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Deviating Features of Protons, Neutrons and Electrons on a Nano Scale

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Abstract
In the previous fourteen years twin physics has been developed to reconcile descriptions of phenomena on quantum mechanical and astronomical scale, by considering them in a complementary way. After having identified several theoretical results as basic physical phenomena, elementary particles and gravitational waves, this model seems to be ready for exploring the region between the extremes of phenomena. In twin physics it is possible to describe two types of protons, three types of neutrons and four of electrons. The expected appearances of these types in nano structured material and the consequences for their features are considered in general. Because these descriptions can be presented in a geometrical way, they are relatively easily accessible. As assistance to workers in this field, the results focus less on the theoretical background and more on first steps towards experimental applications.

Keywords: Twin physics, electricity, magnetism, nano structured material, protons, neutrons, electrons.

Introduction
Twin theorie is based upon the uncertainty principle of Heisenberg and upon his later conviction that physics can be entirely described in a ***complementary*** way. We used the definition of complementarily introduced by Max Jammer, based on a proposition of von Weizsäcker, to tackle uncertainty in a mathematical manner [1-4]. In elaborating these ideas the later work of Einstein is used, in which he suggests that the apparent irreconcilability of quantum-mechanics and relativity theory might be caused by the use of four dimensional space time in the subatomic region as well [5]. Encouraged by this, we do not use time and space as a four dimensional continuum, but consider ***time and space separately*** as one- and three-dimensional items, respectively. To deviate as little as possible from Einstein's theory, we treat space and time mathematically in a similar way. In the same publication, Einstein also suggested to describe phenomena not in an algebraic but in a ***geometric*** way. These suggestions have been combined with those of Heisenberg.

To these starting-points we added the concept of a ***unit of potential energy***, instead of taking an elementary particle as the basic unity. This unit of potential energy is called a Heisenberg-unit (H-unit), an abstract concept without a physical meaning on its own, because potential energy cannot be observed. By definition, this potential energy can be converted into actual energy only by ***interacting*** with another H-unit, to incorporate the basic idea of relativity theory. The H-unit, being the bridge between large- and small-scale physics, may be converted partly as well as in total. The mathematical features of one H-unit are expressed as complementary items of space and time and the interaction between two H-units is formulated by combining them. The resulting general formulation is called the ***zipper***, which is deduced for the qualities 'space' and 'time' separately. Also a zipper for the quality 'mark', being a precursor of charge, electricity and magnetism, is deduced. For a given relative position of two H-units, the zippers of space, time and mark will be combined and this mathematical description will be represented in a physical space, after which descriptions of one or more phenomena are obtained.

In previous publications we applied twin physics to the atomic or sub-atomic scale (proton, neutron, electron, gluon, Higgs particle, photon, the appearance of spin), to general phenomena (gravity, electricity and magnetism, weak force, strong force) and to the astronomic scale (gravitational waves) to check if the relationship with the predictions of Einstein indeed exists. In this paper we return to proportions which are meant for everyday life purpose being actual at the moment: The applicability of twin physics to nano structured materials. This is presented in a way as close as possible to researchers in this field who are eager to know what could be expected experimentally according to twin physics. Abstract formulations are only shown to give an impression; later they will be dropped and the results will be presented only geometrically.

However, for the interested specialist the details can be found in the book "Twin physics, the complementary model of phenomena" [6]. This contains an amended overview of the previous publications and a few additions, with basic explanations and examples. The original development of twin physics can be found subsequently in six publications. The fifth paper starts with a short manual for the use of twin physics; in the sixth paper, equations for all possible cases of time and space are brought together in the index [7-12].

It is not necessary to understand the theoretical deduction of twin physics completely to be able to work with it for a specific application. As a way of introduction for the uninitiated, some relevant concepts deviating from classical physics will be summed up below.

1. Physics is not identical to mathematics; mathematical items will be transformed into physical items by representing them in a physical space and useless parts will be dropped.
2. Space is considered as an independent, finite entity. It is an energetic objects as prominent as mass, having an energy density too low to observe until now. Spatial items are described in a geometric way.
3. Mass always occupies a small amount of space, which is also described in a geometric way.
4. The law of conservation of energy is restricted to conservation of actual energy. Potential energy plays no role in this law, as it describes only mathematical transformations between distinct types of actual energy.

A proper use of twin physics does require some practice. However, thanks to the geometric descriptions and the separate treatment of space and time, this method over time becomes easier to deal with.

In the next section the most important concepts and definitions will be explained, so that you can get an idea of, and become familiar with, the names used. For the layman this may be difficult to grasp, but the later sections can still be followed.

Basics of Twin Physics for Experimental Applications

The ***Heisenberg-unit***, in short called H-unit and indicated by H_i, is an elementary unit of potential energy, expressed in complementary mathematical items. It is an abstract item with no physical meaning of its own, because potential energy cannot be observed. Potential energy can be converted into actual energy by interacting with another H-unit, describing a physical phenomenon. In that way the basics of relativity theory are built-in. An interaction is in general written as $H_i * H_j$.

