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The concept of mass – gravitic and inertial in eurhythmic physics

J.R. Croca
University of Lisbon
Faculty of Sciences

croca@fc.ul.pt

Gildo Magalhães
USP
Faculty of Philosophy, Letters and Human Sciences
gildomsantos@hotmail.com

J. Alexandre Croca
University of Lisbon
Center for Philosophy of Sciences

josealexandrecroca@yahoo.com

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Abstract: The concept of mass, be it gravitic or inertial, has played a major role in traditional physics. The meaning of the concept of mass and the equivalence between inertial and gravitic mass have been and are object of great polemics in the arena of scientific discussion. In the nonlinear complex inter-relational Eurhythmic Physics, the concept of mass, that has been assumed as a fundamental idea, no longer shares this attribute. In this way of looking at Nature the concept of mass loses its fundamental status being only a relational and, under certain circumstances, useful concept.

Keywords: Eurhythmic physics; classical physics; mass; inertial mass; gravitic mass; equivalence principle; complex particle; complex interaction.

O conceito de massa – gravitacional e inercial em física eurítmica

Resumo: O conceito de massa, seja gravitacional ou inercial, tem desempenhado um papel importante na física tradicional. O significado do conceito de massa e a equivalência entre a massa inercial e gravitacional foram e são objeto de grandes polêmicas na arena da discussão científica. Na Física Eurítmica inter-relacional complexa não-linear, o conceito de massa, que foi assumido como uma ideia fundamental, não compartilha mais este atributo. Nessa maneira de olhar para a Natureza, o conceito de massa perde seu status fundamental sendo apenas um conceito relativo e, em determinadas circunstâncias, útil.
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Palavras-chave: Física Eurítmica; física clássica; massa; massa inercial; massa gravítica; princípio de equivalência; partícula complexa; interação complexa.

1 – **Introduction**

The essence of gravity has puzzled philosophers and scientists for centuries. One of the first to entertain a more fruitful notion of the subject was Johannes Kepler in his introduction to *Astronomia Nova* (1609). There he explained gravitation as a force that attracts two bodies as if they were magnetic, and in proportion to their masses, as he exemplified in the case of the reciprocal attraction of the earth and its moon, or in his explanation of the tides as a result of the attraction of terrestrial waters by the moon and the sun.[1] Shortly afterwards, in *Traité du monde et de la lumière* (written between 1629 and 1633), René Descartes would explain gravity differently, stating that the planets were swirled by vortices in the ether.

It is well known that Isaac Newton (*Principia,* 1687) proposed that gravitation is an attraction force that acts instantly at a distance, i.e., it requires no medium to be transmitted through the space separating any two bodies. Gottfried Wilhelm Leibniz criticized this view of act at a distance as appealing to an "occult" force, which he condemned as being equivalent to a miraculous one. As a result, mathematicians preferred for a time to continue using Descartes' theory of vortices moving the planets in the ether. For example, Jean Bernoulli in 1730 explained Kepler's third law using this Cartesian idea.[2]

It is important to notice that, according to Newton's formulation, the concept of "mass" as a measure of the content of matter in a body has a double role. First, the mass is responsible for the inertial resistance to the acceleration a of the body, when subject to a force F, as conveyed by the equation $m = F/a$. Secondly, mass is the source of gravitation, a particular attractive force, expressed in the form of an acceleration (potential or actual) towards a second body, an acceleration which is independent of the matter content expressed by the gravitational mass of any body. The expression of this phenomenon between two bodies is proportional to the product of their masses divided by the square of their distance. It has long been admitted that a body's inertial and gravitational masses are equal, although there is no fundamental binding for this suggestion.[3]

During the second half of the 18th century, Georges-Louis Le Sage worked on a theory that has elicited permanent attention, despite some periods of oblivion. Taking up in 1748 a proposal previously presented in 1690 by Nicolas Fatio de Duillier, Le Sage explained the force of gravity as the result of tiny particles moving at high speed in all directions throughout the universe, at a constant flux. An isolated object A would be struck equally from all sides by this flux, resulting in no net directional force. With a second object *B* present, however, a fraction of the particles that would otherwise have struck A from the direction of B is intercepted, so B works as a shield, and consequently A will be struck by fewer particles. Likewise, B would be struck by fewer particles from the direction of A. One can say that A and B are "shadowing" each other, and the two bodies are pushed toward each other ("gravitational attraction") by the resulting imbalance of forces.

As a consequence of Le Sage's assumption of a stream of particles, their velocity and therefore the velocity also of gravitation must be finite. Even though, generally speaking, most astronomers admitted that gravitation acts instantaneously, around the beginning of the 19th century Pierre-Simon de Laplace considered the opposite possibility that it propagates with a finite velocity, and calculated that this velocity would be many orders of magnitude above the velocity of light.

