The quantum-mechanical foundations of gravity

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Abstract: Starting from quantum mechanics, it is possible to derive gravitational attraction between two elementary masses by using a mathematical description called complementary language. This method incorporates the quantization of Planck and the uncertainty relations of Heisenberg from scratch. Important in the description is the conception of space as an independent entity, not as a lack of matter; its potential is considered as equal to that of mass. In this way the uncomfortable duality that exists in early 20th century quantum mechanics between particle and wave character is changed into a duality between mass and space. A numerical example demonstrates that this new theory encompasses the old one, by calculating the radius of protons. By representing the mathematical descriptions in real time and space, taking full account of physical restrictions, gravity appears as an intrinsic feature of timespace objects. Thus a bridge between quantum mechanics and gravity is found. Based upon these results, a description of black matter and of the Higgs particle is found. © *2014 Physics Essays Publication*. [http://dx.doi.org/10.4006/0836-1398-27.3.380]

Résumé: Il est possible de déduire de la mécanique quantique l'attraction gravitationnelle entre deux masses élémentaires en utilisant une description mathématique appelée langage complémentaire. Cette méthode incorpore la quantification de Planck ainsi que les relations d'incertitude de Heisenberg. Dans cette description, ce qui importe est la conception de l'espace en tant qu'entité indépendante et non comme une absence de matière; son potentiel est considéré comme égal à celui de la masse. La dualité inconfortable qui existe en mécanique quantique au début du vingtième siècle entre la nature corpusculaire et ondulatoire devient ainsi une dualité entre masse et espace. Un exemple numérique démontre par un calcul du rayon des protons que cette nouvelle théorie inclut la précédente. Lorsque l'on représente les descriptions mathématiques dans le temps et l'espace réels, en tenant entièrement compte des restrictions physiques, la gravité apparaît comme une caractéristique intrinsèque des objets de l'espace-temps. On trouve ainsi un lien entre mécanique quantique et gravité. Ces résultats sont utilisés pour obtenir une description de la matière sombre et de la particule de Higgs.

Key words: Gravity; Quantum Mechanics; Complementarity Language; Heisenberg Units; Uncertainty; Higgs Particle; Black Matter; Graviton.

I. INTRODUCTION

There has been an inextinguishable fascination for the appearance of duality and uncertainty, which was first described in early 20th century experiments of quantum mechanics. This has been carried along through the years by at least one physicist in each generation, like Heisenberg[1] (1901–1976), von Weizsäcker[2,3] (1912–2007), Jammer[4] (1915–2010), and Ford[5] (1926). In recent years their ideas were incorporated in a newly developed field of mathematics, complementary language,[6] which takes a fresh look at these apparently unapproachable mysteries and the many propositions to explain them.

The origin of the involvement of *uncertainty* lies in the quantum theory of Planck (presented in 1900), showing that a radiating atom does not lose its energy in a continuous way but in irregular pulses. This forced physicists to reformulate some laws in a statistical way and thus to leave determinism in principle, in favor of some uncertainty. It was a successful idea, giving Einstein, Bohr, and Sommerfeld the key to open the door to a complete theory of atomic physics. But again, in formulating the mathematics, it was necessary to deviate somewhat from pure determinism. In this way indeterminism entered physics, although in the course of the twentieth century many efforts were attempted to exclude it.

The origin of *duality*, the phenomenon that elementary entities can have both wave and particle properties but not at the same time, was proposed in Einstein's theory of the photon in 1905. Twenty years passed before it was recognized as a general principle of nature. It was not until Compton's work in 1923 that the duality of the photon was generally accepted. Then in 1924 De Broglie stated that a wave length for particles was the quotient of the constant of Planck and its impulse. This was validated for photons and soon after verified for electrons, neutrons, and other particles.

The deviation from determinism became more striking in the results of the double slit experiments as carried out by Clinton Davisson and Lester Germer and at the same time by George Thomson (1925–1927). In this experiment, particles emitted from a source, so weak that no more than one

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particle is on the way to a screen at any time; in the screen are two slits, separated by a small distance; the particles go through the slits, fall on a second screen, and leave a permanent mark. The density distribution of the marks after some time shows an interference pattern that is characteristic for waves. A description of these experiments was derived by Erwin Schrödinger, called wave mechanics, in which this behavior of electrons was called the wave character. It expressed the contrast with the particle character, shown when atoms passed a single slit and produced only a dot upon the screen as predicted by the laws of Newton.

For atoms exhibiting this wave character, the laws of Newton seemed to be invalid: it appeared that the atoms choose arbitrary directions during the passage of the double slit, with just some restrictions, and that the multiplication of this effect caused the ring-shaped pattern observed. With this interpretation of the experimental results, the old and the new physics came into conflict with each other. At the time an elementary particle was considered as a point like phenomenon, having a maximum spatial extension on an atomic scale. But an essential feature of a wave is that it is not localized; it is spread out over a region of space. Wave behavior, without the observable presence of a wave in whatever sense, was an uncomfortable paradigm, implying there was a fundamental conceptual problem.

In "Classical and Modern Physics" of Ford[5] a thorough historical overview can be found about the way physicists in that time tried to explain these results. But despite all efforts, the wave like interference patter upon the photographic screen could not be explained by existing laws of physics, which predicted that the major amount of particles would go straight ahead and only a minority would be dispersed by the slit. The first theory to explain the observations was the *uncertainty principle*, formulated by Heisenberg. He stated that it is principally impossible to calculate the location as well as the velocity of an atom with any desirable accuracy, because the product of their uncertainties has a lower limit. It was a successful idea and using this principle it was possible to obtain estimations for the obtained patterns and later it turned out to be a fundamental principle in physics. In this way, following the introduction of quantization by Planck, a second description of the deviation from Newtonian mathematics was found.

Einstein contributed a great deal to the development of quantum theory and his work in general was so revolutionary that its consequences reached far beyond the science from which it originated. Nevertheless, when modifying Newton's law of gravitation into the general theory of relativity, he stayed convinced that determinism was the only real fundament of physics. He strongly believed that his ideas about the coherence of geometry with a mass field would create a still more objective and deterministic foundation for physics than the laws of Newton. When he noticed from quantum-mechanical experiments that matter, space, and time were not so strict and independent as he assumed, he ascribed this to incompleteness of his theory, not to a conceptual problem.

As a first solution for the conflict between old and new physics, the idea took form that *probability* must play a role in elementary processes. It was a way to maintain the principle of determinism by taking into account that in practice, the knowledge of atomic systems is restricted. This supposed practical restriction is an essential ingredient of the probability theory, developed in the first part of the twentieth century. The focusing upon probability had many consequences, the most significant one being the lack of agreement between new concepts and previous laws. Although this intervention was a logical step and proved to be very successful in an experimental sense, it still needs correction, the more so as we know nowadays that even a single photon or electron shows a dual behavior. This means that even one electron, after going through the double slit, hits the screen in a pattern, characteristic for the wave character, and thus probability cannot be the reason for this behavior.

Einstein's gravitational theory, offering no possibility to deviate from determinism, could not be further modified to be consistent with the uncertainty principle. Thus it was impossible to combine gravity, described by this theory, with quantum-mechanical results, although independently both theories were very successful experimentally. Dozens of alternatives to the theory of general relativity have been published, but none of these succeeded in combining the two phenomena into a single unified theory. The conclusion was taken that this was caused by the enormous differences in orders of magnitude between astronomic and subatomic phenomena, but this stayed unsatisfactory. The incompatibility between relativity theory and quantum mechanics remained one of the most important unsolved problems in physics.

In this paper, we show a connection between quantum mechanics and gravity by using complementary language. Because this contains the uncertainty principle as proposed by Heisenberg from scratch, we do not have to introduce probability. In our so-called "twin physics," based on this language, the quantization of Planck is expressed by introducing an elementary amount of potential energy, called the Heisenberg unit (H-unit), possessing dualistic mathematical attributes. Interactions between H-units are theoretical items, describing all potential possibilities and by representing them in a physical space, they appear as phenomena.

The first surprise in exploring the power of this theory was the discovery that, by finding a way to identify the appearing objects, the laws of Maxwell unexpectedly emerged, fitting perfectly in the theoretical construction.[6] Thus H-units could be provided with electromagnetic attributes, including charge. Subsequently, more and more theoretical results of interactions between two H-units could be identified with known phenomena, including dark matter. The second major discovery was that by introducing a third H-unit in the interaction, devoid of any electromagnetic features, and combining it with two charged H-units, the theory acted as a unification theory for elementary particles.[7] In this paper we will show a third revelation: the possibility to describe gravity by introducing a fourth H-unit in the interaction.

The crucial conceptual change as proposed in our theory finds its origin in a different interpretation of the double slit experiments. Ford[5] is convinced that we must give up the idea that a particle goes through one slit or the other; he supposes that with both slits open, the electron wave goes through both slits at once. This points to the necessity of exploring spatial properties of electrons. Jammer[4] suggests in his historical overview of mass in 2000 that spacetime has to be considered as a source of mass in itself. He states that it is inevitable to define the mass of a body or particle, without any implicit reference to a unit of mass, by integrating dynamics into kinematics and expressing the dimension of mass in terms of length and time.

In the previous paper,[7] we followed up on this advice by expanding terms of length to terms of three-dimensional space. The enigma of how gravity can be combined with quantum mechanics is approached by introducing an alternative conception of space: instead of avoiding the confrontation with space as an independent item in physics, it is accepted as basic. This strains our powers of visualization and it is exactly this problem which we solved by developing complementary language.

Additionally, we upgraded space to an energetic object as prominent as mass: both mass and space are considered as energetic objects, generated by interacting H-units, having respectively, a high and a low energy density. There is then no reason any more to believe that our world is governed by some supreme mathematical or statistical system which goes beyond our imagination; our imagination just needs to be extended with space as an independent, energy-containing item.

Turning back to the double slit experiment, the quantum-mechanical experiment can be considered as the first one in which this space is disturbed by the slit such that the disturbance becomes detectable. Gravity is the most obvious and significant spatial effect, so we will consider this effect between two elementary particles. In the two previous papers, we did not bother if their sizes agreed with experimental facts; we just focused on general features as a control of the validity of our theory. But because the problem of combining gravity with quantum mechanics, according to Einstein, is supposed to be due to their orders of magnitude, we will first show that a proton, described by the interaction of H-units, indeed has a size in agreement with general experimental results. After that we will show that two equally charged elementary particles are subject to gravity, attracting each other in the second order of time.

II. THEORETICAL BACKGROUND

In two previous papers,[6,7] we derived a mathematical description called "complementary language," in which uncertainty is interpreted as an independent concept in nature. This method is constructed such that it is compatible with the idea of combining space and time into one continuum, as proposed by Henri Poincaré, elaborated by Hermann Minkowski and reformulated in the theory of special relativity in four dimensions by Albert Einstein in the beginning of the 20th century.

Most notable in the description is the decision to consider space as an independent entity, so not as a lack of matter. This was done by introducing the Heisenberg-unit (H-unit) as basic in nature. It is supplied with pairs of mathematical attributes, one determined and one undetermined, one of major and one of minor importance. The basic principle is their complementarity; in so doing the quantization of Planck and the uncertainty relations of Heisenberg are incorporated from scratch. These attributes are joined to so-called "genes" and the genes are linked to so-called "chromosomes." We use this nomenclature of genetics not because of its conceptual background, but because the formal structure of complementary language has a strong analogy with the language used in genetics. The chromosomes exist in two variants: as a chain of two genes (first order) and as a chain of four genes (second order).

In that way all potential possibilities of interacting H-units are stored in one expression for each order of chromosomes. Because the set of chromosomes of the first order contains eight elements and the set of chromosomes of the second order only four, we considered in the previous papers the second order, offering an accessible overview of their capacity to describe phenomena. In considering second order chromosomes it looks like these are more important in short range interaction.

A H-unit can only be observed by interacting with another one, so it is a mathematical artifact describing an elementary amount of potential energy. By interaction with another H-unit, the potential energy can convert into phenomena called "Heisenberg events" (H-events). This way of dealing with phenomena is called "twin physics" for short.

In our first paper,[6] we tried to obtain a general overview of the potency of twin physics. Attention was concentrated on the development of the mathematics and associations with well-known phenomena. In our second paper[7] the notion of time attributes was improved and the neutral H-unit was introduced. This was successfully applied to develop a basic unification of elementary particles, including features such as charge and spin. In both papers, we used only second order chromosomes.

