Surrounding Matter Theory: first mathematical developments

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Surrounding Matter Theory, an alternative theory to dark matter, suggests mathematical developments. Two of them are presented. Then they are used in the study of a different interpretation of General Relativity (GR) principles using a four-momentum in place of the stress-energy tensor. It is showned that the surrounding effect prevailing in Surrounding Matter Theory appears also as the inner part of such a model. A surrounding effect in the context of particle physics is tried.

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1. Introduction

In Surrounding Matter Theory[?] an alternative theory to dark matter was presented. Its development was suggested by another model more ambitious but quite complicated[?] and constructed with assumptions. Therefore, it might be interesting to try to rewrite the latter in a more straightforward and argumentative way. In order to achieve that, some mathematical developments are required. The present document will present two of them, which deal with null four-vectors. It will be also revisited the famous issue of the absence of algebraic structure for the set of boosts in three dimensional space. It will be reminded a prediction of GR for the space-time deformation generated by a particle in motion. From those developments, some constraints will be applied on physics models trying to replace Einstein equation with a discrete equation using four-momentums in place of the stress-energy tensor. After the improvement of the coherence of one of those models, an insight in gravitation and in particle physics will be tried.

2. An algebraic structure for the set of loaded boosts

Let's write $S = \{(a, B^\mu_\nu)\}$ and let's call it the "set of loaded boosts". a is a strictly positive real number, B^μ_ν is a boost. Of course the speed which is associated with a boost is strictly below the speed of light. Therefore S is the set of (a, B^μ_ν) couples, which can be understood in physics the following way. a is the energy at rest of a non relativistic object, therefore a is a strictly positive real number. B^μ_ν is the boost associated with its motion in a given frame. So S is this set of such couples. Then the algebraic structure of S is inherited from the s isomorphism from the set of strictly positive four-vectors, to S, such as $(a, B^\mu_\nu) = s(D^\mu)$ in the following way.

$$D^\mu = (d_1, d_2, 0, 0) = \gamma \frac{a}{c}\left(1, \frac{v}{c}, 0, 0\right) \tag{1}$$

In (1) it has been written D^μ in such a base that its two last components are null and its first component is positive. a and v are deduced from D^μ by (1). It has been used $\gamma = 1/\sqrt{1 - v^2/c^2}$. In (1) it has been supposed that the first component is positive, hence that the flow of time is positive. If this component is negative then identical calculations are possible, with an opposite direction of time. Then the "1" in (1) is replaced by "-1". The mathematical structures which will be studied in the present document are valid with either positive or negative flow of time. But in the present document a positive flow of time will allways be supposed. Then the B^μ_ν boost of (2) is deduced from v.

$$B^\mu_\nu = \gamma \begin{pmatrix} 1 & -\frac{v}{c} & 0 & 0 \\ -\frac{v}{c} & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix} = B(D^\mu) \tag{2}$$

The definition of $*$, the induced operator acting on S is the following.

$$(a_1, B^\mu_{\nu\,1}) * (a_2, B^\mu_{\nu\,2}) = s(s^{-1}((a_1, B^\mu_{\nu\,1})) + s^{-1}((a_2, B^\mu_{\nu\,2}))). \tag{3}$$

Obvious notations have been used for this equation. It must be noticed that the image of S by s^{-1} is the set of strictly positive four-vectors. Let's call SP this set. Also let's call Q the set of speeds which are strictly below the speed of light. Therefore Q is a subset of $\mathbb{R}^3$.

The result is that $(S, *)$ is isomorphic to $(SP, +)$. A more human sensitive result is that $(S, *)$ is isomorphic to $(\mathbb{R}^{+*} \times Q, op)$. op is the barycentric operator of $\mathbb{R}^{+*} \times Q$, using $\mathbb{R}^{+*}$ for the barycentric loads, and addition in Q. The physics point of view is that this is isomorphic to the set of (a_t, v) couples where a_t is the total energy of an object, and v, being strictly weaker than c is the speed of the inertial center of the object in a given inertial frame, using the barycentric operator.

By the way here an answer is given to the famous GR question of the absence of algebraic structure for the set of boosts with the composition operator. This answer starts by associating each boost with a strictly positive real number.