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[1]Arthur Koestler. *The sleepwalkers. A history of man's changing vision of the universe.* London: Arkana, 1989, p. 341-345.

[2] John D. North. *The measure of the universe. A history of modern cosmology.* New York: Dover, 1990, p. 25.

[3] Peter G. Bergmann. *The riddle of gravitation.* New York: Dover, 1992, p. 9-11.

Anomalies brought about by the use of Newton's law of gravity annoyed ever more the astronomers, for they were obliged to introduce several correction terms to the original law. The acceleration of the average angular velocity of Jupiter and the deceleration of Saturn were not explainable by that law. In 1779, Laplace took up the problem, and was able to show that these were periodic perturbations, so that the mean motions were stable.[4] The same also applied to the mysterious acceleration of the moon, which Laplace demonstrated that was due to the diminishing eccentricity of the earth's orbit, and would in the future revert to a retardation of the moon's movement round the earth. Still another departure from Newton's law baffled the efforts of scientists, the advancement of the perihelion of the planets, most notably Mercury.

In the 1880's Wilhelm Weber and his disciple Friedrich Zöllner consolidated a theory whereby gravitation had an electromagnetic origin. If the force of electromagnetic attraction between corpuscles of opposite charge were slightly greater than the force of repulsion between corpuscles of like charge, gravitation could be accounted for as the net result of attraction and repulsion, and it could be treated with field concepts similar to those of the electromagnetic field.

Other deviations from the classic gravitation formula were considered by Hendrik Lorentz in 1900, and he proposed again an explanation of gravity in terms of electromagnetic action. He also returned to Le Sage's model, substituting particles for trains of electromagnetic waves, and to the idea of Weber and Zöllner, that all matter is an association of positively and negatively charged corpuscles, provided that the force of attraction between corpuscles of different signs is slightly greater than the force of repulsion between corpuscles of the same sign. Later still, in 1946 Arthur Eddington also considered gravitation together with electromagnetism, and followed a suggestion made by Ernst Mach as early as 1893, whereby the lines of force of two electric charges of the same sign terminate on other bodies in the universe, and these distant objects would account for gravitation.[5]

In 1891, Roland von Eötvös experimented with a very sensitive torsion balance and found no significant difference between inertial and gravitational mass, reinforcing what had been admitted by many physicists since Newton's time. This led Max Planck to the conclusion that all forms of energy have gravitational properties, since they have inertia. Accordingly, at the end of 1907, Albert Einstein proposed that large cosmic objects would influence with their gravity the propagation of light, and he introduced the so-called Principle of Equivalence.[6] This postulate presupposes the equality of inertial and gravitational mass, reasoning as pictured in the following mental experiment: an observer in a closed chamber without windows sees a free object accelerating to one side of the chamber (like the floor). This fact can be due to any external field of force (such as gravitation); alternatively, the observer can suppose that the chamber is in an accelerated motion; both situations would be exactly equivalent, and indistinguishable as viewed from the interior of the cabin.

Later, when Einstein worked in the general relativity theory he proposed that gravitation arises as the result of a change in the metrical structure of spacetime caused by the presence of matter or energy. One could say to the same effect that spacetime has mass properties, and their mutual interaction is the cause for space-time modification when matter is

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[4] Edmund Whittaker. *A history of the theories of aether and electricity,* vol. II (American Institute of Physics, 1987), p. 144-145.
[5] Id., ibid., p. 150-151.
[6] North, op. cit., p. 52-53. In fact, the influence of gravity on light rays had already been proposed in 1784 by John Michell – see Jean Eisenstedt, *Avant Einstein. Relativité, lumière, gravitation* (Paris: Seuil, 2007), p. 120-127.

introduced in it. However, that under this theory matter is able to disturb space-time has to be a priori assumed, and notwithstanding the sophistication of the resulting theory, it can be challenged as being merely a descriptive one, and not as an explanation of what the essence of gravity is.

