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UNITARY THEORY
OF ELEMENTARY PARTICLES AND THEIR INTERACTIONS
INCLUDING EINSTEIN'S GRAVITATION AND MACH'S INERTIA:
A GEOMETRO-KINEMATIC LINEAR T.O.E. OF UNIVERSE.

FIRST PART.

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*"A very rational theory must **deduce** the elementary structures (electron, ecc.) not **pose** them 'a priori'"*.
"Einstein Besso correspondence" by P. Speziali. P.S. in the 190.(E. 92) 10.VIII.'52.

"Something that is written badly is always better than something that has not been written at all."
From "Karl Popper's Autobiography" (Ed. by P.A. Schilpp 1974)

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ABSTRACT.

CHAP.**1)** Newton's equation of motion of a test body Π_j (for i. an electron e_j^-) under the action of a source Σ_i (for i. n_i positrons e_i^+) - in which Einstein's linear gravitation plus Lorentz's electromagnetism, equalized to Mach's inertia, are written in an explicit form - opens a unitary outlook of the three interactions. Factorizing c^2 and dividing for the mass m_{ej} of the Π_j : i) *kinematizes the interactions* because interprets the action on Π_j no more by forces but only by the motion of source Σ_i, the action of gradients being due to two *hidden motions* of speed c on curvature radii $\rho_g = 10^{28} \text{cm} = R_U$ and $\rho_e = 2\pi \cdot r_0 = 10^{-13} \text{cm}$; i) *geometrizes matter* because substitutes the material substances m and e (and G) by two lengths: *"l_g i"*$=10^{-53}$cm and *"l_e i"*$= =r_0 = 10^{-13}$cm; specific of interactions and proportional to sources.

CHAP.**2)** This new outlook induces to substitute particles+fields (or quanta) of present *dual* physical scheme (ph.s.), by a *unitary* new ph.s. in which only *"corpuscles-fields (α)"* ((α) field of Th(α)) are present which, from a center $\odot$ are extended, and hence mutually penetrated, over the whole Universe (U), interacting through the only kinematic action of reciprocal *dragging* (4): $V_j = $*"$l_i$"* $V_i/R_{ij} + $*"$l_i$"*, which covers the three said universal interactions and do not give infinity. The extension of (α) fields to the whole U and the motion of expansion of U (deduced by Mach's theory of inertia, in CHAP.**5**) reveals the existence of a *"new universal dragging action"* which generates all the *"present universal inter-actions"*.

CHAP.**3)** Owing to the absence of forces, ((α) field) are gathered together in *"packets"* of number N_j. The expansion of U drags the packets in an double-helicoidal *primitive motion* making them neutrinos ν and antineutrinos $\underline{\nu}$ equipped with ang. momentum (constant) and energy-mass and polar charge of dragging action (proportional to N_j), as to being the structural elements of all particles: bosons and fermions, starting from the photon: neutrino+antineutrino couple: $\gamma = \nu + \underline{\nu}$.

CHAP.**4)** Packets with $N_j = 1$ - single (α) field - give the *quantum of mass* $m_{(\alpha)} = 2,611 \cdot 10^{-66}$g and *quantum of intrinsic energy* $E_{(\gamma)min} = 2,346 \cdot 10^{-45}$erg. The only three free Universe parameters of Th(α): $R_U = 10^{28}$cm, $V_U = c$, and $\aleph = 10^{40}$ applied to the *primitive motion* give Planck's h and Sommerfeld's $\alpha = e^2/\hbar c$ constants (and Newton's G const. in CHAP.**5**). The bipolar photon couple produces the two omopolar rings of the opposite electric charges ($e^+ = \nu + \nu$; $e^- = \underline{\nu} + \underline{\nu}$), the mass-energy, ang. mom. (spin), electric charge and Schwinger's magn. moment of which are calculated by the law of dragging (4).

CHAP.**5)** The forces of inertia become universal interactions as *"counter-dragging actions"*, the hidden parameter $GM_U/c^2 R_U = 1$ of which fixes definitely that the U is finite in mass $M_U = 10^{56}$g, and spherically closed on an extension and curvature of $R_U = 10^{28}$cm. Owing to the $(R_U^2/M_U) = 1$ cm^2/g, the $G = (c^2/R_U)(R_U^2/M_U)$ reveals that numerical value of G is the acceleration of a hidden motion with speed c on a curvature radius, above said, $\rho_g = R_U$ which implies the expansion of the Universe.

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FOREWORD. This work anticipates a book entitled: "Conjectures and first developements for a: *Theory of matter*" in which one of the authors has exposed in a conjectural axiomatic way a "Theory of everything" (TOE), i.e. an exclusively geometric and kinematic unitary theory of elementary particles (fermions and bosons) and of their interactions, founded on a new ontology of basic material objects at the sub-elementary level, where the present *dual* physical scheme - in which the corpuscles form a different reality compared to the field, or quanta - are substituted by a *monistic* physical scheme in which only one type of reality exists made up of *corpuscles-fields*(α) which from a center $\odot$ are extended and compenetrated throughout the whole Universe, interacting by means of only one *dragging* action in which the prime motor is the expansion of the Universe: Theory (α), abbr. Th(α).

The specific interest of the present work (which summarises a part of the book that deals with a few main aspects of gravitation, electromagnetism and inertia; neutrinos, photons, electrons and the Universe) lies in the fact that the theoretical antiparadigmatic setting of Th(α) is derived as a necessary consequence of interpreting Newton's paradigmatic equation of motion, which becomes exclusively geometric and kinematic when the constant c^2 is simply shifted to a factor.

The title "First Part" refers to a second part in which Th(α) is applied to strong interactions and to its hadrons – (α)quark, pions, muons, kappa, nucleons and hyperons - to form a new periodic table of nuclei in agreement with magic numbers, and an equally unusual interpretation of the atomic cortex based on the electron-photon bound system.

FOUR PREMISES.

1 – MACH'S INERTIA.   Mach's conjecture that the material source of the forces of inertia is the mass M_U of the Universe - which frees them from the unsatisfactory Newtonian situation of being originated by the affected body – has never entered the physical scenario, e.g. the unitary program of the other universal interactions (or even the most universal on account of their source), also because no one, and least of all Einstein who introduced it, has been capable yet of giving a concrete physical theory of the causal link between this source, which is so unusually and desperately distant, and its local instantaneous effect: "A theory that accepts Mach's challenge lies in the sphere of wishful thinking" (H.Weyl "Philosophy of mathematics" It. Edition Boringhieri 1967 p.354).

This challenge is accepted and resolved here with (α) fields, whose universal *dragging* interaction is unvaried compared to the speed change of the source with that of the test particle, as required by the mathematical expression of their forces.

The inclusion of the forces of inertia among universal interactions introduces a new circumstance in the unitary program since, based on the *principle of*

congruence formulated in the following, it supplies a formal mathematical model to which all the other interactions must adapt due to the fact that their mathematical structure, as a simple derivative of velocity, is the only element known a priori and with certainty.

    2 – PRINCIPLE OF CONGRUENCE.   In the search for a unitary theory of universal interactions, we shall indicate a *principle of congruence*, as a heuristic criterion, according to which the mathematical expressions of the forces to be unified must assume the same mathematical structure, for example as the number and type of vectorial operators, since, except for a few specific constants, they must necessarily be deduced from a unique common expression.

    3 – VALIDITY OF THE CLASSIC LINEAR LEVEL.   Since our theory is developed on a vectorial tridimensional linear level, it may seem surpassed by today's quantistic theories: the string theory for gravitation and QED theory for electromagnetism. Instead it will prove its entire validity once we have shown: - i) that the linear approximation of gravity has the same physical content of the tensorial formulation of general relativity (Appendix III°); - ii) that the fields (α) introduced herein at a sub-elementary level describe the structure of elementary particles in general, and that of the electron in particular, more thoroughly than the QED, since, besides Schwinger's magnetic moment, they allow to calculate its mass and electric charge (CHAPTER **4**); and finally: - iii) the equation of motion of fields (α) is naturally set in an undulatory form (CHAPTER **2**).

    4 - THE NOMENCLATURE.   The index of symbols used by us does not have the usual meaning of vector or tensor components, but specify the material bodies to which the magnitudes refer; in particular "i" specifies: masses, charges, velocity and accelerations of the body Σ_i, which acts as the source of forces and of motion; while "j" specifies that of the dragged test particle Π_j; and R_{ij} specifies the distance between Σ_i and Π_j, or between the centers $\odot_i$ and $\odot_j$ of fields (α)$_i$ and (α)$_j$, which will be introduced instead of Σ_i and Π_j. We shall use the symbol $\rightarrow$ in two ways: - i) as the direction of interaction between two objects, so that for example ($M_U \rightarrow m_j$) is the action of masses M_U of the Universe on the local mass m_j; but we shall use it also: - ii) to indicate the reference system of a kinematic magnitude, so that for example $V_j \rightarrow S^*$ is a velocity V_j with respect to the fixed stars S^*.

    In principle we will always specificate the reference for any velocity and acceleration, mostly the S^* reference.

    RANGES.   We shall make a close study working mainly on the ranges of a paradigmatic evaluation – for example $R_U = 10^{27}$cm – reserving to specify them also numerically with definite values, which we shall obtain in the last section of Mach's theory of inertia.

CHAPTER **1**

UNITARY GEOMETRO-KINEMATIC THEORY OF GRAVITATION AND ELECTROMAGNETISM.

5 – EXPLICIT EXPRESSION OF NEWTON'S EQUATION OF MOTION. Let us write Newton's equation of motion of a test particle Π_j of mass m_j and electric charge q_j, under the influence of forces of the more general gravitational field **Gr** and electromagnetic field **El** exercised by a source Σ_i, of mass M_i and electric charge Q_i, emphasizing the force of inertia **In** exercised on m_j by mass M_U of the Universe according to Mach's conjecture:

$$m_j \, dV_{j(\to S^*)}/dt = \mathbf{Gr}_{(M_i \to mj)} + \mathbf{El}_{(Q_i \to qj \, (mj))} = {}^- \mathbf{In}_{(M_U \to mj)}. \qquad (0)$$

Let us specify (0) for the most simple emblematic possible case, from which all others can be deduced, and in which the test particle Π_j is an electron e_j^- (of mass m_{ej}) which at instant t with velocity $V_j \to S^*$ transits through point P_j, at the distance R_{ij} from point P_i, where at the very same instant t, with velocity $V_i \to S^*$ given as a datum, it transits through such a numerous compact group of n_i source positrons e_i^+, that it can ignore the counteraction of e_j^-. Let us write the two members of (0) in the most "explicit" form possible expressing the force components not as a function of field vectors, but as a function of the potentials from which they derive, and the potentials as a function of their ultimate irreducible characteristics: i.e. masses, charges, coupling constants, distance, and velocity $\to S^*$.

In expressing inertia we shall push the approximation of acceleration to the usual approximation in which circular motions – or rotations – are constant and therfore the terms are limited to the three canonical terms: linear, centripetal and of Coriolis. Moreover, in order to simplify passages and have a homogeneus expression to the fields in the second member, we shall anticipate a result of our research (**§ 27**) by writing these terms not using the auxiliary reference frame which rotates with velocity $\boldsymbol{\omega}$, as with corpuscular Π_j, but with an expression used in continuous means given only as a function of velocity $V_j \to S^*$ of a Π_j considered as a continuum:

$$\mathbf{In}_{(M_U \to mej)} = -m_{ej} \left(\frac{\partial V_j}{\partial t} + grad \frac{V_j^2}{2} - V_j \wedge rot V_j \right). \qquad \textbf{(In)}$$

According to the *congruence principle* the mathematical expression of these forces, i.e. the number and structure of its terms, since they have been fixed axiomatically by the rule of derivation, are the model to which all other universal interactions must conform in order to establish a unitary vision. We shall see, and with some surprise, that this is already seen in the well-known phenomenology. As a matter of fact, this is the structure we find for the first addendum of the second member of the (0) in the explicit expression of gravitational forces given by Ein-

stein in his (118) of his "The meaning of relativity" (Einaudi 1950, p.104-112) which, adapted to our formalism as stated in Appendix I°i), becomes:

$$\mathbf{Gr}_{(n_i\,m_{ei}\rightarrow m_{ej})}=n_i(m_{ei}m_{ej}G)\left(\frac{1}{c}\frac{\partial}{\partial t}\frac{\mathbf{V}_i}{cR_{ij}}+grad\,\frac{1}{R_{ij}}-\frac{\mathbf{V}_j}{c}\wedge rot\,\frac{\mathbf{V}_i}{cR_{ij}}\right). \qquad \textbf{(Gr)}$$

We can also find an analagous expression in the classic form of Lorentz electromagnetic forces in the Gauss system, as obtained in Appendix I°ii):

$$\mathbf{El}_{(n_ie_i\rightarrow e_j)}=n_i(e_ie_j)\left(\frac{1}{c}\frac{\partial}{\partial t}\frac{\mathbf{V}_i}{cR_{ij}}+grad\,\frac{1}{R_{ij}}-\frac{\mathbf{V}_j}{c}\wedge rot\,\frac{\mathbf{V}_i}{cR_{ij}}\right) \qquad \textbf{(El)}$$

If we divide both members of equation (0) by m_{ej}, we can write:

$$\frac{\partial\mathbf{V}_j}{\partial t}+grad\,\frac{V_j^2}{2}-\mathbf{V}_j\wedge rot\mathbf{V}_j \quad =$$

$$= \quad n_i(m_{ei}G)\left(\frac{1}{c}\frac{\partial}{\partial t}\frac{\mathbf{V}_i}{cR_{ij}}+grad\,\frac{1}{R_{ij}}-\frac{\mathbf{V}_j}{c}\wedge rot\,\frac{\mathbf{V}_i}{cR_{ij}}\right)+$$

$$+ n_i(e_ie_{j}/m_{ej})\left(\frac{1}{c}\frac{\partial}{\partial t}\frac{\mathbf{V}_i}{cR_{ij}}+grad\,\frac{1}{R_{ij}}-\frac{\mathbf{V}_j}{c}\wedge rot\,\frac{\mathbf{V}_i}{cR_{ij}}\right). \qquad (1)$$

6 - THE FIRST STEP TOWARDS A UNITARY THEORY.

The two addenda of the second member at a first approximation satisfy the principle of congruence because they have the same vectorial operational structure of the inertia. Besides, in spite of the fact that they derive from two completely different historical and methodological contexts (one from a recent conjectural speculation, the other from an old phenomenological gestation), they coincide. The fact that these remarkable coincidences cannot be found in the literature is obviously due to the following: i) the preference of theoreticians for synthetic and compact formulations of field vectors instead of the "explicit" ones used here, as a function of the above mentioned last irreducible elements (charges, coupling constants, velocity, and distance); and ii) to the fact that neither of the two gravitational and electromagnetic forces are generally written in an equation of motion in which also the structure of the forces of inertia is given as "explicit", as in the case of the first member of Einstein's (118), for example, where inertia remains in the synthetic form of equation (0).

Already from this first step, the use of "explicit" expressions prepared the way for a unitary vision of the two field interactions between them, and of these

with inertia, in a first stage of "partial congruence" among the three interactions in relation to the number and operational vectorial structure of their respective terms.

7 - SUBSEQUENT STEPS TOWARDS THE UNITARY THEORY. Nevertheless, in order to achieve "complete congruence", which is needed for a unitary interpretation, it being understood that the vectorial structure of inertia is certain, the following must be done:

- 1) the field interactions of the second member must be made to conform to those of inertia considering them too as derivatives of only one potential vectorial function whose vector is a velocity; which is prevented by the scalar potential of the gradient, and by V_j in the term of the rotor:

- 2) the constants as a factor of the two interactions, which now have very different substantial characteristics, must be made homogeneous.

This first unification stage would satisfy the unitary paradigmatic expectations which do not imply insertion of inertia. But since we also want to include Mach's inertia among the universal interactions, we must push the congruence through two further steps:

- 3) first of all we must find a type of Universal Unitary interaction which should be invariable when exchanging the velocity V_i of the source, which appears in the accelerating actions of the gravitational and the electromagnetic fields, with the velocity V_j of the test particle, which appears in the exclusively reactive actions of inertia.

- 4) finally, we have to conform the expression of inertia with the expressions of the field forces by introducing parameters that do not appear at all in it; in other words, not only a coupling constant, but also the entity M_U and the distance R_U of the source hypothesized by Mach.

8) CAN FACTORIZING c^2 UPSET THE VISION OF THE PHYSICAL WORLD ?

As has just been said, the presence of two scalar potentials in terms of the gradient in the second member of (1) stops us from taking into account the two interactions of an exclusively kinematic nature, as inertia really is. Besides, also the two kinematic terms of induction and rotor contained in them are made homogeneous by the static character of the gradient, because V_i and V_j are referred to the velocity of light c. But it is sufficient to *bring to a common factor c^2* to see the following two important effects.

- i) The *"kinematization of interactions"* due to the fact that all the terms in the two interactions appear with an explicitly kinematic character, where the effect of the gradient is determined precisely by the c^2, which is constant and of a very high value compared to the other two terms where V_i and V_j are variable and of a normal value.

- ii) The *"geometrization of matter"* due to the fact that putting c^2 into a factor (having divided both members by m_{ej}) transforms the two constants - which group all the material substances and the coupling constants – into two geometric parameters of the dimensions of a length (the former adapted *ad hoc*) *specific of inter-actions* (g;e) and *proportional to sources* (i) :

$$n_i \, m_{ei} G/c^2 = r_{(S)} \equiv n_i \text{``}l_{gi}\text{''} \cong 10^{-53} \text{cm}, \qquad \text{and} \qquad n_i \, e^2/m_{ej}c^2 = n_i \, r_0 \equiv \text{``}l_{ei}\text{''} \cong 10^{-13} \text{cm},$$

which allow us to transform equation (1) into the following equation (2):

$$\frac{\partial V_j}{\partial t} + grad \frac{V_j^2}{2} - V_j \wedge rot V_j \quad =$$

$$= \; lg_i \left(\frac{\partial}{\partial t} \frac{V_i}{R_{ij}} + grad \frac{c^2}{R_{ij}} - V_j \wedge rot \frac{V_i}{R_{ij}} \right) +$$

$$+ \; le_i \left(\frac{\partial}{\partial t} \frac{V_i}{R_{ij}} + grad \frac{c^2}{R_{ij}} - V_j \wedge rot \frac{V_i}{R_{ij}} \right). \tag{2}$$

Besides coinciding in their mathematical structure, the two field interactions now also show a unexpected homogeneity in the constants, which are both reduced to a length.

Since the values of *"l_{gi}"* and *"l_{ei}"* given here ideally refer to the abstract in-teraction between two electrons, in every concrete case they must be adapted with suitable multipliers n_i (already introduced in equation (1)). Both are known in the respective gravitational and electromagnetic spheres: *"l_{gi}"*, which is adjusted ad hoc, as a "Schwarzschild's ray $r_{(S)}$", will give us the kinematic structure of Net-won's constant G - which calibrates the gravitational interaction allowing us to foresee the phenomenon of expansion of the Universe. *"l_{ei}"*, on the other hand, is the so-called "classical ray r_0 of the electron" which here gives us a resolutory piece of information on the kinematic microscopic structure of the electron in par-ticular, and on the other particles in general.

9 – FACTORIZING c^2: i) KINEMATIZES THE INTERACTIONS AND:
ii) GEOMETRIZES MATTER.

Putting constant c^2 into a factor profoundly upsets the concept of the physi-cal world, since, as we have just said, it drastically imposes two changes.

- i) *Kinematization of the interaction* is due to the fact that the acceleration of the test particle no longer depends on the intermediary notion of the forces, but only on the acceleration of the source (with due attention to the term of the gradi-ent). The notion of the field force disappears together with its sources *m* and *e*,

(and G the intermediary). Thus the motion of the test particle derives directly from the motion of the source by means of a new type of exclusively kinematic interaction, which must be identified and which we will specify as *dragging*.

- ii) *Geometrization of elementary material objects* is due to the fact that the ontology of elementary material objects is no longer represented by mass m, by the electric charge e (and by the constant G), because they disappear from the equation and are substituted by two parameters *"l_{g_i}"* and *"l_{e_i}"* with the dimensions of a length. This calls for a change in the concept of elementary corpuscles by characterizing them exclusively by their position, extension, and state of motion (accelerated) whose intensity is specified by the respective *"l'"s*. We shall indicate these corpuscles devoid of mass and charge with the name of *corpuscles* (α), because they place themselves at a level below that of elementary particles, which consequently will result as kinematic structures formed by them. This shall be the basic level that cannot be reduced any further. Starting from this level the theory that will be formulated will be none other than a TOE.

10 – CONGRUENCE BETWEEN MATHEMATICAL REPRESENTATION AND REALITY ACCORDING TO HERTZ.

The *mathematical emergence* due to the appearance of c^2 in the gradient is the first of two cases presented in this work in which a simple mathematical elaboration (in this case algebraic) completely upsets the physical scheme from which the formalism arises. This poses the question of whether the emergence should be refused, as for instance is usually done with imaginary solutions, or whether it should be accepted as a necessary consequence in physical reality just as it is in mathematical reality. We shall choose the second option following Hertz's thought: "We form for ourselves images or symbols of external objects; and the form which we give them is such that the necessary consequents of the images in thought are always the images of the necessary consequents in nature of the things pictured." (H.Hertz: "Principles of Mechanics" Dover Pubb. Inc. New York (1956) p.3). This case is analogous to that of the appearance of the Zitterbewegung motion with velocity c in the Dirac's relativistic equation of the electron, on which we shall return later.

11 – THE DISCOVERY OF TWO *HIDDEN MOTIONS*.