In the current paper, the supposed feature of neutral H-units to occupy more space than charged ones turns out to be the crucial reason why masses can be subject to gravity at large distances. We found out that the second order of chromosomes is not suited for describing gravitation; this can only be described by the first order. Moreover, at least four H-units have to be involved, because for each mass at least two H-units are needed.

We are very well aware of the fact that twin physics is conceptually difficult at the first encounter, because of the new concepts of time and space, but it turns out to be understandable quit soon. The essential parts are repeated in Secs. II A–II G and adapted to the subject at hand. The derivation of the radius of a free proton is presented in Sec. III A. After that, in Sec. IV, we will consider two elementary particles at an extreme large distance, bringing them step by step closer to each other and considering the occurrence of gravity. Based upon the results, in Sec. V we develop an alternative way to describe Higgs particles.

A. The H-unit and H-event

A H-unit is an elementary amount of potential energy expressed in complementary terms. This amount of energy is considered as being a constant of nature. An H-unit can only manifest itself by interacting with another one; then potential energy can be converted into phenomena. The result of this interaction is the appearance of one or more H-events; they are physical realities like an elementary particle or an empty space.

A characteristic part of an H-event is called a *quality*. We distinguish three of them: *time, three-dimensional space,* and *mark* (mind that in our first paper time and space were considered together as one quality). Only the second and third quality are supposed to add to the energy of an H-event.

According to the Heisenberg uncertainty principle, each experimental result implies an amount of uncertainty. We incorporate this by putting each deviation from a perfectly determined quality in a separate device, being perfectly undetermined. Thus each quality has to be expressed in determinate as well as indeterminate mathematical *attributes*, in general indicated by D_i and U^i, respectively. A basic example of a determinate space attribute is a point; a basic example of an indeterminate one is a space and the combination of them describes a point with some extension. As we will show in the next section, the interaction of H-units is based upon the exchange of their attributes.

To anchor the uncertainty relations of Heisenberg in the description of this interaction, two axioms with their accompanying operators are constructed.

Axiom 1 says that the attributes contribute to any observation in pairs, one being determinate and the other indeterminate. This prevents the occurrence of perfectly determinate or perfectly indeterminate observations. To assimilate this axiom we defined the *join operator* $\triangleright\!\triangleleft$ (pronounced as "is joined with"); a joined pair of two attributes X and Y, written as $X \triangleright\!\triangleleft Y$, is defined as: attributes $X$and Y are necessarily observed together.

Axiom 2 says that a joined pair of attributes contributes to an observation such that one member is of major and the other of minor importance. This allows a difference between almost perfectly determinate and almost perfectly indeterminate features. To assimilate the second axiom, minor attributes are indicated in lower case, so a joined pair is written as $X \triangleright\!\triangleleft y$.

With these axioms and definitions, an H-unit H_i can be supplied with a set of attributes in two types for each quality, each in a major and a minor version. The determinate attributes D_i and d_i and indeterminate ones U^i and u^i are chosen such that D_i and U^i as well as d_i and u^i exclude each other and together constitute a closed major or minor system. Then each quality of H_i can be described by the set h_i of four elements

$$h_i = \{D_i, U^i, d_i, u^i\}. \tag{1}$$

For each of the three qualities time, space, and mark, a different set of these four attributes is defined, as will be explained below, resulting in the three sets $h_i(t)$, $h_i(\mathbf{x})$ and $h_i(q)$ in which $\mathbf{x}$ is three-dimensional space.

B. Interaction between two H-units

The interaction between H-units H_1 and H_2 is notated as $h_1 * h_2$. We suppose that only attributes of one and the same quality (time, space or mark) interact with each other and during the interaction genes are produced. A *gene* g is defined as a joined pair of attributes, which are assigned importance. Its two parts may be attributes of one and the same H-unit or of two different H-units. In general, with P_i being a major attribute of H_i and q_j a minor attribute of H_j, a gene can be written as

$$g = (P_i \triangleright\!\triangleleft q_j). \tag{2}$$

Genes are coupled to each other to construct chromosomes. For this purpose the *link operator* $\propto$ (pronounced as "is linked to") is introduced. The definition of $g_i \propto g_j$ is that g_i and g_j occur combined in an observation. Moreover, if $g_i \propto g_j$ then $g_j \propto g_i$; if $g_i = g_j$ then $g_i \propto g_j$ is defined as g_i. A *chromosome* c is defined as a chain of linked genes. If two genes are $g_i = P \triangleright\!\triangleleft q$ and $g_j = R \triangleright\!\triangleleft s$, then a chromosome of the first order is

$$c^1_{ij} = g_i \propto g_j = (P \triangleright\!\triangleleft q) \propto (R \triangleright\!\triangleleft s). \tag{3}$$

A chromosome of the second order is a chain of two first order chromosomes, thus containing four genes, for instance

$$\begin{aligned} c^2_{ij} = c^1_{ij} \propto c^1_{kl} &= (P \triangleright\!\triangleleft q) \propto (R \triangleright\!\triangleleft s) \\ &\propto (T \triangleright\!\triangleleft u) \propto (V \triangleright\!\triangleleft w). \end{aligned} \tag{4}$$

Because a quality cannot appear simultaneously as complete determinate D_i and completely determinate U^i, a restriction is defined in combining genes into chromosomes. This is expressed as *the exclusion principle,* saying that a gene containing a determinate major attribute of an H-unit cannot link with a gene containing an indeterminate major attribute *of the same H-unit*. The symbol $\|$ (parallel) is used to express a forbidden combination of genes. Because of this principle, chromosomes of two interacting H-units exist only in the first and the second order, so no higher orders exist.

There are two distinct possibilities to link genes to chromosomes: the genes remain unchanged during the interaction, like in $(D_1 \triangleright\!\triangleleft u^1) \propto (D_2 \triangleright\!\triangleleft u^2)$, or their minor attributes are exchanged, like in $(D_1 \triangleright\!\triangleleft u^2) \propto (D_2 \triangleright\!\triangleleft u^1)$. However, because of the exclusion principle, not all combinations are allowed. An example of a forbidden link is $(D_1 \triangleright\!\triangleleft u^1) \propto (U^1 \triangleright\!\triangleleft u^2)$, because $(D_1 \triangleright\!\triangleleft u^1) \| (U^1 \triangleright\!\triangleleft u^2)$; an example of an allowed link is $(D_2 \triangleright\!\triangleleft u^1) \propto (U^1 \triangleright\!\triangleleft u^2)$.

The *set of chromosomes of the first order*, indicated by C^1 and containing 8 elements, is

$$C^1(h_1 * h_2) = \left\{ \begin{matrix} (D_1 \triangleright\!\triangleleft u^1) \propto (D_2 \triangleright\!\triangleleft u^2), (D_1 \triangleright\!\triangleleft u^2) \propto (D_2 \triangleright\!\triangleleft u^1) \\ (U^1 \triangleright\!\triangleleft d_1) \propto (U^2 \triangleright\!\triangleleft d_2), (U^1 \triangleright\!\triangleleft d_2) \propto (U^2 \triangleright\!\triangleleft d_1) \\ (D_1 \triangleright\!\triangleleft u^1) \propto (U^2 \triangleright\!\triangleleft d_2), (D_1 \triangleright\!\triangleleft d_2) \propto (U^2 \triangleright\!\triangleleft u^1) \\ (D_2 \triangleright\!\triangleleft u^2) \propto (U^1 \triangleright\!\triangleleft d_1), (D_2 \triangleright\!\triangleleft d_1) \propto (U^1 \triangleright\!\triangleleft u^2) \end{matrix} \right\}. \tag{5}$$

In practical cases the set reduces largely.

The *set of chromosomes of the second order*, indicated by C^2, is constructed by combining the first order chromosomes above in all possible ways, which is 28. Because of the exclusion principle, 24 of them are canceled, so a set of four elements remains

$$C^2(h_1 * h_2) = \left\{ \begin{matrix} (D_1 \triangleright\triangleleft u^1) \propto (D_2 \triangleright\triangleleft u^2) \propto (D_1 \triangleright\triangleleft u^2) \propto (D_2 \triangleright\triangleleft u^1) \\ (U^1 \triangleright\triangleleft d_1) \propto (U^2 \triangleright\triangleleft d_2) \propto (U^1 \triangleright\triangleleft d_2) \propto (U^2 \triangleright\triangleleft d_1) \\ (D_1 \triangleright\triangleleft u^1) \propto (U^2 \triangleright\triangleleft d_2) \propto (D_1 \triangleright\triangleleft d_2) \propto (U^2 \triangleright\triangleleft u^1) \\ (D_2 \triangleright\triangleleft u^2) \propto (U^1 \triangleright\triangleleft d_1) \propto (D_2 \triangleright\triangleleft d_1) \propto (U^1 \triangleright\triangleleft u^2) \end{matrix} \right\}. \tag{6}$$

This set reduces in practice to a set of one or two elements. Each nonzero chromosome describes potential energy of the interacting H-units, equaling at most twice the potential energy of one H-unit.

To convert them into descriptions of phenomena, the chromosome first has to be represented in a physical timespace (the reason why time is placed before space will become clear in Sec. II F). *The representation* of a mathematical object in a physical timespace is indicated by placing it between square brackets, so the representation of one chromosome in a suitable observational timespace is $[C_n]$. Because in each gene of the chromosome the major attribute is restricted by a minor one, this is called a *small scale observation*, indicated by o_n (mind that in the previous papers this was called complemental observation Ω_n). An example of a small scale observation for the set of chromosomes (5) is

$$[C_1^1] = o_1 = [(D_1 \triangleright\triangleleft u^1) \propto (D_2 \triangleright\triangleleft u^2)]. \tag{7}$$

Then the *small scale set o* is the set of n complementary observations of interacting H-units

$$o_1 = \{o_1, o_2, o_3, ..., o_n\}. \tag{8}$$

To be able to describe a phenomenon fully, we have to involve the unrestricted major attributes. For that reason a *large scale observation* (previously called classical observation), indicated by O_n, is defined as the limit of a small scale observation if the influence of the minor attributes is infinitely reduced, so it contains only major attributes. For instance the large scale observation belonging to the small scale observation (7) is

$$O_1 = [D_1 \propto D_2]. \tag{9}$$

All large scale observations generated by two interacting H-units are collected in the *large scale set O* as

$$O = \{O_1, O_2, O_3, ..., O_n\}. \tag{10}$$

The small scale element o_n is considered as an addition to the large scale one O_n, softening its extreme character. To connect both types of observations with each other, a *zip* z_n is defined as the set of a small scale observation and the belonging large scale one, so

$$z_n = \{O_n, o_n\}. \tag{11}$$

A zip combines a classical observation with the influence of quantum-mechanical results; both observations occur simultaneously.

A *zipper* $Z(h_1 * h_2)$ is defined as the set of all zips of one order, so

$$Z(h_1 * h_2) = \{z_1, z_2, ..., z_n\} = \{\{O_1, o_1\}, \{O_2, o_2\}, ..., \{O_n, o_n\}\}. \tag{12}$$

Distinct zips cannot be observed simultaneously. The zipper is an intermediate step between mathematics and physics. All mathematical information about possible observations is collected, ready to convert into real physical items, but due to additional physical requirements, not each zip can appear.