More recently, some voices criticized the equivalence of inertial and gravitational mass. Among these is Paul Marmet, who decisively opposed that equivalence, and thus doubted the results of the sunlight deflection supposedly detected during solar eclipses.[7]

Benedetto Soldano argued that Eötvös experiments had actually shown that the acceleration of gravity was slightly different for heavier objects than for lighter ones. If the Newtonian gravitational constant really varies, this brings considerable difficulties to both the special and the generalized relativity.[8]

It is likely that the experiments about the anisotropy of space conducted by Maurice Allais with a paraconical pendulum over 50 years in his private laboratory also bring into question the equivalence of inertial and gravitational mass, as suggested by the variation of the rotation of the plane of oscillation of Allais' pendulum during eclipses.[9]

Newton's argument concerning the rotation of a water bucket also impacts directly on the equivalence principle. As described by Newton in Book I of the *Principia,* if a vessel hangs from a long rope and is turned many times around its vertical axis, and then filled with water, when suddenly released the vessel will whirl in the opposite direction.[10] The water surface will at first remain horizontal, but after some time the water will climb up the bucket wall, so that the water surface forms a revolution paraboloid around the vertical axis, and later it will come to rest again as the vessel continues rotating. Newton used this experiment to justify the existence of absolute space. According to André Assis, Ernst Mach, in *The science of mechanics,* explained that the paraboloid is due to the water rotation in relation to the fixed stars, and not to the absolute space.[11] He further analyses the special and the general relativity theory to conclude that it fails to account for the water rotation in Newton's bucket, and contrary to some interpreters, it does not follow what is loosely called Mach's Principle, and the solution proposed by Assis is to return to Weber's law of gravitation, which conforms to Mach's Principle. In this way, as a consequence that the distant galaxies rotate, there would appear a real centrifugal gravitational force, and not a fictitious one as assumed by most interpreters. Assis reaches the conclusion that there is no need for gravitational mass to be equal to inertial mass, although one can be proportional to the other.

There were quite a number of other proposals during the 19th and 20th centuries, but with the preceding presentation of some historical developments of gravitational theory, we are ready to offer in what follows an interpretation based on the principle of eurhythmy.

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7 Paul Marmet. *Einstein's theory of relativity versus classical mechanics*. Gloucester (Ontario): Newton Physics Books, 1997, p. 146-157.

8 B.A. Soldano, "Newton's Gravitational Constant and the Structure of Science", *International Journal of Fusion Energy*, vol. 3, nº 4, October 1985, p. 25-35; see also B.A. Soldano, "What's wrong with Hawking's theory of time and space?", *21st Century Science and Technology,* vol. 6, nº 3, Fall 1993, p. 50-55.

9 Allais' experiments also bear on the constancy of the light velocity and the special relativity. See Rémi Saumont, "Undermining the foundations of relativity", *21st Century Science and Technology,* vol. 11, nº 2, Summer 1998, p. 83-87.

10 Isaac Newton, *Mathematical principles of natural philosophy* (*The Great Books*. Chicago: University of Chicago, 1952, p. 11-12).

11 André Koch Assis, "Relational mechanics and implementation of Mach's Principle with Weber's gravitational force" (Apeiron, Montreal, 2014). The page references are given using the preliminary original edition in Portuguese, *Mecânica relacional* (Campinas: UNICAMP, 1998, p. 134-139). Assis mentions that we can now substitute the fixed stars by the distant galaxies – which were unknown at Mach's time.

2 – The concept of mass in traditional physics

When studying the motion of a body, in the most common cases what we are really allowed to observe is its velocity, and the time variation of the velocity, called acceleration. Furthermore, it is common knowledge that to induce time variation in the velocity of the body an external action is necessary. To this action the name of force was given. So, each observable acceleration experienced by the body is associated with a force

$$a \Leftrightarrow f, \tag{2.1}$$

in the linear Cartesian approximation, we may write

$$a \propto f. \tag{2.2}$$

It is also known, that for the same action, or for the same force, the acceleration experienced by the body decreases proportionally with its size. The bigger the body, for the same action, that is, the same force, the smaller the acceleration. If it is really big enough, for the same action, the body may eventually not experience any time alteration in the velocity. This observable fact may be described saying that the body possesses a kind of inertia that opposes the modification of its velocity. To this constant, relating the action, the force, with the time alteration of the velocity it was given the name of inertial mass m_i, so that we may write

$$f = m_i a, \tag{2.3}$$

a mathematical expression that corresponds to the fundamental equation of classical mechanics.

When a body is placed in a gravitic field, for instance the one of the Earth, we may observe it falling with an acceleration, a time change of its velocity. This observed fact may be described by saying that the Earth impinges onto the body a gravitic action, a gravitic force. Still, there occurs a seemingly strange situation! The falling motion of the body to the Earth, does not depend on its size. Be it great or small, the way the body moves towards the earth is always in the same way. Indeed, from the gravitational attraction formula we see that

$$f = G\,\frac{m_E m_g}{R^2}, \tag{2.4'}$$

or

$$f = m_g a, \tag{2.4}$$

with

$$a = \frac{G m_E}{R^2}, \tag{2.5}$$

in which G, is the gravitational constant, R, the distance to the center of the Earth, m_E, the mass of the Earth and m_g, the gravitic mass of the falling body.