Instead of causing difficulty, the presence of c^2 leads to the extremely important discovery that the interaction of the gradient, precisely the one that is at present considered static, is instead due to the existence of a motion of the source Σ_i of velocity $c{\to}S^*$. Moreover this motion is necessarily a *hidden motion*, because it must exist even when Σ_i appears to be macroscopically still ${\to}S^*$; i.e. when $\mathbf{V}_i=0$.

The factor c^2, which is inserted in both gravitational and electromagnetic interactions in the gradient term (instead of the macroscopic and variable V_i^2 of ordinary motion dealt with later), because fixed and inalterable, reveals that this *hidden motion* is an intrinsic inalterable characteristic of elementary material corpuscles, which replaces the substantial characteristics of gravitational mass and of the electric charge of corpuscles. The two static classic interactions of Newton and of Coulomb, which have so far been interpreted as an intrinsic quality of attraction or repulsion exercised by masses and electric charges through space (for example through an action that curves space or emits quanta, which is the same thing), are instead due to an interaction of a kinematic nature, so to say of the "magnetic" type, due to a *hidden motion* of the source of speed c.

The two parameters *"l_{g_i}"* and *"l_{e_i}"* must interpret two very different interactions numerically and structurally: one monopolar and very weak, the other bipolar and very intensive. This warns us that though they both occur with the same speed c, the two *hidden motions*, the gravitational and the electromagnetic, must be very different from each other, as we shall see in fact.

12 – COMPLETE FORM OF THE GRAVITATIONAL AND ELECTROMAGNETIC INTERACTIONS.

Before continuing our research on the two *hidden motions*, we shall deal with the formal aspect which equation (2) must assume as a consequence of the discovery of these motions.

The three terms of the two field interactions in fact are not sufficiently homogeneous yet, because they do not derive from only one vectorial function, as in the case of inertia. It is a fact that the factorization of c^2 has brought about in one stroke the kinematization of the interactions and the geometrization of the constants, but the terms of the two interactions are still not homogeneous, because of the anomaly of speed c^2 of the gradient, which is constant and has a very high value, compared to speed V_i of the terms of induction, which is variable and of a normal value, and of the rotor, in which V_j is also present.

Each of the two interactions is actually due to the superposition of two distinct motions: i) the hidden microscopic motion, which is always present, constant and inalterable, and whose terms are obtained by the derivation of the function "$l_{(g;e)i}$"c_i/R_{ij} and: ii) the evident macroscopic motion, which is not necessarily present and still variable, whose terms are obtained by derivation of the function "$l_{(g;e)i}$"V_i/R_{ij}. The second member of equation (2) is the total sum of terms obtained phenomenologically from the two derivatives. But, while the derivative of "$l_{(g;e)i}$"V_i/R_{ij} shows all three terms (induction, gradient, and rotor), the derivative of *"$l_{(g;e)i}$"*c_i/R_{ij} remains active only with the term of gradient, because the term of

induction is evidently null due to the fact that c is constant in time, whereas the term of rotor is null for two different and opposed reasons, which appear clearly as soon as the characteristics of the two *hidden motions* are specified. At this point since the term of gradient is of a very high value compared to the corresponding value of macroscopic motion, in the approximation of $c_i \gg V_i$ it absorbs it and remains the only manifest one. We shall call $(d/dt) "l_{(g;e)i}" V_i/R_{ij}$ the "mixed derivative", because in the rotor term enters V_j of the test particle, with a few considerations we developed in Appendix I°iii).

   Each of the two interactions, therefore, the gravitational and the electromagnetic of equation (2), must be split in two motions, of which the hidden one is always present as a necessary consequence of the pure and simple existence of the sources (and for this reason it is shown first in square parenthesis), while the other depends only on the possible motion of the source with speed $V_i \rightarrow S^*$ and of the test parrticle with speed $V_j \rightarrow S^*$:

$$\frac{\partial V_j}{\partial t} + grad\,\frac{V_j^2}{2} - V_j \wedge rotV_j \;=$$

$$= "l_{gi}" \left[\left(grad\,\frac{c_i^2}{R_{ij}} \right) + \left(\frac{\partial}{\partial t}\frac{V_i}{R_{ij}} + grad\,\frac{V_i^2}{R_{ij}} - V_j \wedge rot\,\frac{V_i}{R_{ij}} \right) \right] +$$

$$+ "l_{ei}" \left[\left(grad\,\frac{c_i^2}{R_{ij}} \right) + \left(\frac{\partial}{\partial t}\frac{V_i}{R_{ij}} + grad\,\frac{V_i^2}{R_{ij}} - V_j \wedge rot\,\frac{V_i}{R_{ij}} \right) \right]. \qquad (3)$$

   We notice the invariance of the expression of inertia in the three forms assumed by the equation of motion, and again the structural identity of the two field interactions.

   13 – UNIFICATION OF THE POTENTIAL.
   Each of the four pieces of the second member of equation (3) now appears as "congruent" with the first member because they present as a total derivative with respect to the time of only one potential vectorial function whose vector is a speed of respectively c_i and V_i.

   14 – THE POSSIBILITY OF AN EXPERIMENTAL VERIFICATION.
   The presence of gradient (V_i^2/R_{ij}), which is unknown to current paradigms, enables us to look for a mathematical verification in experimental evidence. Though still small, it is still of the same range as the other two terms of induction and of the rotor, the latter being of the same numeric entity. In the electromagnetic case, due to the macroscopic motion of the source, this term should give an increment of the

static electric action (of attraction or repulsion) of the same range as Lorentz's term, which we still find very difficult to verify in phenomenology due to the difficulty to have consistent "bare charges" in motion.

In the gravitational interaction, on the other hand, the macroscopic motion of conspicuous "bare sources" would give a contribution, which though small compared to Newton's gradient, is still of the same size as the rotor, from which we obtain the shifting of perihelions, as will be seen later for example in the Appendix III°.

15 - EINSTEIN'S HEURISTIC PRINCIPLE.

The total kinematization of the two field interactions, due to the discovery of the *hidden motion* in the gradient, confers a major structural unity (congruence) to the various components of the two interactions, according to a criterion of "sufficient reason", which can be paraphrased from an "heuristic principle" developed by Einstein (l.c.p.112 and p.107) based on his belief that inertia was of a completely kinematic origin: "since it is unsatisfactory to think that such a fundamental interaction as gravitation (and electromagnetism), partly depends on a reciprocal kinematic action of bodies (terms of induction and of rotor) and partly on an intrinsic static characteristic (term of gradient), it should be expected that, if ideas are developed to the ultimate consequences, all the gravitational interaction (as well as the electromagnetic) depends solely on a reciprocal motion of bodies in interaction". These bodies however can no longer be the paradigmatic corpuscles endowed with mass and electric charge, but must be kinematic structures of material objects of a level below elementary particles, such as the "corpuscles-fields (α)" which we shall introduce here.

16 - A DUTY WITH AMPERE.   On the other hand the completely kinematic interpretation of the two interactions, at least as regards electromagnetism, seems to us nothing more than a duty which scientific thought should perform as a necessary consequence of the first steps in this direction taken by Ampère and others in the past century.

17 - THE MEANING OF "l_{gi}" AND "l_{ei}".

Before dealing with the revolution that the factorization of c^2 introduced in the phenomenology of interaction, and in the consequent ontology of elementary material objects, it seems advisable to consider the characteristics and meaning of *hidden motions* starting from the analysis of the two parameters "l_{gi}"and "l_{ei}" which describe them.

We notice first of all that since "l_{gi}" and "l_{ei}" are distanced by factor 10^{40}, they reflect the specific intensity of the two interactions. Perhaps Weyl (Ann. Der Phys. **59**, 129, 1919; Naturwiss. **22,** 145, 1934) was the first to notice this "large number" between r_o and $r_{(S)}$, inferring that the same interval could separate r_o

from R_U (Universe), but still without reaching any conclusions from these coincidences, which we shall on the contrary do here.

In order to discover the characteristics of *hidden motions* we should look for the physical meaning of the two "*l*" magnitudes, which characterize abstractly the specific intensity of the two interactions without direct reference to the characteristics of the motion they represent. However, due to the fact that in the expression of inertia the term of the gradient represents centripetal acceleration, it easily follows that the "*l*"'s are in some relation with the radii of curvature "ρ" of the two motions in which, having fixed speed *c*, "ρ" is the only variable that determines the magnitude of acceleration, here interpreted as the intensity of interaction. But, since "*l*" is proportional to the intensity of interaction, and "ρ" inversely proportional, there will be a relation between them of the "l_i"·ρ_i=const. type in which two physically admissible, and also significant, values of "ρ" show the same distance 10^{40} separating "l_{gi}" from "l_{ei}".

18 -IDENTIFICATION OF ρ_g AND ρ_e AND THEIR REMARKABLE RELATION: "l_i"·$\rho_i \equiv 2\pi \cdot r^2_o$

That the two concrete curvature radii in the Universe are so distant is a well known fact (and mentioned by Weyl as we have seen) i.e.: i) the radius of the Universe R_U=10^{27}cm *(which we shall find and fix in its real range in Mach's theory of inertia)* and: ii) the classic radius of the electron r_o=2.817·10^{-13}cm, (a fundamental length of the level of elementary particles) we have just seen here in the role of intensity parameter of the interaction: r_o="l_{ei}". Further development of Th(α) suggest to take ρ_{ei}=2π·r_o as so to have respectively ρ_{gi}=R_U and ρ_{ei}=2π·r_o. We find that the relation of the inverse proportionality between "*l*" and ρ is verified in both cases by a constant which is of the order of the square of a Fermi:

$$\rho_g \cdot \text{"}l_g\text{"}=10^{27} \cdot 10^{-53}= \quad 10^{-26}\text{cm}^2 \quad =10^{-13} \cdot 10^{-13}=\rho_e \cdot \text{"}l_e\text{"}.$$

The specific electromagnetic case is important due to the singular form it can take:

$$\rho_e \cdot \text{"}l_e\text{"} \equiv 2\pi \cdot r^2_o , \quad (2\pi \cdot r^2_o)$$

which will serve to calculate the structure of the electron.

We shall now discover that the gravitational and the electromagnetic interactions, for the greater part deriving from the term of gradient, are due to *hidden motions* occuring at speed *c* on two trajectories which have two extremely different curvature radii: radius R_U of the Universe for the gravitational interaction and the so called classic radius r_o of the electron for the electromagnetic interaction. We shall gradually discover that the gravitational interaction is a monopolar attraction, because its hidden motion has as its sole curvature that of the Universe, which is concave everywhere, while the electromagnetic one is bipolar, because its hidden motion is developed in the two possible directions of a helicoidal microscopic motion.

19 - THE SINGULAR COINCIDENCES OF DISTANCE IN 10^{40}.

After Weyl, whom we have already quoted, many other authors – among which Dirac himself – have observed the singular "coincidence" that the 40 (*emblematic)* ranges separating the two extreme lengths of the Universe surprisingly separate also the two extreme interactions of nature. This cannot but reveal, while hiding it at the same time, a deep link between the particles and the Cosmos, a link which various authors have been unable to explain in their theories so far. We wonder in fact why those searching for great unifications do not perceive such a clear signal pointing to the *geometric* and *kinematic* direction in which to address the connection between the two types of parameters in question.

Having reduced everything to geometric and kinematic magnitudes has naturally led us to interpret this "coincidence" as a precise causal connection between two types of magnitude, and in other words to derive the disjunction between the two interactions (which we consider to be of a kinematic nature) from that of the two possible extreme curvatures of the Universe (which are obviously of a geometric nature). In other words it lead us to consider the minimum and maximum possible lengths in the Universe (intended as curvature parameters) as the cause that determines respectively the maximum and the minimum intensity of interactions (of a kinematic nature) possible in It.

This is the reason why we have no doubt that the coincidence between the two disjunctions considered above (between r_o and $\boldsymbol{R}_U$ on the one hand and between *"$l g_i$"* and *"$l e_i$"* on the other) contains a precise message as to the type of connection that must be searched between the two types of magnitude; and we are convinced that this is the only possible way of interpreting gravity unitarily in the sphere of other interactions, starting from the electromagnetic and inertial interaction considered here.

We must therefore see how these two motions are realized in nature so as to remain hidden, i.e. being active even when the source appears macroscopically stationary. The reply therefore will be found later: in §.**67** and following as regards the electron, and in the final Chap.**5**) as regards the gravitation, both within Theory (α), which we shall introduce after having read equation (3). But we are now dealing with the physical meaning of these hidden motions.

20 - HIDDEN MOTIONS ELIMINATE MATERIAL SUBSTANCES.

The physical meaning of hidden motions consists in a process of unification, which is not infrequent in physics, in which a material substance carrying a charge that is the source of certain actions must be removed from the scenario of science because its actions can be deduced from the simple *circumstances of motion* of another already known substance or charge. It is sufficient to mention, for exam-

ple, the elimination of "caloric fluid" substituted by the motion of molecules. In our case the two *hidden motions* eliminate both the gravitational charge, i.e. the mass, and the electric charge while substituting the respective actions with two different accelerated motions of a material object that has neither the gravitational nor the electric charge. We shall soon introduce these sources of motion as bodies or fields (α) defined only in terms of a "res extensa" (no matter what it really is) which is in any case devoid of material substances to which forces are attributed at present.

We shall illustrate the meaning of *hidden motion* in the electric and magnetic phenomenology, because it is in this framework that we find two well-known anticipations that, in a descending order of magnitude, help to understand our case, which is located at the sub-elementary level.

21 - ATOMIC LEVEL: 10^{-8}cm.　　Without going into too much detail, the first material substance at a molecular atomic level eliminated by the action of a kinematic circumstance was the magnetic permanent substance when, after the discoveries by Ampère and others in the XIX century, its action was explained in terms of electric motion, which was later explained by the electric charges discovered around the nuclei, therefore on radii of the order of 10^{-8}cm of the atomic dimension "a_o". The magnetic substance disappeared and its interaction was interpreted by the motion of the electric substance.

22 - ELEMENTARY LEVEL 10^{-10}cm.　　The same reduction, though on a minor scale at the elementary level of the single electron, was made by Dirac's equation, which interpreted the magnetic characteristic of the electron in terms of a motion with speed c (the so-called 'Zitterbewegung', the Caldirola's 'tremolio'), with which the electric charge moves yet remaining confined in a region of Compton's wavelength of the electron $\lambda_C = \alpha \cdot a_o = 10^{-10}$cm ($\alpha = e^2/\hbar c = 1/137$). We shall refer to the well-known interpretation - although restrained by the refusal of figurative models - in which the unruly zigzaging motion is more reasonably interpreted as a circular motion of the electric charge on radius λ_C. This brilliant mathematical result allows us to obtain the magnetic moment of the electron at the level of Bohr's magneton, but is unable to enter the successive approximations of Schwinger and of the QED, which we will reach here. Nevertheless, this kinematic reduction at an elementary level does not deal with the electric charge as a material substance, but only establishes that its magnetic characteristic is due to the fact that charge moves about with speed c on a local trajectory of radius λ_C.

The emergence of this speed c for a finite mass particle - totally contradictory to the relativistic approach – placed Dirac in the same situation of "mathematical emergency" as that of c of the *hidden motion* in Newton's equation; which we

met and faced by removing the substantialistic paradigmatic approach. Plunged in his ocean of electrons, Dirac did not even see, or perhaps did not have the courage to take, the opportunity to create the kinematic revolution that presented before him.

23 - SUB-ELEMENTARY LEVEL 10^{-13}cm**.** The kinematic interpretation of the term of gradient in the electromagnetic part of equation (3) is posed at a deeper level because it interprets the electric charge in terms of motion with speed *c* (which we can here call hyper-Zitterbewegung; see § **70)** of a material object devoid of the electric charge which occurs in a region α times narrower than that of Dirac i.e. in the order of the classical radius of the electron $r_0 = (\alpha/2\pi)\lambda_C = 10^{-13}$cm. This third reduction therefore eliminates the electric charge from the group of material substances while interpreting its actions in terms of motion of a material object which is placed at a more elementary level than the electron. This object, which we shall call "*corpuscle-field* (α)*",* forms a kinematic structure macroscopically interpreted as an electron. We shall prove that this motion provides a supplement to the magnetic moment of Dirac's electron, which coincides with Schwinger's approximation.

24 - GRAVITATIONAL HIDDEN MOTION. The gravitational hidden motion of speed *c*, on the other hand, is more subtle and must be searched in the expansion of the Universe with characteristics that we shall be able to find later in this work on the basis of Mach's theory of inertia.

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CHAPTER **2**

THEORY OF "*CORPUSCLES-FIELDS*" (α). THE ACTION OF "*DRAGGING*".

25 - THE NEW ONTHOLOGY OF ELEMENTARY OBJECTS: THE "*CORPUSCLES*" (α).

The fact of having eliminated mass and electric charge from the characteristics that define a material elementary corpuscle, such as the electron, now poses the problem of representing the electron itself, and therefore the elementary particles in general, in a completely different way, as a material object that, once the material substances have disappeared, can be characterized only by its geometry, i.e. by its extension, and its kinematics, i.e. by its state of motion $\rightarrow S^*$. Under these conditions the only type of ontology available to define elementary objects, seems that pertaining to the "*res extensa*", recalling Descartes, which is only provided with extension and movement. We shall soon give further details on these two characteristics of the new type of elementary material objects that equation (3) leads us to place as the basis of matter. For the time being we shall name them "*alpha corpuscles*" because they are at a more elementary level than the electron, where they form kinematic structures that we interpret macroscopically as the electron and other elementary particles in general. We shall indicate them with the symbol "(α)" and shall call the new physical scheme: Theory (α) or briefly: Th(α)**.**

26 - INTERPRETING EQUATION (3): THE "*DRAGGING INTERACTION*".

The four pieces of the second member of equation (3) have the same structure, which can be revealed in its general synthetic form in which "l_i" can have the two values "l_{gi}" and "l_{ei}" and $\mathbf{V}_i$ can also assume the value c_i:

$$\frac{dV_j}{dt} = {}'' l_i {}'' \frac{d}{dt} \frac{\mathbf{V}_i}{R_{ij}}. \tag{5}$$

The exclusively geometric and kinematic equation (5) shows that the unknown variation of motion of the test particle $(\alpha)_j$ depends directly on the known variation of motion of the source particle $(\alpha)_i$ lowered by distance R_{ij}, between $(\alpha)_i$ and $(\alpha)_j$, without the intervention of forces due to material substances m and e, but only by means of circumstances of a geometric and kinematic type that are schematized in "l_i". This type of causal relation between two motions is known in kinematics as "*dragging action*" (no matter what it really is). In this action, without involving forces or potential energies, the variation of motion of $(\alpha)_j$ is due to the fact that it is involved (dragged) into the motion, given as a datum, of a *basic continuous field* that acts as the source of action. The cause of motion of $(\alpha)_j$ is no longer referred to the action of a force deriving from a material substance, but it

derives directly from the (action of) motion of the continuous field $(\alpha)_i$ in which $(\alpha)_j$ is immersed.

A case known in kinematics is that also present in equation (3) in the terms of the rotor, in which the deviating action of Coriolis is exercised on a $(\alpha)_j$, because the latter, with speed V_j, shifts to zones in which the kinematic situation of the basic continuum is different because of the rotor of V_i/R_{ij}. With our generalization also the terms of the induction and of the gradient of equation (3) appear as dragging actions and become homogeneous with the term of the rotor.

27 - DRAGGING REQUIRES *"CORPUSCLES* (α)*"* TO BE *"EXTENDED-FIELDS* (α)*".*

The phenomenon of dragging suggested by equation (5) leads directly to the idea that, rather than being of a granular type (punctiform as a limit), corpuscles (α) are continuous objects extended in space with a center point $\odot$ which correspond to the location of classic corpuscle. In other words, dragging leads us directly to the idea that the *corpuscles* (α) are extended as *"corpuscles-fields* (α)*"* or even briefly *"fields* (α)*"* as we shall call them in the following.

In fact, if the motion of the corpuscle $(\alpha)_i$ "directly" determines the motion of corpuscle $(\alpha)_j$ without the intermediary of forces – and therefore of a continuous mean distinct from $(\alpha)_i$ and $(\alpha)_j$, (or the quanta which is the same thing) which transmits forces – we have to admit in some way that the state of motion of corpuscle $(\alpha)_i$ is not limited to a granule, as in the present dual physical scheme (in which the corpuscles are immersed in an outer field), but extends it self to reach corpuscle $(\alpha)_j$. This means that the motion of $(\alpha)_i$ is present or extends to $(\alpha)_j$, in short, that $(\alpha)_i$, and therefore also $(\alpha)_j$, are extended as *fields* instead of being limited as *corpuscles*.

This leads us to consider that source $(\alpha)_i$ is an extended continuous material object that fills the distance R_{ij}, and moves jointly with "$\odot_i$". This in turn means that in the physical scheme of the World, instead of having many granular corpuscles immersed in one globally immobile continuum – but plastic and elastic (as Lorentz's ether or Einstein's space-time) transmitting the structural stresses of the various charges contained in it – there are as many continuous extended *corpuscles-fields* (α), with center $\odot$, as there are material elementary objects making up the World. Rather than being a limited corpuscle immersed in an extraneous continuum on which the field of forces is created, every elementary object is itself a continuum: as extended as its field and provided with motion. And in other words still, instead of being made up *dually* by many corpuscles immersed in one continuum that is different from them, the World is made up *unitarily* of as many continui as there are elementary objects, all of which being as extended as their field, i.e. as the Universe, and therefore mutually penetrated over their entire exten-

sion: the "*corpuscles–fields"* we indicated under the name of "fields (α)". In short, in one type of basic elementary material object, these "corpuscles-fields (α)" unite the two separate aspects of "corpuscles" and "continuous field" of the present dual physical scheme – which is dual also in the quantum variant where the continuous field is replaced by the corpuscular quanta emitted by the sources.

