Spacetime deformations of electromagnetic nature are far from negligible

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March 3, 2023

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Abstract

We would like to collect a series of considerations concerning the influence, which we believe is relevant, that phenomena of an electromagnetic nature have on the geometry of spacetime. The approach, supported by the critical observation of already well-known properties and sustained by theoretical elements, leads us to attribute a primary role to electric and magnetic interactions. In fact, a seemingly small interpretative effort can help link theories elegantly and mathematically which at the moment appear independent. Einstein's equations have a validity that goes beyond the cosmological one and, with the appropriate corrections, they can clarify what really happens inside matter, starting with the bonds that dominate at the molecular level all the way up the description of the macroscopic characteristics. This analysis allows us to leave the context hitherto reserved exclusively for quantum mechanics and to place the study of the structure of matter in a more classic framework.

Essay written for the Gravity Research Foundation 2023 Awards for Essays on Gravitation.

Like any other form of energy, electromagnetic radiation is capable of warping spacetime geometry. From a purely mathematical viewpoint, this is obtained by placing to the right-hand side of Einstein's equations an appropriate forcing term related to the electromagnetic stress tensor. Rainich's pioneering article [1], and the subsequent paper by Witten [2] show how formal solutions can be derived from this type of approach. The results have been taken up and improved on some crucial issues ([3], sections 4.5, 5.1; [4], appendix E) that we do not intend to discuss here in order not to make the exposition too technical. Unfortunately, the interest in this branch of general relativity has never attracted great interest, above all because the phenomenon of curvature variation associated with electromagnetic waves has never been considered quantitatively relevant. The theory was born in the gravitational and cosmological context and has always had applications in these fields as its main focus.

However, as soon as you enter an atomic structure, where electric and magnetic forces are dominant, the gravitational contribution can become far from negligible. It is evident that here the term "gravitational" should not be correlated with the presence of significant masses in the way we commonly refer to. Although used incorrectly, the adjective testifies to the presence of nontrivial geometric deformations. Results and considerations in this direction have been brought to light in recent publications [5, 6, 7, 8]. As will be better specified later on, electromagnetic-type phenomena evolve following specific geodesics "carved" in the inter-atomic lattice. Practical details are available in the preprints [9, 10], in part well formalized and in part only sketched out in a heuristic way. We will, however, remain in this Essay in a predominantly descriptive area.

When we talk about the laws of gravitation, it is important to note that the concept of mass is linked to objects which, however small they may be, are nonetheless made up of a gigantic number of atoms. This means that in the classic gravitational context, the way matter is made does not come into play in the specification of the laws, implicitly treating the masses as volume integrals of a homogeneous density of mass. However, we know that this is not correct, as the actual mass is concentrated in the atomic nuclei, which occupy a

much smaller portion of space than the entire atom. This disproportion radically changes the points of view, considering that an atom has an average diameter of the order of 10^{-10} meters, while the nucleus has an average diameter of the order of 10^{-15} meters. The ratio in terms of volume becomes 10^{15}. Certainly not a trivial amount! In truth, the singular masses involved are extremely small and it is the enormous quantity of particles that generates the global mass. But it is also true that between one nucleus and the next the gravitational force density is decidedly negligible so that the volume integral is the result of a sum of an overwhelming number of peaks concentrated almost punctually.

If instead we focus on quantities of an electromagnetic nature, things change. The intensity of the fields between one nucleus and another is very large, to the point of having, for example, magnetic fields of the order of Teslas. The stability of matter (which is actually almost devoid of "real" matter) is the consequence of considerable energies which, compared to almost zero average, retain strong chemical bonds. According to this interpretation, "solid" objects appear as a mixture of physical particles and energy in constant evolution. In this regard, we specify that the vacuum, whether internal or external to matter, is not actually "empty" but it is comparable to an electromagnetic background that permeates everything (see, e.g.: [11, 12]).