Another GR famous issue which can be addressed now is the issue of the order of the boosts in their three dimensional composition.[?,?,?] Let's suppose the Universe filled with a constant and uniform distribution of matter. Let's choose and write R a frame in which the universe is at rest. Let' study two A and B objects. If A and B are far enough from each other, the space-time deformation due to A is not noticeable around B and vice versa. In this case an inertial frame R_B attached to B will appear in an inertial frame R_A attached to A following the rule of the composition of the boosts and it will appear a Wigner rotation. "A frame attached to a particle" means that the particle is at rest in the frame. But the space-time structure will be determined without ambiguity. The answer to the question of the order will be conspicuous: R_A to R and then R to R_B. Now if the Universe becomes empty except A and B then no boost composition will be required, only one boost will be relevant, and no Wigner rotation will appear. Also if E_A and E_B are the respective total energies, in R, of A and B, if $E_A >> E_B$ and if A and B are closed enough to each other so that the space-time deformation of the Universe is not noticeable around A, (that is, the deformations of A and B are the only one noticeable around B), then R_B will appear in R with a Wigner rotation and the choice of the order will be obvious too: R to R_A and then R_A to R_B. The final result is that the answer to the questions of which composition of boosts and which chosen composition order between the frames depends of the relative energies associated with those frames.

3. Null four-vectors

The two following paragraphs will depict the two following features of null four-vectors. The "projective loaded boost" term will be explained just below.

1) The set of projective loaded boosts is a barycentric generator of the set of loaded boosts.
2) There is a morphism between the set of null four-vectors with addition and the corresponding set of projective boosts with composition.

3.1. *A barycentric generator for the set of loaded boosts*

Let's study the extension of the s function to the case of null four-vectors. For those null four-vectors, (2) is replaced by its limit from v to c. Similarily S is extended into a set which contains S, and also $S\#$, a subset of its projective space. Let's call "projective loaded boost" an element of $S\#$. Such an element is of the form $(0, H^\mu_\nu)$, where 0 means that the corresponding energy at rest is null, and H^μ_ν is an element of the projective space of the $End(\mathbb{R}^4)$ space, which gets the following shape in some given inertial frame.

$$H^\mu_\nu = \begin{pmatrix} 1 & -1 & 0 & 0 \\ -1 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix} \tag{4}$$

Let's call "projective boost" such a H^μ_ν element. Let's write B_o the set of boosts and $B_o\#$ its projective set. Therefore $B_o\#$ is the set of such H^μ_ν elements. This extension of s is such that there is $s((1, 1, 0, 0)) = (0, H^\mu_\nu)$. Along with this extension of s there is an extension of the B function of (2) which allows to write $B((1, 1, 0, 0)) = H^\mu_\nu$.

Composing two projective boosts yields a projective element of $End(\mathbb{R}^4)$. The composition operator of $End(\mathbb{R}^4)$ can be transported to its projective space naturally. And the usual property is valid in which the result of composition in the projective space is the projective element which is the projection of the composition of any of their representations. That is, the definition of the transported operation does not depends of the choice of the elements of $End(\mathbb{R}^4)$.

Two projective loaded boosts paired with the $*$ operator yield a loaded boost. There is the same result for a projective loaded boost paired with a loaded boost. Therefore, s is extended from SP, to P, the set of positive four-vectors. And this extension of s is still a morphism from $(P, +)$ to $(S\ U\ S\#, *)$, but no longer an isomorphism. Indeed, such an extended s is not injective with the null four-vectors. From now on in the present document, the s and B functions will mean their extended versions.

The result of the present paragraph is that $S\#$, the set of projective loaded boosts, is a generator of S, the set of loaded boosts, using the $*$ operator. And it can be said equivalently, using the s^{-1} function, that the set of null four-vectors is a generator of P with addition. Of course it is not a base of P because there are multiple ways to generate an element of P using addition of null four-vectors. There is one and only one such way for any space direction. More precisely any strictly positive four-vector is the sum of two null four-vectors. In physics, it means that any non relativistic object can be imagined as being only composed of two particles moving at the speed of light. And once the space direction of one of them is knowned, then the motion of the other one is deduced.