A ***set of attributes*** of H_i contains four mathematical attributes, being complementary pairwise. Each pair contains a determinate and an indeterminate attribute according to the definition of complementarity described by Max Jammer. Thus the members of one pair refer to the same universe of discourse, each taken alone cannot account for all phenomena of this universe if taken alone, and they exclude each other [3].

One pair of attributes is of ***major importance*** for the described phenomenon and so written in capitals. The other pair is of ***minor importance***, written in subscript. Thus, a set of attributes can in general be written as:

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

A lower index indicates a determinate attribute D or d, a higher index an indeterminate attribute U or u. This set is defined for three qualities of a phenomenon, being ***time***, ***space and mark*** (the precursor of charge and electromagnetism). An example of a *determinate* space attribute is a point of space; an example of an *indeterminate* space attribute is a finite space in which by definition no single point has a defined position. This way of dealing with complementary supposes the existence of ***physical spaces acting as a unity*** instead of as a collection of points.

The ***set of space attributes*** of H_i is defined as:

$$h_i(\tilde{\mathbf{x}}) = \left\{ \tilde{P}_i, \tilde{S}^i \setminus \tilde{P}_i, \tilde{p}_i, \tilde{s}^i \right\}, \tag{2}$$

Containing subsequently 'point of space' $\tilde{P}_i$, finite spherical 'major space' $\tilde{S}^i \setminus \tilde{P}_i$ with central point $\tilde{P}_i$ excluded, 'pellicle' $\tilde{p}_i$ being a very thin skin of $\tilde{S}^i$ and spherical 'minor space' $\tilde{s}^i$ including central point $\tilde{P}_i$ (see Figure 1). The tildes indicate mathematical items. The pellicle is an infinitesimally thin layer upon the minor space, that is, a singular object; it is a very important element. When a physical object is described by interaction with another H-unit, the tildes will disappear and the complete mathematical object, or a part of it, will describe a physical object to which energy can be ascribed. This object is called a Heisenberg-event, in short an ***H-event***.

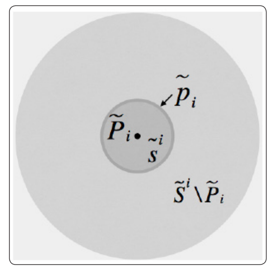

Figure 1: Schematic representation of the space attributes of one H-unit

The ***set of time attributes*** of H_i is a one-dimensional version of the space attributes:

$$h_i(\tilde{t}) = \left\{ \tilde{T}_i, \tilde{F}^i \setminus \tilde{T}_i, \tilde{\tau}_i, \tilde{f}^i \right\}, \tag{3}$$

Containing subsequently 'point of time' $\tilde{T}_i$, deliberately large 'future' $\tilde{F}^i \setminus \tilde{T}_i$, an infinitesimally small 'flash of time' $\tilde{\tau}_i$ and 'flying time' $\tilde{f}^i$. The differences with the traditional way of considering time concern the finiteness of the future and the flying time. It is easy to imagine the meaning of the flying time: Each time measurement is a cyclic process; the flying time is the interval between two time measurements, however small they are, because in between no measurement is possible and so in that region time is principally indeterminate. In history this experimental fact is ignored by extrapolating the time axis to a continuous line.

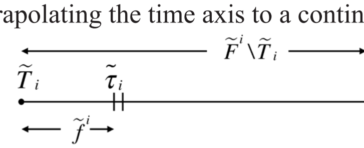

Figure 2: Schematic representation of the time attributes of one H-unit

In general, the interaction between H-units H_i and H_j, written as $H_i * H_j$, is conceived as an ***exchange of information***. All information about the two H-units is given by their attributes of space and time, so these will be combined.

To incorporate the uncertainty relation of Heisenberg, we have defined an axiom saying that attributes may contribute to any observation only in pairs of one major and one minor attribute. These pairs are created by defining the ***join operator*** $\triangleright\triangleleft$, resulting in joined pairs $\tilde{X} \triangleright\triangleleft \tilde{y}$ in which one major attribute is connected to one minor attribute. Joined pairs are linked to chains by defining the ***link operator*** $\propto$, connecting two joined pairs like for instance in $(\widetilde{X}_1 \bowtie \mathrm{y}_1) \propto (\widetilde{X}_2 \bowtie \mathrm{y}_2)$. The operators are defined such that all attributes in one chain, after transformation into a physical space, ***occur combined in the resulting phenomenon***, called the H-event.

A huge amount of chains could be described if we would use all information of two H-units, but fortunately there is a restricting rule deduced from quantum mechanics: Complementary observations cannot be observed simultaneously, so P_i and $S^i \setminus P_i$, originating from one and the same H-unit, cannot appear simultaneously in one observation, neither can joined pairs containing both. We call this restriction the ***exclusion principle***. The consequence is that a chain of joined pairs contains at most two distinct major attributes, one of H_i and one of H_j; then only four distinct chains remain.

The ***zipper*** is a set of four elements with all mathematical information about an interaction between H_i and H_j, transformed into physical time, space, charge and fields. This set is basically the only formula in twin physics; all others are insertions of time, space and later mark expressions into this one. When many H units are involved, they may interact two by two in all possible combinations, but the law of conservation of actual energy determines which interactions can be transformed into a physical space. In many situations this leads to a manageable amount of information.