This brings Einstein's equations back into play, and it is obvious that in the new context the constants involved will have to be rethought, and this will also depend on the type of material with which we are dealing. In a revised interpretation of the equations of general relativity the constants that multiply the right-forcing term will be much larger. We can even be more courageous and advance the guess that the intense spacetime deformations that take place inside the electromagnetic background, can also model with the same constants the phenomena classified up to now as essentially gravitational in nature. In fact, the very weak gravitational attraction between two large masses could be the result of more intense electromagnetic forces between the innumerable particles that make up the two bodies, whose nonlinear interactions cancel each other out, providing a result that is not null but definitely

smaller. This would be an elegant way to address the chapter concerning the unification of gravitational and electromagnetic forces, about which we would not venture to say any more.

At this point it is necessary to mention some experimental evidence to what has been stated above, namely that geometric changes take place inside matter which are not trivial at all. These deformations are not due to the presence of elementary particles as massive elements, but to an energy density which lives inside the material bodies and which is distributed over their entire volume. We claim that the tireless electromagnetic agitation of the vacuum is adapted by the presence of the atoms which display a non-stationary activity inside them, strongly dependent on the type of nuclei. When we were still talking about aether, many supporters believed that it was not at rest (in a reference system integral with the fixed stars), but that it was constantly evolving, being able to adapt dynamically by fluctuating ceaselessly among the atoms [13]. Nowadays, there is no longer any need to suppose the existence of the aether; however, electromagnetic radiation and its associated geometry remain. The two interpenetrate each other, acting on each other and evolving like a fluid, which, although it does not contain masses, behaves as if some mass density really existed. As also underlined in [4, 9], matter could be defined as the indissoluble union of small units of mass and charge that determine the scaffolding, plus something that could be given the name of pseudo-matter. Pseudo-matter cannot be isolated. It is mass density without a container. It is spread and takes both positive and negative values, the contribution of which, integrated in physical space and time, provides a null resultant. To say that pseudo-matter can somehow be assimilated to dark matter is perhaps a bit far-fetched, but we believe that the family it belongs to is the same, as we will analyze below.

It is not necessary to choose sophisticated examples to defend the hypothesis of the existence of strong curvatures within matter. The case of diffraction is emblematic. From abstract rules of geometrical optics, mostly based on phenomenological descriptions, we move on to a relativistic interpretation, where the deviation of light is due to the presence of pre-

existing geodesics. The phenomenon is nonlinear and back-reacting, i.e. the very passage of photons inside matter contributes to the variation of the geometry. We specify once again that there are no specific masses or black holes to bend the trajectories of the rays. The effect is instead due to the geometry induced by the pseudo-matter, which in turn originates from the presence of atomic nuclei and at the same time helps to keep them together. With these assumptions, even deterministic explanations are starting to come to life in a context hitherto relegated to quantum phenomena. In the double-slit experiment, the background radiation, due to the presence of closely spaced holes, assumes a conformation that already prefigures the existence of interference fringes. Particles (materials or photons) only show predetermined paths. Their dynamic behavior depends on how the geodesic system is approached. It is therefore not the interaction between particles (which in some experiments are only sent one at a time to the device) that produces wave interference, but the control that is carried out on them by the modified geometry around the peculiar electromagnetic framework surrounding the two slits (see figure 3.18 in [4]). This also explains why the observation of the phenomenon by masking (even partially) one of the slits disturbs the whole experiment. The act of "observing" has not influence on the single particle, but on the whole apparatus in such a way to reconfigure the preexisting interference fringes. The presence or absence of the particles is irrelevant. We realize we have taken a rather slippery path so we stop here with this topic and we refer to [4] for more explanations.