From expression (2.5) it is easy to see, that for any position of the body, for any value of R, the acceleration does not change no matter the value of the gravitational mass m_g.

3 – Eurhythmic physics

For those not familiar with Eurhythmic Physics[12] we shall present here briefly its essentials. Eurhythmic physics is a natural extension of nonlinear quantum physics[13], which by its turn is a logical consequence of De Broglie's original proposal for understanding, in a causal way, the natural phenomena at the quantum scale.

The basic idea is that any physical systems is indeed a very complex inter-relational relatively stable process. These physical systems are, naturally, in permanent reciprocal interaction with the medium. They modify the medium and are of course modified by it to a greater or lesser degree. On the other hand, it is assumed that we are always dealing with finite physical entities. In this sense, it is not possible to derive universal physical laws, that is, universal absolute rules, valid everywhere and forever. As consequence, there are no universal constants but only relative constants expressing the approximate constancy, under certain specific interacting conditions, of the changes among the interconnected variables. The best we may aim is to devise finite mathematical expressions that could approximately describe the complex interacting natural phenomena at a certain scale of observation and description of reality. Still, whenever the interacting conditions or the level of description change, these mathematical expressions and naturally the constants linking the variables and translating the phenomena, may also change. Hopefully we may, and always with great precaution, in certain broad general conditions, enunciate general principles such as the principle of eurhythmy[14]. Still, we need always to be very careful. We must bear in mind that, as human knowledge increases, the domain of this new complex and finite physics also enlarges. Theories are no more than mere human constructs, resulting essentially from the information we are able to gather, depending significantly on our mental and experimental tools. In such circumstances, there are no final, definite and eternal laws. The best we may hope is to have an increasingly better and better approach in the description of reality.

3.1 The complex particle

In eurhythmic physics a particle is understood as a very complex inter-relational process. The initial proposal for the nature of the complex particle was made by De Broglie in quantum domain in order to explain the duality wave-corpuscle. This concept of De Broglie's complex particle has been generalized from pure nonlinear quantum physics to all physics, that is, eurhythmic physics.

In such conditions, a particle is assumed to be much more than a single point-like entity. A complex particle is composed of two inter-related parts:

1 - An extended, yet finite, region, the theta wave θ, also in the past named guiding wave, subquantum wave, or organized vacuum fluctuation, or empty wave. This extended real physical wave, having a relatively minute intensity, behaves as a kind of sensorium with which the particle feels and interacts with the surrounding medium.

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

[13] J.R. Croca, *Towards a Nonlinear Quantum Physics*, World Scientific, London, 200313 - – L. de Broglie, The Current Interpretation of the Wave Mechanics, A critical study, (Elsevier, Ammsterdam, 1964); L. de Broglie, et J.L. Andrade e Silva, *La Réinterprétation de la mecanique ondulatoire, Tome 1 Principes Géneraux*, (Gauthier-Villards, Paris, 1971).

[14] J.R. Croca, *The principle of eurhythmy a key to the unity of physics*, Unity of Science, Nontraditional Approaches, Lisbon, October, 25-28, 2006. J.R. Croca, *The principle of eurhythmy a key to the unity of physics*, in Special Sciences and the Unity of Sciences, Eds. Pombo, O.; Torres, J.M.; Symons, J.; Rahman, S. (Eds.), Springer, 2012.

2 - A kind of very small and very localized structure, the kernel, called acron, ξ, of relatively high energetic intensity. In previous works, following De Broglie, this very small high energetic region of the complex particle was named singularity, or even corpuscle. Still, due to the confusion with the abstract concept of mathematical singularity and from the fact that this constituent of the particle has its own inner very complex structure, it was renamed acron. This word comes from the Greek άκρον meaning the higher peak, just like acropolis stands for the higher city.

The complex particle may be represented by

$$\phi = \phi(\theta, \xi) \tag{3.1}$$

or, assuming the simplest linear approach,

$$\phi = \theta + \xi, \tag{3.2}$$

where ξ stands for the acron and θ for the theta wave.

Next drawing, Fig.3.1, tries, roughly, to picture the real part of the complex particle.