The *zipper of the first order* is a set of eight elements, derived from the set of first order chromosomes (see Eq. (5)) and containing 8 zips, so

$$Z^1(h_1 * h_2) = \{z_1, z_2, z_3, z_4, z_5, z_6, z_7, z_8\}, \tag{13}$$

each element having a large scale observation written at the left and a small scale observation at the right, so

$$Z^1(h_1 * h_2) = \left\{ \begin{matrix} \{[D_1 \propto D_2], [(D_1 \triangleright\triangleleft u^1) \propto (D_2 \triangleright\triangleleft u^2)]\}, \{[D_1 \propto D_2], [(D_1 \triangleright\triangleleft u^2) \propto (D_2 \triangleright\triangleleft u^1)]\} \\ \{[U^1 \propto U^2], [(U^1 \triangleright\triangleleft d_1) \propto (U^2 \triangleright\triangleleft d_2)]\}, \{[U^1 \propto U^2], [(U^1 \triangleright\triangleleft d_2) \propto (U^2 \triangleright\triangleleft d_1)]\} \\ \{[D_1 \propto U^2], [(D_1 \triangleright\triangleleft u^1) \propto (U^2 \triangleright\triangleleft d_2)]\}, \{[D_1 \propto U^2], [(D_1 \triangleright\triangleleft d_2) \propto (U^2 \triangleright\triangleleft u^1)]\} \\ \{[D_2 \propto U^1], [(D_2 \triangleright\triangleleft u^2) \propto (U^1 \triangleright\triangleleft d_1)]\}, \{[D_2 \propto U^1], [(D_2 \triangleright\triangleleft d_1) \propto (U^1 \triangleright\triangleleft u^2)]\} \end{matrix} \right\}. \tag{14}$$

The *zipper of the second order* is a set of four elements derived from the set of second order chromosomes (see Eq. (6)) containing 4 zips, so

$$Z^2(h_1 * h_2) = \{z_1, z_2, z_3, z_4\}, \tag{15}$$

again each element having a large scale observation written at the left and a small scale observation at the right, so

$$Z^2(h_1 * h_2) = \left\{ \begin{matrix} \{[D_1 \propto D_2], [(D_1 \triangleright\triangleleft u^1) \propto (D_2 \triangleright\triangleleft u^2) \propto (D_1 \triangleright\triangleleft u^2) \propto (D_2 \triangleright\triangleleft u^1)]\} \\ \{[U^1 \propto U^2], [(U^1 \triangleright\triangleleft d_1) \propto (U^2 \triangleright\triangleleft d_2) \propto (U^1 \triangleright\triangleleft d_2) \propto (U^2 \triangleright\triangleleft d_1)]\} \\ \{[D_1 \propto U^2], [(D_1 \triangleright\triangleleft u^1) \propto (U^2 \triangleright\triangleleft d_2) \propto (D_1 \triangleright\triangleleft d_2) \propto (U^2 \triangleright\triangleleft u^1)]\} \\ \{[D_2 \propto U^1], [(D_2 \triangleright\triangleleft u^2) \propto (U^1 \triangleright\triangleleft d_1) \propto (D_2 \triangleright\triangleleft d_1) \propto (U^1 \triangleright\triangleleft u^2)]\} \end{matrix} \right\}. \tag{16}$$

The indication of interaction $h_1 * h_2$ will be dropped in the following. The two zippers above are the heart of the twin theory: they collect each and every phenomenon in the universe which is generated by two H-units. Although a zipper might look terribly complex, in actual cases most of the elements are empty; up till now we have found no more than two nonempty elements per zipper.

Now we are ready to define a Heisenberg-event, written as H-event as the appearance of a zip in real time and space, so as a physical reality. This is our ultimate goal. Before being able to describe an H-event in physical known terms, we have to express the zipper for each of the three qualities time, space, and mark in suitable terms. This is executed for time and space in Secs. II C–II D and combined into one expression in Sec. II F.

C. Attributes of time and two time zippers

The attributes of the three qualities "time," "space," and "mark" may in principle be chosen freely, with the restriction that four attributes are required to describe one quality, of which two being of major and two of minor importance; moreover both of these two pairs have to be complementary, so they exclude each other and together constitute a system which is completely covered. These restrictions leave few possibilities, so for this reason we used imaginary time attributes in the first paper[6] as a first step; but in the second paper[7] we succeeded in defining a complete set of real time attributes.

Although some attributes of time and space differ considerably from the usual concepts of time and space, the classical concepts are encompassed in it. Some minor attributes add to our imaginative faculty, which makes it easier to get acquainted with them.

The four attributes of the quality "time" are

$$D_i(t) = T_i, U^i(t) = F^i \backslash T_i, d_i(t) = \tau_i, u^i(t) = f^i, \tag{17}$$

so the set of time attributes $h_i(t)$ belonging to H-unit H_i is (see Eq. (1))

$$h_i(t) = \{T_i, F^i \backslash T_i, \tau_i, f^i\}. \tag{18}$$

They are called "major point of time," "future," "minor point of time," and "flying time," respectively. *Major point of time* T_i is the first point of a deliberately large interval of time; it can be identified with "mathematical presence." *Future* $F^i \backslash T_i$ is the remaining part of the time axis; it can be identified with "mathematical future". The interval F^i is called the "full time" being arbitrarily large, with

$$F^i = \{t | T_i \leq t < T_e\}, \tag{19}$$

in which T_e is an end-point, excluded from F^i and large enough to stay out of reach during the considered time span. *Flying time* f^i is a small part of the future immediately after T_i, defined as

$$f^i = \{t | T_i \leq t < t_i\}. \tag{20}$$

It is identified with the "physical presence" in accordance with the daily observation that the present for an individual is not a point of the time axis but an interval. If flying time is represented in real time, as belonging to an observation, it is impossible to find an exact point of time within this interval. *Minor point of time* τ_i is defined by

$$\tau_i = \{t | t_i \leq t \leq t_i + dt_i\}. \tag{21}$$

This is an infinitesimally small interval at the upper border of the flying time, considered as the "physical change" of the first order. It is identified as a differential of time related to a speed. The remaining part of the full time, excluding f^i and τ_i, is identified with the "physical future."

Note that during the interaction, major point of time T_i moves forward over the time axis, but it always stays the first point of the considered time interval F^i, moving together with it. Note also that the past, containing all points of time t with $t < T_i$, is not observable, so it is no part of the set of time attributes.

We suppose that all H-units in consideration have congruent time attributes, so two H-units H_1 and H_2 have equal lengths of f^i, τ_i, and F^i. They differ only in the relative position of T_1 and T_2, so their interaction concerning time is determined by their major points of time and the other attributes will have the same shift. In general we choose $T_2 \geq T_1$.

Then there exist *four distinct time cases*:

- In time case 1 the attributes are fully identical, so $T_1 = T_2$.
- In time case 2 they are slightly shifted with respect to each other, such that the major point of one H-unit is part of the immediate future of the other, so $T_2 \in f^1$.
- In time case 3 the major point of one H-unit is part of the minor point of the other, so $T_2 \in \tau_1$.
- In time case 4 they are largely shifted with respect to each other, so $T_2 > t_1 + dt_1$.

Each time case, combined with a space case, leads to the appearance of specific H-events. In this paper we use only time cases 1 and 2; in time case 2 we use the additional restriction that they are only slightly shifted, so $T_2 - T_1 \ll f^1$.

The belonging zippers can be found by inserting the time attributes in Eq. (14) or Eq. (16), using the following definitions for joining and linking:

Joining of time attributes to time genes, *if major points are involved*, is defined as

$$\begin{aligned} &T_i \bowtie f^j = f^j \text{ if } T_i \in f^j; \quad T_i \bowtie f^j = \varnothing \text{ if } T_i \notin f^j, \\ &T_i \bowtie \tau_j = \tau_j \text{ if } T_i \in \tau_j; \quad T_i \bowtie \tau_j = \varnothing \text{ if } T_i \notin \tau_j, \end{aligned} \tag{22}$$

and if major futures are involved:

$$\begin{aligned} &F^i \bowtie \tau_j = \tau_j \text{ if } \tau_j \subset F^i; \quad F^i \bowtie \tau_j = \varnothing \text{ if } \tau_j \not\subset F^i, \\ &F^i \bowtie f^j = f^j \text{ if } f^j \subset F^i; \quad F^i \bowtie f^j = \varnothing \text{ if } f^j \not\subset F^i, \end{aligned} \tag{23}$$

in which $\varnothing$ indicates an empty set.

Linking of time genes is defined as taking the intersection of the constituting genes, so

$$g_i \propto g_j = g_i \cap g_j \tag{24}$$

Then the *time zipper of the first order in time case 2* ($T_2 \in f^1$ and $T_2 - T_1 \ll f^1$) is obtained by inserting the time attributes of H_1 and H_2 in Eq. (14), resulting in the set of eight elements

$$Z^1(t) = \left\{ \begin{matrix} \{\varnothing, f^1 \cap f^2\}, \{\varnothing, \varnothing\}, \{F^2\backslash T_2, \tau_1 \cap \tau_2\}, \{F^2\backslash T_2, \tau_1 \cap \tau_2\}, \\ \{\varnothing, \varnothing\}, \{\varnothing, \varnothing\}, \{T_2, f^2 \cap \tau_1\}, \{T_2, \varnothing\} \end{matrix} \right\}, \tag{25}$$

in which the element $F^1\backslash T_1 \cap F^2\backslash T_2$ is simplified to $F^2\backslash T_2$. Dropping empty elements and one double element, this reduces to

$$Z^1(t) = \{z_1, z_3, z_7, z_8\} = \left\{ \begin{matrix} \{\varnothing, f^1 \cap f^2\}, \{F^2\backslash T_2, \tau_1 \cap \tau_2\}, \\ \{T_2, f^2 \cap \tau_1\}, \{T_2, \varnothing\} \end{matrix} \right\}. \tag{26}$$

The *time zipper of the second order in time case 1* ($T_1 = T_2$) is obtained by inserting the time attributes of H_1 and H_2 in Eq. (16), resulting in a set with four elements, two of them being empty, so this reduces to the set with two elements

$$Z^2(t) = \{z_1, z_2\} = \{\{T, f\}, \{F\backslash T, \tau\}\}. \tag{27}$$

Representing the zips in an observable space is defined as taking the expression itself. By carrying out this operation, a mathematical point or interval of time is converted into a real point or interval of time.

D. Attributes of space and two space zippers

The four attributes of the quality "space" are

$$D_i(\mathbf{x}) = P_i, U^i(\mathbf{x}) = S^i\backslash P_i, d_i(\mathbf{x}) = p_i, u^i(\mathbf{x}) = s^i, \tag{28}$$

so the set of space attributes h_i belonging to H-unit H_i is

$$h_i(\mathbf{x}) = \{P_i, S^i\backslash P_i, p_i, s^i\}. \tag{29}$$

They are called major point of space, major space, pellicle and minor space, respectively.

Major point of space P_i is a point with zero extension. Major space $S^i\backslash P_i$ is a finite sphere with central point P_i, having a radius R chosen arbitrarily large but not infinite, its outer border as well as its central point excluded. *Minor space* s^i is the inner space of a sphere around P_i with $r \ll R$, including the central point. *Pellicle* p_i is a two-dimensional mathematical object, spread out over the surface of s^i like the skin of an apple, having a thickness dr with $dr \ll r$.

We suppose that all H-units in consideration have congruent space attributes, so two H-units H_1 and H_2 having equal radii of minor and major space and equal pellicle width. They differ only in the relative position of P_1 and P_2, so their interaction concerning space is determined only by the two major points of space. Considerably more space cases than time cases exist; for two interacting charged H-units we used eight of them and left one out of consideration. By involving the quality "mark" even more cases exist, as will be explained in Sec. II E. Each space case, combined with a time case, leads to the appearance of specific H-events.

The belonging zippers can be found by inserting the time attributes in Eq. (14) or Eq. (16) using the following *definitions for joining and linking*, analogous to those for time attributes.

The joining of space attributes to space genes is defined, *if major points are involved*, as

$$\begin{matrix} P_i \rhd\lhd s^j = s^j \text{ if } P_i \in s^j; \quad P_i \rhd\lhd s^j = \varnothing \text{ if } P_i \notin s^j, \\ P_i \rhd\lhd p_j = p_j \text{ if } P_i \in p_j; \quad P_i \rhd\lhd p_j = \varnothing \text{ if } P_i \notin p_j, \end{matrix} \tag{30}$$

and if major spaces are involved,

$$\begin{matrix} S^i \rhd\lhd p_j = p_j \text{ if } p_j \subset S^i; \quad S^i \rhd\lhd p_j = \varnothing \text{ if } p_j \not\subset S^i, \\ S^i \rhd\lhd s^j = s^j \text{ if } s^j \subset S^i; \quad S^i \rhd\lhd s^j = \varnothing \text{ if } s^j \not\subset S^i. \end{matrix} \tag{31}$$

Linking of space genes is defined as taking their intersection, so

$$g_i \propto g_j = g_i \cap g_j. \tag{32}$$

The easiest way to find the space zipper is to take the general one in the desired order (the first or the second) and find for each separate space case a simplification, depending on the geometrical situation. Although the zippers look at first glance somewhat threatening, in practice they reduce considerably.