In general the zipper $Z(H_i * H_j) = \{z_1, z_2, z_3, z_4\}$ is a set of four elements, each called a ***zip*** z_n with $n \in \{1, 2, 3, 4\}$:

$$Z\left(H_i * H_j\right) = \left\{ \begin{array}{l} \left\{\left[D_i \propto D_j\right], \left[\left(D_i \bowtie u^i\right) \propto \left(D_j \bowtie u^j\right) \propto \left(D_i \bowtie u^j\right) \propto \left(D_j \bowtie u^i\right)\right]\right\} \\ \left\{\left[U^i \propto U^j\right], \left[\left(U^i \bowtie d_i\right) \propto \left(U^j \bowtie d_j\right) \propto \left(U^i \bowtie d_j\right) \propto \left(U^j \bowtie d_i\right)\right]\right\} \\ \left\{\left[D_i \propto U^j\right], \left[\left(D_i \bowtie u^i\right) \propto \left(U^j \bowtie d_j\right) \propto \left(D_i \bowtie d_j\right) \propto \left(U^j \bowtie u^i\right)\right]\right\} \\ \left\{\left[D_j \propto U^i\right], \left[\left(D_j \bowtie u^j\right) \propto \left(U^i \bowtie d_i\right) \propto \left(D_j \bowtie d_i\right) \propto \left(U^i \bowtie u^j\right)\right]\right\} \end{array} \right\}. \tag{4}$$

In practice at least two zips are empty, so a zipper contains only one or two zips. Each zip is again a set containing two physical elements. De left part contains only major attributes; this is the large-scale zip element. The right part contains a mix of large- and small-scale attributes; this is the small-scale zip-element.

The ***transformation*** of a mathematical zip-element into a physical space is indicated by square brackets: $[\widetilde{X}]$. This is an operation which changes the mathematical object into a physical item, so $[\widetilde{X}] = X$, in which a part of the information may be dropped. After transforming all zip-elements, the two sub-elements of each zip have to be reconciled with each other to one description, according to some obvious rules, to obtain the ***appearance*** of the phenomenon.

The zipper is used for ***three distinct qualities***, being space, time and mark. For the quality ***space***, attributes (2) are inserted in the general zipper (4). The result is called the ***space zipper***:

$$Z_{ij}\left(\tilde{\mathbf{x}}\right) = \left\{ \begin{array}{l} \left\{\left[\widetilde{P}_i \cap \widetilde{P}_j\right], \left[\tilde{s}^i \cap \tilde{s}^j \cap \left(\widetilde{P}_i \bowtie \tilde{s}^j\right) \cap \left(\widetilde{P}_j \bowtie \tilde{s}^i\right)\right]\right\} \\ \left\{\left[\left(\widetilde{S}^i \setminus \widetilde{P}_i\right) \cap \left(\widetilde{S}^j \setminus \widetilde{P}_j\right)\right], \left[\tilde{p}_i \cap \tilde{p}_j \cap \left(\widetilde{S}^i \setminus \widetilde{P}_i \bowtie \tilde{p}_j\right) \cap \left(\widetilde{S}^j \setminus \widetilde{P}_j \bowtie \tilde{p}_i\right)\right]\right\} \\ \left\{\left[\widetilde{P}_i \cap \left(\widetilde{S}^j \setminus \widetilde{P}_j\right)\right], \left[\tilde{s}^i \cap \tilde{p}_j \cap \left(\widetilde{P}_i \bowtie \tilde{p}_j\right) \cap \left(\widetilde{S}^j \setminus \widetilde{P}_j \bowtie \tilde{s}^i\right)\right]\right\} \\ \left\{\left[\widetilde{P}_j \cap \left(\widetilde{S}^i \setminus \widetilde{P}_i\right)\right], \left[\tilde{s}^j \cap \tilde{p}_i \cap \left(\widetilde{P}_j \bowtie \tilde{p}_i\right) \cap \left(\widetilde{S}^i \setminus \widetilde{P}_i \bowtie \tilde{s}^j\right)\right]\right\} \end{array} \right\} \tag{5}$$

Each zipper has at least two empty zips, so in practice it is easier than it looks in this equation. A non-empty zip contains three-dimensional attributes, so after transforming into a three-dimensional physical space, a ***physical object*** is described. The ***type*** of this object depends on the relative position of the two H-units. Basically two types of object can be described: mass and space. The energy density of a ***mass*** has a constant high value; overlapping masses are not allowed. The energy density of a ***space*** has a constant low value; overlapping spaces are allowed up to some maximum of energy density. Below we will mention some relevant masses and spaces.