3.2. *A morphism between the set of null four-vectors with addition and the corresponding set of projective boosts with composition*

The important remark of the present paragraph is given by (5), using the notation of (4).

$$H^\rho_\nu H^\mu_\rho = 2\ H^\mu_\nu. \tag{5}$$

It must be noticed that $2\ H^\mu_\nu$ is representing the same element as H^μ_ν in the projective space of $End(\mathbb{R}^4)$. This equation gets an interesting consequence in physics.

Let's write Dn one given half line of null four-vectors. Therefore one null four-vector is given, which is not equal to 0, let's call it n, and Dn is the set of αn null four-vectors such as α is a positive real number. Then let's write Br the set of the projected boosts which are associated with Dn. Therefore $Br = B(Dn)$ and Br is composed of the projected boosts along the direction indicated by n. This is a trivial case because Br is in fact a singleton of $B_o\#$. In other words there exists an element of $B_o\#$, let's write it H^μ_ν, such as $Br = \{H^\mu_\nu\}$.

The important point is that B is a morphism between each D_n subset of $\mathbb{R}^4$

with addition operator, and its associated Br set with the composition operator. Moreover, B is such a morphism only when restricted to such Dn sets. In other words, if it is already knowned that B is a function from $\mathbb{R}^{4+*}$ to $B_o\ U\ B_o\#$, it is a morphism from $(\mathbb{R}^{4+*},+)$ to $(B_o\ U\ B_o\#, o)$ only when restricted to each of those D_n subsets.

4. Consequences of those null four-vector features

4.1. *New physics models*

These features allow to construct any kind of physics model which is composed of the following assumption and equation.

i The assumption is that matter is made of particles moving at the speed of light.
ii The equation starts the calculation of space-time structure at any space-time event, by addition of the four-momentums propagated along the gravitational waves which are received at the event.

The need of the assumption (i) will be explained further. Let's show the shape of Eq. (ii).

$$D^\mu(x) = \Sigma_{n=0}^{\infty} 1_w(x, y_n) f(x, y_n) C^\mu(y_n) \tag{6}$$

In (6), $1_w(x, y_n)$ is equal to 1 if x and y_n events are connected by a null geodesic and if x is located after y_n along this geodesic. It means that the gravitational wave generated by the particle located in y_n is received in x. $f(x, y_n)$ is the scalar positive function equal to 1 if y_n is equal to x, and which expresses the attenuation of the gravitational wave energy generated by the particle located in y_n.

$C^\mu(y_n)$ is a four-vector. It represents the four-momentum of the particle which is located in the y_n event. Under the assumption (i), this particle is moving at the speed of light and $C^\mu(y_n)$ is a null four-vector. If $f(x, y_n) < 1$, then $f(x, y_n)C^\mu(y_n)$ represents in x the four-momentum of the gravitational wave which is generated by the particle located in y_n. Of course in this equation it is supposed that such a gravitational wave energy is described this way. The validity of this supposition will be discussed further. Once received in the x event, all those gravitational waves add their four-momentums. The final sum is $D^\mu(x)$. Then, from $D^\mu(x)$ will be calculated the space-time structure. Noticeably, this can be done by using the boost of (2), and then from this boost the evolution of the space-time structure can be derived in x.

There are many ways of constructing such a physics model. The choice of the f function, and even the particular way of constructing space-time structure from $D^\mu(x)$ are degrees of freedom for this construction. Let's depict one of those ways of deriving space-time structure from (6).

4.2. *An important prerequisite*

Before that, an important prerequisite must be showned. It is that in GR there is a privileged frame, and the boost which is associated to the motion of matter in this frame, describes the evolution of this privileged frame.

This can be showned using a thought experiment. This thought experiment is simply imagining the energy at rest of a particle increasing progressively, and at the same time the whole energy of the universe decreasing. The asymptotic and then final result is that the universe and the particle have their roles permuted. Now the particle contains the energy of the previous universe, and the universe contains the energy of the previous particle. The result is that the frame in which time elapses the most is no longer the frame attached to the universe. Now this frame in which time elapses the most is the frame attached to the particle. It means that the space-time structure is now the symmetrical result of a permutation of those two frames. It means also that during the experiment, the space-time structure has been modified progressively from the first state to the final one which is symmetric with respect to the first one. And this operation has allowed to revert the time dilatation. For example, if this was a twin paradox configuration, at the end of his brother's journey, the older twin would be the youngest after the thought experiment. Therefore this space-time modification is simply described by the boost transporting one frame into another. It can be noticed that this reasoning is using the well established supposition that GR is coherent.