The *space zipper of the first order*, $Z^1(\mathbf{x})$, is obtained by inserting the attributes of time in Eq. (14), resulting in the set of eight elements

$$Z^1(\mathbf{x}) = \left\{ \begin{matrix} \{P_1 \cap P_2, s^1 \cap s^2\}, \{P_1 \cap P_2, (P_1 \rhd\lhd s^2) \cap (P_2 \rhd\lhd s^1)\} \\ \{(S^1\backslash P_1) \cap (S^2\backslash P_2), p_1 \cap p_2\}, \{(S^1\backslash P_1) \cap (S^2\backslash P_2), ((S^1\backslash P_1) \rhd\lhd p_2) \cap ((S^2\backslash P_2) \rhd\lhd p_1)\} \\ \{P_1 \cap (S^2\backslash P_2), s^1 \cap p_2\}, \{P_1 \cap (S^2\backslash P_2), (P_1 \rhd\lhd p_2) \cap ((S^2\backslash P_2) \rhd\lhd s^1)\} \\ \{P_2 \cap (S^1\backslash P_1), s^2 \cap p_1\}, \{P_2 \cap (S^1\backslash P_1), (P_2 \rhd\lhd p_1) \cap ((S^1\backslash P_1) \rhd\lhd s^2)\} \end{matrix} \right\}. \tag{33}$$

The *space zipper of the second order*, $Z^2(\mathbf{x})$, is obtained by inserting the attributes of time in Eq. (16), resulting in the set of four elements

$$Z^2(\mathbf{x}) = \left\{ \begin{array}{l} \{P_1 \cap P_2, s^1 \cap s^2 \cap (P_1 \bowtie s^2) \cap (P_2 \bowtie s^1)\} \\ \{S \backslash \{P_1, P_2\}, p_1 \cap p_2\} \\ \{P_1 \cap (S^2 \backslash P_2), s^1 \cap p_2 \cap (P_1 \bowtie p_2)\} \\ \{P_2 \cap (S^1 \backslash P_1), s^2 \cap p_1 \cap (P_2 \bowtie p_1)\} \end{array} \right\}. \quad (34)$$

Representing zips in an observable space is, as for time chromosomes, defined as taking the expression itself, i.e., taking the same space object in a three-dimensional real space.

E. The quality mark

In this paper we do not consider the third quality "mark" explicitly, because this would complicate the formulations considerably without a strict necessity. Its attributes contain:[6,7] a *charge* Q coupled to major point P_i, *electric field* $\mathbf{E}_i$, and *magnetic field* $\mathbf{B}^i$, coupled to spaces, as well as *the operator attributes* ∇ and $\partial/\partial t$. Representing mark zips in an observable space is defined as taking the described fields in timespace. The addition of mark attributes will be suppressed in the following zippers.

Gravity seems to have nothing to do with electromagnetism, so it seems logic to drop this quality. However, the difference between charged and neutral H-units, devoid of any electromagnetic feature, facilitates the generation of gravity in a very sneaky way. To distinguish charged and neutral H-units, we call an H-unit with nonempty mark attributes a *"charged H-unit,"* indicated by H_i and an H-unit with empty attributes a *neutral H-unit*, indicated by H_{oi}. Because by definition the potential energy of an H-unit is a constant of nature, the potential energy which H_i uses to mark its own spatial features, has to be allocated by H_{oi} to its space attributes. This storage of potential energy can in principle occur in two different ways: such that the energy densities of its spaces are equal to, or such that they are equally large as those of charged H-units, but having a higher density. As a first step we suppose that *the potential energy densities of space attributes are constants of nature*. Thus the "superfluous" potential energy of H_{oi} can only be stored as enlarged spatial attributes. We assume in the following that they are such that $S^{0i} \gg S^i$ and $s^{0i} \gg s^i$.

F. Timespace zippers

The set of time attributes (18) and the set of space attributes (29) can be combined to one expression: the set of time and space attributes of H_i, written as

$$h_i(t, \mathbf{x}) = \{\{T_i, P_i\}, \{F^i \backslash T_i, S^i \backslash P_i\}, \{\tau_i, p_i\}, \{f^i, s^i\}\}. \quad (35)$$

Now it becomes clear why the time attribute is taken as the first one: As soon as time and space are considered as a four-dimensional continuum, four-dimensional objects might lose a dimension when intersecting each other, and because the quality "time" is considered as the first deciding quality of an observation, it must be the last one to disappear. Thus time elements are placed in the zero position and space elements in positions 1, 2, and 3; consequently we use the expression *timespace instead of spacetime*.

In accordance with Eq. (35), a time zipper can be combined with a space zipper into a timespace zipper. We will use in this paper only the two timespace zippers below: one of the first order in time case 2 and one of the second order in time case 1. For the first one we combine Eq. (26) with Eq. (33) and obtain the timespace zipper of the first order $Z^1(t, \mathbf{x})$ in time case 2 for small shift (so $T_2 \in f^1$ and $T_2 - T_1 \ll f^1$) as a set of four elements $\{z_1^1, z_3^1, z_7^1, z_8^1\}$, described as

$$Z^1(t, \mathbf{x}) = \left\{ \begin{array}{l} \{\{\varnothing, P_1 \cap P_2\}, \{f^1 \cap f^2, s^1 \cap s^2\}\} \\ \{\{F^2 \backslash T_2, (S^1 \backslash P_1) \cap (S^2 \backslash P_2)\}, \{\tau_1 \cap \tau_2, p_1 \cap p_2\}\} \\ \{\{T_2, P_2 \cap (S^1 \backslash P_1)\}, \{f^2 \cap \tau_1, s^2 \cap p_1\}\} \\ \{\{T_2, P_2 \cap (S^1 \backslash P_1)\}, \{\varnothing, (P_2 \bowtie p_1) \cap ((S^1 \backslash P_1) \bowtie s^2)\}\} \end{array} \right\}. \quad (36)$$

The second timespace zipper which will be used is a zipper of the second order in time case 1, so for $T_1 = T_2 = T$. In that case the other time attributes are identical as well, so $\tau_1 = \tau_2 = \tau, f^1 = f^2 = f$, and $F^1 = F^2 = F$. The sets (27) and (34) are combined and we obtain *the timespace zipper of the second order in time case 1* as the set of two elements $\{z_1^2, z_2^2\}$, written as

$$Z^2(t, \mathbf{x}) = \left\{ \begin{array}{l} \{\{T, P_1 \cap P_2\}, \{f, s^1 \cap s^2 \cap (P_1 \bowtie s^2) \cap (P_2 \bowtie s^1)\}\} \\ \{\{F \backslash T, S \backslash \{P_1, P_2\}\}, \{\tau, p_1 \cap p_2\}\} \end{array} \right\}. \quad (37)$$

The zippers above describe distinct ways in which two H-units convert their potential energy into phenomena by interacting; the zips cannot appear simultaneously. Each zip contains two elements: the left one is on a large scale, containing only major attributes; the right one is on a small scale, containing minor attributes and eventually also major attributes. The large and small scale parts of one zip are observed simultaneously.

Because a zipper collects all mathematically described observations, without distinguishing whether they really can happen, we need one step more to reach reality:

The *appearance* $A(z_i)$ of zip z_i is defined as an interpretation of the two simultaneous observed elements O_i and o_i in physical reality, describing one or more H-events. The *set of appearances* $A(Z)$ is defined as the set, containing one interpretation of each zip, so

$$A(Z(t,\mathbf{x})) = \{A(z_1), A(z_2), ..., A(z_n)\}. \quad (38)$$

It is the collection of H-events, generated as a result of an interaction between two H-units. One or more elements may be empty; until now we did not find sets with more than two nonempty appearances. If two H-events are generated, we suppose that they are compatible with each other; moreover, we suppose that each of the events contains the same amount of energy.

The reason that the appearance of a nonempty zip can be empty is because of physical restrictions. For instance the time element of an observation is too small for the corresponding geometrical object to appear, or elements of small and large scale in one zip have no coinciding timespace points. In these cases the geometrical object will be removed or reduced. This operation is called the *reduction of a time or space chromosome,* indicated by placing the element between broken brackets $\langle\rangle$.

If a ring-shaped intersection of pellicles $p_1 \cap p_2$ occurs in a zipper, it always has to be reduced because this is a nonsingular object.[6] Its appearance is supposed to be a spherical minor particle inside the ring, having a diameter equal to its width and a rest mass equal to the total spatial energy of the pellicle ring.

G. The concepts of mass and space

Previously,[7] we defined mass as the appearance of a four-dimensional timespace object, describing elementary particles. However, if we want to consider a mass as being an object comparable with a space, we need a further reaching distinction. If both mass and space are considered as being generated by interacting H-units, than both have to be considered as the appearances of energetic timespace objects.

Because it is an experimental fact that mass has some extension, we introduce the combined expression *energetic space* for any appearing timespace object. Then the most striking difference between the appearance of mass and that of space is in the concentration of energy: In mass, the energy exists at an extremely high concentration, whereas in space, the energy concentration is so low that until now it is considered as zero. We suppose that the conversion of potential energy into phenomena occurs in a complementary way, as a contraction or as an expansion, which seems to be a natural step in a theory based upon complementarities.

If the rest energy of a mass-carrying particle is supposed to be homogeneously distributed over the occupied space region, we define the quantity *energy density of mass,* indicated by ρ_m, as

$$\rho_m = m_0 \times \frac{c^2}{V_{m_0}}, \quad (39)$$

in which m_0 is the rest mass of the particle, c is the velocity of light, and V_{m_0} is the volume of the particle. A space appearing in one and the same zipper as a mass, is supposed to carry the same amount of energy as the mass. Mind that, as well as in experiments as in our theory, they cannot be observed simultaneously. If we suppose this energy to be homogeneously distributed over the occupied volume, we define the quantity *energy density of space,* indicated by ρ_s, as

$$\rho_S = m_0 \times \frac{c^2}{V_S}, \quad (40)$$

in which V_S is the volume of the space. As a first approximation we assume that both magnitudes are constants; of course is $\rho_m >> \rho_S$.

With these definitions we can expand our previous definition of mass[7] as follows.

Mass is the appearance of a timespace object with high energy density, also called *compact space* and space is the appearance of a timespace object with low energy density, called *extended space*. In case the set of appearances contains only a space, without an accompanying particle, this is called a *free space*. Thus, in general, the timespace appearance of an H-event maybe a compact, an extended or a free space. In this way the uncomfortable duality between particle character and wave character in the famous quantum-mechanical experiments in the first part of the 20th century is changed into the distinction between compact space and extended space, which for convenience may be expressed in the classical terms mass and space.

We repeat the previously[7] introduced names for three types of compact spaces, distinguished by their spatial object. The first one is *major particle* σ, which is the appearance of the intersection of minor spaces $s^1 \cap s^2$. The second one is *minor particle* π, appearing in the intersection of pellicles $p_1 \cap p_2$. The third one is *dot particle* δ, being the appearance of intersection $s^2 \cap p_1$. We also introduced the massless point particle Π, having no spatial extension. This nomenclature will be expanded by two types of extended space. The first is *major extended space,* indicated by Θ, being the appearance of (a part of) a major space. The second is *minor extended space* indicated by θ, being the appearance of (a part of) a minor space. Moreover two types of free space are introduced, appearing in a set without any particles: The first is *major free space* is indicated by Θ^0; the second is *minor free space* indicated by θ^0.

III. THE CONNECTION BETWEEN THEORY AND REALITY

Having presented above twin physics based upon complementary language, such that relevant zippers are at hand, we have to take one more step before investigating the possibility to describe gravity. In our previous work, we mostly did not verify appearances identified with elementary particles numerically; only an estimation of the velocity of neutrinos was derived, being in agreement with experimental results. Because gravity is a macroscopic effect which we want to approach from the subatomic side, we want to know if a proton, in twin physics described as a major particle, indeed has the size as experimentally determined. So we will calculate the radius of a free proton by interpreting a relevant zipper and using the experimentally determined mass of the proton, the constant of Planck and the speed of light.