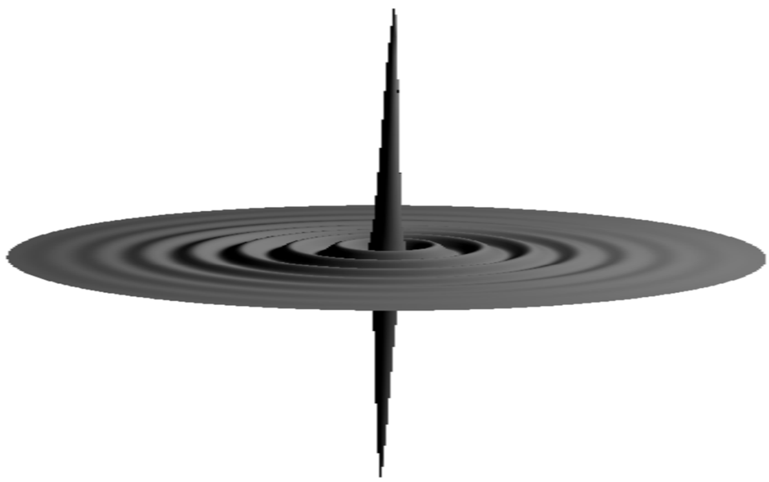


Fig.3.1 – Graphic sketch of a complex particle.

As stated, the energy of the theta wave is very small. Indeed, a first estimation[15] for the ratio between the energy of the photonic acron and that of its associated theta wave gives

$$\frac{E_\xi}{E_\theta} \approx 10^{+54} \tag{3.3}$$

A most important assumption of nonlinear quantum physics is the principle of

[15] J. R. Croca, *Found. Phys.* 34, 1929 (2004).

eurhythmy. This principle concretely states that although the acron being immersed in its theta wave field moves in a stochastic way, it preferentially goes to the regions where the intensity of the theta wave field is greater. This means that the probability of finding the acron is proportional to the intensity of the global wave in which the acron is immersed

$$P(x) \propto |\theta|^2 dx. \tag{3.4}$$

This principle was introduced early in the first quarter of the XXth Century by Louis de Broglie to describe quantum phenomena. In order to explain the single particle double slit interference, De Broglie introduced this principle initially calling it the guiding principle.

The principle of eurhythmy is indeed the cornerstone, the very organizing principle for helping in the description and prediction of natural phenomena. This principle concretely states that the complex acron is associated with a kind of sensorium, its theta wave, with which it feels the surrounding medium. The acron being immersed in its theta wave has a propensity to move in a stochastic way to where the intensity of the theta wave field is greater. This is a natural consequence of that fact that if the acron moves to other regions of lesser field intensity its mean life is unsurprisingly shorter. In short, this principle states that the complex beings must interact with the surrounding medium in such a way that allows them to persist. This principle has been generalized[16] to include other sciences like, for instance, biology and others.

As may be easily understood, the principle of eurhythmy is only meaningful in the context of complex systems. Even in the limiting case of the fundamental acron the situation keeps always essentially the same because this minute entity is indeed already a very complex organized structure of the subquantum medium.

3.2 Motion of a complex particle

The average motion of a body, that is, of a single acron or of collectively assumed and relatively independent acra, depends, in last instance, on the theta wave field "seen" by it. When the theta wave field intensity, seen by the acron is symmetric, $I(r) = I(-r)$, The average motion of the acron is null, since the propensity to move in any direction is equal. In such a case, in average, the particle remains still, $v = 0$. In order to have an average privileged motion, an average velocity $v \neq 0$, the intensity of the field seen by the acron needs to be asymmetric. By increasing or decreasing the degree of asymmetry the same happens to the propensity to move.

This situation may be easily understood if we assume, for simplicity reasons, that the intensity of the field seen by the acron has a Gaussian form in each direction

[16] R. N. Moreira. *The crisis in theoretical physics science, philosophy and metaphysics*, in *A New Vision on Physis*, p. 255, Eds. J.R. Croca and J. Araújo, Centro de Filosofia das Ciências da Universidade de Lisboa, Lisboa 2010; G. Magalhães, *On eurhythmy as a principle for growing order and complexity in the natural world*, p. 313, Eds. J.R. Croca and J. Araújo, Centro de Filosofia das Ciências da Universidade de Lisboa, Lisboa 2010; G. C. Santos, *Between two worlds. Nonlinearity and a new mechanistic approach,* p.331, Eds. J.R. Croca and J. Araújo, Centro de Filosofia das Ciências da Universidade de Lisboa, Lisboa 2010; P. Alves, *Theses towards a new natural philosophy,* , p. 359, Eds. J.R. Croca and J. Araújo, Centro de Filosofia das Ciências da Universidade de Lisboa, Lisboa 2010; G. Magalhães, "Some reflections on life and physics: negentropy and eurhythmy", *Quantum Matter, vol 4, 1-9, 2015.*

$$I(x) = \begin{cases} I_1 = Ae^{-\frac{x^2}{\sigma_1^2}}, & -\infty \leq x \leq 0 \\ I_2 = Ae^{-\frac{x^2}{\sigma_2^2}}, & 0 \leq x \leq \infty \end{cases}, \tag{3.5}$$