This solves Einstein's perplexity about the duality of the physical scheme within which he himself used to move: "If one considers this stage of the theory is struck by the dualism inherent to the fact that the material point considered in the newtonian sense and the field as physical continuum keeps one near the other as elementary concepts." ("Albert Einstein scientist and philosopher" Ed. Ital. Einaudi 1958 p.20)

28 – AN ECHO OF FARADAY.   In fact this idea of elementary objects extended as the Universe - both beautiful and terrible especially because it denies the impenetrability of material elementary objects - has only one singular though authoritative precedent. Historians know well the idea of *"extended fields of force"* proposed but not pursued by Faraday in his letter toTaylor: "We know the forces and verify their presence in every phenomenon of creation, but that of abstract matter in no one; therefore why should we admit the existence of that about which we know nothing, which we are unable to conceive, and of which there is no philosophic need ?" So Faraday rids himself of the "material central point" of Boscovitch's still dual conception and introduces his unitary and monistic idea of extended atoms of force. "The point of view now established on the composition of matter seems necessarily to imply that *matter* fills all space, or at least all the space in which gravitation is extended [including the sun and its system] (square parentheses in the text); because gravitation is a property of matter that depends on a certain force, and it is this force that forms matter. Seen in this way, matter is not only mutually penetrable, but each atom extends, so to say, through the entire solar system, though it maintains its own centre of force" (M.Faraday "A speculation touching.." in "Experimental researches in Electricity" II, p.291). One is fascinated by the simplicity with which Faraday announces such overwhelming ideas.

Fields (α) can be considered the next step, the last possible step in the course of the geometrization and kinematization of physics, that can be taken paraphrasing Faraday as follows: "We know motion and its accelerations, and verify their presence in every phenomenon, but that of the abstract force in none; so why should we admit etc…"   "In this concept matter is not only mutually penetrable, but each body (α) - though it seems more arduous today - extends through the entire Universe while maintaining its own figure centre, or singularity ⊙".

29 – THE NUMBER $N_{(var)}$ AND THE PACKETS $N(\alpha)$.   Since fields (α) do not exercise between them any physical action of the type of attraction or repulsion due to forces, nothing prevents them from arranging themselves in any variable number $N_{(var)}$, even a very large or extremely large number as we shall see, with their centres coinciding among themselves so as to form a global object which we shall call "packet (α)" of $N_{(var)}$ number, indicating the generic one among them with the symbol $N_i(\alpha)$, $N_j(\alpha)$ etc. and the respective centres always with $\odot_i$, $\odot_j$.

30 - $N_{(var)}$ IS THE ONLY VARIABLE OF Th(α); AND IT ESTABLISHES THE BASIC QUANTIZATION.

According to Th(α), the only physical reality existing in the Universe are fields (α) generally gathered in packets $N(\alpha)$. Each material object, both of the matter type, i.e. fermions (electrons and (α)quarks), and of the energy type, i.e. bosons (photons), can be made up of nothing else than structures with an integer number $N_{(var)}$ of fields (α), and therefore of packets $N(\alpha)$, so that the positive integer $N_{(var)}$, which varies from packet to packet, forms the only variable that determines all the variable characteristics of Th(α). Thus the values attributed to the packet with $N=1$ (single field (α)) is the basic irreducible quantum of every specific characteristic, such as mass-energy, intensity of interaction, etc.

In the (α) theory in fact quantization does not occur with the introduction of new corpuscles, different from those of the sources and different for each type of interaction, and that fractionize action and move it far away. Instead the basic continuum in it, which is only one in the standard theories, is quantized "*due to flaking*" in as many single continuums, the (α)fields, as there are material elementary objects forming the Universe, each extending over the entire Universe and therefore all mutually penetrated with each other.

31 - THE MOTION OF (α) FIELDS IS: *TRANSLATORY RIGID.*

Equation (3), which is written in function of the potentials, describes the physical situation in all space, relating to any point P_j the variation (acceleration) of the vectorial speed $\mathbf{V}_i$ of the center $\odot_i$ of the source corpuscle Σ_i, which transits through P_i at distance R_{ij} from P_j. For an extended continuous material object, such as the (α) fields extended over the entire space, the characteristic that all of its points have the same acceleration indicates that their motion is *pure translatory rigid*. In fact the vectorial invariance of $\mathbf{V}_i$ over the entire space implies that the rotatory component of rigid motion is identically null.

This very hard position is not a conjecture introduced by Th(α), but a condition imposed by the paradigmatic potential vectors, both the classic electromagnetic $\mathbf{A}$ and the gravitational $\mathbf{Æ}$ of Einstein's equation (118) – introduced in equation (1) – which in any given distant point P_j in space indicate, and they could not

do otherwise, the acceleration of the corpuscular source that moves in point P_i. Since the physical scheme (α) has transformed the corpuscular sources in continuous fields extended over all space, this condition is represented by the translatory rigidness of motion, also the accelerated motion, of fields (α). This is then interpreted in the relation $\partial V_i/\partial(x,y,z)=0$, which intervenes in the derivation of V_i/R_{ij} in Appendix I°iii).

In the current gravitational and electromagnetic paradigms the spatial structure of the field (for example the conformation of its equipotential surfaces) moves rigidly in block only when the sources have a uniform translatory motion $\rightarrow S^*$, but this rigidity is lacking when the sources accelerate $\rightarrow S^*$. In this case the elasticity of the field, in which variations are transmitted with the finite speed of waves according to the retarded potentials, intervenes. But the condition of the delay of the waves is not part of the structure of potential functions and is introduced as an additional hypothesis which on the other hand has no reason to exist in Th(α).

THE OVERPRESENT *DRAGGING CURRENT*. It is clear that the extension and rigidity of fields (α) induces in each point P_j of space a real current of speed V_i due to the motion of the source body $\Sigma_i(\alpha)$, which is the local agent of dragging on each potentiated body $\Pi_j(\alpha)$. It is in this way that the physical scheme of fields (α) extends to all space the material current that in standard theories is limited, for instance, to those wires in which corpuscles flow.

32 - THE *"SUPERPOSITION OF ELEMENTARY EFFECTS"* IS SUBSTITUTED BY:
"SUPERPOSITION OF ELEMENTARY OBJECTS".

As regards this rigidness we can refer to the fact that in the dual paradigmatic physical scheme – in which the continuum of the field, given only once in the whole Universe, is a different material object than the corpuscles – the realization in P_j of different physical situations due to a diferent number of sources Σ_i is obtained by the *'superposition of effects'* in the one continuous field that *must* necessarily be plastic and elastic. The consequence of this deformability is the finite speed with which its deformations spread in space in the form of waves: and these are given, in short, by the laws of the field. In the unitary physical scheme of fields (α), on the other hand, the realization in P_j of different physical situations due to a different number of sources $\Sigma_i(\alpha)$, is given by the simple *'superposition of objects* (α)*'* which are rigid and mutually compenetrated. This leads to an enormous simplification in the formalism in which the differential laws of the field, with their inevitable boundary conditions, are replaced by a simple summation of finite terms.

FIRST TRIBUTE TO BONDI.   To our knowledge, perhaps it was only Bondi who in the last pages of his "Myths and hypotheses in Physical Theory: demystification of some great ideas in physics" (Zanichelli 1971, p.97) had ventured with "reckless hope" of being able to give a Unitary and Global Formulation of Physics as a whole of the Σ M/R type, in order to give "a total reply without any awkward accessories". Exactly as the one given here by Th(α).

33 – FIELDS (α) ARE ELEMENTARY MATERIAL OBJECTS THAT CANNOT BE REDUCED FURTHER.

Rigidness is the necessary condition that makes the (α) fields "invariable under any physical condition", with the obvious exception of reciprocal rigid motion. This guarantees in principle that they are:

elementary material objects that cannot be reduced further,

 i.e. they are not susceptible of being interpreted as structures of other objects, which automatically makes Th(α) a TOE (Theory Of Everything).

It is the linear position that mostly simplifies things and no experimental emergency can contradict it, since the delay of electromagnetic actions was attributed to corpuscular photons emitted by decelerating sources with respect to S^*.

00 – The novelty of the new way of seeing things urges us to describe them once more in different words. The physical scheme of *"corpuscles-fields (α)"* consists of postulating that physical reality is not made up dually of different types of elementary corpuscles – made up of different material substances – which are immersed in only one field, equally material but different from them and extending over the entire Universe, but is made of only one type of elementary material objects – describable in terms of pure extension ("res extensa") and of its motion – which, starting from a point ⊙, are extended like the Universe, and are therefore mutually superposed and penetrated over their entire extension. This extension is finite and devoid of boundaries, i.e. it is closed in itself in a spherical (or better hyperspherical) symmetry in the fourth spatial dimension as we shall prove in Mach's theory of inertia.

34 - DRAGGING AT THE 1st ORDER. THE FUNDAMENTAL LAW OF PHYSICS.

Law (5) of dragging (at the second order in the derivatives of coordinates) is the purely geometrical and kinematic form in which we were able to write Newton's equation of motion (0) purifying it of the forces and the material substances that produced them. But while the original form (0) of Newton's equation does not refer to any necessary presupposition, the exclusively kinematic form of equation (5) leads to the *mathematical emergence* – the second and the most exacting in our

work – that is the fact that it necessarily leads back to the primitive function from which it is derived:

$$V_j = {}^{''}l_i^{''} \frac{V_i}{R_{ij} + {}^{''}l_i^{''}} .\qquad (4)$$

Equation (4) is the basic law of dragging which indicates that: the speed $V_j{\to}S^*$ of a potentiated field $(\alpha)_j$ – which is free to move with respect to S^* - is directly proportional to speed $V_i{\to}S^*$ of field source $(\alpha)_i$, and is inversely proportional to the distance R_{ij} between the centers $\odot_i$ and $\odot_j$ of the two (α)fields, by means of a parameter *"l_i"* having dimensions of a length, which synthesizes the specific characteristics of motion of $(\alpha)_i$.

In spite of its *"exemplary simplicity"* – considering that it is impossible to have anything more simple – this is the only law from which Th(α) must deduce the description of the World more completely than in equation (5), which is its necessary consequence. For lovers of folklore we can say that equation (4) is the longed for "unique formula" that describes all that takes place in the Universe. As a fact Th(α) infers all the extreme Variety and Variability of the World from precisely itself and from its derivatives (of which we shall limit ourselves here to (5)).

The unity of equations (4) and (5) gives the first realization of that maximum unitary program dreamt of, it seems, only by Mach: "There will hover before him as an ideal an insight into the principles of the whole matter, from which accelerated and inertial motions results in the *same* way" (E.Mach "The sciene of Mechanics", Open Court Pv.Co. Illinois 1960.Cap.II°, §6, n°11p296). (In reality Mach's winged sentence is difficult to translate).

35 – NATURAL ELIMINATION OF INFINITES.   The *"l_i"* in the denominator – which therefore must figure also in equation (5) (whose general structure it does not alter) – represents quite a natural fact regarding dragging, so that speed V_j of the dragged body can never reach infinity when R_{ij} tends to zero – a possibility that occurred in the formation of packets (α) as was seen in § **29** – but will obviously tend to V_i; eliminating at the base, on account of the kinematic nature of things, those infinites that disturb the paradigms founded on forces. To simplify matters, we shall ignore *"l_i"* in the denominator, because in fact in Th(α), R_{ij} never reaches zero, except in the fundamental case of fusion between packets (α) of photons described by the law (4/trj) which we find in § **46**.

36 – TWO IMPORTANT CHARACTERISTICS OF Th(α).
Before proceeding with our discussion let us make a short interval to show two characteristics of the field (α) theory that illustrate its power of penetration in

the crucial problems of modern physics by showing that: - i) the motion of (α) fields is in an undulatory form, and: - ii) Bell's inequality is solved unexpectedly. To do so we need to go back to equation (4) – which is the causal law of motion of $(\alpha)_j$ under the effect of motion of $(\alpha)_i$ – and take the second member of equation (4) (deprived of *"l_i"* in the denominator) as the expression of what we shall call the "physical situation" $\Phi_{i \to j}$ in P_j due to the presence and motion of field $(\alpha)_i$, whose center $\odot_i$ moves at a speed $\mathbf{V}_i$ at a distance R_{ij} from P_j. We obtain:

$$\Phi_{i \to j} = \text{"}l_i\text{"}\mathbf{V}_i/R_{ij}. \qquad (\Phi_{i \to j})$$

37 - i) *UNDULATORY LAW OF MOTION* AND SOLUTION OF COMPLEMENTARITY.

If we place ourselves in point P_j to observe the progress in time of the "physical situation" $\Phi_{i \to j}$, i.e. the motion of $(\alpha)_i$ in point P_j, and if for simplicity we limit ourselves to a constant motion in time $((\partial\Phi_i/\partial t)=0)$ along the x axis of the coordinates, we can write:

$$d\Phi_i/dt = (\partial\Phi_i/\partial x)(V_x) \qquad (d\Phi)$$

which gives us the motion of $(\alpha)_i$ in P_j in an undulatory form because it describes it as a spheric wave with only one peak in $\odot_i$: a wave, therefore, that we may call solitary (or perhaps also solitonic).

For general reasons, which we shall see later, in nature there can never be a uniform linear motion of this type for any (α), but only, as a minimum, a uniform helicoidal motion whose equation, though always a consequence of $(d\Phi)$, is more complex, similar to the equations of undulatory mechanics and comparable to them; in particular to the "double solution" theory of de Broglie.

As a first result therefore, Th(α) accepts the enigma of complementarity in its strictest ontological form and resolves it in the simplest way by means of its objects (α) which are at the same time "individual corpuscles" and "extended continuous fields" that move like waves. In the experiment of the two slits – just as in the most sophisticated equipment with single photons – each field (α) passes through the two slits and instantaneously feels the effects of the distribution of matter which surrounds it even at a considerable distance.

38 – ii) *"THE INSTANTANEOUS ACTION OF CONTACT"* ON THE ENTIRE UNIVERSE, AND NON LOCAL CAUSALITY.

Every single field $(\alpha)_i$ is in a reciprocal "contact" situation with every other field $(\alpha)_j$, *point by point* over the entire Universe. As a consequence, because of their perfect rigidness, the only action that can be exercised between them – which we called "dragging", whatever it is - is not an "instantaneous action at a distance" between their centres, which could be very distant in space, but an:

"*instantaneous action of contact point by point over the entire Universe*".

This resolves in a new and unexpected way the contrast as regards Bell's results that recently arose between the locality of actions, which is implicit in the causal (relativistic) theories, and the non-locality, which seems to be required by the indeterministic (quantistic) theories. Though we are not in a position to treat the subject thoroughly, we would like to point out that our scheme is rigourously causal and local, thanks to its "action of point by point contact", yet at the same time it appears decidedly non-local when referred to centers of (α) fields which can be at any rate distant in space, because this action between rigid fields is extended over the whole Universe.

39 - OVERCOMING GALILEO'S PRINCIPLE OF INERTIA.

Taking up our discourse on equation (4), we note that it proposes a *mathematical emergency* that obliges us once more, for the second time and in a more exacting way in this work, to decide whether to ignore it because unknown and even opposed to the dominating paradigm, or to accept it as a thing that reveals an existing physical reality which, according to Hertz's "coherence criterium", obliges us to find the physical reality it represents, just as we had done previously with c^2. In fact equation (4) contains a dramatic reversal of the principle of inertia, because it foresees the existence of uniform motions of bodies (α) as a result of an impressed exterior physical action, which openly contradicts Galileo's fundamental intuition, and its mathematical formulation in Newton's law of motion - the solid base on which modern and contemporary physics are founded. These unexpected dragging effects of the first order, however, instead of creating an embarassing situation for Th(α) appear as really existing and are the source of a few important corroborations.

However (4) does not brutally expel the inertial paradigm from science; the paradigm is still represented by its consequent equation (5); but it deprives it of its particular present "status" of being the only basic stronghold, by inserting it into a more ample view of the World, in which it appears as a particular aspect of a more general criterion introduced by dragging.

40 – THE FALSELY INERTIAL NATURAL MOTIONS AND:
WEYL-MAJORANA'S COSMOLOGICAL PRINCIPLE".

Fundamental kinematic phenomena have emerged in contemporary physics: the motion of photons (or of light, we might say), that of the neutrinos, and the spin of elementary particles, which seem to be of inertial origin and nature, because they are uniform, but instead they violate precisely the principle of inertia because they are unchanged and constant (during and) after every interaction that their carriers exchange with other material objects of the world.

As regards the motion of light, the problem was created by restricted relativity, which claimed to eliminate cosmic ether and its intrinsic characteristics that supported the uniform motion of electromagnetic waves. At this point a peremptory affirmation - posed as a question of principle - on the invariability of the speed of light actually hid instead of clarifying the problem of its causal justification. Einstein himself radicalized the problem by introducing photons that travel in an absolute void. Nevertheless, neither he nor anyone after him, as far as we know, was able even to acknowledge the existence of this enormous problem, which in our opinion lies hidden in the deep waters where physicists leave all matters they are unable to solve at the moment.

A reasonable interpretation of these misleading inertial motions makes it necessary to abbandon the criterion of *"RESISTENCE TO CHANGE"*, which is the base of the principle of inertia, and to recur to a criterion of *"ADAPTATION"* to external unalterable circumstances inducers of Universal origin.

We shall call this requirement as "*Weyl-Majorana's cosmological principle*" (Quirino Majorana 1871-1957, to be not confused with his nephew Ettore M. 1906-1938) on account of two different reasons that now the senior author will expose for himself.

> A PERSONAL EVIDENCE. MAJORANA: 1956.   At the end of a life devoted in particular to a numberless and sophisticated experimental researches about a light speed variation between bodies in high motion – all failed – during the '55 and '56, totally changing his strategy, Majorana, who followed W. Ritz balistic theory, tried to find these variations in the speed of photons emitted by conducting electrons of metals very far away in the periodic table of elements. In those years, as a young student in my twenties, fascinated by these adventures against the tide in physics, I had gone to assist this old and indomitable uncle over his eighties (my grandmother's brother) who, marginalized in the institute that he had directed during twenty years in Bologna, used still work by himself tireless without external supports. At the end of this experiment one night, admitting the ultimate null result, Majorana almost absent-mindedly said to himself: "It looks as if photon speed, instead of being determined balistically by the characteristics of the source, would be determined by some *external circumstance of universal origin that imposes its exact value*." We cannot know if he would have expressed this conjecture in the "rendiconto" because he died the next year without leaving any document on it. However I had been struck by the novelty and the importance of this idea so that, when I attained a clear knowledge of the expansion of the Universe, I realized that that one could probably be the *external circumstance* that Majorana conjectured.

WEYL'S BOOK: 1968.   So it had been this personal experience, and my consequent belief about this further connection between the local facts and the Cosmos – besides Mach's one that I already knew – that in '68, about ten years later, immediately recalled to me the same thought in the last appendix of Weyl's book: "Philosophy of Mathematics and Natural Science" (edited in 1949 in English and only in 1967 in Italian) – anyhow forgotten until now. This idea however was formulated in a less properly cinematic context in which, instead of the invariant characteristics of kinematic nature of matter, like in the more direct Majorana's conjecture, and as it would be natural to expect on the inertia subject contested by Weyl, the request is applied to the invariant characteristics of elementary particles of substantial kind like mass and electric charge.

Weyl says: "Classical physics derives the conservation of charge and mass from a resistence to change, though it admits the existence of bodies of arbitrary charge and mass. As regards fixed charges and masses of elementary particles, this point of view remains unsatisfactory. Their conservation must depend on an *adaptation* and not on a *resistance to change*. The direction of the axis of a spinning top [for example the position of the earth's axis] (square brackets and italics in the text) is maintained instant by instant by resistance to change or inertia – which we have called inertial field – whereas the direction of a magnetic needle is determined by an adaptation to the magnetic field. If the conservation of a magnitude depends on inertia, its initial value can be chosen arbitrarily; but since it is not possible to eliminate disturbances completely, deviations can occur in the course of time. Adaptation, on the contrary, imposes a definite value independent of the past history and which is therefore re-established after any disturbance, and at any rate after a long lapse of time as soon as the previous conditions are restored." (H.Wey "Philosophy of Mathematics and Natural Science" Ital.Ed. Boringh.'67 Appendix F: the last and most interesting appendix in the book, p.351).

We wonder whether having been distracted by kinematics (i.e. practically by *"c"* and by *"h"*), to which he had to resort for his examples, depended on the fact that, a few lines before, he imprudently dealt with the units of measure, in which precisely *"c"* and *"h"*, made equal to 1, hide their presence behind this fictitious value.

41 - THE TWO COMPONENTS OF DRAGGING: *UNIVERSAL* AND *LOCAL*.
THE DISCOVERY OF THE *"NEW UNIVERSAL ACTION"* THAT GENERATES ALL
THE OTHERS *"UNIVERSAL INTER-ACTIONS"*.

The extension of fields (α) over the entire Universe, together with the kinematic characteristic of its expanding motion – which will emerge from the analysis of *hidden motion* on ρ_g in § **79** - leads to the consequence that the contributions to

global dragging in a generic point P_j, are due to the contextual superposition of two very different types of Σ_i sources: i) the "Universe" $\Sigma_{i(U)}$ and: ii) the "local packets" $\Sigma_{i(N\alpha)}$.

-i) The *"action"* of the Universe. Primarily and unavoidably in each P_j there is the very particular, intense, and inalterable *"component of the Universe"* (which we shall dedicate to Weyl) due to the expanding motion of the Universe which induces a doubly helicoidal *primitive motion* in all packets (α). This motion makes them neutrinos and antineutrinos, and extends to the photons and to spins, as will be seen soon. Instead of paradigmatic "inter-action", which presupposes the counteraction of the test particle, the definition of "action" for this component, which is unknown to the paradigm, explains the fact that there is no counteraction not because the single packets are extremely small as compared to the Universe, but because before, or independently of this motion, they possess no motion with which to carry out the counteraction.