A ***solid particle σ*** may be generated by two H-units if their minor spaces overlap each other far enough. This can be described by zip z_1 and identified with a neutron or proton. A ***pellet particle π*** may be generated if their pellicles are intersecting or coinciding; it is a tiny spherical particle inside the pellicle. This can be described by zip z_2 and identified (among others) with a spin particle, supplying another particle with a magnetic spin. A ***dot particle δ*** may be generated if a minor space intersects a pellicle. This can be described by zips z_3 or z_4 and identified with an electron. The lower border of a dot particle is a ***point particle* Π**, having zero size; it cannot store spatial energy and so it has no mass, but it may store the energy of a charge, as we will explain later. A ***neutral macrospace*** Θ may be generated if two major spaces are intersecting and the pellicles are not. If zip z_2 describes a macrospace, it cannot describe a pellet particle (and the other way around). The size of Θ is supposed to be astronomic. A ***magnetic macrospace*** $\Theta^{\mathbf{B}}$ will be generated in the same circumstances if at least one H-unit is marked; its size is much smaller than the neutral macrospace. We estimate molecular or somewhat larger, but anyhow not astronomic.

For the quality ***time***, attributes (3) are inserted in the general zipper (4). The result is called the ***time zipper***:

$$Z_{ij}(t) = \left\{ \begin{array}{l} \left\{\left[\widetilde{T}_i \cap \widetilde{T}_j\right], \left[\tilde{f}^i \cap \tilde{f}^j \cap \left(\widetilde{T}_i \bowtie \tilde{f}^j\right) \cap \left(\widetilde{T}_j \bowtie \tilde{f}^i\right)\right]\right\} \\ \left\{\left[\widetilde{F}^i \setminus \widetilde{T}_i \cap \widetilde{F}^j \setminus \widetilde{T}_j\right], \left[\tilde{\tau}_i \cap \tilde{\tau}_j \cap \left(\widetilde{F}^i \setminus \widetilde{T}_i \bowtie \tilde{\tau}_j\right) \cap \left(\widetilde{F}^j \setminus \widetilde{T}_j \bowtie \tilde{\tau}_i\right)\right]\right\} \\ \left\{\left[\widetilde{T}_i \cap \widetilde{F}^j \setminus \widetilde{T}_j\right], \left[\tilde{f}^i \cap \tilde{\tau}_j \cap \left(\widetilde{T}_i \bowtie \tilde{\tau}_j\right) \cap \left(\widetilde{F}^j \setminus \widetilde{T}_j \bowtie \tilde{f}^i\right)\right]\right\} \\ \left\{\left[\widetilde{T}_j \cap \widetilde{F}^i \setminus \widetilde{T}_i\right], \left[\tilde{f}^j \cap \tilde{\tau}_i \cap \left(\widetilde{T}_j \bowtie \tilde{\tau}_i\right) \cap \left(\widetilde{F}^i \setminus \widetilde{T}_i \bowtie \tilde{f}^j\right)\right]\right\} \end{array} \right\} \tag{6}$$

Each time zip describes the dynamics of the corresponding space zip, so the first time zip describes that of the first space zip, et cetera. A described object can only factually appear if the belonging time zip allows this, that is, if the corresponding element is non-empty. After transforming into a real time axis, such a time zip contains one dimensional attributes, being an interval, a point of time or both. In this way we get a description if the object moves in acceleration, with a constant velocity or not at all.

As the last quality we consider the quality ***mark***. The set of mark attributes is defined in such a way that an entire H-unit can be distinguished from another H-unit like having an ***identity***. A basic type of identity can be found in everyday life in a referendum with three choices, being "you vote in favour, you vote against or you vote abstain". The mark attributes for ***points*** of space are expressed mathematically as a constant number being ***plus, minus or zero***. The plus or minus mark transforms into a positive or negative charge.

The mark attributes for ***spaces*** are two vector fields. A radial one is considered as a ***major determinate*** attribute and a circular one as a ***major indeterminate*** attribute. Without going into the details for the minor attributes of mark, the ***set of mark attributes*** of H_i is defined as:

$$h_i(\tilde{q}) = \left\{ \left\{ \tilde{Q}_i, \tilde{\mathbf{E}}_i \right\}, \left\{ \tilde{Q}_i \times i, \tilde{\mathbf{B}}^i \right\}, \left\{ 1, \tilde{\nabla} \right\}, \left\{ i, \partial/\partial\tilde{t} \right\} \right\}. \qquad (7)$$

Note that each element is again a set of two elements, because points and spaces will get different identities: Each major attribute (the first or the second element) is a set of a constant, real or imaginary number and a vector field. The determinate vector field $\tilde{E}_i$ is tangential, the indeterminate vector field $\tilde{B}_i$ is circular and, like in classical physics, these mathematical fields have an infinite reach. The complete set shows subsequently an electric set and a magnetic set, a nabla set (with $\tilde{\nabla} = \left\{ \partial/\partial\tilde{x}, \partial/\partial\tilde{x}, \partial/\partial\tilde{x} \right\}$ and a time derivative set. Inserting them in general zipper (4), we obtain the ***mark zipper***, which we will not show here.

After transforming into real time and space, the mark zips contain charges, fields or a combination of them. They can appear only if the charge can be attached to a ***real point***, and the field to a ***real space***, described by the corresponding space zip. It is important to note that by transformation, the mathematical fields will be ***restricted*** to the described geometric region. This will result in the description of charged elementary particles, generated in combination with a so-called spin particle or surrounded by a finite magnetic field, producing a spin. In this paper we will use the resulting charges and magnetic fields without showing how to deduce and apply the mark zipper [6].