whose plot is seen in next figure, Fig.3.2

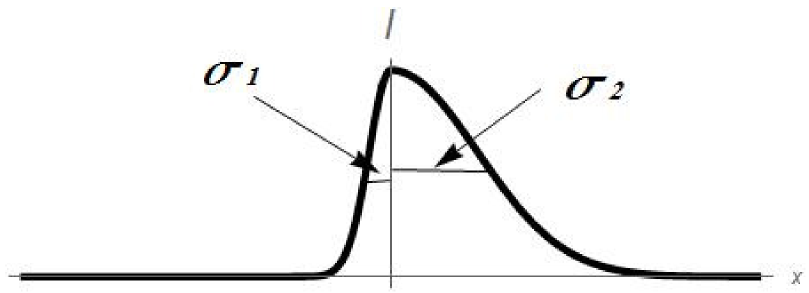


Fig.3.2 – Plot of the intensity field seen by the acron

The average velocity v, that is, the propensity for the body to move, is translated by the drift μ, given the difference in the probability p to go forward, minus the probability of going backwards q

$$v \propto \mu \propto p - q \tag{3.6}$$

which by its turn may be approached[11] by the genesis formula Γ

$$v = \Gamma = \frac{\nabla I}{I}, \tag{3.7'}$$

or for the unidimensional case,

$$v = \frac{I_x}{I}. \tag{3.7}$$

For a Gaussian intensity field, of the generic form

$$I = Ae^{-\frac{x^2}{\sigma^2}},$$

we have

$$v = -\frac{2}{\sigma^2}x. \tag{3.8}$$

The average velocity, for a field given by (3.5) is, for each branch,

$$\overline{v_1} = \frac{1}{\sigma_1}\int_{-\infty}^{0}\left(-\frac{2}{\sigma_1^2}x\right)dx = \sigma_1, \qquad -\infty \leq x \leq 0, \tag{3.9}$$

$$\overline{v_2} = \frac{1}{\sigma_2}\int_{-\infty}^{0}\left(-\frac{2}{\sigma_2^2}x\right)dx = -\sigma_2, \quad 0 \leq x \leq \infty\ . \tag{3.9'}$$

In this situation, the average total velocity is, in the linear approximation, $\bar{v} = \overline{v_1} + \overline{v_2}$

$$\bar{v} = \frac{1}{\sigma_1} - \frac{1}{\sigma_2} = \frac{\sigma_2 - \sigma_1}{\sigma_1 \sigma_2}, \qquad (3.10)$$

by making

$$\alpha = \frac{\sigma_2}{\sigma_1} \geq 0 \qquad (3.11)$$

translating the degree of asymmetry, we may write

$$\bar{v} = \frac{1}{\sigma_1} \frac{\alpha - 1}{\alpha}. \qquad (3.12)$$

The plot of this function, for a fixed value of σ_1 and an increasing $\alpha \geq 1$, translating the average velocity of the body, may be seen in next drawing, Fig. 3.3.

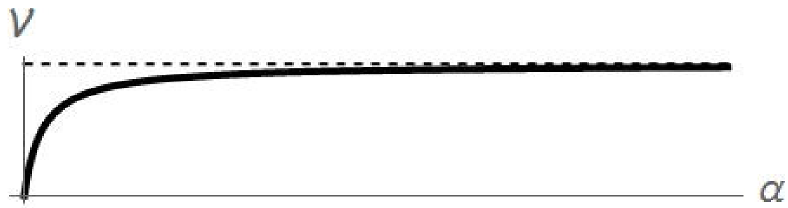


Fig.3.3 – Plot of average velocity of the body as the asymmetry of the field increases

This expected result means that when there is perfect symmetry in the intensity of the theta wave field seen by the acron, $\alpha = 1$, the average velocity is zero $\bar{v} = 0$. As the asymmetry increases, $\alpha \to \infty$, that is, as the field tends to be relatively constant, the same happens with the propensity to move, $\bar{v} \to const$. This effect is shown in next plot, in which for the same σ_1, we see different increasing values of σ_2, Fig. 3.4.

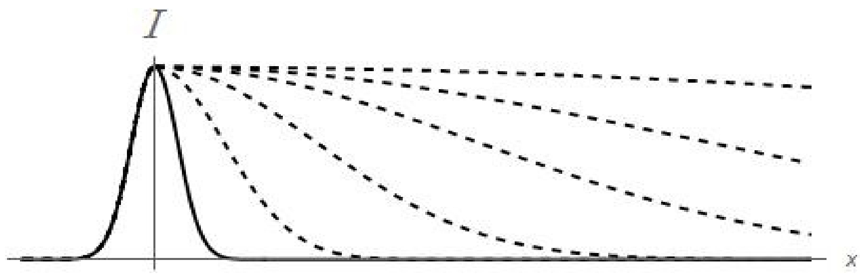


Fig.3.4 – Plot for the asymmetry increasing of the intensity of the theta wave field.