A. The radius of a proton

A proton is identified[7] as the appearance of a zipper in the second order in time case 1 and space case 2, indicated as timespace case (1, 2). In that case the time attributes of both H-units are identical. The space attributes are such that both major points exist inside the overlapping minor codomain, so $r_1 = r_2 = r$ and $0 < P_{12} < r$ and thus the shape of the proton is slightly nonspherical. The H-units are supposed to have equal and positive charge. The second order timespace zipper in timespace case (1, 2) is obtained by inserting the geometric features in Eq. (37), resulting in

$$Z^2(t,\mathbf{x}) = \{z_1^2, z_2^2\} = \left\{ \begin{array}{l} \{\{T,\varnothing\},\{f, s^1 \cap s^2\}\} \\ \{\{F\backslash T, S\},\{\tau, p_1 \cap p_2\}\} \end{array} \right\}. \quad (41)$$

The set of timespace appearances has two elements

$$\begin{aligned} A\left(Z^2(t,\mathbf{x})\right) &= \left\{A\left(z_1^2\right), A\left(z_2^2\right)\right\} \\ &= \left\{\sigma\left(f, s^1 \cap s^2\right), \pi(\tau, p_1 \cap p_2)\right\}, \end{aligned} \quad (42)$$

written in short, with only geometrical indications, as

$$A\left(Z^2(t,\mathbf{x})\right) = \left\{\sigma_{s^1 \cap s^2}, \pi_{p_1 \cap p_2}\right\}. \quad (43)$$

Major particle $\sigma_{s^1 \cap s^2}$ with volume $s^1 \cap s^2$ appears, according to Eq. (42), in the flying time f. After this, in minor point of time τ, minor particle $\pi_{p_1 \cap p_2}$ appears in the pellicle intersection around the particle surface. It has a spherical shape with diameter equal to the pellicle width. In the marked timespace zipper,[7] which is not represented here, it can be seen that $\sigma_{s^1 \cap s^2}$ has a charge and $\pi_{p_1 \cap p_2}$ is neutral. These two appearances cannot be observed simultaneously because they originate from distinct zips. In agreement with that, they are observed in two parts of the time axis which follow up each other: f and τ.

Distinct appearances of one zipper are supposed to have the same energetic content, so

$$E(\sigma_{s^1 \cap s^2}) = E\left(\pi_{p_1 \cap p_2}\right), \quad (44)$$

in which E is energy. Assuming that the major particle has a relatively low velocity $\mathbf{v}_\sigma$ with respect to the velocity of light, we take its energy as equal to its rest mass. The minor particle has to compensate its much lower mass by moving through the pellicle with a high velocity $\mathbf{v}_\pi$, such that

$$m_\sigma \times c^2 = m_\pi \times c^2 \times \left(1 - \frac{\mathbf{v}_\pi^2}{c^2}\right)^{-\frac{1}{2}}, \quad (45)$$

in which m_σ and m_π are the rest masses, $\mathbf{v}_\pi$ is the velocity of π, and c is the velocity of light.

Even if we choose for the radius of π, being half the width of the pellicle, half of the radius R of the minor space (which is much larger than expected for a pellicle), $\mathbf{v}_\pi$ is very close to c. This can be shown by approximating the geometrical object of σ, which is $s^1 \cap s^2$, by a perfect sphere with radius R. In that case is

$$m_\sigma = \frac{4}{3}\pi \times R^3 \times \rho_m, \quad (46)$$

and

$$m_\pi = \frac{4}{3}\pi \times \left(\frac{1}{2}R\right)^3 \times \rho_m. \quad (47)$$

In these equalities we suppose that they have equal mass densities (the use of π for a minor particle as well as a mathematical number is potentially confusing, but it only occurs here). Thus m_σ is 8 times as large as m_π, implying that $\mathbf{v}_\pi$ differs by less than 0.01% from c.

Now we make a connection between the particle–wave duality and the mass–space duality of the proton by considering the appearance of the minor particle, moving through the circular pellicle intersection with almost the speed of light, as coinciding with the wave character. The well-known energy balance between particle and wave is

$$m_\sigma \times c^2 = h \times \upsilon_1, \quad (48)$$

in which m_σ is the rest mass of the proton, h is the constant of Planck and υ_1 is the frequency.

We translate this to complementary language by choosing $\upsilon_1 = (1/f)$ with f being the flying time of the interacting H-units. There is no other attribute of the H-units which could possibly represent a frequency; remember that it is the interval of time in which no distinct observations are possible. The lapse of f after an event before a second event can be observed, like the repetition of a wave, is considered as the minimum condition for a stable observation. This does not imply that the turning frequency υ_2 of the other particle, minor particle π, also equals f. It only has to be such that the observation upon the pellicle ring is repeatedly observed at one or more positions on the ring. Thus it might travel in a lower frequency, such that subsequently the same spots are observed, according to the contour of a ring. Thus the requirement for υ_2 is

$$\upsilon_2 = \frac{\upsilon_1}{n}, \quad (49)$$

with n being an integer. Because velocity $\mathbf{v}_\pi$ of minor particle π equals the circumference of the pellicle times its frequency, we can write

$$\mathbf{v}_\pi = 2\pi \times R \times \upsilon_2, \quad (50)$$

with R being the radius of the pellicle. Because $\mathbf{v}_\pi$ differs by less than 0.01% from c, this can be approximated by $c = 2\pi \times R \times \upsilon_2$ so $\upsilon_2 = 2\pi \times R/c$ and Eq. (49) can be written as

$$\upsilon_1 = n \times \upsilon_2 = \frac{n \times c}{2\pi \times R}. \quad (51)$$

Thus the energy balance Eq. (45) can be written as

$$m_\sigma \times c^2 = \frac{h \times n \times c}{2\pi \times R}, \quad (52)$$

so

$$R = n \times \frac{h}{2\pi \times c} \times \frac{1}{m_\sigma} = n \times \frac{\hbar}{c} \times \frac{1}{m_\sigma}. \quad (53)$$

In this expression for the radius of the proton, the two sides of its dual character represented by its mass and its velocity, meet each other: On the one hand the mass m_σ has to spread out over the minor space $s^1 \cap s^2$, approximated by a sphere with radius R; on the other hand, this radius must be n times a number which combines h and c, two constants of nature, the first being related to astronomic and the second to subatomic observations. The remaining question concerns the magnitude of the integer n. It turns out when choosing $n = 4$ and substituting the constants of nature $\hbar = 1.05 \times 10^{-34}$ Js and $c = 3.00 \times 10^8$ m/s and taking $m_\sigma = 1.67 \times 10^{-27}$ kg, the radius of the proton is

$$R = 4 \times \frac{\hbar}{c} \times \frac{1}{m_\sigma} = 0.84 \times 10^{-15}\,\text{m}, \quad (54)$$

in agreement with experimental results. We do not know if particles with other values of n also exist in nature; this is left for future research.

This result tells us that a free proton, described by twin physics, indeed has a subatomic size similar to the experimentally known value. We consider this result for the moment as enough indication that our theory is capable of describing gravity at a subatomic level, if it exists.

IV. GRAVITY

In this section, we will consider two equally charged major particles and show that they attract each other in the second order of time, according to our theory. Each of them is generated by the interaction of two H-units, so at least four H-units must be involved. We only consider *zippers of the first order*, because no zips of the second order could be identified with gravity. The quality "mark" is not described; however, we have to keep in mind that spatial attributes of neutral H-units are supposed to be much larger than those of charged H-units. For the moment we assume (see Sec. II E) that they are such that $S^{0i} \gg S^i$ and $s^{0i} \gg s^i$, sufficiently large for the considered cases. We only will use these zippers in *time case 2 with slightly shifted time axes* (see Eq. (36)). Then $T_2 \in f^1$ such that the intersection of differential $\tau_1 \cap \tau_2$ is nonempty and small enough to be considered as the second differential of time, so $T_2 - T_1 \ll f^1$.

To introduce the possibility of mutual attraction at a large distance, thinking in terms of H-units, we have to involve at least one neutral H-unit out of the four. To keep our considerations as symmetrically as possible, we suppose that *both major particles are generated by the interaction of one neutral H-unit* (H_{0i}) *and one charged H-unit* (H_i).

For the two subatomic particles we choose major particles σ_i and σ_j with masses m_i and m_j, generated by the interaction of neutral H-unit H_{0i} with charged H-unit H_i, and by H_{0j} and H_j, respectively. For each pair we assume that the minor space of the smallest H-unit exists completely inside that of the largest, so $s^i \subset s^{0i}$ and $s^j \subset s^{0j}$, which implies that the geometries of the generated particles are perfect spheres. We consider only the case that their major points do not coincide, so $P_{0i} \cap P_i = \varnothing$ and $P_{0j} \cap P_j = \varnothing$; however, the results for coinciding major points are the same. First, we consider the two particles at an extremely large distance, such that the constitutive H-units have no overlapping major spaces. Subsequently we consider them closer to each other in each following section, Secs. IV A through IV D, step by step involving more overlapping attributes of space.

A. Extremely large distance

The particles are supposed to exist so far from each other that even the major spaces of their constituent neutral H-units do not intersect; thus their distance is larger than twice the radius of a neutral major space. To describe σ_i we insert $H_1 = H_{0i}$ and $H_2 = H_i$ in timespace zipper (36). Because the major point exists inside s^{0i} without touching the large pellicle, $P_{0i} \in s^i$ and $s^i \subset s^{0i}$, so the timespace zipper $Z^1(t, \mathbf{x}) = \{z_1^1, z_3^1, z_7^1, z_8^1\}$ for H_{0i} and H_i (see Eq. (36)), describing the generation of a particle, reduces to

$$Z^1(t,\mathbf{x}) = \left\{ \begin{array}{l} \{\{\varnothing,\varnothing\},\{f^{0i}\cap f^i, s^i\}\} \\ \{\{F^i\backslash T_i, (S^{0i}\backslash P_{0i})\cap(S^i\backslash P_i)\},\{\tau_{0i}\cap\tau_i,\varnothing\}\} \\ \{\{T_i,P_i\},\{f^i\cap\tau_{0i},\varnothing\}\} \\ \{\{T_i,P_i\},\{\varnothing,\varnothing\}\} \end{array} \right\}. \quad (55)$$

Considering zip z_1^1: the large scale observation (which is the left part) is empty; the small scale observation (the right part) is a spherical sphere s^i in the interval of time $f^{0i} \cap f^i$. Dropping the empty part, the zip can be written as

$$z_1^1 = \{f^{0i} \cap f^i, s^i\}. \quad (56)$$

Considering the time attributes of zip z_3^1: in the large scale part the future $F^i \backslash T_i$ is observed and in the small scale observation the intersection of the time differentials $\tau_{0i} \cap \tau_i$; they are observed simultaneously, so this can be replaced by $\tau_{0i} \cap \tau_i$. Considering its space attributes: because $S^{0i} \gg S^i$ the large scale part can be replaced by $S^i \backslash \{P_{0i}, P_i\}$ and because the small scale part is empty, this remains as the only information about the geometry. The zip can be written as

$$z_3^1 = \{\tau_{0i} \cap \tau_i, S^i \backslash \{P_{0i}, P_i\}\}. \quad (57)$$

Considering zip z_7^1: the small scale part has time element $f^i \cap \tau_{0i}$, but this does not include the large scale time element T_i, so both parts of the zip cannot appear simultaneously and thus no H-event appears. Considering zip z_8^1: the small scale part is empty, so this zip has only a large scale element; according to the Heisenberg uncertainty principle, each experimental result implies an amount of uncertainty and this is lacking, so this zip cannot appear in physical reality. Thus we skip these elements and the remaining set is

$$Z^1(t,\mathbf{x}) = \{z_1^1, z_3^1\} = \{\{f^{0i} \cap f^i, s^i\}, \{\tau_{0i} \cap \tau_i, S^i \backslash \{P_{0i}, P_i\}\}\}, \quad (58)$$

so two H-events are generated. Because of their required complementarity, one of them is compact space and the other is extended space. Because the geometric element of z_3^1 is much larger than that of z_1^1 and the H-events must have the same energy, z_1^1 appears as a compact space and z_3^1 as an extended space. Then the appearance of z_1^1 is

$$A(z_1^1) = \sigma_i(f^{0i} \cap f^i, s^i), \quad (59)$$

which is a spherical major particle σ_i with geometry s^i, observed during the part of the present $f^{0i} \cap f^i$. The space s^i cannot be observed as well in the second appearance A_3^1, so the geometry of this appearance is reduced to $S^i \backslash s^i$ and

$$A(z_3^1) = \Theta^i(\tau_{0i} \cap \tau_i, S^i \backslash s^i), \quad (60)$$

which is a spherical space having a hole in it, observed in the second differential of time.