The following items can be described by the subsequent zips of the mark zipper. Keep in mind that this is only possible for interactions having at least one marked H-units, so for $H_i * H_j$ or $H_i * H_0$.

The ***first mark zip*** $z_1(q)$ may describe a real ***charge*** Q, appearing if a real point of space is described by space zip $z_1(\mathbf{x})$; also it may describe an electric field inside a solid particle. The ***second mark zip*** $z_2(q)$ may describe a real, finite ***magnetic macrospace*** $\Theta^{\mathbf{B}}$, appearing if two major spaces are intersecting but the pellicles are not intersecting; the size is molecular or possibly larger. Also it may describe a ***rotation*** of the magnetic field. Depending on the space case, this zip also may describe a ***pellet particle*** π , possibly with a magnetic field inside, which is a tiny spherical particle having a diameter equal to the width of the pellicle. Both objects, the macrospace and the pellet particle, cannot appear simultaneously. The ***third or fourth mark zip*** $z_3(q)$ or $z_4(q)$ may describe ***electron e*** or a photon, appearing in several specific space cases.

An H-unit having an empty set of mark attributes is called a ***neutral H-unit***, indicated by H_0. Because a marked H-unit H_i uses a part of its potential energy for marking, it has less potential energy available for spatial items. We suppose that marking takes up most of its potential energy and therefore a ***marked H-unit is much smaller*** than a neutral H-unit: $\tilde{S}^i << \tilde{S}^0$ and $\tilde{s}^i << \tilde{s}^0$ The radii of these four mathematical spaces are supposed to be constants. The smallest one, marked minor space $\tilde{s}^i$, is supposed to have a diameter equal to that of a proton; the largest one, neutral major space $\tilde{S}^0$, is supposed to have an astronomical size. The marked major space $\tilde{S}^i$ is estimated as molecular or maybe larger and the neutral minor space $\tilde{s}^0$ as in between of the marked minor and major spaces, so $s^i < s^0 < S^i$. These estimations are based upon identifications of interactions with known experimental sizes of particles and molecules.

Thus we have ***three types of H-units***, each having the same amount of potential energy: Two small ones H_i being positively and negatively marked, respectively, having a minor space of atomic size and a major space of molecular size or somewhat larger (but not astronomic), and one large H-unit H_0 having a minor space of molecular size or maybe larger and a major space of astronomic size. The enormous differences in size between marked and neutral H-units allow the zipper to describe ***atomic as well as astronomic phenomena***.

To describe a specific phenomenon having electric, magnetic or electromagnetic properties, at least one H-unit of an interaction has to be marked. We distinguish ***three mark cases***: in mark case 1 both are marked in the same way, in mark case 2 they are oppositely marked and in mark case 3 one H-unit is neutral.

Next a proper space case has to be chosen, depending on which zip or zips you would like to be non-empty. We distinguish ***seven space zippers*** for interactions between H-units of equal size (both marked or both neutral) and ***twelve more*** for those with mixed sizes (one marked and one neutral). We distinguish ***four time cases***. In principle each space case may be combined with each time case, but not all combinations will result in a physical appearance, because a physical object cannot be described by an empty time zip.

The interaction of two H-units may describe elementary particles and spaces. For more complicated phenomena we need more H-units. A zipper for more than two H-units does not exist, but it is very well possible to consider ***clusters of H-units*** in a practical way. We deal with a cluster by starting with the interaction of two H-units out of the cluster and then trying to establish if some potential energy is still left to incorporate the next one, and so on. This energetic approach has been proved to be successful in descriptions of the decay of the neutron, the hydrogen atom and gravitational waves. However, in this paper we consider only phenomena which can be described by the interaction of two H-units.

In the next section we will show the procedure for describing a space. This will be more detailed as the following cases, to give an impression of how it works. In section 4 we will show particles generated by two marked H-units and in section 5 those generated by one marked and one neutral H-unit. The features of the last ones will deviate from the first ones; possible consequences of this difference for materials at a nano scale will be indicated in section 6.

Spaces Generated by Two Neutral H-units

If two neutral H-units H_{0i} and H_{0j} interact without intersecting pellicles, which is interaction $H_{0i} * H_{0j}$ in ***space case 7*** (according to the numbering in Backerra, 2018b), their major spaces partly overlap so that their pellicles are not overlapping at all [6]. The geometrical representation of this interaction is shown in Figure 3.

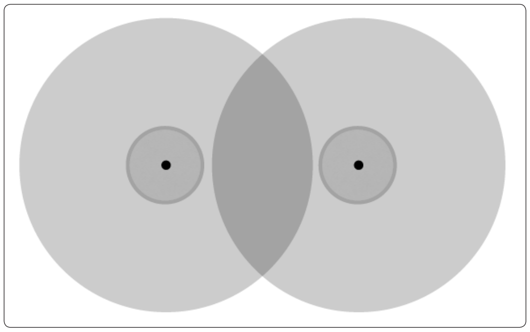

Figure 3: Representation of the mathematical description in space case 7

The space zipper is reduced to the set:

$$Z_{0i0j}(\mathbf{x}) = \left\{ \varnothing, \left\{ \Theta\left(S^{0i} \cap S^{0j} \right), \varnothing \right\}, \varnothing, \varnothing \right\}, \quad (8)$$