Now the need of naming the frames appears. Let's call Ru a frame attached to the universe. It can be supposed that the universe is filled with a constant, homogenous distribution of matter, therefore this matter is supposed to be at rest in Ru. Let's call Rp a frame attached to the particle. The result of the thought experiment is that the particle generates locally a space-time deformation which is described by the boost from Ru to Rp. Of course, this deformation is local to the particle but the more energy at rest of the particle, the more this deformation is valid around the particle. A "more valid deformation" means that the space-time deformation exists significatively over a larger space-time domain.

Now in the particular case of a particle moving at the speed of light, this boost becomes the projective boost described by (4).

Of course it might happen that between the two opposite and extreme cases of the thought experiment, the space-time deformation would be completely different from the one occurring during those two cases. But this would be a strange situation. Indeed there would exists two different change of coordinates, one for the progressive determination of the frame in which time elapses the most, along the process from one extreme case to the other, and another which is the usual boost of Special Relativity (SR).

It is already knowned in relativity that the frame in which time elapses the most is a privileged frame and is required to be as such. Therefore the space-time deformation appearing in the experiment is described by a boost which allows to transform progressively this privileged frame from the first case to the second one. And it means that this frame remains privileged during the whole process, even though it is no longer the frame in which time elapses the most between the two extreme situations. This frame is simply a frame in which the particle is at rest. Its physics relevance is only local to the particle.

This ends the explanation of the prerequisite. The final result is that it exists potentially a privileged frame in any space-time event. And for any particle located in x, this privileged frame exists in x and is transformed by the particle, using the boost which is associated with the four-momentum of the particle. Roughly speaking for the understanding, let's write that this boost is calculated in the "old privileged frame", that is, the one "just before the particle", and that it transforms this old privileged frame into the new one, that is, the one "just after the particle".

4.3. *From four-momentum to space-time structure*

Now it is possible to depict briefly one of those ways of deriving space-time structure from (6). The first step is to calculate a boost from each $D^\mu(x)$ four-momentum. It has been showned that a coherent way to do that is to use the B function of (2). The result is a $B^\mu_\nu(x)$ boost. It is not a projective boost, because $D^\mu(x)$ is not null. A null $D^\mu(x)$ would not determine correctly a space-time structure because s is not injective for null four-vectors and energy information would be lost. It means that (6) is only relevant for two or more terms in the sum.

The second step is to derive the metric from $B^\mu_\nu(x)$. Let's call R_0 the privileged frame of the prerequisite, in x, before the reception of the gravitational waves of (6). Let's call R'_0 this privileged frame after the action of the boost which results from (6) and (2). Therefore, R_0 is the "old privileged frame", and R'_0 is the "new privileged frame". Let's write x' the first event in which this transformation takes place, along the time of R_0.

Now the second step can be done which is to derive the metric from this $B^\mu_\nu(x)$ boost. R'_0 is obtained by transforming R_0, in x, using the $B^\mu_\nu(x)$ boost. It is required to rescale the lengths of the "boosted" time and space axis. The boosted time and space axis are the time and space axis which have been modified by the boost, in their states after the boost. Let's call "one step" this process in which R_0 is replaced by R'_0 and then by this rescaled frame. The rescaling is done in such a way that the resulting time line described successively by those successive steps is a geodesic. Equivalently this constraint is that the privileged frame must be inertial. This is detailed by the following equations, relating X'^ν the coordinates after the boost, to X^μ the coordinates in R_0, and then relating $X"^\rho$ the final rescaled coordinates in R'_0 to X'^ν.

$$X'^\nu(x') = B^\nu_\mu(x)X^\mu(x) \tag{7}$$

$$X"^\rho(x') = S^\rho_\nu(x')X'^\nu(x) \tag{8}$$

$$g_{\alpha\beta}(x) = B^{\rho}_{\alpha}(x) B^{\kappa}_{\beta}(x) S^{\mu}_{\rho}(x') S^{\nu}_{\kappa}(x') g_{\mu\nu}(x') \tag{9}$$

$S^{\mu}_{\rho}(x')$ is a symetric transform which has the ability of being diagonalized in R'_0. Its value is determined by the constraint above (the time line of the set of successive privileged frames must be a geodesic). Eq. (7), (8) and (9) show how $g_{\mu\nu}(x')$ the new metric is deduced from $g_{\alpha\beta}(x)$ the old one, due to the action of $B^{\nu}_{\mu}(x)$, which results from the $D^{\mu}(x)$ added energy.