The solid line represents a symmetric field. Dashed lines, for increasing values of σ_2, for the same constant σ_1, lead to a growing degree of field asymmetry. In such circumstances the average velocity tends to stabilize at a maximal possible velocity $\bar{v} \to 1/\sigma_1$.

As $\alpha \to \infty \quad \Rightarrow \quad \bar{v} \to \frac{1}{\sigma_1}$.

This limiting average velocity, $\bar{v} \sim 1/\sigma_1$, obtained whenever $\sigma_2 \gg \sigma_1$. So, the average speed experienced by the body lies between two extremes. As long as the asymmetry of the intensity of the field is maintained the same happens with the average velocity, which lies between the two limiting situations, $0 \leq \bar{v} \leq 1/\sigma_1$.

Naturally, if we want to increase the velocity of the body, then we need to increase the asymmetry of the field and vice-versa. This action is usually done by interaction with other physical systems.

A "natural" degradation of the asymmetry of the particle field may be obtained by placing the field of the particle in interaction with an external field. The self-field of the particle is also known as mother theta wave field. In this situation, the self-theta wave field intensity I_0 tends, due to the interaction with the extended field I_M, to homogenize, leading to a progressive decrease in the self-field asymmetry. This progressive decrease in the asymmetry leads, naturally, to a reduction in the average velocity leading, eventually, to a null average velocity. This action is traditionally described by saying that a frictional damping force has acted on the body.

If on the contrary, one wants to increase the velocity of the body, then it is necessary to increase the asymmetry of the field. As long as the increasing in the asymmetry of the theta wave field intensity is maintained, the average velocity also keeps increasing, naturally, to its maximal velocity that occurs, as we have seen, when $\sigma_2 \gg \sigma_1$.
This change in the field asymmetry may result from the interaction with other bodies. When two bodies are led to approach each other two situations may occur:

1 – They coalesce into a single body. That is, the reciprocal interaction of the two physical systems leads to the emergence of a new physical system. In this case the theta wave field intensity between the two bodies increases, as may be seen in Fig.3.5.

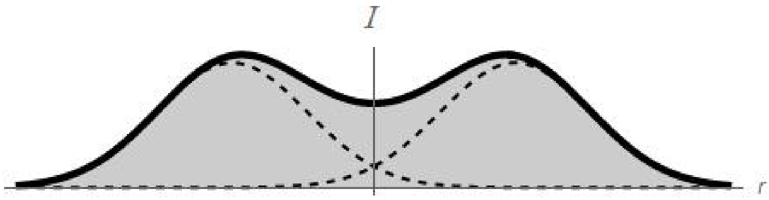
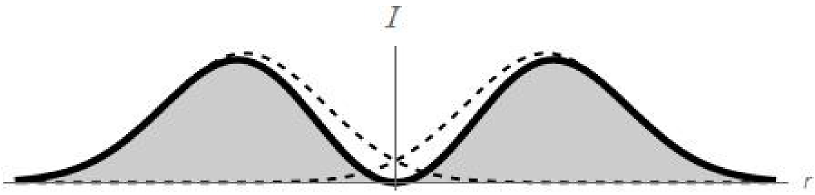


Fig. 3.5 – Coalescence – attraction

2 – Each interacting body tries to maintain its own strong identity. In such case, there occurs a kind of self-interacting situation that creates a plunge in the field between the two bodies leading to a kind of repulsion,

Fig. 3.6 – Anti-coalescence - repulsion



that may be described as if a kind of repulsive action, or a repulsive force acts equally on each body. In such situation, the reaction equals the action with opposite directions and the two bodies maintain their own identities.

These natural observed phenomena, are traditionally described by the so-called attraction or repulsion law.

Naturally, for the same external action, the reaction, the change experienced by the body, the modification of average velocity, that is the acceleration, depends on the number of acra that compose the body.

In such conditions for the same external action on the body we have:

1- The body is composed of a single acron. In this case the alteration in the overall asymmetry of the field, $I_{0_1} = |\theta_{0_1}|^2$, the change in the acceleration is great.

2 - The body is composed by many acra. Each of these acra has its self-theta wave field, $I_{0_i} = |\theta_{0_i}|^2$, and the total field of the body is $I_0 = |\theta_{0_1} + \theta_{0_1} + \theta_{0_2} + \cdots + \theta_{0_N}|^2$. So, the same external action needs to be shared by all single particles. In these conditions, it is no surprise to verify that the overall induced asymmetry, and consequent change in the velocity of the composed body is very small.