So only the second space zip $z_2\,(\mathbf{x})$ is non-empty, describing a neutral space. This can only appear in reality if it is combined with a suitable time zip $z_2\,(t)$. Because in all four time cases $z_2\,(t)$ is non-zero (as the only one), we take the zipper in ***time case 3*** as an example:

$$Z_{0i0j}(t) = \left\{ \varnothing, F^{0i} \setminus T_{0i} \cap F^{0j}, T_{0i}, \varnothing \right\} \quad (9)$$

Then $z_2(t)= F^{0i} \setminus T_{0i} \cap F^{0j}$, describing overlapping futures of the two H-units. Usually we combine time and space zips into a time-space zipper like this:

$$Z_{0i0j}(t,\mathbf{x}) = \left\{ \varnothing, \left\{ F^{0i} \setminus T_{0i} \cap F^{0j}, \Theta\left(S^{0i} \cap S^{0j} \right) \right\}, \left\{ T_{0i}, \varnothing \right\}, \varnothing \right\}, \quad (10)$$

containing all information about the interaction. Zip $z_3\,(t, \mathbf{x})$ contains no spatial object and so nothing appears; this zip will be dropped. Only zip $z_2\,(t, \mathbf{x})$ remains, describing a more or less ***oval object***; because it has an astronomic size, we ascribe a low energy density to it and identify it as a ***neutral space*** $\Theta_{0\,i\,0\,j}$ (see Figure 4). It exists in the described part of the time-axis, the overlapping futures.

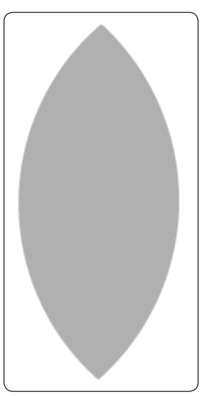

Figure 4: Representation of the generated neutral space $\Theta_{0\,i\,0\,j}$ in space case 7

If many neutral spaces Θ_{0102}, Θ_{0304}, etcetera are overlapping, the energy density in those areas increases. In Figure 5 this is indicated by the more dark areas. As soon as a certain maximum of the energy density is reached, new H-units are no longer allowed to generate space in such an area, so their energy stays potential and they may interact in another way, for instance with a marked H-unit.

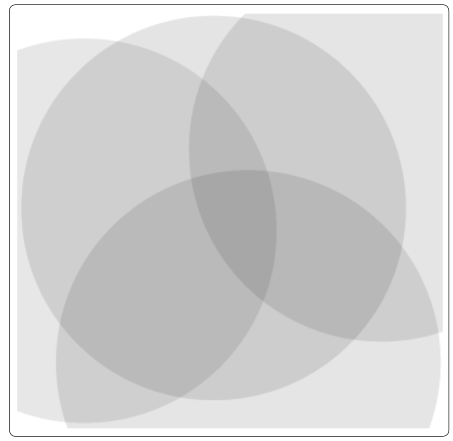

Figure 5: Representation of overlapping neutral spaces

If the H-units ***both are marked*** (i.e., interaction $H_i * H_j$), then in ***space case 7*** the generated space has the same shape, only its size is much smaller than a neutral space. The mark zipper shows that this space is magnetized, so we call it a ***magnetic space***, indicated by $\Theta_{ij}^{\mathbf{B}}$.

If ***only one H-unit is marked*** (i.e., interaction $H_i * H_0$), interacting in ***space case 7A***, then their major spaces overlap, but their pellicles and minor spaces do not. In that case their intersection is equal to the complete marked major space (because this is the smallest one) and so a ***spherical magnetized space*** may be generated, indicated by $\Theta_{i0}^{\mathbf{B}}$.

Particles Generated by Two Marked H-units

In this section we consider interactions between two marked H-units H_i and H_j, indicated by $H_i * H_j$. Their marks may be both positive, both negative or opposite; if necessary this will be indicated. By choosing several space cases, the interaction generates subsequently one type of proton, one type of neutron and two types of electrons. The type of a particle is decided by the choice of the space case. Suitable time cases are indicated without considering them in detail.

Proton of type 1

We consider interaction $H_i^+ * H_j^+$, ***coinciding*** in space. This is ***space case 1***. The mathematical representation looks the same as in Figure 1, only all attributes are doubled. The first space zip $z_1(\mathbf{x})$ describes a real, small spherical space, being the transformation of the coinciding minor spaces; in its centre there is a real point of space. The coinciding marks transform into a charge, attached to this point. The generated object is a marked solid particle σ, identified with a ***proton of type 1*** and written as σ_{ij}^+. It appears only in ***time case 1***.

The second zip $z_2\,(\mathbf{x})$ describes two ***coinciding pellicles***, transforming into a spherical ***pellet particle*** π at the surface of the proton (see Figure 6). According to the time zipper, it moves with a constant velocity over the surface of the proton. The mark zipper says that inside this particle is a magnetic field, providing the proton with spin as it turns around over its surface; thus we call it a ***spin particle***, written as $s_{ij}(p_i)$. The angle of the turning plane is arbitrary; within this plane it may turn in two directions, so the produced spin is ***up or down***. Proton and spin particle are shown together in Figure 6.