This is a possible construction of a space-time structure which is done in order to be as much coherent as possible with relativity. This new model is discrete, as compared with GR which is continuous. These equations have been obtained by discretizing simply the spherically symmetric static case. In the Schwarzschild metric of this case, a free falling particle, being at rest when located infinitely far from the center of the symmetry, follows a time line which is transformed by those equations.[?] Finally, from this discrete metric the continuous metric must be interpolated. For example, this can be done by using the sinc function. This yields a continuous metric which is valid at the microscopic scale. From it, for gravitation, an average value might be calculated, resulting in a metric more relevant for the macroscopic scale.

But whatever is that exact construction, without any of the features of the previous paragraph, this physics construction would be either not possible or incoherent. Let's detail this.

4.4. *First feature*

Without the algebraic structure of the set of loaded boosts, along with the first feature (projective loaded boosts being generators of loaded boosts using the $*$ operator), it would not be possible to calculate in a coherent way the boost from (6) and then (2). Let's explain this.

In the particular case where the particles are close to each other, this calculation of the boost which is generated by matter can be incoherent in the case of an object which is composed of several smaller objects. Indeed its calculation can be done first by calculating the boost of the big object, and it can be done also by calculating the boosts for the smaller objects, and then deducing from that the boost of the big object. Of course those two calculations must yield identical results. Those possible incoherences were exposed in Ref. **?**. The same solution as the one chosen in Ref. **?** is constructed in the present document, in a more detailed manner. This manner is to use assumption (i), (ii), and the $*$ operator.

This was about the composition of different objects in space. For comparison the composition of different objects along the time axis will be studied in the next paragraph.

Another requirement, appearing in any cases for the calculation of the boosts with (6) and (2), is that associativity of this calculation is mandatory (without speaking about commutativity, or any neutral element). And associativity is given by the algebraic structure of the set of loaded boosts.

It must be noticed that the reasoning of the present paragraph supports already the validity of assumption (i). Moreover, the next point is that this assumption might be simply required in GR.

4.5. *Second feature*

Without the second feature (morphism between null four-vectors and projected boosts), the new models which execute (6) and then (2) would not respect energy conservation. This is shown in the case of three particles, named for example P_1, P_2, P_3. They are supposed to be located close to some given x event. Their speeds are supposed to be colinear and sharing the same direction. Let's write $D_1^\mu(x))$, $D_2^\mu(x))$, and $D_3^\mu(x))$ their respective four-momentums. It is supposed $D_3(x) = D_1(x) + D_2(x)$. Now the time order of appearance of those particles in x must not lead to different spacetime structures in x. Otherwise, the conservation of energy principle would not be satisfied because the generated geodesics would be different. For example a fourth particle coming in the vicinity of x would follow different trajectories and therefore different evolution of its four-momentum in R_0 and R'_0, the frames which are used by (7), (8) and (9). It means that P_1 and P_2 without P_3, or P_3 alone, must yield identical metrics. The result, for the evolution of the privileged frame calculated by (2), is (10).

$$B(D_1^\mu(x)) \circ B(D_2^\mu(x)) = B(D_1^\mu(x) + D_2^\mu(x)) \tag{10}$$

And it has been showned that the domain of this morphism is the set of null four-vectors. More precisely, it has been showned that this morphism is valid only when restricted to any D_n set. But this is exactly what is required in order to solve the physics incoherences which have been explained just above.
Now let's consider once again the case of objects which are so close to each other that the gravitational waves do not take place and are replaced by immediate interaction. It results that the assumption (i) is required for having a valid Eq. (6) in this case.

Moreover what has been showned is that, in the context of GR, only from the prerequisite above and the second feature, conservation of energy requires assumption (i).

Assumption (i) is required in GR. Of course it does not imply any direct consequence in fundamental physics since the size of the particles of this assumption is not knowned. But the consequence in GR is that a discrete model arises. Indeed any particle which is not moving at the speed of light now must be modelled by a group of particles moving at the speed of light. Either the number of particles in such a group is finite, or infinite. If it is infinite then it is a countably infinite.