This dragging of the Universe is an exceptional discovery because, not only it reveals the existence of a: *new universal action* unknown today, but also that of a sole basic action, which onthologically precedes all the others, and of which it is the primary cause as we shall presently see in detail. It surpasses the present inertial paradigm, and in agreement with our equation (4), it gives the uniform motion of neutrinos and photons as though compelled by an inductive universal action.

-ii) The *"inter-action"* between the packets. In a secondary line in each P_j there are one or more possible *"local components"* due to the *primitive motion* which the packets $N_i(\alpha)$ near P_j have acquired through the effect of the component of the Universe. This secondary local component – which acts only on the level of accelerations of equation (5) – first of all binds the packets in (binary) stable structures corresponding to bosons and fermions, i.e. to the energy quanta (photons) and to particles of matter that have charge and mass (elecrons and (α)quark). Successively it binds them to form the structure of all the most complex objects in the world with parameters corresponding to those of known universal interactions, as we shall presently see for gravitation, electromagnetism, and inertia.

One of the main reasons that explains the success of Th(α) is the fact that it was able to see and clearly distinguish these two components of dragging, the first of which is totally unknown to present paradigms, and as has already been said, it is the one from which all things derive their motion and life.

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CHAPTER **3**

THE *PRIMITIVE MOTION* INDUCED FROM THE UNIVERSE.

42 – A STURDY COPERNICAN REVOLUTION.

The discovery of this primordial dragging action of the expanding Universe leads us to make an ample gesture that upsets the causal chain of all present paradigms by affirming that:

the "pimordial motion" from which all others originate is the motion of expansion of the Universe.

It is the primordial or metaphysical datum from which all the rest must be deduced in a unitary manner as a causal effect, i.e. all the material structures and complex phenomena of the world starting from the elementary particles as well as their interactions. It is therefore "given as a datum," as though it was activated from outside the Universe, or better still, taking the last step which we find inevitable (also not to give place to an unproposable indefinite regression), it is as if it were:

"moved by the hand of God".

This means that each field (α) is at the same time a field $(\alpha)_i$ source of motion since it participates in the *primordial motion* of expansion, and at the same time also a field $(\alpha)_j$ because it is subject to the dragging of $(\alpha)_i$ in a local inalterable *primitive motion* whose characteristics we shall now examine. This causes the $Th(\alpha)$ to deduce the subtle web of physics from this sole position on the motion of the Universe and from the characteristics that can be given to it.

43 – SECOND TRIBUTE TO BONDI.

We shall quote Bondi again (l.c.p.101), where he too with an attitude in many aspects similar to ours, regarding the motion of the Universe and its role in physics asserts that this motion is not to be deduced from laws of local interactions – as is being attempted at present for example with general relativity – but, being one and not reproducible, it must be taken for what it is, i.e. "given as a datum". It is worthwhile quoting Bondi: "The best thing we could do as regards the motion of the Universe is to describe it without looking for its law"… "It is therefore pointless to ask questions regarding forces that set motion to the Universe since the best we can do is describe that one and only movement from which no deviations can exist. This is the way the Universe moves, and that is all."

44 – THE THREE FREE PARAMETERS OF $Th(\alpha)$

In tackling the quantitative description of *primitive motion* induced by the Universe in packets $N(\alpha)$, and therefore the total physics of $Th(\alpha)$, we have to indicate the free parameters of the Universe (α) and their units of measure.

Instead of 18-20 independent parameters of the standard model, Th(α) requires only three free parameters: the first two – coherently with its exclusively geometric and kinematic structure - fix the geometry R_U and the kinematics V_U of the Universe, while the third is the pure number 10^{40}, already seen at work, which fixes the ranges between two extreme levels, the Universe and level (α), which Th(α) places in direct contact in its description of the World:

(present) extension of the Universe: $R_U = 10^{28}$cm;

speed of expansion of the Universe: $V_U = 10^{10}$cm/s $\equiv c$;

pure *"emblematic first"* number (principal): $\aleph = 10^{40}$.

Besides $V_U = c$, we shall continue to use the orders of magnitude that emerged in Mach's theory of inertia before indicating them numerically on the basis we shall develop in the last chapter.

The pure *"emblematic second"* number: $\alpha = e^2/\hbar c = 1/137.037$ which connects all the magnitudes of level (α), will be deduced from a combination of the three free parameters that we have just given.

45 – THE *"DOUBLY HELICOIDAL PRIMITIVE MOTION"* OF PACKETS $N_j(\alpha)$.

Th(α) infers the existence of the *doubly helicoidal primitive motion* of packets $N_j(\alpha)$ from Weyl's universal dragging action due to the motion of expansion of the Universe with horizon speed c, and it deduces its characteristics from the equations of dragging (4) and (5), in which an *"l_U"* relating to the source of the Universe must be included, which we shall identify in dealing with Mach's principle: *"l_U"* $= M_U G/c^2 = 10^{28}$cm $\equiv R_U$.

Deferring the detailed deduction to the already quoted text of Th(α), we shall here only make a synthetic description of *primitive motion* sufficient to deduce the h constant of Planck, the α constant of Sommerfeld (and then also Newton's G constant), before passing on to neutrinos and photons, and then to define the kinematic structure of the electron, which emerged, as has been seen, from the electromagnetic component of *hidden motion* which occurs on the curvature radius: $\rho_e = 2\pi \cdot r_o$.

In fact the expansion of the Universe drags every $N_j(\alpha)$ packet, making it travel not in a straight line - a geodesic of the Universe – but in a complex doubly helicoidal trajectory in which the center $\odot_j$ of the packet travels through a small helix $\varepsilon_{\hat{u}}$, right or left indifferently (*small primary phase of the neutrino)* of a constant radius, independent of N_j: $R_{\hat{u}} = \alpha \cdot R_U \cdot \aleph^{-1} = 2.055 \cdot 10^{-15}$cm. At the same time, however, in order to conserve the moment, which we shall presently illustrate, the axis of this small helix does not follow the geodesic just mentioned, but spirals around the geodesic travelling through the big helix ε_γ (*large secondary phase of the photon)* with a constant radius, independent of N_j: $R_\gamma = R_U \cdot \aleph^{-1} = r_o =$

$=2.817\cdot10^{-13}$cm of the helicity opposed to $\varepsilon\hat{u}$. In the *small primary phase*, depending on whether its helicity is left or right, the single packet becomes a neutrino or an antineutrino, which we shall call cumulatively *utrinos* "û". In the neutrino+antineutrino bound state, on the other hand, the characterisics of the *large secondary phase* appear like those that define a photon γ, as we shall see schematically hereunder. Therefore summarizing:

$$R_\gamma = \boldsymbol{R}_U\cdot\aleph^{-1} = 2.817\cdot10^{-13}\text{cm} = R\hat{u}\cdot\alpha^{-1}.$$

46 - APPLICATION OF EQUATION (4)   A simple argument of "sufficient reason" as to the necessary diversity among packets having different N_j, leads us to establish that the primary dragging action of the Universe must be expressed in the existence of two different components of motion orthognal to each other: longitudinal V_{lg} and transversal V_{trj}. The main longitudinal component, which reflects the absolute characteristics of the source Universe – and is therefore fixed and scalarly inalterable – is deduced directly from equation (4):

$$V_{lg}\text{="}l_U\text{"}(\boldsymbol{V}_U/\boldsymbol{R}_U) = c. \tag{4/lg}$$

The transversal component V_{trj}, on the other hand, reflects the characteristics of the test particle $N_j(\alpha)$, and is proportional to the variable N_j, which represents the material contents of the packet: $V_{trj}= k_V N_j$ (in which k_V represents $V_{trj(min)}$, a fraction of c, which corresponds to the minimum packet with $N_j=1$). The $V_{trj(min)}$ is fixed starting from the free parameters of the Universe lowering $\boldsymbol{V}_U$ by parameter $\aleph$, which establishes the range between the Universe and the elementary (α)level: $V_{trj(min)}=\boldsymbol{V}_U/\aleph=10^{-30}cm/s=k_V$. This means that for $V_{trj(max)}=c$ it will be $N_j=10^{40}$. V_{trj} can also be deduced from equation (4) when the aforesaid condition is introduced into it:

$$V_{trj}\text{="}l_U\text{"}(N_j/\aleph)(\boldsymbol{V}_U/\boldsymbol{R}_U) = (\boldsymbol{V}_U/\aleph)\,N_j = k_V N_j. \tag{4/trj}$$

Owing to its direct proportionality with N_j, this V_{trj} plays the main role in all the variable characteristics of the packets $N_j(\alpha)$, i.e. of matter. Equation ($4/trj$) implicitly contains the answer to the question posed in § **35** as to what happens when R_{ij} between (α)fields or packets reaches zero; which is the fundamental and also the only case of fusion that takes place between packets of bosons, practically between the photons. When a $N_i(\alpha)$ packet is fused with a $N_j(\alpha)$ packet the resulting $N_k(\alpha)$ packet has a transversal speed $V_{trk}= k_V N_k$ where $N_k=N_i+N_j$.

47 – APPLICATION OF EQUATION (5) (IN THE EXPLICIT FORM (3)):
        THE HELICOIDAL MOTION.

Around a packet that moves in any direction with speed *c,* Weyl's field – which is distributed like a star around a point standing $\rightarrow S^*$ - takes on a cylindrical distribution exhibiting a singular rotational component due to the variation of the

vector in a direction normal to itself, which however does not relate to the *intensity* of the vector, as occurs in the usual local kinematic fields, but to its *direction.* Through the last term of equation (3), this vorticity operates on V_{trj} compelling it to travel in a circle with a constant radius $R\hat{u}$ – already seen, and which we shall call "of Coriolis" – which, together with longitudinal translation creates the small primary helicoidal phase of the total double helicoidal motion.

With this first spiral phase, packet (α), which has already been transformed into a neutrino or an antineutrino according to the helicity, acquires the characteristics of a polar charge of interaction of local dragging, which can assume all the intensity with reference to the curvature radius $\rho_{\hat{u}j} = (\alpha \cdot \boldsymbol{R_U})/N_j$ of its trajectory, and, among others, also that of the electron $\rho_{\hat{u}e} = 2\pi \cdot r_o$ discovered in equation (3), whose justification is one of the aims of this work.

This interactional polar charge advances at speed c in Weyl's singular homogeneous kinematic field, in which, therefore, just as any electric charge moving in a constant magnetic field, it moves with a constant radius R_γ (of Lorentz) that can be calculated starting from the term of rotor of equation (3):
$$A_{j(Nj)} = V^2_{trj}/R_\gamma = \text{"} l_U \text{"} \cdot N_j \cdot \mathbf{V}_{trj} \wedge \text{rot}(\boldsymbol{V_U}/\boldsymbol{R_U}),$$
which means that R_γ:　　$R_\gamma = (\mathbf{V}_{trj}/N_j)(\boldsymbol{V_U}/\boldsymbol{R_U}) = 10^{-13}cm= \boldsymbol{R_U}/\aleph = r_o$,　- i) is constant due to the obvious constance of the two ratios, the first of which is guaranteed by proportionality (4/trj): $V_{trj} = k_V N_j$; - ii) that R_γ is the radius of the Universe $\boldsymbol{R_U}$ lowered by the same factor $\aleph$ whose $\boldsymbol{V_U}$ we have lowered.

It is therefore natural that $V_{trj(min)}$ is what is needed for the minimum packet with $N_{j(min)} = l$, i.e. for the single (α) field, to accomplish one single circulation on $2\pi R_\gamma$ within the time $t_U = 2\pi \boldsymbol{R_U}/c = (2/3)\pi 10^{18}$s　it employs to cross the Universe $2\pi \boldsymbol{R_U}$ with speed c:
$$V_{trj(min)} = 2\pi R_\gamma /(2/3)\pi 10^{18} = 3 \cdot 10^{-30}\text{cm/s} = c/\aleph = k_V.$$

Therefore, besides obviously having the same longitudinal speed $V_{lg} = c$, the two helicoidal phases also have the same transversal speed $V_{trj} = k_V N_j$. This implies that – being $R\hat{u} = \alpha R_\gamma$ – the great angular moment (in (α) unit) $N_j V_{trj} R_\gamma$ of the secondary phase, at every turn equilibrates in the Universe the small angular moment $N_j V_{trj} R\hat{u}$ of the primary phase, which in that turn completes $1/\alpha$ turns in the contrary direction.

48 - PARADIGMATIC JUSTIFICATIONS OF THE SECONDARY PHASE.

Before passing on to the characteristics acquired by packet $N_j(\alpha)$ in its *primitive motion,* we consider it appropriate to justify double helicity with paradigmatic arguments of general relativity which appeared quite indpendently of those specific to Th(α).

It happens that this dynamic requirement (of the contextual existence on the same material object with an intrinsic spin moment, of an equivalent and contrary counter-moment that preserves conservation) also emerged in a paradigmatic environment in at least two contexts independent of each other and separated in time: one in the '30-'40's, and another in the '60's. Their approach is different from that of Th(α). In fact though they necessarily started from an object with intrinsic angular moment of spin, which, at those moments, could have been nothing else but the electron and therefore in an electromagnetic environment, they later develop their arguments in the dynamic sphere of general relativity.

It is an interesting result of classical/relativistic deduction according to which a particle "*equipped with spin*", that moves by inertia in the absence of external fields, cannot travel on a geodesic line, but must travel in a spiral around it in circular motion with an orbital angular moment of equivalent value but contrary to that of the spin. The characteristics of this motion, moreover, identify it with Dirac's quantistic Zitterbewegung.

WEYSSENHOFF.   In 1938 J.W.Weyssenhoff (Nature **141**, (1938) p.328) took note of the works of M. Mathisson (Acta Pys.Pol. **VI**, (1937) p.163; p.218) and of J.Lubanski (Acta Pys.Pol. **VI,** (1937) p.356) who - following Einstein's and Grommer's (Einstein's faithful Polish collaborator) well known line of thought since 1923 and using the equations formulated ten years before by J.Frenkel (Zeitsf. Pys **37**, (1926) p.224) - had demonstrated that instead of moving along a geodesic line, a free particle with spin had to follow a helicoidal course around it. Weyssenhoff – partly with the unfortunate Raabe, dead in 1943 – had developed these ideas in sufficient detail during the last war and had even published them ten years later in five joint articles (J.W.Weyssenhoff and A.Raabe, Acta Pys. Pol. **IX,** (1947) I,II,III,IV,V, p.7-53). According to these, the general conservation of momentum in the flight system compels the particles with an intrinsic angular moment (spin) to assume an external angular moment, equal and opposed to spin, which when applied to the case of the electron – the only one available at that time – coincides with Dirac's Zitterbewegung.

CORBEN.   The same result was obtained by H.C.Corben with the same relativistic formalism (both special and general) though with a completely different approach (H.C.Corben (Pys.Rev. **121,** 6 (1961) p.1833; Nuovo Cim. **20,** 3 (1961) p.529). Corben quoted Bohm, Vigier and others (Progr.Teor.Phys. Kyoto **23,** 496 (1960) and Moeller (Ann.Inst. Henri Poincaré **11-12,** 251(1949) – according to whom, for brevity and using the words from his abstract: "A free spinning point particle moving according to the laws of classical relativistic point-particle mechanics move along a helix";…. "which is the classical analog of the Dirac Zitterbewegung".

49 – THE COUNTER-MOMENT. These results – together with other more recent and analogous ones – take on exceptional importance in Th(α), but could not attract, as in fact they did not, as much attention in the paradigmatic environment in which they remained as isolated sporadic facts, devoid of a more general context and in which at any rate there could be no interest for example to consider the Zitterbewegung of the electron outside Dirac's quantistic formalism.

The deep reason for the existence of the second, contextual, angular moment 'controversial' with and 'equivalent' to the first, also in paradigmatic theories, lies in the fact that there is one more or less conscious necessity to conserve moment. In Th(α), however, this reason takes on a definite character of necessity due to the causal relation the two circulations have with the inductive action of the Universe which is devoid of moment.

In the paradigmatic works just quoted, the inhibition to visualize spin as a circulation, counterposes two angular moments of 'equivalent' value but of a different nature (with some confusion in the results). In Th(α), on the other hand, the two counterposed moments are of the same nature, both angular orbital, and of different value yet 'equivalent' in the sense explained above.

In short the secondary phase of the primitive motion is nothing but a direct necessary consequence of the primary phase and this is because the packet in it acquired an intrinsic angular moment (though still orbital), and with it the character of a generalized electric polar charge that counterspins in the field (of Weyl) in which it is immersed. But while in paradigmatic physics these two characteristis are independent, in Th(α) they are one and the same thing because the character of polar dragging charge does not depend on the two different material substances but on the same kinematic circumstance that generates angular moment.

Finally we wish to make two remarks: i) one, already referred to, is that in Th(α) the 'free spinning point particle' is the (α) packet in its primary phase in which it has already appeared as a neutrino, as we shall see; and ii) that none of the authors quoted above had ever suggested to attempt experimentally a confirmation of this counter-spin of the electron.

50 - GEOMETRY OF THE PRIMITIVE MOTION.

In each of the two helicoidal phases of the *primitive motion,* the relation of the two respective constant radii being $R_{\hat{u}}=\alpha\cdot R_\gamma$, and the constance of the common longitudinal speed being $V_{lg}=c$, we can define:

i) two wavelengths $\lambda_{\hat{u}j}=\alpha\cdot\lambda_{\gamma j}$ (corresponding to the path of the helix) inversely proportional to N_j. In particular we have an important product $\lambda_{\gamma j}\cdot N_j=2\pi\boldsymbol{R}_U$ which we shall use presently;

ii) two curvature radii of the trajectories $\rho_{\hat{u}j}=\alpha\cdot\rho_{\gamma j}$ inversely proportional to N_j: $\rho_{\hat{u}j}=(\alpha\cdot\boldsymbol{R_U})/N_j$ seen above;

iii) two frequencies $f_{\hat{u}j}=f_{\gamma j}/\alpha$ directly proportional to N_j of which $f_{\gamma j}=c\cdot N_j/2\pi\boldsymbol{R_U}=N_j\cdot10^{-18}\text{s}^{-1}$ serves to define the energy (and equivalent mass) of the packet.

It is evident that the sole variable parameter of Th(α), as said above, is the number N_j, on which all the other variations that can be found in the Universe (α) depend.

51 – *OPEN STRUCTURES* AND *CLOSED STRUCTURES.* We must anticipate here that in their *primitive motion* packets (α) can assume only two different kinematic configurations: an "open" configuration or a "closed" one.

- i) "Open" configurations are those in which the packets move along trajectories open in space, which we shall call *"light speeding"*. These are expressed in only two structures: i) the neutrinos and the antineutrinos (cumulatively already indicated as "utrinos" "û") which are single $N_j(\alpha)$ packets, and: ii) the photons γ, which are the heteropolar bonds of neutrinos plus antineutrinos of equal energy, as we are about to see.

- ii) "Closed " configurations, on the other hand, are those in which two homopolar neutrinos move in circular trajectories locally closed in space, which we shall call *"ring standing"*. These are expressed in two polar variants with a ring-shaped structure which is the stable bound state of two homopolar utrinos of equal energy: neutrinos for the positrons e^+ and antineutrinos for the electrons e^-. The same structure – which is not stable when isolated – makes up the (α)quarks, which are rings completely analogous to electrons but with utrinos, and therefore mass and intensity of action, $1/\alpha=137$ times stronger and size 137 times smaller.

But we whill see all that better below.

52 – *PRIMITIVE MOTION* MAKES THE (α) PACKETS THE BASIS OF MATTER AND ENERGY.

The doubly helicoidal kinematic structure imposed by the Universe on *primitive motion* gives $N_j(\alpha)$ packets four physical characteristics: two that are absolute invariables when N_j varies, and two that are variable proportionally to N_j.

The two invariable characteristics when N_j varies are:

i) the constant and scalarly invariable *"longitudinal speed"* $V_{lg}=c$, which animates the only two structures in the free flight of the neutrinos and the photons, and then curves in the circular trajectories of the only two closed ring-shaped structures of the two particles of mass: electrons and (α)quarks;

ii) the constant and inalterable *"moment of action"* $N_j\cdot\lambda_{\gamma j}\cdot c=(\alpha)h$ that characterizes all the packets when N_j varies and is converted in the *angular moment (of spin)* $m_\alpha N_{je}\cdot R_e\cdot c=h$ in the ring-shaped structure of the electrons, and of (α)quark (m_α being the equivalent of mass as we shall soon see).

We have called this unvarying magnitude $(\alpha)h$ - which gives Planck's constant in (α) units - *moment of action* so as to bring together in one expression the original definition of Planck's "quantum of action" and the subsequent interpretation as the "angular moment" of rotations and spin of the particles. Actually in spite of the correct dimensions of the kinematic angular moment, in the two "light speeding" structures of neutrinos and photons, the length λ_γ is not orthogonal, but parallel to speed c. This moment of action, however, takes on this orthogonality when it produces the "ring standing" structures in which its conservation transforms the $\lambda_{\gamma e}$ of the photon into the radius R_e of the ring-shaped structure of the electron, (or of the (α)quark) as we shall see presently.

The two characteristics that vary proportionally to N_j are:

iii) the *"energy"* $E_{\gamma j}=h \cdot f_{\gamma j}$, which is proportional to N_j through the frequency $f_{\gamma j}$ of the secondary phase of the "light speeding" particles, neutrinos and photons. It appears as a *resting mass* $m_o=E_\gamma/c^2$ in the annular structure of the electrons (and of the (α)quarks). We shall establish here the relation:

$$m_{\gamma j}=k_\gamma \cdot V_{trj} \qquad\qquad (m\gamma)$$

between the mass equivalent of a photon $m_{\gamma j}=E_{\gamma j}/c^2$ and the transversal speed $V_{trj}=k_V \cdot N_j$ of its packet, in which $k_\gamma=m_o/\alpha\ c=9.108 \cdot 10^{-28}/2.187 \cdot 10^8=4.164 \cdot 10^{-36}$g s/cm – which will be useful later – is derived from $V_{trj(e)}=\alpha \cdot c$ of the kinematic structure of the electron, which we shall see in § **67**;

iv) the *"polar charge of interaction"* $A_{\hat{u}j}=c^2/\rho_{\hat{u}j}$, which is proportional to N_j through the acceleration $A_{\hat{u}j}$ of the *primary phase* that determines the "local dragging" of variable intensity and is inversely proportional to the curvature radius $\rho_{\hat{u}j}$.