The total appearance can be written as

$$A(Z^1(t,\mathbf{x})) = \{A(z_1^1), A(z_3^1)\} = \{\sigma_i(f^{0i} \cap f^i, s^i), \Theta^i(\tau_{0i} \cap \tau_i, S^i \backslash s^i)\}. \quad (61)$$

The appearing H-events are major particle σ_i and major extended space Θ^i. Both events are compatible with each other: The particle appears in the present and a surrounding space appears immediately after that.

The appearance of the second pair of H-units is, analogous to Eq. (61), major particle σ_j and major extended space Θ^j. None of these four generated timespace objects has an intersection with another one, so nothing is generated which could be identified with gravity.

B. Overlapping major spaces of the neutral H-units

As the second step we consider the two masses closer to each other, such that S^{0i} and S^{0j}, the major spaces of the two neutral H-units, are overlapping each other. We suppose that their pellicles are not yet involved. Also we suppose that S^i and S^j, the major spaces of the charged H-units, do not intersect with S^{0i} and S^{0j}. With only overlapping neutral major spaces, the interaction of four H-units will be decided by the interaction of *only the neutral ones* H_{0i} and H_{0j}; the charged H-units are hidden inside their minor spaces.

To consider this interaction, we use timespace zipper (36) in a different way as we did above: not for one neutral and one charged H-units, but for two neutral H-units. Inserting $H_1 = H_{0i}$ and $H_2 = H_{0j}$, obtaining the timespace zipper $Z^1(t,\mathbf{x}) = \{z_1^1, z_3^1, z_7^1, z_8^1\}$ for overlapping H_{0i} and H_{0j} as

$$Z^1(t,\mathbf{x}) = \left\{ \begin{array}{l} \{\{\varnothing,\varnothing\}, \{f^{0i} \cap f^{0j}, \varnothing\}\} \\ \{\{F^{0j} \backslash T_{0j}, (S^{0i} \backslash P_{0i}) \cap (S^{0j} \backslash P_{0j})\}, \{\tau_{0i} \cap \tau_{0j}, \varnothing\}\} \\ \{\{T_{0j}, \varnothing\}, \{f^{0j} \cap \tau_{0i}, \varnothing\}\} \\ \{\{T_{0j}, \varnothing\}, \{\varnothing,\varnothing\}\} \end{array} \right\}. \quad (62)$$

Zips z_1^1, z_7^1, and z_8^1 are geometric empty, so they are dropped. The remaining zipper is

$$Z^1(t,\mathbf{x}) = \{z_3^1\} = \{\tau_{0i} \cap \tau_{0j}, S^{0i} \cap S^{0j}\}, \quad (63)$$

and because $T_{0j} - T_{0i} \ll f^{0i}$, the difference of minor points of time $\tau_{0i} \cap \tau_{0j}$, each considered as differentials of time, can be written as a second differential of time dt^2, so the appearance is

$$A(Z^1(t,\mathbf{x})) = A(z_3^1) = \Theta^0(dt^2, S^{0i} \cap S^{0j}). \quad (64)$$

The H-event is a *free major space* Θ^0 having a disklike shape of two spherical segments and appearing with a second differential of time. Thus a change is described and because no charge or fields are existing in H_{0i} and H_{0j}, this only can be a geometric change. This might be a change of R, the radii of S^{0i} and S^{0j}, or a change of their distance $P_{0i}P_{0j}$. A change of R is not possible because the density of potential energy of an H-unit as well as its total potential energy are supposed to be constant. Thus they come closer to, or move away from each other. In moving away the case would be finished immediately, so the neutral H-units can only move toward each other. If the radius of the major space of H_{0i} and of H_{0j} is R_0 and the thickness of the disk is h (in line with $P_{0i}P_{0j}$), than h increases quadratically from zero (when the major spaces start to overlap) to $R_0 - r_0$ (in which r_0 is the radius of a minor space of H_0). As soon as $h = R_0 - r_0$ is reached, a new case has developed which will be considered in the next section. Consequently, the distance between major particles σ_i and σ_j, existing close to P_{0i} and P_{0j}, also decreases in an accelerated way. Thus the two major particles move in an accelerated way towards each other. Remember that this attraction can't have an electromagnetic origin, because this quality is not involved in the discussion. Thus we identify it with *gravity* between major particles σ_i and σ_j. The case is finished as soon as the neutral pellicles touch each other.

C. Touching pellicles of the neutral H-units

As the third step, the two pairs of H-units are considered as so close to each other that also the smaller major spaces S^i and S^j, belonging to the charged H-units H_i and H_j, overlap each other. Now all four H-units have to be considered in one zipper, but because we do not yet have zippers for more than two H-units available, for the moment we have to search for a simplification: We suppose that the charged major spaces exist completely inside the neutral pellicle, so $S^i \subset p_{0i}$ and $S^j \subset p_{0j}$ and if the radius of the charged major spaces is R, this implies that $r_0 > R$. Then we can neglect H_i and H_j once more, considering the interaction between only H_{0i} and H_{0j} as defining the interaction between the four H-units.

If their major spaces S^{0i} and S^{0j} overlap far enough, their pellicles p_{0i} and p_{0j} start to intersect such that the overlapping space is singular. We call this the touching of the pellicles; the overlapping space is indicated by p_{0i0j}. Then the timespace zipper $Z^1(t,\mathbf{x}) = \{z_1^1, z_3^1, z_7^1, z_8^1\}$ (see Eq. (36)) for touching pellicles of H_{0i} and H_{0j} is

$$Z^1(t,\mathbf{x}) = \left\{ \begin{array}{l} \{\{\varnothing,\varnothing\},\{f^{0i}\cap f^{0j},\varnothing\}\} \\ \{\{F^{0j}\backslash T_{0j}, S^{0i}\cap S^{0j}\},\{\tau_{0i}\cap\tau_{0j}, p_{0i0j}\}\} \\ \{\{T_{0j},P_{0j}\},\{f^{0j}\cap\tau_{0i},\varnothing\}\} \\ \{\{T_{0j},P_{0j}\},\{\varnothing,\varnothing\}\} \end{array} \right\}. \tag{65}$$

Zip z_1^1 is geometric empty, so it is dropped. Zip z_8^1 cannot appear because the small scale element is empty; it is also dropped. In z_3^1 the small scale observation is part of the large scale one, so their simultaneous occurrence reduces to the small scale observation $\{\tau_{0i}\cap\tau_{0j}, p_{0i0j}\}$. In z_7^1 the large scale time observation, which is major point of time T_{0j}, is not an element of the small scale time observation $f^{0j}\cap\tau_{0i}$, so they cannot appear simultaneously; the zip has no appearance so it will be dropped. The zipper reduces to

$$\begin{aligned} Z^1(t,\mathbf{x}) &= \{z_3^1\} \\ &= \{\{F^{0j}\backslash T_{0j}, S^{0i}\cap S^{0j}\},\{\tau_{0i}\cap\tau_{0j}, p_{0i0j}\}\}. \end{aligned} \tag{66}$$

Thus the total appearance contains only one element,

$$A\left(Z^1(t,\mathbf{x})\right) = A\left(z_3^1\right) = \theta^i\left(dt^2, p_{0i0j}\right). \tag{67}$$

This H-event is *a free minor space* θ^i appearing in the second differential of time. As in the previous case, it is a space in the shape of two intersecting spheres, only it is much smaller. The element of time is the same, so it is the same type of appearance: H_{0i} and H_{0j} approach each other with the second order of time and consequently the two major particles σ_i and σ_j accelerate toward each other, which again can be identified with *gravity*. This goes on until the maximum overlap is reached before the spherical segments break open to a ring-shape, which will take a relatively very short time because the cross section of a pellicle is very small. After that we enter the next step.

D. Overlapping minor spaces of the neutral H-units

As the fourth step, the pellicles p_{0i} and p_{0j} of the neutral H-units intersect each other such that the intersection is a ring around their overlapping minor spaces. As long as the charged major spaces, supposed to exist inside the neutral minor spaces, are not involved, we can continue to neglect the charged H-units. Then the timespace zipper $Z^1(t,\mathbf{x}) = \{z_1^1, z_3^1, z_7^1, z_8^1\}$ (see Eq. (36)) for overlapping pellicles of H_{0i} and H_{0j} is

$$Z^1(t,\mathbf{x}) = \left\{ \begin{array}{l} \{\{\varnothing,\varnothing\},\{f^{0i}\cap f^{0j}, s^{0i}\cap s^{0j}\}\} \\ \{\{F^{0j}\backslash T_{0j}, S^{0i}\cap S^{0j}\},\{\tau_{0i}\cap\tau_{0j}, p_{0i}\cap p_{0j}\}\} \\ \{\{T_{0j},P_{0j}\},\{f^{0j}\cap\tau_{0i}, s^{0j}\cap p_{0i}\}\} \\ \{\{T_{0j},P_{0j}\},\{\varnothing,\varnothing\}\} \end{array} \right\}. \tag{68}$$

Zips z_1^1 and z_3^1 can be reduced like above. Zip z_7^1 has a nonempty time element $f^{0j}\cap\tau_{0i}$ in the small scale part, but this does not include the classical time element T_{0j}, so the two parts cannot appear simultaneously and no H-event appears; it is dropped from the zipper. Zip z_8^1 is dropped because it has no small scale element. Thus we can write the zipper as

$$Z^1(t,\mathbf{x}) = \{z_1^1, z_3^1\} = \left\{ \begin{array}{l} \{f^{0i}\cap f^{0j}, s^{0i}\cap s^{0j}\} \\ \{dt^2, p_{0i}\cap p_{0j}\} \end{array} \right\}. \tag{69}$$

These two zips have to appear complementary: one as a mass, the other as a space.

If z_1^1, describing the intersection of minor spaces, would appear as a compact space, it would be impossible for the described ring-shaped space in z_3^1 to appear as an extended space with the same total energy, because its volume as well as its energy density are much smaller than those of z_1^1. The reversed situation is possible, so z_1^1 appears as an extended space and z_3^1 as a compact space. The appearance of a ring-shaped pellicle intersection, being a nonsingular object, is defined as a spherical object existing inside the intersection, having a diameter as large as the pellicle width and touching both borders; it is called a minor particle π. Then the total appearance of the zipper is

$$A\left(Z^1(t,\mathbf{x})\right) = \left\{\theta^0\left(f^{0i}\cap f^{0j}, s^{0i}\cap s^{0j}\right), \pi_0\left(dt^2, p_{0i}\cap p_{0j}\right)\right\}. \tag{70}$$

The appearing H-events are *minor particle* π_0 and *minor extended space* θ^0. As expected, they indeed are compatible with each other, because π_0 exists at the border of θ^0 and according to the time elements, appears immediately after it, in the second differential of time. It might be a *graviton*.

Minor particle π_0 has two degrees of freedom: it can travel in one of the two available directions through the ring, so the ring acts as a one-dimensional object for the particle; its energy is the rest mass plus the kinetic energy. Because the pellicle ring is described with a second differential of time, it is a changing ring and because we assumed the pellicle width to be constant, this can only be a change of its radius. This can occur in two ways: by changing radii of the neutral minor spaces or by a changing distance between the major points. A change of radii is no solution because the density of potential energy of an H-unit as well as its total potential energy is supposed to be constant.

Thus the major points of the H-units have to move toward or away from each other, causing the radius of the ring to increase or decrease; because an increase would finish the case, we consider only the decrease. If the radius of the pellicle ring $p_{0i} \cap p_{0j}$ increases with the second order of time, the distance between major points P_{01} and P_{02} will decrease in an accelerated way, as a geometrical consequence. The major particles σ_i and σ_j, existing close to these major points, consequently also accelerate toward each other, which again can be identified with *gravity*.

The movement toward each other continues until the charged major spaces are reached; then it is not reasonable any more to approximate the interaction by considering only the neutral H-units, neglecting the charged ones. To continue with the closer cases, we need to develop a zipper for more than two H-units.