The existence of electromagnetic waves (possibly mixed with particles to form a plasma) trapped by their own self-generated geodesics, may explain the ball-lightning phenomenon (see, e.g. [14, 15]). The natural shape for this type of structures is the toroid, which dynamically behaves like a fluid dynamic vortex ring [16]. If it is therefore true that electromagnetism acts on geometry in such a marked way, one can think that the action can be extended to phenomena of a classically gravitational type, such as the motion of the planets around our Sun. Magneto-hydrodynamics (see, e.g. [17, 18]) studies the evolution of plasma at both the solar system and cosmological levels. A geometry altered by the presence of

masses and combined with that coming from electromagnetic radiation provides new vistas. In [19], it is hypothesized that the Sun can impose its presence through three types of phenomena: the emission of photons, the solar wind, the generation of encapsulated and geometrically growing electromagnetic structures. Precise construction details based on the resolution of Maxwell's equations are provided for the latter. If the effect has some weight on the evolution of the planets, it would not be difficult to explain the coplanarity of their orbits and the geometric growth of their distances from the Sun (Titius-Bode law).

It's time to introduce the model equations and we will do it as concisely as possible due to lack of space. However, all explanations are accessible in [4]. It should first be observed that the electromagnetic background contains regions where the divergence ρ of the electric field is non-zero at points where there may be no charges. This statement may seem very unconventional, but sooner or later becomes necessary to face the issue if we want to fully understand the dynamics of electromagnetic phenomena. To introduce the problem, the most basic example is that of a charged capacitor with parallel plates of infinite size. The charge or the distance of the plates is then altered in a uniform manner, always maintaining parallelism so as not to develop magnetic fields. Since information travels at a finite speed (that of light) it is inevitable that momentary zones are created between the plates with $\rho \neq 0$ which compensate each other between positive and negative values, so that Gauss's theorem still applies to the whole system. A full discussion of this problem is available [20]. Thus, the non-stationary electromagnetic vacuum also contains a pseudo-charge, which does not correspond to the presence of physical charges. The intensity of ρ becomes more accentuated in situations where the dynamics are predominant. On the other hand, in subatomic physics it is convenient to define virtual pairs of particles and anti-particles, in our opinion precisely to meet the need to give meaning to the presence of charge density without charge.

We denote by $\vec{E}$ the electric field, by $\vec{B}$ the magnetic one, and by $\vec{V}$ a velocity vector field. In particular, $\vec{V}$ indicates the evolution of the electromagnetic information, which, as said, is not necessarily carried by real massive bodies like charged particles. The set of model

equations in Minkowski space, coupling Maxwell's equations and Euler's equation for non viscous fluids, reads as follows:

$$\frac{\partial \vec{E}}{\partial t} = c^2 \mathrm{curl}\vec{B} - \rho\vec{V} \qquad \frac{\partial \vec{B}}{\partial t} = -\mathrm{curl}\vec{E} \qquad \mathrm{div}\vec{B} = 0 \tag{1}$$

$$\rho\left(\mu^{-1}\frac{D\vec{V}}{Dt} + (\vec{E} + \vec{V}\times\vec{B})\right) = -\epsilon_0^{-1}\vec{\nabla}p \tag{2}$$

with $\rho = \mathrm{div}\vec{E}$; c is the speed of light and ϵ_0 the vacuum permittivity constant. The setting is not dissimilar from those analyzed within the framework of plasma physics or magneto-hydrodynamics. The nontrivial exception is that we do not introduce any mass density here. The scalar p is a potential denoting pressure density per unit of surface, which, differently from fluid dynamics, can also attain negative values. It represents the link between electromagnetic and Newtonian-type forces. The term $\vec{E} + \vec{V}\times\vec{B}$ recalls Lorentz's force. Finally, the constant μ is dimensionally equivalent to Coulomb/Kg. The set of equations extends the classical Maxwell's model in vacuum (just impose $\rho = 0$).