This local interaction charge (which is bipolar with reference to helicity) is owned by the packet also in free flight structures with speed c, i.e. in neutrinos and in photons, in which, obviously, it does not appear as a local interaction. However, when the packet is bound in the two ring-shaped structures, mentioned above: electric and strong, it clearly manifests itself through two definite values of $\rho_{\hat{u}j}$ (and consequently of N_j), which characterize these two structures. From equation (3) we already know that the curvature radius $\rho_{\hat{u}e}$ that gives the intensity of the electrostatic interaction of the electron must be $2\pi \cdot r_o$. Here we only need to check that this is the one $Th(\alpha)$ derives from the parameters of the ring-shaped structure it brings into action.

In their *primitive motion* therefore the $N_j(\alpha)$ packets have acquired the four physical characteristics needed to build all the elementary particles without adding anything: i.e. both those of energy (the bosons: practically photons) and those of matter (the fermions: practically neutrinos and electrons, and also the (α)quarks).

THE INDISSOLUBLE BOND BETWEEN MASS AND ELECTRIC CHARGE. Therefore in (α)Th mass and electric charge are always joint as two different aspects of the same cinematic structure whose characteristics furnish the mass (of electrton § **67**) as well as that of his polar charge (electric § **69**). Standard theories, without being able to give a theoric explanation of it, shaw that electric charge is always combined with a mass but admit neutral particles deprived of electric polar charge. On the contrary in (α) theory, both in the electric and in strong nuclear world, neutral particles are necessarily binary structures formed by two rings of opposed polarities as we effectively will see that it happens.

53 – THE ACTION OF THE LONGITUDINAL COMPONENT $V_{lg}=c$ IN OPEN AS WELL AS IN CLOSED STRUCTURES.

We wish to notice that also the longitudinal component $V_{lg}=c$ of primitive motion always exerts a kind of dragging action in relation to the ray of curvature on which it develops. In fact also in the open structures of the utrinos and photons in which the V_{lg} seems to develop on a rectilinear trajectory, this trajectory is actually no more rectilinear than is allowed by the intrinsic curvature radius $\boldsymbol{R}_U$ of the Universe, which we shall see when dealing with Mach's inertia theory. This component of action therefore is monopolar and, considering parameters of the §**18** , are of a gravitational intensity, but it should not be confused with that of the hidden motion of Newton's gradient, because the motion of the utrinos and photons considered here is quite evident in space, even though its curvature is hidden behind the appearance of a locally rectilinear motion.

We wonder what contribution of curvature this could bring to the trajectory of the rays that run very close to the great masses.

In the annular structure of electron this component becomes that of magnetic intensity calibrated by Bohr's magneton, which we shall see presently (and in an analogous, but proportionally stronger manner in the (α)quarks).

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CHAPTER **4**

FIRST REMARKABLE *NUMERICAL* RESULTS OF THE Th(α).

i) QUANTIZATION OF MASS AND ENERGY.
ii) CALCULATION OF THE CONSTANT: *h* OF PLANCK, α OF SOMMERFELD and:
iii) MASS *m*, CHARGE *e*, MAGNETIC MOM. μ (SCHWINGER) OF THE ELECTRON.

i) **54** – THE QUANTIZATION OF MASS AND ENERGY.

As we said in § **30**, and then considered again at the end of § **50**, the parameter N_j, namely the number of (α) fields that form the $N_j(\alpha)$ packets, is the only variable from which all variations that we can have in the (α) Universe depend. In § **46** we have also indicated how N_j determines, in its turn, the $V_{trj}=k_V \cdot N_j$ of helicoidal primitive motion of packets putting $k_V=V_{trj(min)}=\boldsymbol{V_U}/\aleph=10^{-30}$cm/s only a size that now instead we shell specify according to the exact numbers of § **80**:

$$V_{trj(min)}=2\pi \cdot r_0 / t_{max} = c \cdot r_0/\boldsymbol{R_U} = c/\aleph = 6{,}272 \cdot 10^{-31}\text{cm/s}.$$

This V_{trj}, easier to identify rather than N_j, becomes therefore the key to enter in the different characteristics of (α) packets, beginning from the equivalent mass for which in § **52** we have predisposed the ($m\gamma$): $m\gamma_j=k\gamma \cdot V_{trj}$: in which $k\gamma$ is deduced by the specific case of electron (α) of § **67**, whose packet must have a $V_{trj(e)}=\alpha \cdot c$:

$$k\gamma=m_0/\alpha \cdot c=9{,}108 \cdot 10^{-28}/2{,}187 \cdot 10^8=4{,}164 \cdot 10^{-36}\text{g s/cm}.$$

Therefore, introducing $V_{trj(min)}$ in ($m\gamma$) we will obtain the equivalent mass of minimum packet with $N_j=1$, single (α) field, that is to say the quantum m_α of mass of (α)Th:

$$m_\alpha=k\gamma \cdot V_{trj(min)}=4{,}164 \cdot 10^{-36}\text{x } 6{,}272 \cdot 10^{-31}=2{,}611 \cdot 10^{-66}\text{g: } \textit{minimum quantum of mass.}$$

(We notice surprisingly that a similar number strangely emerges in analogous circumstances in the string theory). This evanescent number would obviously remain in the limb of conjectures if not for the fact that, introduced – as hereafter – in the expression of *"moment of action"* of § **52**, would not give exactly Planck's constant.

Now, if we insert directly in $m=E/c^2$ – that however we shall autonomously find hereafter – the numeric result just obtained for m_α we will find the corresponding minimum value, 'id est' the quantum, of energy:

$$E(\gamma)_{min}=m_\alpha \cdot c^2=2{,}611 \cdot 10^{-66}\text{x } 8{,}987 \cdot 10^{20}=2{,}346 \cdot 10^{-45}\text{erg: } \textit{minimum quantum of energy.}$$

POSSIBILITY OF AN EXPERIMENTAL CONTROL. We wonder whether this quantum base of energy, $E(\gamma)_{min}=10^{-45}$erg, which is unknown to paradigmatic theories, can in some way be detected, for example in the sophisticated measurements of photon frequency variation of the photons that fall into the gravitational field.

55 – IN Thα ENERGY IS A MATTER OF *THINGS* NOT OF *MODES*.   It is important that in Th(α) energy should be a magnitude of "things" and not of "modes", because it is exclusively determined by the number N of fields (α) that make up the packets, both those of the "light speeding" particles of neutrinos and photons, and those of the "ring standing" structures of the mass particles: electrons and (α)quarks. The exchanges of energy are therefore only exchanges of packets bound in a structure of photons.

To show even better that N_j is the only parameter that characterises all the variables of Th(α), we have a table that shows how it fixes the different values of energy and of the equivalent mass of packets, as well as their charge of interaction.

		cinem.	geom.		energy	mass	interaction	
	N_j	V_{trj}	$\lambda_{\gamma j[cm]}$	$f_{\gamma j[s^{-1}]}$	$E_j(\gamma)_{[erg]}$	$E_j(m)/c^2_{[g]}$	$\rho_{\hat{u}j[cm]}$	$A_{\hat{u}j}$ [cm/s²]
min.	"$\underline{1}$"	$c/\aleph$	10^{+28}	10^{-18}	10^{-45}	$10^{-66}(m_\alpha)$	10^{+28}	10^{-8}(grav.)
elect.	10^{38}	$c\,\alpha$	10^{-10}	10^{+20}	10^{-7}	$10^{-28}(m_e)$	10^{-13}	10^{33}(electr.)
max.(nucl.)	10^{40}	"$\underline{c}$"	10^{-13}	10^{+23}	10^{-4}	$10^{-24}(m_{(\alpha)Q})$	10^{-15}	10^{35}(strong)

Besides defining the "quantum" 10^{-45}erg of energy and of mass 10^{-66}g, the minimum values also refer to the minimum of interaction, which is gravitational. They have already appeared in the works of various authors as the mass or minimum energy of the photon or the neutrino: (M.A. Tonnelat Jour.Phys. et le Rad. 12, 9, (1951) p.829; G.J.Whitrow Nature 4302 (1952) p.611; D.F. Curdgelaidze Sov.Phys JEPT 20,6,(1965); M.Sachs Nuovo Cim. 37,3,(1965) p.888; S.Hayakawa Prog.Theor. Phys.Lett. Dic.1965 p.538; A. Inomata Prog.Theor.Phys. 39,5,(1968) p.1370).

The intermediate values included for a $V_{trj}=\alpha\,c$ are those of the only other level that relates to the organization of the World according to Th(α) – which is detached from the maxima of the *"emblematic second"* α number – and refers to the annular structure of the electron and the electric interaction, as we shall presently see. The maximum values on the other hand refer to the annular structure of the heavy particles, i.e. to (α)quark ((α)Q), and their strong interactions dealt with in a subsequent work.

56 - THE CONSTANTS *"h"* OF PLANK, "α" OF SOMMERFELD AND "G" OF NEWTON ARE OF A KINEMATIC NATURE OBTAINED AS IMPORTANT PRODUCTS OF $\boldsymbol{R}_U$, $\boldsymbol{V}_U$ AND $\aleph$: *"h"* AND "α" IN THE PRIMITIVE MOTION; "G" IN THE EXPANSION MOTION OF THE UNIVERSE .

With the first two free parameters $\boldsymbol{R}_U=10^{28}$cm and $\boldsymbol{V}_U=10^{10}$cm/s applied to primitive motion we obtain the *"moment of action"* which we have already mentioned, which is the Planck's h constant. If $\aleph=10^{40}$ then is joined to $\boldsymbol{R}_U$ and

V_U, we obtain the constant $\alpha=e^2/\hbar{\cdot}c$, the so-called Sommerfeld's fine structure constant. The ratio between V_U^2 and R_U gives the numeric value and the kinematic interpretation of Newton's constant G, as an effect of the expansion of the Universe, which we shall see in CHAPT.**5**.

57 - THE. *"MOMENT OF ACTION"* OF PRIMITIVE MOTION IS PLANCK'S h CONSTANT.

The remarkable invariant product $R_U{\cdot}V_U=10^{38}$cm^2/s with dimensions of a kinematic angular momentum gives no information on the variable packets in their primitive motion, until we substitute R_U with another important product seen above, $N_j{\cdot}\lambda_{\gamma j}=2\pi{\cdot}R_U$ (§**50**), in which the two inversely proportional parameters N_j and $\lambda_{\gamma j}$, representing the variability of packets, appear:

$$(1/2\pi)N_j{\cdot}\lambda_{\gamma j}{\cdot}c =10^{38}\text{cm}^2/\text{s}=(\alpha)\hbar.$$

Thus written, this product is the Planck's $\hbar$ constant in kinematic units (α), from which, as soon as $N_j=1$ is specified, and the mass dimension is introduced through the mass equivalent $1N=m_\alpha=2.611{\cdot}10^{-66}$g – which we have indicated in § **54** – we obtain, first in symbols and then in numbers:

$$m_\alpha 2\pi{\cdot}R_U{\cdot}c = h.$$
$$2.611{\cdot}10^{-66} \text{ x } 6.283 \text{ x } 1.347{\cdot}10^{28} \text{ x } 2.997{\cdot}10^{10} = 6.62\underline{4}{\cdot}10^{-27} \text{ g}{\cdot}\text{cm}^2/\text{s},$$

in which the numeric values of R_U is derived from (G/1) of § **78**, as we shall see in the context of Mach's theory of inertia.

58 – $E=m{\cdot}c^2$ CAN BE OBTAINED WITHOUT RELATIVITY FROM THE EXPRESSION (α) OF h.

From the structure of $h=m_\alpha N_j{\cdot}\lambda_{\gamma j}{\cdot}\boldsymbol{c}$ given in terms of the primitive motion of packets (α), we can express the radiant energy $E(\gamma)=h{\cdot}f_\gamma$ of the photons (bosons) directly in function of their equivalent mass, which is converted in the rest mass of the particles (fermions); i.e. we can derive the "most famous formula of physics" $E=m{\cdot}c^2$ without relativistic assumptions. By introducing the expression (α) of: $h=m_\alpha{\cdot}N_j{\cdot}\lambda_{\gamma j}$ $\boldsymbol{c}$ and $f_{\gamma j}=c/\lambda_{\gamma j}$ in $E(\gamma)$, and bearing in mind that $m_\alpha{\cdot}N_j=m_j$, we obtain:

$$E(\gamma)_j = h{\cdot}f_{\gamma j} = m_\alpha N_j{\cdot}\lambda_{\gamma j}{\cdot}c{\cdot}c/\lambda_{\gamma j} = m_j{\cdot}c^2 = E_{(m)j},$$

which efficiently expresses the structural unity of the two distinct forms of energy:

$$h{\cdot}f_\gamma = E(\gamma; m) = m{\cdot}c^2.$$

59 – THE STRUCTURE OF UNIVERSE OF SOMMERFELD'S CONSTANT: $\alpha=e^2/\hbar c$.

The second important product we shall consider involves all three constants of the Universe R_U, V_U, and $\aleph$, and is achieved by deriving a pure dimensionless number obtained by the ratio between the product $R_U{\cdot}V_U$ seen above – written in the final paradigmatic form $m_j{\cdot}\lambda_{\gamma j}{\cdot}c=h$ – and the product itself written for the same generic mass m_j in which however R_U is lowered for $\aleph$ to obtain $R_U/\aleph=r_o$.

If now for m_j we introduce the mass m_e of the electron, as suggested by the parameter r_0 pertaining to it, we should specify: - i) $\lambda_{\gamma j}$ as λ_C $(=h/m_e\,c)$ relating to the electron in the expression of h, and: - ii) $m_e \cdot r_0 \cdot c$ as e^2/c from the well known classic relation $r_0 = e^2/m_e \cdot c^2$, above seen in § **8** . Then this ratio, without 2π which is missing under h, becomes the dimensionless constant $1/\alpha = \hbar c/e^2$:

$$\frac{\boldsymbol{R}_U \boldsymbol{V}_U}{\boldsymbol{R}_U \Big/ N \, \boldsymbol{V}_U} = \frac{m_j \lambda_{\gamma j} c}{m_j r_0 c} = \frac{m_e \lambda_C c}{m_e r_0 c} = \frac{h}{e^2 \Big/ c} = \frac{2\pi}{\alpha} \qquad (2\pi/\alpha)$$

In particular the $(\lambda_C/r_0) = (2\pi/\alpha)$ will play an important double role in the calculation of electron structure. The $(2\pi/\alpha)$ suggests to interpret r_0 as the wave length $\lambda_{\hat{u}j}$ of the small primary phase (of the neutrino), which corresponds to λ_C on the big helix of the secondary phase (of the photon), in this phenomenological way establishing the value of radius $R_{\hat{u}}$ of the small helix, which in § **45** ($R_{\hat{u}} = \boldsymbol{R}_U/\aleph \cdot \alpha$) was given as *a datum*.

For the numeric value and the physical interpretation of Newton's constant G, the reader is referred to § **71** and following, which explains Mach's theory of inertia.

60 – THE NEUTRINO AND THE ANTINEUTRINO.   As repeatedly stated above, the single packet $N_j(\alpha)$ in its doubly helicoidal *primitive motion* is a neutrino or an antineutrino, according to whether it has left or right helicity in its primary phase of utrino.

61 –THE BOUND STATES AMONG THE UTRINOS.

We know that due to its complex *primitive motion*, each utrino is the source of local interactions that may determine bound states among utrinos. These are to be studied and deduced starting from equation (5) by means of a mathematical analysis, which is not shown here, while we shall only state a simple coupling rule among utrinos, which is inferred from the analysis and proves to be sound:

TWO UTRINOS FORM A STABLE BOUND STATE WHEN THEY HAVE:
1) EQUAL ENERGIES AND: 2) PARALLEL BUT OPPOSITE SPINS.

In spite of its qualitative formulation, thanks to this rule we can proceed further in our research on the structures of utrinos. In this sense it can be compared to the first simple rules (following Bohr, so to say) stated in any nascent paradigm, while awaiting for somebody proficient able in mathematics to deduce them, in our case, from equation (5) given above.

The senior author points out that, due to a lack of sophisticated dynamics in the agitated field of elementary particles, the resort to a few early qualitative schemes, also in form of simple tables, was opportunely recommended precisely here in

Rome (in the lecture room of the 'Accademia dei Lincei' incredibly packed with people) by Gell/Mann himself, who had stopped in Rome for the centenary celebrations of Mendeleev and his tables on the way back from Stockholm in 1969. The younger author was not even born at that time.

Surprisingly, this first rule refers not to one but to two types of bound states, very different from each other (see above), which we shall respectively call "open structures" or "light speeding" identified with photons, and "closed structures" or "rings" identified with mass particles, i.e. the electron and the (α)quark. This double possibility of bound state is what gives to Th(α) the variety needed for a correct and complete interpretation of the World.

62 - "OPEN STRUCTURES": THE FREE PHOTONS.

The first type of bound state refers to two utrinos, which, due to the dragging of the Universe, interweave their large helixes in a rather complex way and thus coupled cover two contiguous open trajectories in space. As their spins are sufficiently parallel, to appear opposed, the two utrinos must have opposed helicity and therfore they must be a neutrino and an antineutrino, i.e. a "couple" of opposed intrinsic helicity. Obviously only one type of these structures exists which must be identified with the photon in a state that we shall call the "free flight" state, to distinguish it from the other possible state: the "bound state" in which the photon is bound to rings having electric (or strong) charge, which we shall discuss in a subsequent work.

We shall call this bond "*hetero/helicoidal*". This is the most widespread and final bond in nature, and it dissolves only in catastrophic collisions in which the utrinos of the photon are broken into pieces giving life to couples of fermions, in other words to electrons or (α)quarks.

63 - "CLOSED STRUCTURES": THE PARTICLES THAT HAVE A MASS.

The second type of bound state, on the other hand, is made up of two utrinos, which due to local reciprocal transversal dragging, superposed over the longitudinal dragging of the Universe, travel on a trajectory closed in a circle, as they are located on opposed bands of the same diameter. According to the geometry of the system, their spins are exactly parallel, and in order to be opposed the two utrinos, they must have the same helicity i.e. they must either be both neutrinos or both antineutrinos, the exact opposite of the case of the photons. Therefore, there are two and only two types of this structure, which differ in the intrinsic helicity of their utrinos, as with any other characteristic. They are identified with the two polarities that differentiate fermion type objects, in which particles are distinguished from antiparticles; in other words, they distinguish the negative electric and nuclear charges from the positive ones.

> The senior author can never forget his emotion, when for the first time very many years ago, (once up on a time on the shores of the Mediterranean), he penetrated so deeply into the structure of the electric charge.

Naturally this bound state can be achieved only for a certain threshold of the energy of the utrinos, i.e. of the photon from which they derive, and this will prove to be the calculation of the mass, and also of the charge, of the electron, as we shall see further on.

We shall call this very stable type of bond *"homo/helicoidal"*; nevertheless, in the annihilation of couples (in which the two rings meet and disintegrate giving life to two equal photons that move in opposite directions with a lowering of energy compared to the original photon), this bond gives way to the stronger affinity of the "*hetero-helicoidal*" bond mentioned above.

64 – THE FREE PHOTON.

The rather complex kinematic configuration of the free photon is the configuration in which, on advancing with longitudinal speed $V_{lg}=c$, a neutrino and an antineutrino of identical energy "*revolve around one another*" under the action of local reciprocal dragging in a counter spiral direction each on its own helix with transversal speed $V_{trj}=k_V N_j$. The resulting object therefore will have wave length "λ_j" and frequence "f_j", which correspond exactly to what we have just seen in the secondary helicoidal motion of the large helix, whose parameters have been indicated as belonging to the photon: $\lambda_{\gamma j}$ and $f_{\gamma j}$, respectively in inverse and direct relation with parameter N_j.

We shall pause here to see how this complex "revolving around one another" can give place to both helicities of the photon – which nevertheless are not one the antiparticle of the other – and also to linear polarization in any direction orthogonal to advancement. Similarly we shall not mention the theory of the "photon bound" to the rings of the electric (or strong) charge, both because their structure will be the end of this branch of work, and because the de Broglie's ondulatory theory and relativistic expressions of mass and energy, which are deduced therefrom *without relativity*, must be dealt with in said second part of the work. We shall proceed instead along the line that leads to the birth of structure of the rings of electric charge.

65 – THE NEUTRINO THEORY OF THE PHOTON.

It is well known that, starting from the early, only mathematical conjectures of de Broglie in 1932, a theory of light, i.e. of the photons, as a structure of particles of spin $\hbar/2$, later identified with neutrinos, and finally with the neutrino+antineutrino couple, thrived weakly but continuously, also in Italy, with a literature which, up to a few years ago, can be summarized as follows.

L de Broglie, C.R. Acad. Sci. (pris) 195, 862 (1932); **197**, 1377 (1933) ; **199**, 1165 (1934) ; T. Jordan, Z. Phys. **93**, **464** (1935); **98**, 759 (1936) ; **99**, 109 (1936) ; **102**, 243 (1936); **105**, 229 (1937) ; L. de Broglie and J. Winter, C. R.Acad. Sci. (paris) **199**, 813 (1934) ; N. S. Nagendra Nath, Proc. Ind. Acad. Sci. **3**, 488 (1936); Sokolow, Phys. Z. Sowiet. **12**, 148 (1937); R. de L. Kronig, Physica **2**, 968 (1935); M. H. L. Pryce, Proc. R. Soc. London Ser A **165**, 247 (1938).

