quantum mechanics it was shown[8] that its basic cornerstone of it, the famous relations of Heisenberg, failed to be adequate to describe certain quantum phenomena such as the working of the new imaging devices. The resolution attained in practice by these new imaging devices, the super-resolution microscopes[9], goes far beyond the reach of Heisenberg relations.

The development of this body of knowledge — classical physics, relativity, and quantum mechanics — was mainly based on mainly based on the linear Cartesian framework in which the whole is equal to the sum of the constituent parts and, furthermore, the reaction is proportional to the action. In this way of looking at natural phenomena what is assumed is the absolute general validity of the principle of superposition, the scale invariance and the infinite division, where true emergence has no place.

Now, for better understanding Nature, at very short time scales and spatial scales, at a deeper level – in order to overcome the difficulties posed by the Cartesian linear method – it is necessary to develop new more general approaches for physics.

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[7] See for instance: G. Nimtz, A. Enders and H. Spieker, *Wave and Particle in Light and Matter*, ed. by Van der Merwe and A. Garuccio, New York: Plenum, 1993; G. Nimtz, Phys. Rev B 47 (1993):9605; A. Enders Recami, Found. Phys. 31 (2001):1119.

[8] J.R. Croca, *Towards a Nonlinear Quantum Physics*, London: World Scientific, 2003; J.R. Croca, "Experimental Violation of Heisenberg's Uncertainty Relations", talk at the 5th UK Conference on the *Conceptual and Philosophical Problems in Physics*, at Oxford, Sept. 1996; J.R. Croca, Hadronic Journal 22, 1999:29-39 ; J.R. Croca and F. Selleri, Comm. Math. Theor. Physics, vol. 2 (1999):61-69.

[9] G. Binning and H. Roher, *Reviews of Modern Physics*, 59 (1987):615; D.W. Pohl, W. Denk, and M. Lanz, *Optical stethoscope image recording with resolution λ/20*, Appl. Phys. Lett. Vol. 44, n. 7 (1984):651.

In this sense a global nonlinear physics of the complex, the Eurhythmic Physics, has been recently developed[10] to explain and predict new experimental evidence and, at the same time, promote the true unity of all domains of physics. Naturally, we must be aware that this new physics of the complex in any way denies the great achievements of traditional physics, classical physics, relativity and quantum mechanics. At their scales of applicability they were, and still are, very good theories. What is wrong is the naïve belief that these traditional theories, mere human constructions, built at a certain time from experimental evidence, seen with the conceptual tools then available, are the last, the final and definitive theories.

2. Eurhythmic Physics

Here we shall briefly present the fundamentals of the nonlinear physics of the complex. Eurhythmic Physics was developed based on five basic assumptions. They are here called assumptions not postulates, as commonly expressed in relation to other theories, because we are quite aware they are no more than simple assumptions. Nevertheless, the advantage of these assumptions lies in the concrete fact that they will allow the development of a new more general and global unified physics. This new more general physics not only permits us to better understand and integrate the traditional linear Cartesian physics but also allows us to disclose a whole new universe of experimental and technological possibilities...

First assumption:

There is an objective Reality. This reality is observer independent. Still the observer reciprocally interacts with the very same reality being modified and, of course, modifying It in a greater or lesser degree.

Second assumption:

There is a basic physical natural chaotic medium named the subquantum medium. All physical processes that occur are emergences of this natural chaotic medium. By chaotic medium, it is understood a medium

[10] J.R. Croca, *Eurhythmic Physics, or Hyperphysics, The Unification of Physics*, Berlin: Lambert, 2015.

in which, in general, it is not possible to make predictions. This subquantum medium is, in some way, alike to the *Apeiron*, the indefinite medium of Anaximander. The subquantum medium is the true real being, the one which exists by itself.

Third assumption:

Physical entities, like particles and fields, are more or less stable organized states of the basic chaotic subquantum medium.

Fourth assumption:

In general, the complex physical entities, the particles, are very complex relatively stable organized states of the subquantum medium. They are composed of an extended, yet finite, region — the theta wave — and inside there is a kind of relatively very small localized structure — the acron.