The equations can be derived through an energy tensor (thus they can be written in covariant form), which, in addition to including the well-known electromagnetic stress, incorporates a mass tensor resembling that of a dust of particles for a perfect fluid (remember, no mass density though!). The same energy tensor is the one to plug on the right-hand side of Einstein's equation. Among the extraordinary properties of this system of equations there is the possibility of constructing explicit solutions of (1)-(2) which, despite being of the classical type, reflect all the prerogatives of photons, i.e. they travel without dispersion along straight lines at the speed of light; they behave like particles and electromagnetic waves at the same time; they respect the rules of geometrical optics. Although the theme has now become out of fashion, the result answers the age-old question of attributing a clear definition to the notion of wave-particle. Furthermore, associated with these waves, exact solutions of Einstein's equation are computable. It is also surprising to note that to construct the photon-waves it is necessary to hypothesize that inside them $\rho \neq 0$; nevertheless,

in the metric generated by their passage we find the condition $\rho = 0$, thus rediscovering the standard Maxwell's equations in vacuum. All of this material is well documented and available in [3, 4]. We would like to dwell on the exposition but this is not possible in order to remain within the limits of this Essay.

From these reasoning it follows that the actual matter is immersed in an electromagnetic soup which already contains the essence of the matter itself, and the laws that regulate its dynamics are the embryo of those that will become known laws in the presence of matter. In this primordial universe, the only law that is not established a priori is that of Coulomb, which will automatically derive from the basic model once elementary particles are introduced. There is no precise metric that describes this universe (bad news for cosmologists!), presenting itself as a predominantly calm ocean, but full of constantly evolving substructures at various scales of magnitude, which can be created or annihilated depending on the circumstances. The structures develop approximately respecting the basic rule that the frequencies of the vortexes involved are inversely proportional to their dimensions.

Arrived at this point the reader, alongside the considerations made above which some may consider fanciful, will wish to know innovative extensions. A very recent experiment still awaiting replication would not only validate the above, but would pave the way for revolutionary applications. The recipe is to put pseudo-matter into rotation inside an asymmetrical cavity. In the specific case it is a dielectric ring with an appropriate design. The ring is stressed through a conductive winding to which a radio-frequency signal is applied. Via a high voltage power supply, a stationary electric field is also added. For an appropriate choice of the input frequency, internal Newtonian forces with non-zero average resultant begin to press on the entire apparatus, exerting a side thrust in violation of the action-reaction principle. The thrust is orders of magnitude greater than expected, somehow confirming that the constants involved need to be revisited. The laboratory test is documented in [21], and some partial explanations in relativistic terms are provided in [10], where Einstein's equations are exactly solved in simplified situations. Hopefully, future numerical approximations

will provide more details. We remind that pseudo-mass and pseudo-charge are not relativistic invariants. This means that the reaction of the vacuum can be different depending on how we stress it, and therefore that we can exploit this property to our advantage (any relation to the Unruh effect [22]? Or to the work of Woodward on capacitors [23]?). The distortion that the pseudo-matter in asymmetrical rotation brings to the molecular lattice is momentary. The possibility of "deceiving" the classical conservation principles may be based on the recovery delay of the initial molecular configurations and the repetition of the impulses at a rate of billions times per second. The ring is about ten centimeters in size and the information travels at speeds comparable to that of light. There are margins for hypothesizing that the "reaction" does not occur instantaneously but that there is room for a new "action", thus circumventing fundamental theories. The importance of this discovery is primary, for example, in the construction of the so-called "EM-thrusters" in the space sector.

The moral of this article, which deliberately does not report theoretical mathematical passages, is that with common sense and a necessary correction of the gravitational constant in the case of electromagnetic fields, a sequence of practicable paths is obtained aimed at answering ancient questions without the need to introduce a "new physics". The revision requires a wide-ranging intervention that cannot be carried out by a single individual, and touches on many crucial aspects underlying theories that are considered already consolidated. However, we believe that an effort must be made in the directions indicated, in order to acquire a unified and deeper understanding of the matter that surrounds us.

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