Such interaction is traditionally described by saying that the body possesses a kind of inertia that opposes the alteration of its motion. This inertia, this opposition to the change in the overall theta wave field asymmetry experienced by the body is, naturally, a function of the number of acra $N(\xi)$. This physical action, inducing an alteration in the theta field intensity asymmetry, is commonly named force, F.

In the linear approximation, the alteration of the asymmetry of the field leading to a modification of the average velocity with time, the acceleration, a, decreases inversely with the number, $N(\xi) \cong \rho_i N_\xi$, of acra the body possesses

$$a = \frac{1}{\rho_i N_\xi} F, \tag{3.13}$$

in which ρ_i is a proportionality constant.

Traditionally this proportionality term is called inertial mass

$$m_i = \rho_i N_\xi. \tag{3.14}$$

In such conditions, equation (3.13) may then be written

$$F = m_i a, \tag{3.15}$$

which is usually known as the fundamental dynamic equation of classical mechanics.

3.2 Motion of a complex particle in a large theta wave field

In a first approximation, in order to simplify the problem and for a better comprehension of the situation we considered the motion of a particle assumed to be isolated, which of course does not translate the real situation. In reality, we have always an extended theta wave subquantum field in which the complex particle is immersed. Now we are going to consider explicitly the extended field.

When a single acron or a group of acra, with a self-overall theta wave field of intensity I_0, are immersed in an extended field of intensity I_M, the total intensity field I_T, seen by the acron is, in the linear approximation, given by,

$$I_T = |\theta_0 + \theta_M|^2, \tag{3.16'}$$

Assuming that the two wave fields are not coherent between themselves we have simply,

$$I_T = I_0 + I_M, \tag{3.16}$$

And the propensity for the acron to move, the average velocity, in the field is

$$v = \frac{\nabla I_T}{I_T} = \frac{\nabla(I_0 + I_M)}{I_0 + I_M} = \frac{\nabla I_0 + \nabla I_M}{I_0 + I_M}. \tag{3.17}$$

Let us see how the body behaves for two extreme physical situations.

1 – The extended field intensity is practically constant $I_M \cong const$ and the intensity of the self-field is much greater than the extended field, $I_0 \gg I_M$, then we have

$$v = \frac{\nabla I_0}{I_0}. \tag{3.18}$$

This situation corresponds to the previous studied case, in which the acron, for all practical purposes, sees only its self-field.

2 - The extended field is relatively much more intense, $I_M \gg I_0$, and $I_0 \cong const$. For this case the average velocity is given by

$$v = \frac{\nabla I_M}{I_M}. \tag{3.19}$$

In this extreme situation, the acra, the body "sees" for all practical purposes only the extended theta wave field.

It is worth to point out, that when the extended theta wave field is a gravitic field we arrive at two different conclusions concerning the nature of the gravitic mass:

a) In the first extreme case, the body is not sensitive to the field. Indeed, when moving through the gravitic field no modifications on the motion of the body are observed. From the observed results, we are led to conclude that the body does not possess gravitic mass, $m_g = 0$.

b) For the second extreme case, the observed motion of the body does indeed depend on the field. Therefore, in this situation the body is said to have gravitic mass, $m_g \neq 0$. This gravitic mass is, naturally, a function of the number of acra the body owns, $m_g = m_g(N_\xi)$, so that in the linear approximation it may be written

$$m_g = \rho_g N_\xi. \tag{3.20}$$

Since the very same body may have or not have gravitic mass, depending on the interrelation context with the medium, the conclusion to draw is that the concept of mass, gravitic mass, is only a relational concept, thus devoid of any physical ontological status.

Between these two extreme situations, the overall motion of the body depends on the relative conjugated effect of the two fields.

From expressions (3.14) and (3.20) we see that both the inertial and gravitic mass are proportional to the number of acra, the only entities that, in reality, have a real physical ontological state.

Consequently, from,

$$m_i = \rho_i N_\xi \text{ and } m_g = \rho_g N_\xi,$$

it follows that

$$m_g = \frac{\rho_g}{\rho_i} m_i, \tag{3.21'}$$

or simply,

$$m_g \propto m_i. \tag{3.21}$$

This means that in general the gravitic mass is proportional to the inertial mass. Nevertheless, for certain particular relational conditions of the fields, we may have,

$$\rho_i = \rho_g, \tag{3.23}$$

leading to the equality between the gravitic and inertial masses

$$m_g = m_i. \tag{3.24}$$