Because this is the first case in which two energetic timespace objects are generated, we consider the *energetic situation* for a moment. If the volume of θ^0 increases, more potential energy is converted into timespace energy. The two objects, space θ^0 and particle π_0, being H-events generated by the same H-units, must have the same energy, but the rest mass of the particle π_0, containing the total spatial energy of the pellicle ring $p_{0i} \cap p_{0j}$, is not enough to balance the spatial energy of $s^{0i} \cap s^{0j}$. Thus its kinetic energy has to balance the energy. If the energy of the minor extended space is $V_s \times \rho_s$ and the energy of the minor particle is $V_m \times \rho_m$, in which V is volume and subscripts s and m indicate space and mass, and if $\mathbf{v}_\pi$ is the velocity of π_0, then

$$V_m \times \rho_m + \frac{1}{2} \times m_\pi \times \mathbf{v}_\pi^2 = V_s \times \rho_s. \quad (71)$$

If the radius of the ring according to Eq. (71) increases with the second order of time, particle π_0 inside the ring is taken in this development and so its track is an outgoing spiral. Because the ring is a one-dimensional path for the particle, this acceleration can only be directed along its path, which implies that there is also a nonzero component of this acceleration of π_0 in the radial direction of the ring. This goes on until $P_{0i}P_{0j} = r_0$ because then another case develops, or until the situation becomes disturbed because of the involvement of the charged major spaces S^i and S^j; the minor particle might leave the scene as a neutrino.[7]

E. Summarizing the occurrence of gravity

Above we considered four cases for the interaction between two neutral H-units having charged H-units inside their minor spaces. If the distance between their major points of space is so large that no geometrical attributes overlap at all, then no gravity is described; but in the remaining three cases with decreasing distance between them, indeed, they were found to move toward each other in an accelerated way, taking the major particles with them. We identified this with gravity, which is exactly what we wanted to show. The gravitational acceleration at a relatively large distance might be different from that at a relatively small distance, because the derivations are different.

Mind that the derivation in the second case is only valid if the size of a neutral H-unit is sufficiently larger than that of the charged H-unit. For the third and fourth cases the size difference has to be so large that the charged H-unit exists completely within the minor space of the neutral H-unit. Thus it is important to know more about the size of the neutral H-unit.

Because we presume that the Higgs particle is generated by neutral H-units interacting, we will consider experimental results about the Higgs particle and try to interpret them in terms of twin physics.

V. THE HIGGS PARTICLE IN TERMS OF TWIN PHYSICS

In the Standard Model the Higgs field is taken up as a central part of particle physics, describing how the world is constructed. This field is supposed to fill up all space, but it confirms itself only by the Higgs particle, which is supposed to be a boson with zero spin and by that reason called a scalar particle. The entire Standard Model rests on the existence of this particle, because the basic idea is that particles in general acquire mass from contact with this field and this is basic for the existence of gravity.

At the 4th of July 2012 the CERN announced the discovery of a particle, produced by particle collision, looking very much like a Higgs boson.[8] At the 14th of March 2013, at the Moriond Conference in Geneva, the collaboration of experiments with the ATLAS and CMS detectors at CERN1's Large Hadron Collider presented preliminary new results that further elucidated the discovered particle. From that moment, nobody hesitated any more about its existence.

Although the concept of the Higgs particle is based upon the Standard Model, the experimental confirmation of its existence is not proof that the Standard Model is the best model to describe physics in general. It remained an open question, whether this is the Higgs boson of the Standard Model of particle physics, or possibly the lightest of several bosons predicted in some theories that go beyond the Standard Model. There are several serious problems in the Standard Model. Neutrino's should have zero mass, but experimentally they turn out to have a very small amount of mass. Moreover it is still not understood why this model describes only about 1/5th of all mass in the cosmos.

According to twin physics, we can consider the Higgs particle in a different way. A neutral H-unit contains a large major space and is able to generate particles by interaction with a charged H-unit. This is comparable with the assumption that all particles acquire mass from the Higgs field. Both the Higgs field of the Standard Model and the major space of twin physics are not observable as an independent physical item. The difference is only in the size of the space: the Higgs field being infinite, the major space having a large but finite radius. As discussed in the previous 3 sections, two particles according to twin physics do indeed attract each other in a way that we can identify as gravity. The difference with the Standard Model is that gravity is not considered as a field, but as an intrinsic feature of timespace objects, generated by neutral H-units.

We attempt to determine whether a Higgs particle can be considered as the interaction of two neutral H-units without charged H-units in their minor spaces. If their minor spaces overlap sufficiently, so that the major point of one H-unit is inside the minor space of the other, then the overlapping minor spaces appear as mass, free of electromagnetic features, with a maximum size equal to the size of the minor space. In the previous paper[7], it was shown that spin results from electromagnetic features of the constituent H-units, so this particle has no spin or zero spin. If indeed a Higgs particle is generated, its size has to be much larger than the size of a proton, because a neutral minor space is much larger than a charged one. The Higgs particle has a mass of about $126\,\mathrm{GeV/c^2}$ which is approximately 225×10^{-27} kg; a proton has a mass of 1.67×10^{-27} kg. According to our first approximation that the energy density of mass is a constant (see Sec. II G), approximating both objects by spheres, the proportion of their radii is the third root of the proportion of their masses, so the radius of a neutral minor space is about five times the radius of a charged one. Thus our approximation in Sec. IV is that the neutral H-units are large enough to store the charged minor space completely in its neutral minor space, is valid; the assumption in Sec. IV C that also the charged major space can be stored in it, possibly is not valid.

Next we attempt to describe a Higgs particle by the zippers, to see if one can be recognized as the particle detected by the CERN and if there may exist more similar particles. Because, for the moment, we are only interested in major particles, $s^{01} \cap s^{02}$ has to be nonempty, so we will describe only the first two elements of the spacezipper of first order, $z_1^1(\mathbf{x})$ and $z_2^1(\mathbf{x})$, and the first element of the spacezipper of second order, $z_1^2(\mathbf{x})$. Then, the *relevant zips of the first order* are in general (see Eq. (14)),

$$\{z_1^1, z_2^1\} = \left\{ \begin{array}{l} \{[D_1 \propto D_2], [(D_1 \triangleright\!\triangleleft u^1) \propto (D_2 \triangleright\!\triangleleft u^2)]\} \\ \{[D_1 \propto D_2], [(D_1 \triangleright\!\triangleleft u^2) \propto (D_2 \triangleright\!\triangleleft u^1)]\} \end{array} \right\}, \tag{72}$$

and the relevant zip of the second order (see Eq. (16)) is in general,

$$z_1^2 = \{[D_1 \propto D_2], [(D_1 \triangleright\!\triangleleft u^1) \propto (D_2 \triangleright\!\triangleleft u^2) \propto (D_1 \triangleright\!\triangleleft u^2) \propto (D_2 \triangleright\!\triangleleft u^1)]\}. \tag{73}$$

The timezips exist in four distinct cases, as pointed out in Sec. II C, if we take, in general, $T_{02} \geq T_{01}$. In time case 1 is $T_{02} = T_{01}$; in time case 2 is $T_{02} \in f^{01}$ and $T_{02} \neq T_{01}$; in time case 3 is $T_{02} \in \tau_{01}$; in time case 4 is $T_{02} > t_{01} + dt_{01}$. For the first order, the two timezips are in general (see Eq. (72))

$$\{z_1^1(t), z_2^1(t)\} = \left\{ \begin{array}{l} \{T_{01} \cap T_{02}, f^{01} \cap f^{02}\} \\ \{T_{01} \cap T_{02}, (T_{01} \triangleright\!\triangleleft f^{02}) \cap (T_{02} \triangleright\!\triangleleft f^{01})\} \end{array} \right\}. \tag{74}$$

This reduces for time case 1 to two equal zips $z_{1,2}^2(\mathbf{x})$ of the first order,

$$z_{1,2}^1(\mathbf{x}) = \{T_0, f^0\}, \tag{75}$$

and for time case 2 to only one nonempty zip

$$z_1^1(t) = \{\varnothing, f^{01} \cap f^{02}\}. \tag{76}$$

For the second order, the timezip is only nonempty in time case 1, but because the small scale element is empty, it has no timespace appearance. So *only the timezips of the first order remain*.

To obtain the corresponding spacezips of the first order, the attributes of space are inserted in Eq. (72), resulting in two equal zips,

$$z_1^1(\mathbf{x}) = z_2^1(\mathbf{x}) = \{P^{01} \cap P^{02},\ s^{01} \cap s^{02}\}. \tag{77}$$

Then, to obtain appearances of $s^{01} \cap s^{02}$, *two distinct space cases are relevant*: for the first case $P_{01} = P_{02}$ (so also $s^{01} = s^{02} = s^0$) and for the second $P_{01} \neq P_{02}$ and $P_{01} \in s^{02}$ (implying that $P_{02} \in s^{01}$). Inserting Eq. (72) gives for the first space case,

$$z_{1,2}^2(\mathbf{x}) = \{P_0, s^0\}, \tag{78}$$

and for the second one,

$$z_{1,2}^2(\mathbf{x}) = \{\varnothing, s^{01} \cap s^{02}\}. \tag{79}$$

Notice that time and space do not behave symmetrically: for space we obtain in each of the two cases two equal zips, but for time we obtain in one of the two cases only one zip, which is $z_1^1(t)$ (see Eq. (76)). Combining the spacezips, Eqs. (78) and (79), with the timezips, Eqs. (75) and (76), we obtain four possible timespace zips, given below

In the first case, for $T_{01} = T_{02} = T_0$ and $P_{01} = P_{02} = P_0$, the zip is

$$z_{1,2}^2(t, \mathbf{x}) = \{\{T_0, P_0\}, \{f^0, s^0\}\}. \tag{80}$$

The first appearance $A^1\left(z_{1,2}^2\right)$ is a stable observable major particle σ with volume s^0 in flying time f^0, containing both T_0 and P_0. To reflect not only minor attributes, as usual, but also major attributes, we indicate this by $\sigma_{P_0 \cup s^0}(T_0 \cup f^0)$. In this way, we observe the large scale elements explicitly, which is necessary because the remaining three zips do not contain all major points. The indication $T_0 \cup f^0$ means that the physical presence is appearing at a large scale, so this major particle can be identified as a stable particle. If the Higgs particle as detected by CERN would be described by this zip, it would have been strange that such a heavy particle had not been observed earlier. Thus it is unlikely to be the CERN particle and we conclude that $\sigma_{P_0 \cup s^0}(T_0 \cup f^0)$ only exists at an astronomic distance as black matter and, combined into clusters, possibly *black holes*. The proportion ratio of about 134 between the mass of a Higgs particle and that of a proton, makes it likely that clusters of black particles exist in the universe, which explains why the Standard Model cannot describe about 4/5 of all mass in the cosmos.

In the second case, for $T_{01} = T_{02}$ and $P_{01} \neq P_{02}$, the zip is

$$z_{1,2}^1(t, \mathbf{x}) = \{\{T_0, \varnothing\}, \{f^0, s^{01} \cap s^{02}\}\}. \tag{81}$$

The second appearance $A^2\left(z_{1,2}^1\right)$ is the stable observable major particles $\sigma_{s^{01} \cap s^{02}}(T_0 \cup f^0)$. No major points of space are present, although a major point of time appears;

previously we did not obtain this type of zip, because it occurs only in first order zippers. Its volume $s^{01} \cap s^{02}$ is less than in the first appearance, so the particle is lighter. Again $T_0 \cup f^0$ appears, so the physical presence appears at a large scale, so again this observation is not expected to be the result of CERN experiments.

In the third case, for $T_{02} \in f^{01}$ and $P_{01} = P_{02}$, the zip is

$$z_1^1(t, \mathbf{x}) = \left\{ \{\varnothing, P_0\}, \{f^{01} \cap f^{02}, s^0\} \right\}. \tag{82}$$

The third appearance $A^3(z_1^1)$ is major particle $\sigma_{P_0 \cup s^0}(f^{01} \cap f^{02})$. The appearing geometry is the sphere s^0 with a large scale observable point in its centre. The appearing interval of time is a part of the physical presence $f^{01} \cap f^{02}$; if $T_{02} - T_{01}$ is infinitesimally close to f^{01}, this interval is infinitesimally small. Because time is the deciding quality of an observation, this is another type of particle than that in the first and the second appearances. The time appears only at a small scale and not during the full presence, which introduces the concept of probability. The physical presence can not, by definition, be split up into smaller intervals of observation, so the particle may only be observed by chance by repeating the experiment a number of times. Bear in mind that this probability does not serve as a way to deal with large numbers of items, as was proposed in the years after the discovery of quantum mechanics. This probability is a feature of the observation itself; the particle is stable, because no minor point of time appears. As a first step we suppose the smaller $T_{02} - T_{01}$ is, the smaller the chance to observe it becomes. The meaning of the large scale geometry is not clear yet, so for the moment we do not identify this particle.