The theory was again taken up in the years 1957-1972.

K. M. Case, Phys. Rev. **106**, 1316 (1957); N. Rosen and P. Singer, Bull. Res. Counc. Israel F **8**, 51 (1959); I. M. Barbour, A. Bietti and B. F. Touschek, Nuovo Cimento **28**, 452 (1963); D. K. Sen, nuovo Cimento **31**, 660 (1964); B. Ferretti and I. Venturi, Nuovo Cimento **35**, 644 (1964); B. Jouvet, Nuovo Cimento **38**, 951 (1965); P. Bandyopadhyay, Nuovo Cimento **38**, 1912 (1965); W. A. Perkins, Phys. Rev. B **137**, 1291 (1965); Phys. Rev. D **5**, 1375 (1972); V. S. Berezinskii, Zh. Eksp. Teor. Fiz. **51**, 1374 (1966); [Sov. Phys. JEPT 24, 927 (1967)]; J.Mickelsson, J.Math. Phis. **26** (9), 2346 (1985). We have no documentation on more recent developments.

This theory should have suggested, also in paradigmatic terms, that the electron+positron couple formed by photoproduction was nothing else but an adequate transformation of the neutrino+antineutrino couple of the generating photon. The paradigmatic impediment to this idea lies in the fact that the standard neutrino does not possess an electric charge (as Prof. Beneventano had good reason to object when questioned off the mark on the subject). The neutrino of Th(α) on the other hand, as demonstrated in § **52**, has all the possible values of charge relating to the curvature radius $\rho_{\hat{u}j}$ of the primary phase, and therefore in particular can even possess that of the electric charge: $\rho_{\hat{u}e} = 10^{-13}$cm (already discovered in form (3) of Newton's equation) when its energy becomes that of the photon of Compton, as we shall soon see.

66 – THE PHOTOPRODUCTION OF THE ELECTRON+POSITRON COUPLES.

In Th(α) the creation or photoproduction of the couples is nothing else but the transformation of the open structure of photons in closed ring-shaped structures which have the characteristics of the particles of mass. According to Th(α), the collision of the photon against a heavy particle unable to absorb it, frees its two utrinos from their bond and hence the antineutrino, *"crushed into two identical parts"* - with a typical *"halving"* process, which is also found in strong rings in the production of nucleons - forms the ring of the negative charge, while at the same time the neutrino forms the ring of the positive charge in the same way.

67 – THE THRESHOLD ENERGY OF THE RING-SHAPED STRUCTURE. CALCULATION OF THE MASS OF THE ELECTRON.

The bound state of two homopolar utrinos closed in a ring, can be formed only for a certain level of energy of the generating photon, and therefore of its utrinos. In Th(α) the problem is to determine the intensity of the local interaction of reciprocal dragging between the two utrinos that allows them to remain bound on the circular trajectory. The transversal speed V_{trj} that gives this result will later indicate the wavelength of the generating photon, i.e. its energy and therefore the mass of the electrons that emerge.

Law (5) of local dragging tells us that the centripetal acceleration $A_{ûj}$ which maintain each of the two utrinos $ûj$ (considered as potentiated) to circulate on the ring, through the adequate parameter *"l_i"*, is due to the *effective* part $A_{ûi(eff.)}$ of the intrinsic acceleration of the other utrino $ûi$ (considered as the source of local dragging) divided by the distance D_{ij} between the two utrinos:

$$A_{ûj}=\textit{"}l_i\textit{"}\cdot A_{ûi(eff.)}/D_{ij}. \tag{5ûj}$$

With the structural data we have at our disposal, let us examine the single elements of (5ûj) introducing some approximations, which make the problem more understandable without loosing its main points.

- $A_{ûj}$. The first approximation consists in considering that the acceleration of the first member of (5ûj) is simply $A_{ûj}=c^2/R_e$ namely that of the potentiated utrino which covers the circle of ray R_e (which as we shall see is 10^{-10}cm) at speed c, whilst the real dragged object is the $N_j(\alpha)$ packet, whose center $\odot_j$ does not actually cover the circle but a helix – which is the small primary utrino phase – that spirals round the circle on the utrino ray $R_û$ (which is known to be of 10^{-15}cm).

- As to R_e the conservation of the "momentum of action" (§ **55**): $m_\gamma\cdot\lambda_\gamma\cdot c$=cost=$h$, in the transformation from the open structure of the photon to the closed structure of the ring, keeping $V_{lg}=c$ and m_γ fixed, makes that the photon wavelength λ_γ is transformed to the ray R_e of the ring and hence the acceleration induced in the potentiated utrino $ûj$ becomes $A_{ûj}=c^2/\lambda_\gamma$, with $D_{ij}=2\lambda_\gamma$.

- *"$l_{ûi}$"*. Now going to the second member of (5ûj) we notice that the *"$l_{ûi}$"* is known because the geometry of the system (App. II°) tells us that ray of curvature $\rho_û$ of the utrino which generates (effective) acceleration in the ring is the known utrino ray $R_û$ (that we shall write in the form $R_û=\alpha\cdot r_o$) so that the *"$l_û$"*$\cdot\rho_û=2\pi\cdot r_o^2$, of § **18** gives us at once *"$l_{ûi}$"*$=(2\pi\cdot r_o/\alpha)=\lambda_C$ in which the second equality is the result of the: $\lambda_C/r_o=2\pi/\alpha$ of § **59**.

- $A_{ûi(eff.)}$. Finally, and always with $R_û=\alpha\cdot r_o$, let us write the effective acceleration as given in the App. II°: $A_{ûi(eff.)}=V_{trûi}^2/\pi\cdot\alpha\cdot r_o$.

At this point, inserting the expressions found and suitably gathering the terms – after crossing out λ_γ in the two denominators – we can write the (5ûj) :

$$c^2 = \lambda_C \frac{V^2_{\text{trûi}}}{\alpha \cdot 2\pi \cdot r_o}, \qquad (5/e)$$

which, solved respect to $V_{\text{trûi}}$, and recalling that $(2\pi \cdot r_o/\lambda_C) = \alpha$ (§ 59) gives us at once:

$$V_{\text{trûi}} = \alpha \cdot c .$$

And this, inserted in the form: $\lambda_\gamma = c \cdot 2\pi \cdot r_o/V_{\text{trûi}}$ (always from § 59) gives us for the wavelength of the generating photon just the Compton λ_C that phenomenology indicates as necessary for the electron photoproduction.

Actually, in order to produce the electron+positron couple, the generating photon must have double energy, therefore a wavelength half that of Compton. But the calculation developed by us is correct, because of the halving of each of the two utrinos – mentioned above – during which their wavelength doubled (since $V_{\text{trj}} = k_V N_j$ of § **26** was halved).

It is a peculiar circumstance that α should introduce in the kinematic contest as a factor of reduction of transversal speed V_{tri} in relation to c, the same parameter α which reduces $R_{\text{û}}$ in relation to r_o in the geometric contest. It is for this reason that we shall call "punctum mirabile" the set of numeric coincidences in which the exceptional event of the creation of matter from radiant energy occurs.

It is interesting to note that, being calibrated by "$l_{\text{û}}$"$=\lambda_C = 2.426 \cdot 10^{-10}$cm, the interaction that bonds the two utrinos *inside* the ring is $2\pi/\alpha = 2\pi \cdot 137$ times more intense than the electric interaction exerted by the ring *outside*, calibrated by "le"$=r_o = 2.817 \cdot 10^{-13}$cm. As a matter of fact "$l_{\text{û}}$" is the parameter that calibrates the strong interaction between the (α)quark, which will be seen in our next work. In other words, the electric ring is sustained inside by strong dragging interactions of an hadronic level, while on the outside (and at a certain distance) it exercises interactions of an electric level.

68 – THE STRUCTURE OF THE ELECTRON AT THE DIRAC'S LEVEL.

So far Th(α) has autonomously found the same parameters seen in § **23** for Dirac's electron theory, in which an electric charge covers a circle with radius λ_C at speed c. This gives us the magnetic moment at Bohr's approximation:

$$\mu_B = e \cdot \lambda_C = e \cdot h/m_e \cdot c = \text{Bohr's magneton.} \qquad (\mu_B)$$

In Th(α) the mechanical angular momentum, interpreted macroscopically as spin, is given 'a priori' by the conservation of the "moment of action" which coincides with Planck's constant, already present in (μ_B), in which we still have to interpret the 1/2 factor as being due to the subdivision of the unitary momentum of the generating photon: $\qquad m_e \cdot \lambda_C \cdot c = h/2$.

However, even at this 'Dirac' level so to say, Th(α) has two advantages: - i) that there is no contradiction due to the peripheric speed c with which the ring is

covered, and: - ii) that of having calculated the value of mass m_e of the elctron theoretically, which Dirac had to introduce manually. We shall now go on to a further approximation, the last possible one, in which we shall see that the electric charge is cancelled in favour of the motion of the (α) packets discovered by us.

69 – THE DRAGGING WITH SPEED c ON A $\rho_{\hat{u}e}=2\pi\cdot r_0=2\pi\cdot2.817\cdot10^{-13}$cm. CALCULATION OF THE "CHARGE" OF THE ELECTRON.

At this point, finally, Th(α) satisfies the phenomenological requirement of equation (3) to make the electric substance disappear by interpreting its actions as dragging due to a motion of speed $\sim c$ on a curvature radius $\rho_{\hat{u}e}=2\pi\cdot r_0$. In fact according to the geometry of our system – in which $R_{\hat{u}}=\alpha\cdot R_\gamma$ – the photon, that has a wavelength of $\lambda_{\gamma e}=\lambda_C$, is made up of two utrinos with utrino wavelength: $\lambda_{\hat{u}e}=\alpha\cdot\lambda_{\gamma e}=r_0=2.817\cdot10^{-13}$cm and a slightly larger curvature radius: $\rho_{\hat{u}e}\cong3.5\cdot\lambda_{\hat{u}e}=9.859\cdot10^{-13}$cm (derived from $\rho_{\hat{u}}=R_{\hat{u}}/\sin^2\vartheta$ valid for a regular helix – in which $\vartheta=2.62°$ for a $V_{tr\hat{u}}=\alpha\cdot c$). This value, as we have seen, is carried to the ring-shaped structure of the electron; but here a geometric effect of contraction intervenes, so that the curvature radius of the small helix which develops on the torus also contracts in relation to the additional curvature due to the curved axis of the torus – besides becoming variable between the throat and the back of the torus. This reducing effect should be a very small factor of π, but its exact calculation can be obtained only by a rather complex formalism of differential geometry, which we shall leave to experts on the subject.

In conclusion, Th(α), which arose from this result in an independent form, provides for a kinematic structure of the electron in which the helicoidal motion of (α) packets develops precisely with a curvature radius of $\rho_{\hat{u}e}=2\pi\cdot r_0$, which emerged from law (3) of Newton's equation of motion.

THE DIMENSIONS OF THE ELECTRON. The structure of the electron as a ring with radius $\lambda_C=2.42\cdot10^{-10}$cm may appear to be completely discordant, not so much with the standard theory that hypothesizes that it is punctiform (in an unexplicable uniformity with other substantially different elementary particles), but rather with the phenomenology that attributes it a dimension of 10^{-16}cm. But we now know that this is the extension of the core of the electric charge in the small-helix of the utrino: $R_{\hat{u}}=2.055\cdot10^{-15}$cm.

70 – THE MAGNETIC MOMENT TO THE APPROXIMATION OF SCHWINGER AND BEYOND.

At this point Th(α) goes even further because *hidden motion*, found by structural means, supplements magnetic moment in Schwinger's approximation, which Dirac's theory was unable to obtain. Just as circulation with speed c on radius λ_C produces the magnetic moment μ_B of Bohr, circulation with speed $\sim c$ on

a curvature radius of the utrino small helix: $\rho_{\hat{u}e}=2\pi\cdot r_o=(\alpha/2\pi)\lambda_C$ – now seen as the cause of interaction at the electric level – produces a supplement of the magnetic moment:

$$\mu_S =(\alpha/2\pi)\cdot\mu_B=0.00116\cdot\mu_B, \qquad (\mu_S)$$

which corresponds to that obtained by Schwinger (Phys.Rev. **73**, 416 1948) with a "radiating correction of the magnetic interaction of energy" in an external magnetic field, for example of a nucleus, with far less immediate and direct considerations than proposed here.

With reference to the term Zitterbewegung which is used for circulation on Dirac's radius λ_C, this even narrower circulation on radius $\rho_{\hat{u}e}=2\pi\cdot r_o$ can be indicated as a sort of "hyper-Zitterbewegung", as we did above, taking up a denomination used by J.Brandmuller in Naturwiss. **38**, 139 (1951) – shared by K.Huang in Amer.J.Phys. **20**, 479 (1953) – for a sort of epicyclic motion, which could nevertheless give this result in a context in which the various movements remained as pure "ad hoc" rather queer hypotheses without any reasonable physical justification. Caldirola too (Nuovo Cim. **9**,108 1945) proposed something similar in a purely classic cotext justifying the result with an interesting remark that in the expression of r_o, Planck's constant does not figure explicitly.

But there is more to it, because in the (α) structure now given for the electron, we can perceive further contributions to the magnetic moment due to powers greater than α which we have not yet dealt with. It is the transversal component of motion on the small helix of the utrino, which takes place with speed $V_{tr\hat{u}}=\alpha\cdot c$ on the radius $R_{\hat{u}}=\alpha\cdot r_o$ of the utrino – already seen at work in the internal interaction to the structure of the electric ring.
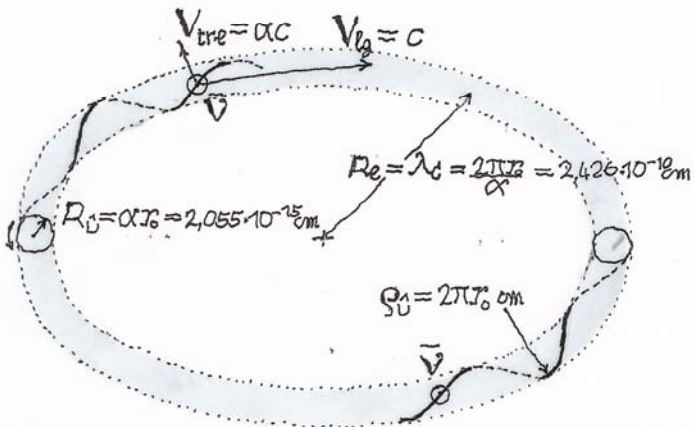
This set of unexpected and fundamental results fully confirm the complex kinematic structure of the electric charge discovered by us.

The most subtle and emblematic result usually attributed exclusively to QED – as Feynman rightly used to repeat – is now found in the kinematic structure of Th(α) which introduces in a compact theorical scheme the singular indication of *hidden motion* which appeared as a result of the simple kinematicized reading of Newton's equation of motion.

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ELECTRIC CHARGE
(A NOT IN SCALE PERSPECTIVE VIEW)

$$Q^- = \bar{V} + \bar{\nu} \quad ; \quad Q^+ = V + \nu$$

$$V_{tre} = \alpha c \qquad V_{lg} = c$$

$$R_e = \lambda_c = \frac{2\pi r_0}{\alpha} = 2{,}426 \cdot 10^{-12} m$$

$$R_\nu = \alpha r_0 = 2{,}055 \cdot 10^{-15} cm$$

$$\varphi_\nu = 2\pi r_0 \; cm$$

$$\bar{\nu}$$

$$r_0 = 2{,}817 \cdot 10^{-13} cm \quad ; \quad \alpha = 1/137{,}037$$

CHAPTER **5**

THEORY OF MACH'S INERTIA AND OF NEWTON'S *G* CONSTANT.

71 – We shall now try and show that Th(α) fully and correctly achieves Mach's conjecture, namely that though reactive, rather than accelerating like all the others, the actions of inertia are real forces whose material source is the mass of the Universe. On this subject we will show two things.

i) First that the universal dragging interaction allows to interpret the **In** actions of inertia as a special case of dragging and places them in the same unitary vision as the other two field forces: **Gr**. And **El**.. As a matter of fact the action of dragging, and only that, unlike the paradigmatic forces, remains present when instead of the speed $V_i{\rightarrow}S^*$ of the source Σ_i indicated in the gravitational forces in the second member of (3), it substitutes in its expression of forces the speed $V_j{\rightarrow}S^*$ of the test-particle Π_j, which is shown in the first member of (3) in the expression of inertia.

ii) In the second place, in corroboration of the homogeneity of the three field interactions, we will show that in fact the expression of the forces of inertia has the same structure as the other two universal interactions, since it contains all the parameters that appear in them, that is the coupling constant, the entity and the distance of the source; but in the (*G/0*) (§ **87**) shape they must take on in the equation, these parameters are hidden by their own values, when, and only when, they are identified exactly with those of the Universe conjectured by Mach. (*G/0*) will thus present itself as the casket that: i) contains the secret numbers of the Universe; ii) shows the kinematic structure of Newton's *G* constant, and; iii) reveals the gravitational interaction as an effect of the locally hidden motion of expansion of the Universe.

72 – THE FORCES OF INERTIA AS ACTIONS OF *"COUNTER-DRAGGING"*.
   THE SYMMETRIZATION BETWEEN V_i AND V_j.   (*"l_U"/R_U*)=1.

The difficulty of inserting inertia forces of the first member of (3) in the unitary vision already obtained between the other two universal forces of the second member, is not so much in the lack of source parameters (entity, distance, and coupling constant), which we will find hidden by their own value, as in the fact that the reactive inertial forces, **In,** exerted on the potentiated body Π_j depend exclusively on the acceleration dV_j/dt $({\rightarrow}S^*)$ of the potentiated body Π_j and not on acceleration dV_i/dt $({\rightarrow}S^*)$ of the source body Σ_i, as occurs for the other two active accelerating forces: **Gr** and **El**. In the paradigmatic physical scheme of forces it is not possible to interpret the inertial forces as a particular case of the gravitational ones, and therefore to obtain this unitary interpretation, we have to leave the para-

digmatic physical scheme and detect a new formulation of the interaction that should be invariant on inverting the two accelerations. We have carried out this conceptual revolution in § **26,** where, urged by completely different motivations, we replaced the idea that force is due to a material substance with the idea of dragging among the (α)fields of the Th(α), which possesses this invariance, as we shall now demostrate working through successive steps in the equation (3).

To show the invariance of dragging on passing from active action (which contains V_i of source Σ_i) to the reactive action (which contains V_j of test particle Π_j), we have to transform equation (3) of § **12** – restricted to gravitational effects – from an equation of motion of Π_j (under the action of Σ_i) to an equation of forces exerted by Σ_i on Π_j, considering the two symmetrical cases in which:

R) Σ_i accelerates $\to S^*$ and with respect to Π_j when Π_j is stationary $\to S^*$ (V_j=0), or:

ii) Σ_i is stationary $\to S^*$ (V_i=0) and Π_j accelerates with respect to Σ_i and to S^*.

In case i) (possible only at the macroscopic level in which Π_j can be constrained to keep $\to S^*$ stationary by the action of a second source Σ_k that opposes Σ_i) V_j=0 deletes the entire first member and the term of the rotor of the second member from (3). From this we shall later exclude the term of gradient in c^2 – that of the hidden microscopic motion – because, though predominant, it does not interfere with the reasoning that refers only to the effects of macroscopic motions (and at any rate at the end, in the inner spheric shell of the Universe, disappears). The only actions on Π_j that stay active are those that are due to the macroscopic motion of $\Sigma_{i \equiv} M_i$, represented by the two accelerative terms of induction and of gradient in V_i^2, multiplied by the obvious geometric parameter $"l_{gi}"=M_i G/c^2$. We shall for the first time write these actions in the gravitation paradigm:

$$\mathbf{Gr}_{i\,(\Sigma i \to \Pi j \equiv S^*)} = "l_{gi}" \left(\frac{\partial}{\partial t} \frac{\mathbf{V}_i}{R_{ij}} + grad\, \frac{V^2_i}{R_{ij}} \right). \qquad \textbf{(Gr}_\textbf{i}\textbf{)}$$

Without giving up anything essential, we shall also disregard the second of these two terms, unknown to the current paradigms, identified in § **12** and **14** – where we have also indicated a possible experimental check – and concentrate on the first term which, in analogy with electromagnetism, is usually called of induction. If we remain in the paradigm of forces that are exerted through the field, this term of induction – as also the electromagnetic one – emerged also in Einstein's general gravitation in the linear form given by him in his (118) (Appendix I° i), in which he, nevertheless, committed an enormous mistake – on which we shall comment briefly in Appendix IV – and interpreted it as a term that generates an *"accelerating force"* on Π_j, in other words the contrary of the force of inertia that does not accelerate Π_j, though it is produced by the acceleration of Π_j. This term cer-

tainly determines the accelerating actions induced on Π_j by the accelerations of gravitational sources $\Sigma_{i\equiv}M_i$, for example in the explosions of the supernovae, but these actions – which are nowadays actively looked for in the big interferometers – are the gravitational waves that arrive locally with the delay of retarded potentials. Thus, apart from Einstein's oversight, these actions find a good interpretation in the "general gravitation" paradigm.

However this paradigm does not tell us anything about the actions, that are also contextual, that an Σ_i source stationary $\to S^*$ exerts on a Π_j which on the contrary is accelerated $\to S^*$.