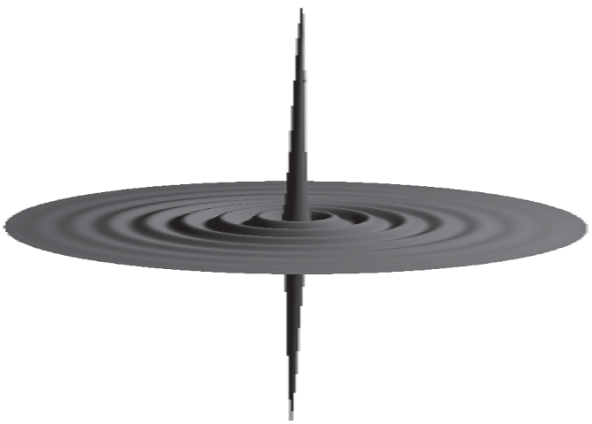

Fig. 2.1 – Sketch of a complex particle.

Fifth assumption:

The principle of eurhythmy. This basic organizing principle, allows the making of mathematical predictions. It states that the acron moves chaotically in the theta wave field following a stochastic path that in average leads it to the regions were the intensity of the field has greater intensity.

The principle of eurhythmy[11] comes from the Greek *euritmia*, which is composed by the root *eu* plus *rhythmy*. The prefix *eu* stands for the right, the good, the adequate, and *rhythmy*, for the way, the path, the harmonic motion. The composed word thus means: the adequate path, the good path, the good way, the right way, the golden path, and so on.

As it may be easily understood, the principle of eurhythmy is only meaningful in the context of complex systems. Even in the limit case of the fundamental acron, the situation is basically the same. Indeed, even this minute entity is already a very complex organized structure of the subquantum medium. The principle tells us that the acron transits from one state of the theta wave field to another, but not in a deterministic way. This means that it is not possible to predict the future state of the acron neither from the basic theory nor due to the multiple highly complex interactions with the surrounding medium. This impossibility of predicting the future state of the acron, even in principle, is described through a chaotic interaction between the acron and the theta wave field. Still, one must be aware that it does not stand for an ontological truth but only for a mere operational pragmatic statement. Furthermore, in order to better clarify the meaning of the basic assumptions, it should be kept in mind that here the concept of chaos refers to an epistemological chaos and not to an ontological one. In any case, this basic principle tries to describe very complex reciprocal interactions so that, even in principle, it is not possible, at least at this stage of description of the physical reality, to predict with certainty the next outcome. Yet, even if there is an inherently practical impossibility of predicting the next state of the acron, it is nevertheless possible to establish an overall statistical tendency or propensity for the acron to reach the next stage. This fact naturally leads to the practical formulation of the principle of eurhythmy which has the great advantage of allowing an easy mathematical formulation. Thus, in this sense, and under the recognized approximations, the principle of eurhythmy states that the acron transits from a previous state to the next state in such a way

[11] The Greek name *eurhythmy* for the basic principle of Nature was suggested to me by my dear friend Professor Gildo Magalhães.

that the transition probability is proportional to the intensity of the theta wave field.

On the other hand, due to the highly complex nonlinear nature of the phenomena, from one scale of observation and description of the Physics to the next, it should also be kept in mind that the properties of new emergent complex entities — even if they are a composition of parts — cannot, in general, be derived from the properties of the building elements. This statement is a simple consequence of the fact that the composite parts interact and therefore modify themselves reciprocally in a greater or lesser degree. In such conditions, the whole, the resulting emergent entity, has properties of its own. The best we may aim is to predict, in certain particular given conditions, the emergence of a new physical entity and, if we are fortunate enough, some of their general broad properties.

The principle of eurhythmy is a basic key for the understanding of the whole physical world. Indeed, this principle has been generalized by some authors[12] to include other sciences, for instance biology.

3. Some consequences

From those assumptions it is possible to develop Eurhythmic Physics. The interested reader may check footnote 10 for particulars. In this paper, we shall refer only a few consequences of this new way of looking at Nature. We shall now see that some very important concepts of traditional physics, such as Force, Masse and Charge, are indeed not basic fundamental concepts. They are simple derivable useful notions adequate only at their proper scale of application and description of *Physis*.

[12] R.N. Moreira, "The Crisis in Theoretical Physics, Science Philosophy and Metaphysics" *in* J.R. Croca and J.E. Araújo (eds.), *A New Vision on Physics, Eurhythmy, Emergence and Nonlinearity*, Lisboa: CFCUL, 2010, pp. 255-312; G.M. Santos, "On Eurhythmy as a Principle for Growing Order and Complexity in the Natural World" *in* J.R. Croca and J.E. Araújo (eds.), *op. cit.*, Lisboa: CFCUL, 2010, pp. 1-106.

3.1 The concept of force

The concept of force plays a capital role in traditional physics. Indeed, forces, be it gravitic, electromagnetic, or any other, are assumed to be the most basic and fundamental interactions in Nature. Now, in the physics of the complex, the concept of force has a much less important role.