To say the least, this gives a very good reason for trying to develop such new models which are discrete and in which space-time structure is calculated under this assumption (i). From there, the previous reasonings imply (ii) (that is, Eq. (6)).

But (6) is assumed to sum null four-vectors in any cases, otherwise it might generate once again violations of the conservation of energy principle. Therefore, similarily the gravitational wave four-momentums must be assumed to be null four-vectors. This is coherent with the formulation of the stress-energy tensor of a gravitational wave in some literature, for example in Ref. **?**.

4.6. *The surrounding effect as an inner part of those physics models*

Let's rewrite (6), shifting the energy at rest from left to right.

$$U^\mu(x) = \frac{1}{\sqrt{1-\frac{v^2}{c^2}}}\left(1, \frac{v_x}{c}, \frac{v_y}{c}, \frac{v_z}{c}\right) = \frac{D^\mu(x)}{E/c} \tag{11}$$

$$E = \sqrt{E_t^2 - E_c^2} \tag{12}$$

$$E_t = c\ \Sigma_{n=0}^{\infty} 1_w(x, y_n) f(x, y_n) C^0(y_n) \tag{13}$$

$$E_c^2 = c^2\ \Sigma_{i=1}^{3}(\Sigma_{n=0}^{\infty} 1_w(x, y_n) f(x, y_n) C^i(y_n))^2 \tag{14}$$

$U^\mu(x)$ is the four-velocity associated with $D^\mu(x)$. v_x, v_y, v_z, are its x, y, z space components, in some given inertial frame. Practically speaking this frame will be the privileged frame described above. v is the space norm of this speed. E, E_t, and E_c are respectively the energy at rest, total energy, energy of motion of $D^\mu(x)$. The denominator of (11) has been detailed in (12), (13) and (14) using once again Eq. (6).

It has been illustrated in Ref. **?**, that such an equation predicts a particular effect. This effect was called "surrounding" in Ref. **?**. Stated in one sentence, this effect is an increase of the equivalent G constant (that is, an increase of each gravitational forces), in a way which is inversely proportional with the energy of matter surrounding the location where the force is exerted.

Let's try an illustrative calculation from Eq. (6). For this, let's suppose for simplification that only the particle which is located in y_0 pertains to an object generating a gravitational force. Let's suppose that the other particles, therefore those located in y_n, with $n > 0$, represent the contribution of the universe, that they are distributed symmetrically in space with respect to x. It can be easily supposed that the sum of their energies will be strong in front of the energy of the particle located in y_0. Those latter suppositions are often valid in reality, at least for gravitation. One consequence is that the sum in x of the contributions of the particles which are located in y_n, for $n = 1$ to $n = \infty$, will be a four-momentum having approximately no space components. The result is given by (15) and (16).

$$U^\mu(x) = \frac{1_w(x, y_0) f(x, y_0) C^\mu(y_0)}{E/c} + \frac{\Sigma_{n=1}^{\infty} 1_w(x, y_n) f(x, y_n) C^\mu(y_n)}{E/c} \tag{15}$$

$$U^\mu(x) \simeq \frac{1_w(x,y_0)f(x,y_0)C^\mu(y_0)}{E/c} + (1,0,0,0) \tag{16}$$

Now let's suppose that $\Sigma_{n=1}^{\infty} 1_w(x,y_n)f(x,y_n)C^0(y_n)$, the total energy surrounding the x event, increases. It is supposed that the object generating the gravitational force does not experience any modification during that increasing process. It follows that E increases, since from (12), (13) and (14) there is $E \simeq \Sigma_{n=1}^{\infty} 1_w(x,y_n)f(x,y_n)C^0(y_n)$. Increasing E in (16) without modifying $C^\mu(y_0)$ results in decreasing v. Therefore, v is decreasing in $D^\mu(x)$, and then in $B_\mu^\nu(x)$ after the execution of (2). It results a weakening of the transformation, from $g_{\alpha\beta}(x)$ into $g_{\mu\nu}(x')$, which is done by executing (7), (8), and (9). Then, any continuous $g_{\mu\nu}$ metric interpolated in a mathematical regular manner from this discretization, will experience a decrease of its curvature.