In this situation, which is so to say symmetrical, in which the stationary source Σ_i does not emit waves, the gravitational paradigm does not tell us anything, it does not provide for any action from the motionless source that is exerted on Π_j in acceleration. If anything it can provide for the contrary, which however has nothing to do with inertia. The gravitational paradigm, also in its most extended form introduced by Einstein – which we have called "general gravitation" – does not tell us anything except on the gravitational forces which are of the active accelerating type, the exact opposite of the inertial forces which are only of reactive and of the passive type. To include inertial forces in a unitary speech next to the gravitational forces, without committing the usual mistake of identifying them with them, as already stated, we have to identify a new conception of the interaction between bodies that should include, as special cases, the two interactions: the gravitational and the inertial, each with its own specific mathematical expression and its well distinguished intrinsic characteristics.

If we now rewrite ($\mathbf{Gr}_i$) in the dragging $\mathbf{Dr}_i$ physical scheme of Th(α):

$$\mathbf{Dr}_{i\,(\alpha\Sigma i\to\alpha\,\Pi j\equiv S^*)} = \text{"}l_{dr i}\text{"}\left(\frac{\partial}{\partial t}\frac{\mathbf{V}_i}{R_{ij}} + grad\,\frac{V^2_i}{R_{ij}} \right), \qquad (\mathbf{Dr}_i)$$

while maintaining the same mathematic expression, and especially the same parameter $\text{"}l_{dr i}\text{"}=M_iG/c^2=\text{"}l_{g i}\text{"}$, the physical interpretation will change completely since the induction term, just like any other term, is interpreted as being due to the dragging current of $(\alpha)\Sigma_i$ that invests $(\alpha)\Pi_j$. But in this different interpretation, and only here, because of the obvious cinematic nature of things, $(\alpha)\Pi_j$ is subjected to the same dragging flow when $(\alpha)\Sigma_i$ were compelled to be stationary $\to S^*$ whilst $(\alpha)\Pi_j$ were compelled, by a local $(\alpha)\Sigma_k$ source different from $(\alpha)\Sigma_i$, to move with speed $V_j=-V_i$ with respect to $(\alpha)\Sigma_i\equiv S^*$. This action, which we shall call *counterdragging* $\mathbf{Cdr}_i$ (because the current and its action move in the opposite direction with respect to V_j) will still be expressed by ($\mathbf{Dr}_i$), where $-V_j$ appears instead of V_i, as well as the rotor term appears:

$$\mathbf{Cdr}_{i\ (\alpha\Sigma i \equiv S^* \rightarrow \alpha\Pi j)} = - \text{``}l_{dri}\text{''} \left(\frac{\partial}{\partial t} \frac{V_j}{R_{ij}} + grad \frac{V^2_j}{R_{ij}} - V_j \wedge rot \frac{V_j}{R_{ij}} \right). \quad (\mathbf{Cdr}_i)$$

In theory (α) this expression has a general validity in the sense that source $(\alpha)\Sigma_i$, stationary $\rightarrow S^*$, can be any local body M_i that is at a variable distance R_{ij} from the test particle Π_j, which is accelerated with respect to it and with respect to S^*. In these cases, however, the constant factor $\text{``}l_{dri}\text{''}=M_iG/c^2 \approx 10^{-28}$cm is so small that the *counter-dragging* effect is negligible. But when we consider as the source the total of masses $M_U=10^{56}$g of the Universe, which is certainly always present, we then obtain two compensated effects – which we shall examine later – so that: i) the new $\text{``}l_{dri}\text{''}$ takes on a very particular value $\text{``}l_U\text{''}=M_UG/c^2=10^{28}$cm; ii) the distance $R_{Uj}=10^{28}$cm, in turn, presents itself as an absolute constant which, factorized, *exactly* lowers $\text{``}l_U\text{''}$, giving rise to the very considerable dimensionless Universal constant – the first (implicit) form of the "*fundamental formula of the Universe*":

$$\frac{\text{''}l\text{''}_U}{R_U} = 1 . \quad (U)$$

This formula, finally inserted in $(\mathbf{Cdr}_i)$ – in which the constant R_U however leaves the gradient to operate only on V_j which assumes the parameter $1/2$ – gives it the correct form of the expression of the actions of inertia exerted by Universe as that of the first members of equations (1), (2) and (3):

$$\mathbf{Cdr}_{U(M_U \rightarrow \alpha\Pi j)} = - [\ 1\ ] \left(\frac{\partial V_j}{\partial t} + grad \frac{V_j^2}{2} - V_j \wedge rot V_j \right). \quad (3/\mathbf{In})$$

It is therefore clear that the reactive actions of inertia are not, nor could they ever be, accelerating gravitational forces (as Einstein had carelessly attempted to say in his "The meaning of relativity" (Einaudi 1950, p.97 and foll.) in which – discredited by one of the authors – he endeavoured in vain to pass the inertial reactive forces as the accelerating force (*"acelerating force"* .c.p.105) of the gravitational waves), but are a particular manifestation of the unitary dragging action of Th(α), from which in various cases all the universal interactions so far considered descend parallelly, i.e. besides the accelerating interactions: the monopolar gravitational and the bipolar electromagnetic, also the monopolar reactive inertial interactions, which we have just seen.

73- THE *"l"* PARAMETERS: AN UNUSUAL UNIVERSAL SYMMETRY IN $\aleph$.

Now that we have all the three *"l"* parameters that define the specific intensity of the three long radius interactions: the gravitational, the electromagnetic, and the inertial, we can build an important comparative table. In fact the parameter of

inertia $\textit{"l}_U\textit{"}=\textbf{\textit{M}}_UG/c^2=10^{28}$cm is not only enormous compared to that of the electric action already seen $\textit{"l}_e\textit{"}=10^{-13}$cm, but it is bigger precisely by the same *"emblematic"* order of magnitude $\aleph=10^{41}$ by which the latter, in turn, is larger than the gravitational one: $\textit{"l}_g\textit{"}=10^{-54}$cm as we saw in § **8** and **9**. According to this table, therefore, the disjunction between the specific intensity of the two, homopolar, actions that now appear as the extreme actions of nature, gravitation and inertia, has a range of 10^{82} within the abyss of which electric interactions, the only ones in which energy (i.e. the photon) can freeze in the mass (i.e. in the electron), establish a perfect symmetry by placing themselves exactly half way. But this disjunction is not surprising at all, if we consider that 10^{82} indicates by how much the mass of the source Universe is larger than the one introduced in *"l_g"*, since this is the number of nucleons that make up the Universe. This allows us to build a very significant picture:

$$\text{« } l_g \text{ »} \approx 10^{-54}\text{cm} \qquad 10^{41} \qquad \text{« } l_e \text{ »} = 10^{-13}\text{cm} \qquad 10^{41} \qquad \text{« } l_U \text{ »} = 10^{28}\text{cm}.$$

The effective intensity of inertial action is then brought back within the known ordinary macroscopic limits, since the gigantic value of source $\textbf{\textit{M}}_U=10^{56}$g is lowered an exact half by factor $G/c^2=10^{-28}$cm/g and the other half by the invariant distance $\textbf{\textit{R}}_U=10^{28}$cm of the source.

74 – THE NEW MACH'S *"ABSOLUTE REFERENCE SYSTEM"*: $S^*\equiv\textbf{\textit{M}}_U$.

From a physical point of view, the forces of inertia are produced by the field formed by the superposition of all (α) fields that make up form the Universe; a global field that we can indicate as "Mach's static field" – a counter part of "Weyl's kinematic field" – which reproposes in a more concrete form the ever vigilant idea of cosmic ether (L. Kostro "Einstein and the ether" Dedalo 2001). As a matter of fact it reintegrates a material universal reference system $S^*\equiv\textbf{\textit{M}}_U$ which is absolute, because immovable in principle, and which is physically present in every point P_j of the Universe where it affects all bodies when accelerated with respect to it.

BONDI ONCE MORE.   For the third time, we quote from the booklet mentioned above (l.c.p.102) the thought of Bondi, who concludes with an important reference to Mach: "It seems to me, as it seems to anyone who attributes any importance to Mach's principle, that the universe enters all experiments, because it is responsible for the inertia of bodies that take part in the experiment itself". An unavoidable consideration sufficient alone to falsify any theory of relative motion.

75 – ERNEST MACH: THE REAL PROMOTER OF ABSOLUTE MOTION.

As a staunch sustainer of the exclusively relational, and therefore relativistic, nature of motion, Mach writes: *"I have no difficulty that the first rotation* (that with respect to fixed stars which produces inertial actions (our parentheses)) *be*

called absolute, provided one always remembers that absolute means relative to the fixed stars" (l. c. p254, in a notation reported only in the iv edition). With this statement Mach intended to defeat once and for all the "conceptual mostruosity" of Newton's absolute space.

This is certainly true; however, if we look carefully at things, it is equally true that with this statement together with that for which stars are the source of the forces of inertia, Mach simply gave the necessary physical concreteness to that same reference system that for Newton was only faulty on account of the immateriality of abstract space. Actually, with no prejudice to the necessary relationality of motion, we can easily paraphrase Mach's statement and declare in turn that: *"we have no difficulty that this rotation should be called relative to fixed stars, provided we always remember that they form an irremovable and therefore absolute reference system."* In fact, since they make up the entire Universe, they are irremovable in principle, besides being so in fact, as Mach himself often repeated not too far from the quotation above.

For this good reason – and with a proper exclamation about "the singularity of human destiny"- we consider Mach, and not certainly Newton, the real founder of absolute motion as he showed the existence of a concrete material, irremovable, hence absolute, reference system that makes up the source of inertial forces and is therefore connected in a causal way to local motions, at least the accelerated ones.

76 – THE FORMULA OF THE UNIVERSE: ($"l_U"/R_U$)=1.   The formula $"l_U"/R_U$ appears as one of the most important formulas of physics, because it contains and specifies the numbers of the Cosmos and the secret of the expansion of the Universe, which is implicit in the kinematic nature of gravitation, as we shall now see when writing it in another two forms: ($G/0$) and ($G/1$), that will gradually become more and more explicit.

In the compact form already written, the formula $"l_U"/R_U$ first of all reveals that the anomaly of the expression of inertia of not showing, as all other interactions, the material characteristics of the source (coupling constant, entity, and distance) is only apparent due to it being so uniquely concealed by its factors. In the second place, it confirms that this source is really the whole Universe while giving the consistence of an actual physical theory to Mach's conjecture, which thus introduces the actions of inertia with full rights among the other universal interactions, as was our intention to do from the start.

77 – (G/O) ESTABLISHES THE *STATIC CHARACTERISTICS* OF THE UNIVERSE.

To continue our research on the Universe, we shall write its formula in its explicit form, known in various cosmological contexts, which reveals its so to say static characteristics of: entity, extension, and form:

$$\frac{G}{c^2}\frac{M_U}{R_U} = 1\,. \tag{G/0}$$

From a qualitative point of view, (G/0) shows that the Universe is finite, both as material entity (mass-energy) M_U and as extension R_U. As to the form of the Universe, (G/0) shows us that it is of closed spheric symmetry, due to the fact that the distance R_U between any inner point P_j and M_U is an absolute constant independent of P_j.

This characteristic of P_j of always being in the centre of the Universe, belongs is attributed to the closed varieties with spheric symmetry (as can easily be seen in the only case perceptible to us on the surface of the sphere). This demonstrates that besides giving the finite extension of the Universe, R_U also fixes the curvature radius, which is invariable from one point to another. This, in its turn, leads to the important consequence that no rigorously rectilinear motion can exist in it, because also those that appear such, occur in reality on a constant curvature radius equal to R_U. In § **53** we saw that, due to this, neutrinos and photons in free flight are the source of a weak gravitational interaction, which is different from that of their intrinsic energy.

From the quantitative point of view (G/0), since the disjunction between the known value of $G/c^2 = 10^{-28}$ and the estimated value of $R_U = 10^{28}$ is symmetrical, this indicates that the numeric value of mass $M_U = 10^{56}$ must be the square of R_U as we shall soon be able to prove. This extremely unusual relation between geometry and mass of the Universe evidently conceals another secret of the Cosmos, which we have not yet been able to unravel.

We here wish to clarify that these contents of (G/0) make all discussions on boundary conditions vain, as they encumber theories based on differential equations, such as general relativity. Values that are different from M_U and R_U (and a number of others that derive from them as we shall presently see) would not satisfy (G/0), which is set once and for all by the expression of the forces of inertia. Paraphrasing Bondi's colourful expression mentioned above (§ **43**), we can say that "this is the way the Universe is made, and that's it".

In conclusion (G/0) contains the numbers of the Universe and conceals the secret of its motion of expansion, which generates gravitational interaction, as we shall now see in its most expressive form (**G/**1).

78 – (G/1) REVEALS THE *KINEMATIC CHARACTERISTICS* OF THE UNIVERSE. THE VALUE OF NEWTON'S CONSTANT *G* AS THE IMPORTANT PRODUCT: $V^2_U \cdot R_U^{-1}$.

In order to discover the kinematic characteristics of the Universe, we shall write its formula in a still more explicit form, obtained by resolving with respect to

G and multiplying and dividing the second member by $\boldsymbol{R}_U$:

$$G = \frac{c^2}{\boldsymbol{R}_U} \cdot \left(\frac{\boldsymbol{R}^2_U}{\boldsymbol{M}_U}\right) = 6.672 \cdot 10^{-8}\ \mathrm{cm}^3 \mathrm{s}^{-2} \mathrm{g}^{-1}. \qquad (G/1)$$

This $(G/1)$ points out the kinematic nature of Newton's constant G revealing that its numeric value, which calibrates the gravitational interaction, is given by the acceleration of a *hidden motion* of speed c on a curvature radius $\boldsymbol{R}_U$. The physical dimensions are then restored by the numeric factor $(\boldsymbol{R}^2_U/\boldsymbol{M}_U)=1\mathrm{cm}^2\mathrm{g}^{-1}$, which, as mentioned in the ranges of $(G/0)$, is equal to 1. This statement is partly a conjecture that is made valid by the fact that the numeric values derived therefrom for $\boldsymbol{R}_U$ and $\boldsymbol{M}_U$ give precise numbers up to the third decimal figure when inserted in formulas logically independent of this $(G/1)$, as for example we have seen in the calculation of Planck's constant in § **55**.

$(G/1)$ proposes, quite independently and in a more detailed way, the discovery already made when examining equation (3) that the gravitational interaction is determined by a *hidden motion* with speed c on a curvature radius $\boldsymbol{R}_U$ exactly what has just remerged in $(G/1)$.

Thanks to $(G/1)$ we can see that also Newton's constant, as well as that of Planck and Sommerfeld, is substantially in an important product among the first two free parameters of the Universe linked by a circumstance of motion. But while h and α are linked by the *primitive motion* induced in packets $(\alpha)_j$ considered potentiated by the expansion of the Universe, G is on the contrary linked directly by the *primordial motion* of packets $(\alpha)_i$ considered as sources of expansion of the Universe.

The idea that the most secret core of Newton's constant can be contained in an acceleration expressed by the relation between the square of the speed of light and the radius of the Universe, is certainly not part of the present paradigmatic expectations.

79 – THE *HIDDEN MOTION* OF (G/1) IMPLIES THE EXPANSION OF THE UNIVERSE.

Finally we must try and discover which is the *hidden motion* with speed c that occurs on the curvature radius $\rho_g = \boldsymbol{R}_U$ and is responsible for the main part (the gradient) of gravitational interactions that exist as deduced from $(G/1)$ (and had already been deduced from equation (3)) even when the local sources appear to be stationary with respect to S^*. A motion that cannot certainly be confused with the falsely rectilinear *evident* motion of the open "light speeding" structures of neutrinos and photons seen in § **53**.

$(G/0)$ of Mach's theory of inertia allowed us to ascertain that the tridimensional Universe is closed with a spheric symmetry with a radius of $\boldsymbol{R}_U$ in a four-

dimensional continuum so that each of its points is at the same time a centre and a periphery – as for example a P_j on the spheric surface in the usual bidimensional reduction -. Now, if P_j appears stationary on the spheric surface and in spite of this the equations indicate that it has a motion with speed c on a curvature radius $\rho_g = R_U$ not perceptible along the surface, we can only deduce that this motion is normal to the surface and consequently due to its expansion.

The gravitational interaction, given as the effect of the expansive motion of the Universe, is therefore interpreted kinematically (i.e. its kinematization) in the unitary vision we have given of the other two field interactions: the electromagnetic and the inertial.

In spite of the great clarity of this interpretation and its congruence with the other two considered interactions, it cannot be denied that as things stand the gravitational interaction continues to be enveloped in a secret aura that has distinguished it since its origin. Particularly we note the strange circumstance due to which the motion that expands the Universe is also the motion that provides the attractive interaction that tends to coagulate in clusters of galaxies and stars all the objects gravitating within It.

80 – NUMERIC CALCULATION OF THE CONSTANTS OF THE UNIVERSE: $R_U, M_U,$ ℵ, AND OF $E(\gamma)_{min}$ AND m_α..

In reality $(G/1)$ permits us to calculate R_U and M_U directly and with precision – we shall stop at the third decimal figure – from which it is then possible to specify exactly other values of which so far we had only given the ranges. The specifications of these numbers would appear ingenuous if were they not the immediate result of simple fundamental formulas, for the greater part already known and rather difficult to doubt.

We therefore find for R_U:

$$R_U = c^2/G = 8.987 \cdot 10^{20} / 6.672 \cdot 10^{-8} = 1.346 \cdot 10^{28} \text{cm} ,$$

and this, introduced in $(R_U^2/M_U) = 1\text{cm}^2/\text{g}$, gives the numeric value of M_U:

$$M_U = 1.814 \cdot 10^{56} \text{g}.$$

From R_U it is possible to specify ℵ by means of the position of $r_o = R_U/ℵ$:

ℵ $= R_U/r_o = 1.346 \cdot 10^{28}/2.817 \cdot 10^{-13} = 4.778 \cdot 10^{40}$; number of (α)fields in the (α)quarks.
ℵ$^2 = 22.829 \cdot 10^{80}$; number of (α)quarks in the Universe.
ℵ$^3 = 109.076 \cdot 10^{120}$; number of (α)fields in the Universe.

Through the crossing time of the Universe: $t_{max} = 2\pi R_U/c = 2.823 \cdot 10^{18}$s, we can indicate the various parameters of the minimum packet with $N=1$, a single (α)field:

$f_{\gamma\ min} = 1/t_{max} = 3.542 \cdot 10^{-19}$s^{-1};
$V_{tr\ min} = 2\pi \cdot r_o/t_{max} = c \cdot r_o/R_U = c/\aleph = 6.272 \cdot 10^{-31}$cm/s.

We shall use $V_{tr\ min}$ to find the $m_\alpha = m_{\gamma\ min}$ from the relation $m_{\gamma j} = k_\gamma \cdot V_{trj}$, found in § **52** where $k_\gamma = m_o/\alpha\ c = 9.108 \cdot 10^{-28}/2.187 \cdot 10^8 = 4.164 \cdot 10^{-36}$g s/cm :

$m_\alpha = k_\gamma \cdot V_{tr\ min} = 4.164 \cdot 10^{-36}\ 6.272 \cdot 10^{-31} = 2.611 \cdot 10^{-66}$g. *minimum quantum of mass.*

(we note with surprise that it is a number that strangely comes up in analogous circumstances also in the theories of strings.)

We now have two numbers R_U and m_α found independently, which when introduced in the (α) expression of Planck's constant $\hbar = m_\alpha R_U \cdot c$ can be calculated with precision:

$\hbar = m_\alpha R_U \cdot c = 2.611 \cdot 10^{-66} \times 1.346 \cdot 10^{28} \times 2.997 \cdot 10^{10} = 1.054\underline{3} \cdot 10^{-27}$ g·cm^2/s.

We proudly consider this result – already anticipated in § **55** – as a seal that backs the numerous conjectures we have had to get over.

From $\hbar$ and $f_{\gamma\ min}$ we obtain the minimum quanta (α) $E(\gamma)_{min}$ for energy:

$E(\gamma)_{min} = 2\pi\hbar \cdot f_{\gamma min} = 2.346 \cdot 10^{-45}$erg; *minimum quantum of energy.*

A different – adventurous – calculation independent of m_α can be made dividing mass M_U of the Universe by the number $\aleph^3$ of (α)fields that make it up, and thus surprisingly obtain a number that is $\pi/2$ smaller than the other adopted above, namely:

$m_\alpha = M_U/\aleph^3 = 1.664 \cdot 10^{-66}$g;

which once again shows the important internal coherence also of the numeric parameters of Th(α).

From M_U and m_{pr} we can obtain the number N_{pr} of protons in the Universe:
$N_{pr} = M_U/m_{pr} = 1.814 \cdot 10^{56}/1.672 \cdot 10^{-24} = 1.084 \cdot 10^{80}$.

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APPENDIX I°.

i) – THE GRAVITATIONAL LINEAR FORCE ACCORDING TO EINSTEIN.