Due to the nature of the complex particle, composed of a wave plus the acron, the traditional concept of force, be it attractive or repulsive, may be understood in a very easy and intuitive way. The theta wave field of a relatively isolated particle has approximately a radial symmetry. In these circumstances, the acron immersed in this field moves in a random way according to the principle of eurhythmy. Since the probability of moving in each direction is the same, in average, the acron remains still.

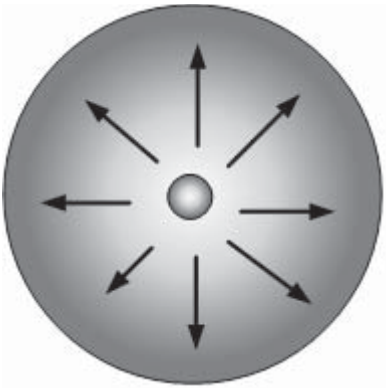

Fig. 3.1 – Due to the radial symmetry of the theta wave field intensity the acron does not move in average.

When there happens to be two particles placed in such a way that the two theta wave fields overlap, the resulting field intensity increases in the overlapping region and consequently the radial symmetry of the intensity previously "seen" by the acra is broken (see Fig 3.2). In this situation, according to the principle of eurhythmy, the acra naturally tend to approach each other. This is what is commonly called attraction, or attractive force.

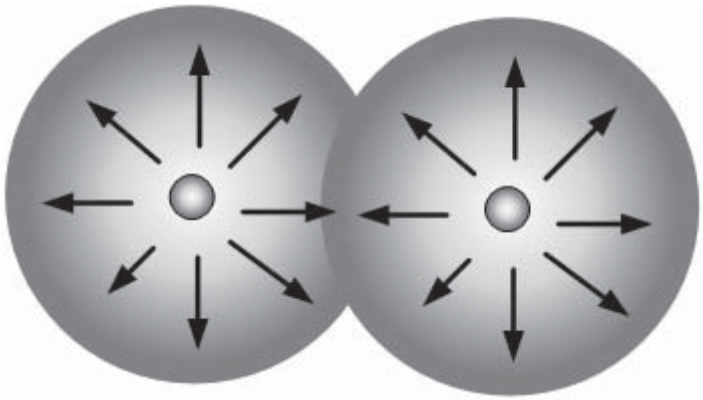

Fig. 3.2 – The symmetry of the theta wave field intensity is broken and the acra tend to approach.

It is possible to show[13] that when not very near to the central positions the average motion of the acra is approximately described by the common attraction force law varying with the inverse square of the distance.

The repulsion, or repulsive force, happens when, due to a nonlinear interacting complex process, the waves overlap in phase opposition. In this case, instead of increasing, the global intensity decreases. In such conditions, the acra tend, according to the principle of eurhythmy, to draw apart from each other.

3.2 The concept of mass and charge

In traditional physics, the concepts of mass and charge also play a major role. In fact, they have been assumed to be the most basic fundamental properties of the particles. Now in the more general framework of nonlinear physics, these concepts no longer have the same status. Indeed, as it was shown[14], they are only secondary derivable concepts more or less adequate according to the physical situation we want to describe. In order to understand this last statement, it is convenient first to analyze briefly how the complex particle moves when injected in a relatively large theta wave field of approximate constant intensity.

[13] R.N. Moreira, *op. cit.*, pp. 255-312.

[14] G.M. Santos, *op cit*., pp. 1-106.

As a consequence of the organizing principle of eurhythmy, the motion of the acron is always relative to the surrounding theta wave field. So, when a complex particle enters a large theta wave field, as can be seen in the sketch shown in Fig 3.3, two extreme cases may happen:

Fig. 3.3 – The complex particle, a small theta wave with an acron, enters a large theta wave field.

a) The relative intensity of the entering theta wave is much greater than the one of the extended theta wave field.

Fig. 3.4 –The large theta wave field with relative feeble intensity.

In this situation, for all practical purposes, the acron completely ignores the extended theta wave field and sees only its own initial theta wave. Suppose now that the small theta wave field of the particle, a photon for instance, enters in a large gravitic field. In this case, this very phenomenon – the acron ignoring the large field in which is immersed – may be interpreted by saying that the particle, the photon, is massless, meaning that, in this situation, the photon is not subject to gravitic interaction. The same conclusion could be drawn if the same photon enters an electromagnetic field. Also in this case we would be lead to say that the photon is a chargeless particle in the sense that it does not respond, interact, that is, does not depend on the electromagnetic field.

b) The relative intensity of the entering theta wave is much less than the one of the large theta wave field, see Fig.3.5.