This calculation was done only on illustrative purposes. It was based on some suppositions. For example, the number of particles involved in (6) might happen to be much lower than what was supposed implicitely. In that case, another kind of calculation must be done, taking into account the size of the cells of the grid of the gravitational waves intersections. This kind of calculation is out of the scope of the present document.

$$\frac{v}{c} = \frac{\sqrt{\Sigma_{i=1}^{3}(\Sigma_{n=0}^{\infty} 1_w(x,y_n)f(x,y_n)C^i(y_n))^2}}{\Sigma_{n=0}^{\infty} 1_w(x,y_n)f(x,y_n)C^0(y_n)} \tag{17}$$

But (17) derives directly from (6), whithout any supposition. And it shows that the space velocity of the resulting four-velocity is inversely proportional to the total surrounding energy. The denominator of the right-hand side of this equation is a sum of positive scalars, whether the three spatial sums of the numerator involve positive or negative scalars.

It was not showned how this effect takes place precisely in any cases, but the result of the present paragraph is that the surrounding effect is an inner part of those new physics models.

5. A development in particle physics

5.1. *A physics picture*

The figure 1 tries to show the architecture of physics in a very simple manner. The physics aspect of SR and GR are supposed to be embodied into the component untitled "gravitation" in the figure. In that particular envision, gravitation is using the mathematical features of SR and GR to create the gravitational predictions of today's physics. When presenting this picture the aim is to show that GR and SR are each of them used by gravitation, but only SR is used by particle physics. GR is not used by particle physics.

But under some particular assumptions, GR might have a role to play in particle physics.

5.2. *"Awakening" GR in particle physics*

A simple way to have particle physics affected by GR is to assume the following assumption.

iii "There are no four forces but only one which is gravitation. The three other forces are only macroscopic effects of gravitation in the particular context in which they operate".

Under this assumption, it is more than a guess that any increase or decrease of the underlying gravitation would be immediatly and proportionally, or almost proportionally, transfered to each of the three other forces.

Let's notice that under this assumption (iii), and assuming also assumption (i) (but this one has been showned to be a requirement), the conjecture that the gravitational waves used in (6) are transporting four-momentums being null is supported. Indeed, under the assumption (iii) except for its localization a particle is equivalent to the gravitational waves it generates. Also, the term "macroscopic" which is used in the formulation of assumption (iii) is coherent with assumption (i). Indeed, the size of such fundamental particles moving at the speed of light must be weaker than

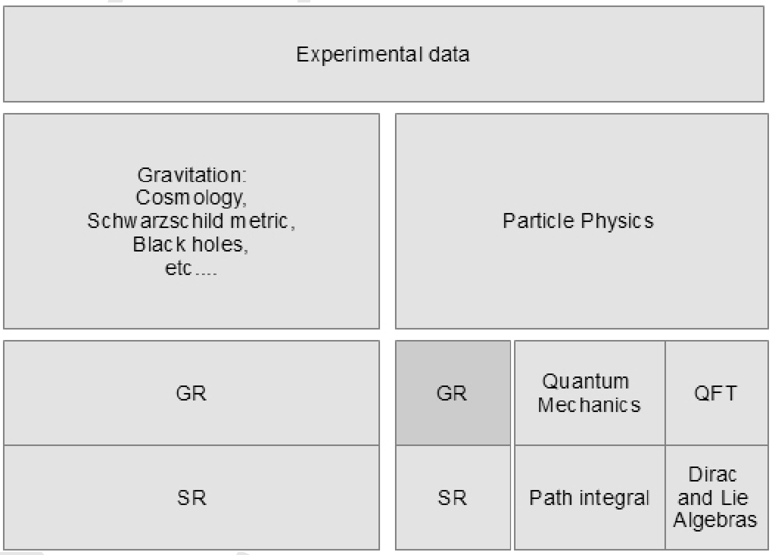

Fig. 1. This rough and simple picture of today's physics is presented in order to remind the role of relativity in gravitation and in particle physics. Only some components are presented. The "GR" and "SR" rectangles are representing only the mathematical models related to "GR" and "SR", respectively. The "GR" rectangle on the right is grayed because GR is not used in today's particle physics.

the size of any knowned fermion.

Now using (i), (ii), (that is, a new model for the mathematical GR as previously explained), and this (iii) physics assumption, then it results the two following consequences.