In "The meaning of relativity" (Einaudi 1950, p.85 and foll.) Einstein writes the four-dimensional tensorial equation, but not the linear one:

$$d^2x^\mu/ds^2 + \Gamma^\mu_{\alpha\beta}(dx^\alpha/ds)(dx^\beta/ds) = 0, \qquad (90)$$

as a more general expression of the *"motion of a material particle* (of unitary mass) *subject only to the action of inertia and gravitation"* (p.85) in which *"by anology with Newton's equation <u>we shall consider the first term as the expression of inertia, and the second as the expression of the gravitational force"*</u>. (p.88). To demonstrate that in his theory Mach's principle is *"present at least in part"*, he carries an approximation beyond his previous studies (the deflection of light and the displacement of the perihelion) transforming equation (90) into the tridimensional and linear *"usual vectorial annotation"* (p.107):

$$d[(1+\underline{\sigma})\mathbf{v}]/dl = \text{grad } \underline{\sigma} + \partial \mathbf{Æ}/\partial l + \text{rot}\mathbf{Æ} \wedge \mathbf{v} \qquad (118)$$
$$\underline{\sigma} = \kappa/8\pi \, f\sigma(dV_o/r)$$
$$\mathbf{Æ} = \kappa/2\pi \, f\sigma(dV_o/r) \, (\partial \mathbf{x}_\alpha/\partial l) \, .$$

Ignoring the first member – with the oversight of $(1+\underline{\sigma})$ drastically removed by authors such as Weinberg and others – we shall assume the second member, multiplied by the potentiated mass m_j as the more general expression of the gravitational forces, observing that it is already written in the form that interests us, as a function of the potentials $\underline{\sigma}$ and $\mathbf{Æ}$ rather than of the field vectors. However, we wish to go beyond this and write the potentials in the specific form that is given in the following two lines in which: i) we write $8\pi G/c^2$ instead of 'κ'; ii) we give the source a definite value M_i instead of the integrals of volume; and iii) we write 'ct' instead of the relativistic time 'l', V_j/c instead of $\mathbf{v}$, V_i/c instead of $\partial \mathbf{x}_\alpha/\partial l$ (in which $V_j \to_{S*}$ e $V_i \to_{S*}$) and R_{ij} instead of r; and therefore with our annotations:

$$\underline{\sigma}_i = \frac{G}{c^2}\frac{M_i}{R_{ij}} \qquad ; \qquad \mathbf{Æ}_i = \frac{4G}{c^2}\frac{M_i}{R_{ij}}\frac{V_i}{c} \, ,$$

in which, on cancelling $1/c^2$, which appears in both members, rearranging the terms (having disregarded factor 4 in the two very small cinematic terms compared to the gradient), and resolving G and M_i into factors we obtain:

$$\mathbf{Gr}_{(Mi \to mj)} = m_j \, (GM_i) \left(\frac{1}{c}\frac{\partial}{\partial t}\frac{V_i}{cR_{ij}} + grad\frac{1}{R_{ij}} - \frac{V_j}{c} \wedge rot\frac{V_i}{cR_{ij}} \right). \quad (\mathbf{Gr})$$

ii) – THE ELECTROMAGNETIC FORCE OF MAXWELL-LORENTZ.

We shall now write force: $\quad \mathbf{El}._{(n_i e_i \to e_j)} = \mathbf{E}_i + (V_j/c) \wedge \mathbf{B}_i \quad$ which the most

general electromagnetic field of vectors $\mathbf{E}_i$ and $\mathbf{B}_i$ exercises on a potentiated electron (e_j^-), which at instant t with speed $\mathbf{V}_j{\rightarrow}S^*$ transits through P_j at the distance R_{ij} from point P_i, where at the same instant a compact group of source positrons $n_i(e_i^+)$ transits with speed $\mathbf{V}_i{\rightarrow}S^*$. Using Gauss's units to point out *"c"*, while expressing the field vectors $\mathbf{E}_i$ and $\mathbf{B}_i$ in function of the explicit form of the potentials: scalar $U_i{=}n_i(e_i/R_{ij})$ and vectorial $A_i{=}n_i(e_i/R_{ij})(\mathbf{V}_i/c)$ from which they derive $\mathbf{E}_i{=}{-}\partial A_i/c\partial t$ - -$\mathrm{grad}U_i$; $\mathbf{B}_i{=}\mathrm{rot}A_i$, we finally obtain:

$$\mathbf{El}_{(n_i e_i \rightarrow e_j)} = n_i(e_i\, e_j)\left(\frac{1}{c}\frac{\partial}{\partial t}\frac{\mathbf{V}_i}{cR_{ij}} + grad\,\frac{1}{R_{ij}} - \frac{V_j}{c}\wedge rot\,\frac{\mathbf{V}_i}{cR_{ij}}\right). \quad \textbf{(El)}$$

iii) – OPERATORIAL FORM OF THE DERIVATIVE OF: $\mathbf{\Phi}_{\Sigma i\rightarrow Pj} = \text{"}l_i\text{"}\mathbf{V}_i/R_{ij}$.

Considering $\partial\mathbf{V}_i/\partial(x,y,z)=0$ and the kinematic nature of the vectorial part of $\mathbf{\Phi}_{\Sigma i\rightarrow Pj}$, the total derivative of $\mathbf{\Phi}_{\Sigma i\rightarrow Pj}=\text{"}l\text{"}\mathbf{V}_i/R_{ij}$ can assume a different form, if the last three terms of the canonic form are manipulated so as to obtain a more intrinsic form –typical of continuous means – in which a gradient describes the variation of $\mathbf{\Phi}_i$ in the direction of $\mathbf{\Phi}_i$ itself (i.e. of speed) and a rotor describes it in the orthogonal direction. Considering that speed is always referred to the same S^*, reducing the indices to the minimum, and using some known vectorial relations, we obtain:

$$d\mathbf{\Phi}_i/dt = \text{"}l\text{"}d(\mathbf{V}_i/R)/dt = \text{"}l\text{"}\{(1/R)(d\mathbf{V}_i/dt) + \mathbf{V}_i\, d(1/R)/dt\}= \qquad (i)$$
$$= \text{"}l\text{"}\{(1/R)(d\mathbf{V}_i/dt) + \mathbf{V}_i\,[\nabla(1/R)\bullet\mathbf{V}_j]\} = \qquad (ii)$$
$$= \text{"}l\text{"}\{(1/R)(d\mathbf{V}_i/dt) + V^2{}_i\,[\nabla(1/R)] + V_j\wedge[\nabla(1/R)\wedge\mathbf{V}_i]\}, \qquad (iii)$$

which we shall write, using the usual vectorial symbols in kinematics and in the dynamics of continuous means, taking into account that $(d\mathbf{V}_i/dt)\equiv(\partial\mathbf{V}_i/\partial t)$ because of $\partial\mathbf{V}_i/\partial(x,y,z)=0$,:

$$d\mathbf{\Phi}_i/dt = \text{"}l\text{"}\{(1/R)(\partial\mathbf{V}_i/\partial t) + grad\,(V^2{}_i/R) + V_j\wedge rot(\mathbf{V}_i/R)\}. \qquad (3)$$

We have called this expression a "mixed derivative", because in it at the end of (ii) the symbol $\mathbf{V}_j$ has been used to indicate the speed (of components dx/dt, etc.) of the extreme free point P_j of vector R_{ij}. When splitting into the two terms of (iii), this symbol can assume two different meanings. In fact while in the term of gradient P_j it is always a point of a field, and therefore we have to write $\mathbf{V}_j\equiv\mathbf{V}_i$, in the terms of the rotor in cases that represent the kinematic dragging of Coriolis, P_j, it is the position of an independent material point moving in the field with its own speed, different from $\mathbf{V}_i$, that must therefore be indicated with a different symbol V_j, as for example occurs phenomenologically in the electromagnetic and gravitational interactions represented in equation (3).

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APPENDIX II°.

"EFFECTIVE ACCELERATION".

In the helicoidal motion of the $N_i(\alpha)$ packet on the utrino small helix of ray $R_{\hat{u}}$, the intrinsic acceleration of its center $\odot_i$ is always directed towards the centre of helix. Therefore at a point P_j external to it (a possible center $\odot_j$ of a test packet $N_j(\alpha)$), the dragging action, namely the acceleration $A_j = \text{"} l_i \text{"} A_i / D_{ij}$, alternatively oscillates between two phases, temporally equivalent, one of which is centripetal towards $\odot_i$ while the other is centrifugal depending on whether the trajectory of $\odot_i$ turns the convex or the concave part towards P_j . Nevertheless, the centripetal phase prevails because it occurs when D_{ij} is smaller, precisely of a size $2R_{\hat{u}}$. Therefore in order to select the centripetal attractive effect alone, we need to identify what we shall call *"effective acceleration"* $A_i(\text{eff.})$ which is obtained by a weighted average of the two opposite effects.

The calculation of this effective quota, however, is not at all simple, mainly if we consider that the helicoidal motion of point P_j – given as the center $\odot_j$ of a $N_j(\alpha)$ potentiated packet – is analogous (and in the opposite direction) to that of $\odot_i$. To simplify things without losing the essential part of the phenomenon, we shall adopt two approximations. I) With the first we place ourselves in the flight plane in which the two packets (that is to say the two utrinos) travel in couples, in the plane therefore in which $\odot_i$ moves at speed $\mathbf{V}_{tri}$ on a circle of $R_{\hat{u}}$ radii. In fact this situation does not reduce reality, as it may seem, but on the contrary corresponds to the only two fundamental cases at the elementary level: the one with the two heteropolar utrinos that travel together to form the photon (a light speeding structure which not dealt with here) and the one of the two homopolar utrinos that circulate from opposite sides of the same diameter in the ring standing structures of the electrons, which on the contrary interest us directly. Ii) As a second approximation we shall suppose the centre $\odot_j$ of $N_j(\alpha)$ is fixed in the flight plane at a distance D_{ij} from the circle covered by $\odot_i$, which is much greater than the radius $R_{\hat{u}}$ of this circle: $D_{ij} \gg R_{\hat{u}}$. In this connection we notice that in the electron structure $R_{\hat{u}} = 10^{-15}$cm, while $D_{ij} = 10^{-10}$cm .

In these conditions, limiting the integration simply to a first approximation, the factor of reduction to apply to the intrinsic acceleration of $\odot_i$ is little less than ½ and to make our calculation shorter, we shall schematize it in $1/\pi$, moreover assuming:

$$A_i(\text{eff.}) = (1/\pi) \cdot A_i = V^2_{tri} / \pi \cdot R_{\hat{u}}.$$

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APPENDIX III°.

VALIDITY OF THE LINEAR GRAVITY.

We shall now give some solid arguments on the fact, which is usually totally ignored, that the linear vectorial expression of gravitation in the form indicated by Einstein himself in (118) is a correct and complete representation of this interaction which does not require that the tensorial non-linear formalism of the general relativity (G.R) be resorted to.

1) – THE LOGICAL ARGUMENT OF CONGRUENCE.   In our opinion, the most pressing argument is the one on which we built the principle of congruence: if a unitary theory exists, then the complex expression of the forces of inertia – logically established a priori – is a model to which all the other Universal interactions must conform. However, the forces of inertia have their correct and complete linear vectorial expression in ordinary space, in the form given here in the first member of equation (1) with the approximation to which we limited the derivative of speed. In this approximation, therefore, the congruent form of gravitational forces must be the linear vectorial form given by Einstein himself and not the four-dimensional tensorial non-linear form of general relativity.

Any possible transposition in a curved four-dimensional space cannot add other different components of the gravitational force that are not present in the successive approximations of the vectorial derivative or in the successive derivatives. We can also transpose the linear expression in a curved four-dimensional environment with a tensorial formalism, as occurs for example in the analogous electromagnetic transposition, but certainly this cannot introduce any new physical circumstance: the representation is different but the physics is the same. If the representation in a curved space had a greater physical content, then we would have an absurd situation in that any further components of the gravitational action would not have the corresponding component of inertia which remains fixed in its euclidian form (1) and in its possible generalizations.

In this connection we consider the works of C.Cattaneo interesting. In these works the author transposed the four-dimensional formalism of G.R. in a semi-classical form (“Nuovo Cimento”, *10*, 318, 1958; ib. *11*, 733, 1959; ib. *13*, 237, 1959; “Ann. Di Mat.” XLVIII, 1959; “Rend. Acc. Lincei”, XXXII, 1962; “Comptes rendus Acad. Sci. **197**, 1959; ib.**252**, 1961; ib.**253**, 1961).

We can see from the above the significant methodological revolution introduced in the unitarian program simply by accepting – and then demonstrating concretely – the idea of Mach that the forces of inertia are a true universal interaction.

2) – EPISTEMOLOGICAL ARGUMENT.　　　　From a general point of view of the 'economy of nature', it does not seem reasonable to admit that electromagnetism can be described in a correct and complete manner in the tridimensional flat and rigid space by linear vectorial formalism, where gravitation requires an extremely more complex picture in which a material curved plastic space is necessary, forcedly mixed with time in non-linear tensorial four-dimensional formalism. Between the two interactions, if ever, electromagnetism represents the greater complexity, both because of the double polarity of the charges, and of the enormously greater intensity of the interaction, which is more appropriate to point out the details of its complexity, as in fact occurred in history. In other words, if electromagnetism is a *complete* theory in its pseudo Newtonian euclidian frame, we cannot a priori see any reason why the economy of nature should require such a complete revolution of this aspect due to gravitation.

3) – TWO FAILED UNIFICATIONS.　　　　The third argument refers to the failure of two unifications (both obtained by us), which Einstein and his followers had attempted in vain: i) that of gravitation with inertia, in the first place, which for Einstein represented a duty towards the principle of equivalence, and: ii) that of gravitation with electromagnetism, as a natural complement of the field theories.

- i) Having categorically stated – against the enormous phenomenological and mathematical differences just seen – that the idea that forces of inertia could not be distinguished from gravitational ones was "the most successful idea of his life", Einstein was compelled to give a proof thereof within the framework of his new theory of gravitation. But, we must remember, Einstein was not at all interested in finding a unitary theory of the two interactions; he was much more interested in saving the principle of equivalence by eliminating the autonomous existence of the forces of inertia, which immediately refer us to Newton's absolute frame which today finds its expression in Mach's masses of the Universe. For this purpose Einstein followed the way pursued by us, because in order to "see" these forces, he had to abandon the non-linear scheme of his tensorial formulation (90), and to adopt the linear vectorial formulation of (118). Here, instead of looking for the reactive forces of inertia where they are to be found, i.e. in the first member, which he imprudently writes in an implicit form, he expected to find them in the right member, i.e. in the two new gravitational kinematic components which he added to Newton's scalar component. But these are the new accelerating gravitational forces: one is produced by the gravitational waves, the other is the transversal force that moves the perihelion of the planets. To state that a force of inertia is an "accelerating force" (l.c. p.107) – which in reality is the term of induction – is

one of the most absurd things that has ever been written in physics. It does not even matter that none of his followers so far has ever credited him with this piece of unreasonableness. As a matter of fact, considering that the very inventor of the principle of equivalence committed this absurdity, it is a crushing proof of its manifest vacuity.

The younger of the two authors has thoroughly discussed this position of Einstein in his recent experimental degree thesis, which was greatly appreciated by an examining board, who were not fully aware that it automatically distorted the principle of equivalence.

But against this unvoluntary gaffe, Einstein himself has provided an interesting proof that the three components of the gravitational forces of (118) contain one needs to compare them with the already known inertial forces, thus ruling out that in the tensorial formulation one may be dealing with a physics that does not really appear in it.

- ii) As to the unification with electromagnetism, in spite of the number of years and the innumerable variants attempted also in collaboration, its failure is proof, so to say, "of the contrary" of our thesis that the tensorial formulation in a curved space is at least superfluous with respect to the unitary undertaking.

4) – PHENOMENOLOGICAL ARGUMENT.   The most decisive argument however, confirming the validity of the general arguments given above is the fact that the three phenomena usually produced in suppport of GR are also explained in linear formalism, certainly much more simply and with a kinematics that brings them closer to the analogous electromagnetic arguments.

-i) *DEFLECTION OF LIGHT.*   As is known, besides the value of 0.87" calculated according to Newton in his first approach of 1907, Einstein later made another identical contribution of the variable curvature of space, thus obtaining 1.74" which proved to be more consistent with the measurements, which moreover gave poor results. Our Th(α) needs to take account of an increase in Newton's term due to the last term of Einstein's (118), which we introduced in equation (3).

-ii) *REDSHIFT OF LIGHT.*   The loss of frequency, i.e. of energy, of the photons that come out of the gravitational field (as well as the increase in those that fall into it) is arbitrarily and erroneously given as a confirmation of the fact that in GR the curvature near the masses also involves time which slows down the movement of the clocks and therefore the atomic frequencies taken as a model. The forecast of GR, however, proves to be wrong because this loss of frequency is calculated conserving the energy applied to the particular case of a material object, which being bound (by our Weyl's principle § **40**) not to lose speed, loses intrinsic energy in the form of the frequency of its necessary internal

structure. This is exactly what happens in the case of Compton's impact in which the photon loses frequency but not speed →S^*. If the frequency were less at the start, then at redshift it should have a double value, which is not the case. We again quote Cattaneo ("Rend. Acc.Lincei", XVII, p.54, 1959): "We can see how this effect, which is assumed to be a crucial proof of general relativity, may be interpreted as a principle of conservation of the total energy of photons."

This phenomenon, however, reveals two important things: first that the photon is an object with an internal structure as demonstrated in Th(α): secondly that this structure, which in itself paradigmatically should be of an electromagnetic nature, is affected by gravitational forces, thus denouncing a necessary structural unity with the latter, as demonstrated by Th(α).

-iii) *PRECESSION OF THE PERIHELION.* Unlike the other two arguments, the advance of the perihelion (the correct calculation of which caused Einstein palpitations) is considered the most specific effect of the relativistic curvature. However, also this can be calculated as a transversal action of Coriolis that makes the ellipse rotate, with the term of the rotor of linear gravity of equation (2). The complexity of an exact derivation, also on account of the uncertainty of the parameters of the sun, can be justified in a first general approximation by recurring to the electromagnetic parallelism and transducing the simple formula of Larmor's precession $\omega_L = e\mathbf{B}_{el}/2m_e$ to the gravitational case. In our case the charge of gravitational interaction that appears at the numerator is annulled by the mass that appears at the denominator. There remains the vector field $\mathbf{B}$, expressed by the rotor of its potential vector, which in the gravitational case becomes:

$$\mathbf{B}_{Gr}=\text{rot}\mathbf{A}_{Gr}=4(GM_\odot/c^2)(V_\odot/R^2_{\;\circlesplit\;\odot})$$

where $M_\odot=2\cdot10^{33}$g is the mass of the Sun, $V_\odot=2.03\cdot10^5$cm/s the equatorial speed of the Sun, and $R_{\circlesplit\;\odot}=5.55\cdot10^{12}$cm the medium distance of Mercury from the Sun (*"$l_\odot$"*$=GM_\odot/c^2=1.548\cdot10^5$cm):

$$\omega_L = 4\,\text{``}l_\odot\text{''}\,(V_\odot/R^2_{\;\circlesplit\;\odot}) = 0.391\cdot10^{-14}\text{rad/s},$$

against the value of $6.651\cdot10^{-14}$rad/s which can be calculated from a much more elaborate expression of S.M.Carrol ("Lecture Note on General Relativity" Univ. Of California, p.179):

$$\omega_a=[3\sqrt{(GM_\odot)^3}]/c^2(1-e^2)\sqrt{R^5_{\;\circlesplit\;\odot}}$$

This result, which can at least find the correct range by considerations based on *kinematics* instead of *curvature*, suggests that we should look for a theorem establishing the equivalence between the two different approaches, as for instance Schroedinger's theorem of equivalence between his differential equation and Heisemberg's matrix formalism.

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APPENDIX IV°.

EINSTEIN'S FAILURE ON MACH'S PRINCIPLE.

Einstein was the first to try and give the consistency of a physical theory to Mach's conjecture − extracted by him from oblivion and named "Mach's principle" − in the final pages to his 1922 "The meaning of relativity", where as a last and most prestigious crowning part of his General Relativity, he formulated the (118) of our App. 1 i), to show that in it the actions of inertia are present "*at least in part*" as mutual action between gravitational bodies; even claiming to confirm Mach's idea on the basis of this recognition, which on the contrary was totally false.

"*Though these effects are outside any experimental possibility on account of the smallness of κ (=$8\pi G/c^2$=10^{-27}), they certainly exist according to the theory of general relativity, and are considered a potent confirmation of Mach's idea on the relativity of all actions of inertia*". (op.cit. p107). And further, in conclusion: "*The idea proposed by Mach, that is that inertia depends on the mutual action of bodies, is contained as a first approximation in the equations of the theory of relativity, from which it is deduced that inertia depends at least partly on the mutual action between masses. Since it is not satisfactory to make the hypothesis that inertia partly depends on mutual actions and partly on an independent property of space, Mach's idea becomes extremely probable.*"

But in fact not even this small part is present because − if we limit ourselves to the term of induction, which is the clearest − the forces that Einstein calls forces of inertia, having defined them himself as "accelerating forces" (nor could he do otherwise), are in fact forces produced by gravitational waves that are not in the least related to the forces of inertia. Einstein's mistake, which was then repeated by his followers, consists in having taken it for granted that since the forces of inertia are exchanged between masses, they can only be a particular case of the gravitational forces, which were already well known and which Einstein extended to terms depending on the kinematics of interacting bodies that did not exist in Newton's theory. This mistake first of all reveals a lack of critical analysis of the fact that though the forces of inertia belong to universal forces (or rather the most universal on account of their source), they make up a category of their own because of the structural and mathematical formal differences that distinguish them from others. In fact: i) they are not accelerating active but reactive non-accelerating and as such they never have an independent existence but only subordinate and consequent to the existence of an active accelerating (or decelerating) force; ii) they are contextual to the acceleration of Pj compared to the source M_u, and not retarded for retarded potentials as the gravitational actions that come from an accelerated

source Σ_i. From the formal mathematical point of view then, the speed (and acceleration) of the potentiated body appears in their expression rather than in the acceleration of the source body that appears in gravitational actions. Substantially, Einstein's error is in the fact that he looked for forces of inertia where there certainly were not any, that is in the second member of (118), where the gravitational forces are, and not in the first member, where though only briefly, there are forces of inertia, as he himself affirms in his text that we have underlined in App.I° i).

In other words Einstein, and his followers after him, did not understand that a unitary theory of all the universal forces that should include the forces of inertia according to Mach's thought, was a much more difficult problem than they had anticipated, because it required scientific imagination to reformulate a new physical scheme of nature with a different way of conceiving universal interactions.

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D.R.P., G.A.R.   Jan.1.2004

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INDEX OF NAMES.

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"A new scientific truth does not prevails because persuades his opposers showing them the light, but rater because at the end they die and a new generation turns up that is already accustomed to it."

(Max Planck, "Scientific Autobiography and Other Papers" New York 1949, p.33)