Fig. 3.5 –The large theta wave field with relative high intensity.

Since the large theta wave field is much more intense than the one of the entering particle, the acron is full sensitive to the extended field. In such conditions, the average motion of the acron practically results from the interaction with the large extended theta wave field. If we are dealing with a gravitic field, the conclusion to draw is that the entering particle has mass. In the case of electromagnetic field, the particle would be said to have charge.

Nevertheless (and here is where the crucial point lies), the same particle could be said to have mass when immersed in a very intense gravitic field or, on the contrary, if placed in a relatively feeble gravitic field, the same particle would not be considered to have mass. So, according to the situation, the very same particle could be said to have or not to have mass or charge. Since the concepts of mass or charge depend on the specific interacting situation, it naturally follows that they do not enjoy a fundamental basic status.

3.3 Genesis Formula

Another consequence of eurhythmic physics that not only has direct physical implications but also applications to other sciences, namely to humanities, is related with the genesis formula,

$$\Gamma = \frac{\nabla I}{I}.$$

This expression, which may be derived from nonlinear complex eurhythmic physics, translates the average velocity, i.e. the propensity for a complex physical entity to move in a theta wave field of intensity I.

In order to have some insight in the deep meaning of the genesis formula let us see what happens to a complex entity when immersed in a theta wave field which intensity increases linearly with the distance,

$$I(x) = ax.$$

The genesis formula, for this particular medium in which the complex particle is immersed, assumes the form in which the intensity of the theta wave field **I** is represented in dashed line and the genesis $\boldsymbol{\Gamma}$ in bold solid line.

$$\Gamma = 1/x.$$

The plot of the genesis $\Gamma = 1/x$ together with the linear increasing theta wave field intensity $I(x) = ax$ may be seen at Fig. 3.6

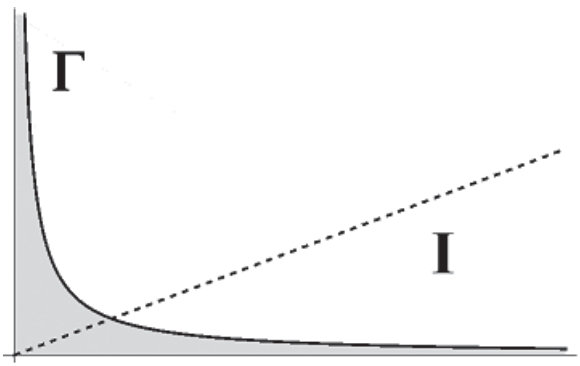

Fig. 3.6 – Plot of $\boldsymbol{\Gamma}$ solid bold line and of linear field intensity **I** dashed line.

For this increasing linear field intensity, the genesis formula tells us that the average velocity of the acron, instead of increasing, surprisingly decreases.

This apparently unexpected interacting behavior of the complex entities is perfectly understood in light of the principle of eurhythmy. Furthermore, this comportment of the complex physical entities has many similarities with the average behavior of the complex systems, namely of human beings.

In order to see the correctness of the statement, consider for instance a possible situation: suppose that there is a person who is very fond of chocolate. It so happens that at the place where this person lives, it is extremely difficult to find chocolates.

One day, this person is agreeably surprised by receiving by post a big parcel containing small chocolates sent by a friend.

The person eagerly opens the box and starts eating the chocolates one-by-one. In the beginning, his eagerness, his propensity to eat chocolates, is great and he eats the chocolates very quickly. Still, as time goes by, his aptitude to eat them keeps decreasing and, after a certain time, he practically stops eating the chocolates.

This happens because the person is full up of chocolates. If he voluntarily did not stop, he would certainly be ill.

In these conditions the genesis formula, in the last instance, describes the natural propensity for the complex entities to move in a eurhythmic way in the medium in which they are immersed.

ABSTRACT

A complex global nonlinear physics, eurhythmic physics, promotes not only the epistemic unification of the known branches of physics but also establishes a deep interconnection with complex human sciences.

Keywords: unity of *Physis* – eurhythmy – eurhythmic physics – nonlinear physics – linear physics – complex entities – emergence – complex human sciences.

RESUMO

Uma física não linear global e complexa, a física eurítmica, promove não apenas a unificação epistémica dos dois conhecidos ramos da física, como também estabelece uma interconexão profunda com ciências humanas complexas.

Palavras-chave: unidade da *Physis* – euritmia – física eurítmica – física não-linear – física linear – entidades complexas – emergência – ciências humanas complexas.