In the fourth case, for $T_{02} \in f^{01}$ and $P_{01} \neq P_{02}$, the zip is

$$z_1^1(t, \mathbf{x}) = \left\{ \{\varnothing, \varnothing\}, \{f^{01} \cap f^{02}, s^{01} \cap s^{02}\} \right\}. \tag{83}$$

The fourth appearance $A^4(z_1^1)$ is major particle $\sigma_{s^{01} \cap s^{02}}(f^{01} \cap f^{02})$, without large scale attributes, so its geometry is $s^{01} \cap s^{02}$, observable during part of the physical presence $f^{01} \cap f^{02}$. As in the third appearance, if $T_{02} - T_{01}$ is infinitesimally close to f^{01}, it appears only during an infinitesimal part of the physical presence, so the observation is characterized by chance, although the particle itself is stable. In this case, time as well as space appear only at a small scale. Because the Higgs particle indeed is observed only after repeated experiments and the experiments were carried out with elementary particles at a small scale, we propose that this describes the detected Higgs particle of CERN.

To consider the fourth appearance fully, we turn back to the total zippers for two neutral H-units for time case 2 ($T_{02} \in f^{01}$ and $T_{02} \neq T_{01}$) and the second space case ($P_{01} \neq P_{02}$ and $P_{01} \in s^{02}$). Inserting timespace attributes with these features in Eq. (14), we obtain for the time zipper of the first order,

$$Z^1(t) = \left\{ \begin{array}{l} \{\varnothing, f^{01} \cap f^{02}\}, \{\varnothing, \varnothing\} \\ \{F^{02}, \tau_{01} \cap \tau_{02}\}, \{F^{02}, \tau_{02} \cap \tau_{01}\} \\ \{\varnothing, \varnothing\}, \{\varnothing, \varnothing\} \\ \{T_{02}, f^{02} \cap \tau_{01}\}, \{T_{02}, \varnothing\} \end{array} \right\}, \tag{84}$$

and for the space zipper of the first order,

$$Z^1(\mathbf{x}) = \left\{ \begin{array}{l} \{\varnothing, s^{01} \cap s^{02}\}, \{\varnothing, s^{01} \cap s^{02}\} \\ \{S^{01} \cap S^{02}, p_{01} \cap p_{02}\}, \{S^{01} \cap S^{02}, p_{01} \cap p_{02}\} \\ \{P_{01}, s^{01} \cap p_{02}\}, \{P_{01}, \varnothing\} \\ \{P_{02}, s^{02} \cap p_{01}\}, \{P_{02}, \varnothing\} \end{array} \right\}. \tag{85}$$

Clearly, the time zipper lacks the symmetry occurring in the space zipper between the first and second elements, the fifth and seventh and the sixth and eight. The two zippers can be combined into one timespace zipper and, because $z_3^1 = z_4^1$, written as $z_{3,4}^1$, this can be reduced to the set of four elements $\left\{z_1^1, z_{3,4}^1, z_7^1, z_8^1\right\}$, described as

$$Z^1(t, \mathbf{x}) = \left\{ \begin{array}{l} \{\{\varnothing, \varnothing\}, \{f^{01} \cap f^{02}, s^{01} \cap s^{02}\}\} \\ \{\{F^{02}, S^{01} \cap S^{02}\}, \{\tau_{01} \cap \tau_{02}, p_{01} \cap p_{02}\}\} \\ \{\{T_{02}, P_{02}\}, \{f^{02} \cap \tau_{01}, s^{02} \cap p_{01}\}\} \\ \{\{T_{02}, P_{02}\}, \{\varnothing, \varnothing\}\} \end{array} \right\}. \tag{86}$$

Zip $z_{3,4}^1$ can be reduced to only the small scale element. In zip z_7^1 the large scale space element P_{02} can only appear simultaneously with the small scale element $s^{02} \cap p_{01}$ if $P_{02} \in p_{01}$ and this is not the case, so it has no appearance. Zip z_8^1 contains no small scale elements, so it has also no appearance. Thus the zipper of the first order is the set of two elements $\left\{z_1^1, z_{3,4}^1\right\}$, written as

$$Z^1(t, \mathbf{x}) = \left\{ \begin{array}{l} \{f^{01} \cap f^{02}, s^{01} \cap s^{02}\} \\ \{\{F^{02}, S^{01} \cap S^{02}\}, \{\tau_{01} \cap \tau_{02}, p_{01} \cap p_{02}\}\} \end{array} \right\}. \tag{87}$$

Zip z_1^1 appears as a major particle σ. Zip $z_{3,4}^1$ appears as a minor particle π only if $\tau_{01} \cap \tau_{02}$ is nonzero, which is valid for $T_{02} - T_{01} \leq dt_i$ (in which dt_i is an infinitesimal small interval of time, see Eq. (21)). In that case the difference of minor points of time $\tau_{01} \cap \tau_{02}$, each considered as differentials of time, can be written as a second differential of time dt^2. The minor particle contains large scale attributes for both time and space; both are undetermined, representing the future and the intersection of two large spaces. We assume that they do not add useful information, so we ignore them. Then the total fourth appearance for $T_{02} - T_{01} \leq dt_i$ can be written as

$$A^4\left(Z^1(t, \mathbf{x})\right) = \left\{\sigma_{s^{01} \cap s^{02}}\left(f^{01} \cap f^{02}\right), \pi_{p_{01} \cap p_{02}}\left(dt^2\right)\right\}. \tag{88}$$

Thus the Higgs particle $\sigma_{s^{01} \cap s^{02}}(f^{01} \cap f^{02})$ appears with an accelerated minor particle, appearing in the intersection of pellicles. For $T_{02} - T_{01} > dt_i$ the total fourth appearance reduces to one element,

$$A^4\left(Z^1(t, \mathbf{x})\right) = \sigma_{s^{01} \cap s^{02}}\left(f^{01} \cap f^{02}\right), \tag{89}$$

so then the Higgs particle appears without the minor particle.

Turning back to the third appearance and deriving the same for $T_{02} \in f^{01}$ and $P_{01} = P_{02}$, we obtain the zipper of the first order as

$$Z^1(t,\mathbf{x}) = \left\{ \begin{matrix} \{\{\varnothing, P_0\}, \{f^{01} \cap f^{02}, s^0\}\} \\ \{\{F^{02}, S^0\}, \{\tau_{01} \cap \tau_{02}, p_0\}\} \end{matrix} \right\}, \quad (90)$$

so the total third appearance for $T_{02} - T_{01} \leq dt_i$ can be written as

$$A^3\big(Z^1(t,\mathbf{x})\big) = \big\{\sigma_{P_0 \cup s^0}\big(f^{01} \cap f^{02}\big), \pi_{p_0}\big(dt^2\big)\big\}. \quad (91)$$

Again we find an accompanying minor particle, in this case existing in the complete pellicle.

For $T_{02} - T_{01} > dt_i$ the total third appearance reduces to one element,

$$A^3\big(Z^1(t,\mathbf{x})\big) = \sigma_{P_0 \cup s^0}\big(f^{01} \cap f^{02}\big). \quad (92)$$

Because in the third and fourth appearances both major particles can be accompanied by an accelerated minor particle, we consider also the third one as a Higgs particle.

Summarizing, two interacting neutral H-units are able to generate four distinct major particles. We call them black particles, because no electromagnetic features are present. Two of them, being the major particles $\sigma_{P_0 \cup s^0}(T_0 \cup f^0)$ and $\sigma_{s^{01} \cap s^{02}}(T_0 \cup f^0)$, one being spherical and one disk-shaped, having different masses, and appearing at an astronomic scale. The third and fourth black particles $\sigma_{P_0 \cup s^0}(f^{01} \cap f^{02})$ and $\sigma_{s^{01} \cap s^{02}}(f^{01} \cap f^{02})$, again one being spherical and one disk-shaped, having different masses, and both are only by chance observable. Considering the last two cases with a complete zipper, we found that for $T_{02} - T_{01} \leq dt_i$ an accelerated minor particle accompanies the Higgs particle; for $T_{02} - T_{01} > dt_i$ it appears alone. Because their descriptions are highly similar, we conclude that both can be considered as Higgs particles. The accompanying minor particles might be gravitons.

VI. CONCLUSION

It is possible to introduce a direct relationship between particle–wave duality and mass–space duality. Using this approach, the radius of protons can be calculated in agreement with experimental results, using the constant of Planck and the velocity of light. This shows that twin physics in principle describes reality. The definition of mass being complementary to space, presented here and applied to a combination of charged and neutral H-units, delivers the key to the understanding of gravity.

A neutral H-unit differs from a charged one not only by its electromagnetic neutrality: By allocating its potential energy to geometry, it has larger geometric attributes, so can connect charged masses over large distances and convert potential energy into gravity. Because the concept of the H-unit is based upon quantum mechanics, this implies that a theoretical relationship between gravity and quantum mechanics has been found. The existence of the neutral H-unit is the bridge between them. Even if gravity at a subatomic scale turns out to be unmeasurable, because of its extreme small magnitude, its derivation is of utmost importance, because it leads to an alternative description of the Higgs particle.

In the previous paper[7] the neutral H-unit served as a background for particles generated by two charged H-units, necessary to stabilize their mass; no gravity occurred. In this paper, we discovered that particles, generated by one neutral and one charged H-unit, are subject to gravity, up to a distance equal to the radius of the neutral major space. Moreover, we considered the interaction of two neutral H-units, without the involvement of charged H-units. They were able to generate four distinct major particles, called black particles, two of them appearing at an astronomic scale and two at a subatomic scale. In the description of the last two, probability is found as a basic feature of the appearing particles, not as a way to deal with large numbers of items. Two of them can be identified as Higgs particles. The accompanying minor particles might be gravitons.

The advantage of this alternative description is, that black matter can be described using the same formulation. Moreover, according to twin physics, neutrinos do have mass,[7] whereas according to the Standard Model they have zero mass, which is not in agreement with experimental results.

In the case of gravity, the presented twin physics view differs from the traditional view in three aspects:

- Traditionally, gravity is supposed to affect all types of mass and the attracting gravitational force is supposed to reach to infinity. On the other hand, in twin physics, the range of influence is limited, which introduces the possibility to escape from gravity. Moreover, masses generated by only charged H-units are not sensitive to gravitation, because they lack the large major spaces of neutral H-units.
- Traditionally, the gravitational constant is an empirical constant used for all calculations of the gravitational force between two bodies. In the twin physics view, the gravitational acceleration at a large distance is calculated in a different way than that at a smaller distance, which introduces the possible existence of a second gravitational constant, valid at large distances.
- Traditionally, gravity is considered as one of the four forces of nature and both gravity and electromagnetism are considered as fields. Twin physics does not contain the notion of force. Gravity cannot be considered as a field, because it is an intrinsic timespace feature; electromagnetism, on the other hand, is described by the addition of fields and charges to timespace objects.

We conclude from these three points of difference that the concept of gravity has been totally revised by using the basics of quantum mechanics. A fundamental difference between gravity and electromagnetism is reflected in the fact that electromagnetism can be described by chromosomes of the second order, and gravity only by chromosomes of the first order. In physical reality, their difference might be expressed by saying that the quality "space" defines the basics of H-events, while the quality "mark" gives gender to them.

To complete the description of gravity, the theory has to be expanded to a larger number of interacting H-units in one zipper. The gravitational acceleration has to be calculated and compared with experimental values. The conceptual problems, arising in physics from the results of quantum-mechanical experiments, turn out to be the key to finding new, compatible concepts of mass, space, and gravity. In this theory, indeterminism and space play the main roles. It would be most interesting to find out whether the relativity theory of Einstein, being purely deterministic, can be expanded in an indeterministic way.

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