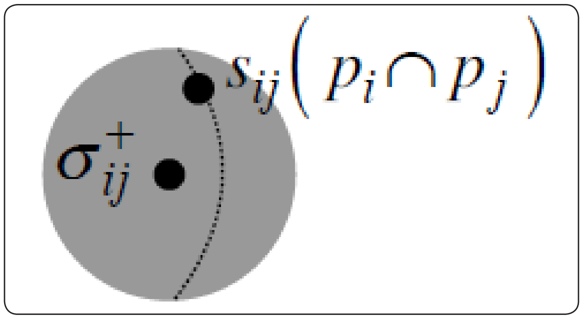

Figure 6: Proton of type 1 and its spin particle

If the marks are ***opposite,*** so for $H_i^+ * H_j^-$, the resulting charge is zero and the generated particle is identified with a neutron of type 1, decaying after some time (see Backerra, 2016b). It will play no role in this paper.

Neutron of type 2

If two marked H-units with the same or opposite marks are ***almost coinciding*** in space, which is interaction $H_i * H_j$ in ***space case 2***, then the geometrical representation of the interaction is given in Figure 7.

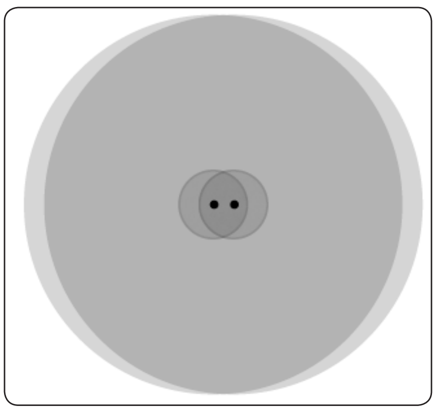

Figure 7: Representation of the mathematical description in space case 2

After transforming this into a three-dimensional physical space, $z_1(\mathbf{x})$ is an ***almost spherical*** object of atomic size, a solid particle σ. The deviation from spherical may be arbitrarily small; however, for clarity we depicted in Figures 6 and 7 a considerable deviation of spherical. Because the points of space are not coinciding, no physical point of space is described and so no charge can appear. This object is identified with a ***neutron of type 2*** (see Figure 7), written as σ^0_{ij}. According to the time zipper, the neutron appears only in ***time case 1***.

The second zip $z_2(\mathbf{x})$ describes the ***intersection of two pellicles***, which is a ring-shaped object. Like in the example of section 4.1, it transforms into a pellet particle π travelling over the surface of the neutron (see Figure 8). In this case its track is restricted to one direction. According to the mark zipper, inside is a magnetic field, providing the neutron with spin as it turns around. So again we call it a ***spin particle***, written as $s_{ij}(p_i \cap p_j)$. Inside its fixed turning plane it may turn in two directions, producing a spin ***up or down***.

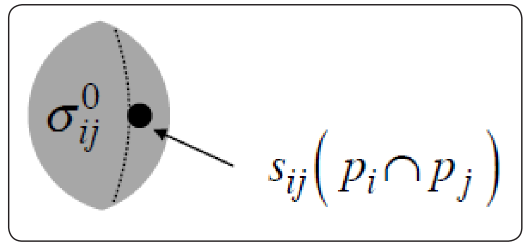

Figure 8: Neutron of type 2 and its spin particle in space case 2

Electron of type 1

If in interaction $H_i * H_j$ the ***points of space*** are located ***inside each other's pellicles***, which is ***space case 3***, then the geometrical representation of the interaction is given Figure 9.

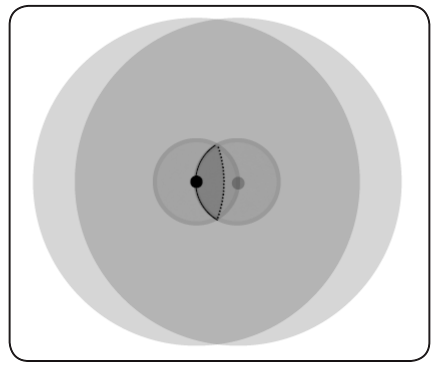

Figure 9: Representation of the mathematical description in space case 3

After transforming space zip $z_3(\mathbf{x})$, describing the intersection of the right pellicle with the left minor space, we obtain an object with the shape of a cap and a point of space in its centre, called a ***dot particle*** δ (see Figure 10). Its ***mass*** is much smaller than a proton, but much larger than a pellet particle, because it occupies a more extensive part of a pellicle. According to the mark zip it has a charge, located in its centre (the left black dot) and it moves with a constant velocity through the pellicle around the grey dot at the right, so with a radius at an atomic scale. This object is identified as an ***electron of type 1***, which we will indicate by e^1_{ij}.

Zip $z_2(\mathbf{x})$ describes the intersection of both pellicles, transforming into a ***spin particle***, written as $s_{ij}(p_i \cap p_j)$, with spin up or down. These two phenomena can appear only in ***time case 4***. Note that the spin particle is described by the same zip and written in the same way as that of the proton, but because this is another space case, it acts as the spin of an electron.