1) Gravitation is replaced by a new model in which the surrounding effect plays a central role.
2) Particle physics is modified: the surrounding effect arises.

In gravitation, such a modification has been described in Ref. **?**. It shows that the surrounding effect suggests a solution to the most important gravitational issues of today.

In particle physics, the surrounding effect would modify noticeably the physics predictions in the case of triple nuclear collisions.[?] Indeed those collisions would be predicted to behave in a completely different manner. This would be hardly noticeable for the electromagnetic and weak forces because they involve only two incoming particles in close interactions. But this would imply an important modification of the strong force because this one involves also three body interactions. Any group of three particles closed to each other would experience low values of the strong force between them, because the surrounding effect would be strong, due to their close proximity to one another. But any group of two particles or any group of three particles having one of them far enough from the two others, would experience stronger values of the strong force, because the surrounding effect would be weak.

It results a very simple scheme for a possible solution of the Millennium problem.[?,?]

6. Discussion

Mathematically, an algebraic structure for the set of loaded boosts was described, and two features of null four-vectors were showned.

Concerning physics, what was described by an assumption in Ref. **?** was showned to be more than an assumption. It is a prerequisite. It is that a moving particle in a given frame generates locally the space-time deformation described by the boost which is associated with its speed in this frame. This implies the existence of a privileged frame, which in some cases is the frame in which time elapses the most.

From those mathematical developments, and from that prerequisite in physics, it has been showned that the assumption that matter is made of particle moving at the speed of light is also more than an assumption. It is a requirement.

Of course this last sentence can be discussed, because the reasoning leading to it is not pure mathematics but is based on a thought experiment. But to say the least, the developments of the new physics models of the present document have been showned to be relevant, if not required. What follows is the development of those new physics models in which it is tried to calculate space-time structure in a discrete manner. It is tried to replace Einstein continuous equation with a discrete equation using a four-momentum in place of the stress-energy tensor. Some constraints have been applied on such models.

Then it appears that the surrounding effect of Ref. **?** is an inner part of those models. Therefore a surrounding effect arises in gravitation. A new gravitational model similar to the surrounding model[?] might be derived.

The assumption that the four forces derive from the gravitational force enforces the coherence of those models. And it allows them to apply in particle physics. Then the surrounding effect arises also in particle physics. A confinement of the strong force appears immediatly.

The final result is that a modification of GR is relevant, if not required, in which the surrounding effect plays a central role. The first result is that this surrounding effect is added to gravitation. The second result is given under the assumption that the four forces derive from the gravitational force. It is that the surrounding effect arises in particle physics as well. Those new models suggest solutions to the most important gravitational problems of today as well as a solution to the Millennium Yang-Mills problem.

7. Glossary

o: the composition operator.
$\mathbb{R}$: the set of real numbers.
$\mathbb{R}^+$: the set of positive real numbers.
$\mathbb{R}^{+*}$: the set of strictly positive real numbers.
$\mathbb{R}^3$: the three dimensional set of real numbers. The choice of the canonical base is implicit.
$\mathbb{R}^4$: the four dimensional set of real numbers. The choice of the canonical base is implicit. The first dimension is reserved for the physics time axis. The Minkowskian quadratic form is implicit.
$\mathbb{R}^{4+*}$: the set of positive four-vectors which are different from 0.
Four-vector: an element of $\mathbb{R}^4$.
Null four-vector: a four-vector having a Minskowskian value of 0.
Positive four-vector: a four-vector having a positive or null Minskowskian value.
Strictly positive four-vector: a four-vector having a strictly positive Minskowskian value.
SP: the set of strictly positive four-vectors.
P: the set of positive four-vectors.
Q: the set of space vectors which space norm is strictly below the speed of light.
$End(\mathbb{R}^4)$: the algebra of endomorphisms of $\mathbb{R}^4$.
SR: Special Relativity.
GR: General Relativity.
Boost: the particular Minkowskian isometry described by SR and used for describing the space-time coordinates transformation between two inertial frames, one of them being in constant velocity with respect to the other.

Loaded boost: a (a, B) couple where a is a strictly positive real number and B is a boost.
B_o: the set of boosts.
$B_o\#$: the set of projected boosts.
S: the set of loaded boosts.
$S\#$: the set of projected loaded boosts.

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