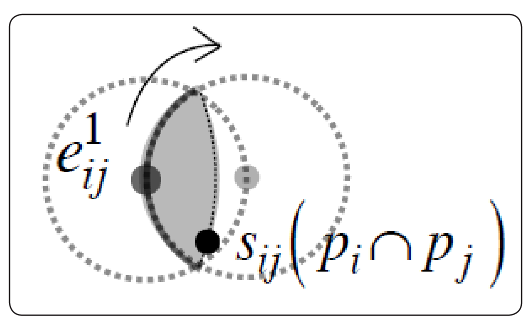

Figure 10: Electron of type 1 and its spin particle in space case 3

The electron of type 3

If the distance between the points of space of interaction $H_i * H_j$ is ***larger than twice the radius of the minor space***, which is ***space case 6***, then the minor space attributes do not intersect at all. After transforming into real time and space, two objects are described: a point and a space. The mark zipper adds a charge to the point and a magnetic field to the space. The resulting phenomena are a point charge, identified as an ***electron of type 3***, indicated by e^3_{ij}, and a ***magnetic macrospace*** $\Theta_{ij}^{\mathbf{B}}$ having a more or less oval shape (see Figure 11). According to the time zipper, they can appear only in ***time case 3***; then the time zip shows that the point of space (the black point) moves with a constant velocity around the non-appearing grey point. The dotted circles indicate the non-transformed pellicles for clarity. The electron of type 3 exists in combination with a magnetic macrospace, together revolving around the light grey dot. Now the spin is not produced by a spin particle (see Figure 10), but by the much larger magnetic macrospace $\Theta_{ij}^{\mathbf{B}}$ (see Figure 11).

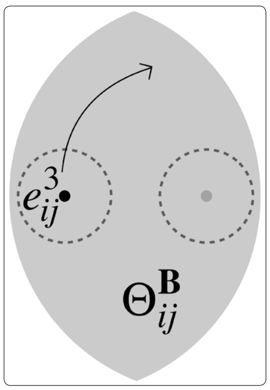

Figure 11: Electron of type 3 and its magnetic macrospace in space case 6

Particles Generated by Mixed Interactions

In this section we consider interactions between a marked H-unit H_i and a neutral H-unit H_0, indicated by $H_i * H_0$ and called ***mixed interactions***. The mark of H_i can be positive or negative and may be written as H_i^+ or H_i^-. The basic difference with the cases in section 4 is that H_0 is much larger than H_i , so their pellicles cannot coincide and the complete major space of H_i fits inside that of H_0.

Proton of type 2

We consider interaction $H_i^+ * H_0$ in ***space case 9D***. Then their points of space are ***coinciding***. Their pellicles do not coincide or intersect because they are concentric, and the marked minor space is completely overlapped by the neutral minor space. The first space zip $z_1(\mathbf{x})$ describes a spherical space, being the transformation of the marked minor space, with a real point of space in its middle. The mark Q_i^+ transform into a ***charge***, attached to this point. The generated object is a marked solid particle σ_{i0}^+, identified with a ***proton of type 2***. It appears only in ***time case 1***. The second zip $z_2(\mathbf{x})$ describes a space with the size of the marked major space, transforming into a macrospace around the proton. The mark zipper indicates a magnetic field inside, so this is ***magnetic macrospace*** $\Theta_{i0}^{\mathbf{B}}$.

The proton and its magnetic macrospace are shown in Figure 12. Note that in this case no spin particle is described on the surface of the proton. If the proton together with its magnetic macrospace is rotating around another object, then a spin will be produced, which is possibly different from the spin of the proton of type 1. We will call this a ***spatial spin***, to make a distinction with the spin produced by the spin particle. If the proton moves straight forward, as is possible in a gravitational process (Backerra 2016b), then it has ***no spin***.

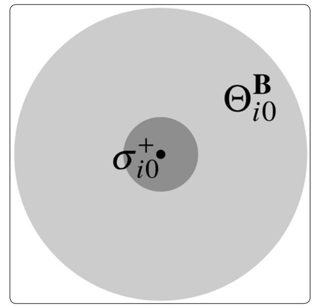

Figure 12: Proton of type 2 and its magnetic macrospace in space case 9D

Neutron of type 3

If we consider interaction $H_i * H_0$ in ***space case 9C***, the mark of H_i being positive or negative, then the points of space are ***almost coinciding***. The marked minor space still is overlapped completely by the neutral minor space, so again a solid particle σ is generated, but because no point of space appears, no charge can appear and so the generated particle is neutral. This object is identified with a ***neutron of type 3***, written as σ_{i0}^0. It is surrounded by ***magnetic macrospace*** $\Theta_{i0}^{\mathbf{B}}$. The difference between this situation and the one in Figure 12 is that the neutron deviates by an infinitesimal fraction from spherical. As in the case of the proton of type 2, the neutron of type 2 has no spin particle. If it turns around some other object, its accompanying magnetic macrospace will produce a ***spatial spin***; if not, is has ***no spin***.

Electron of type 2

If in interaction $H_i^- * H_0$ the marked ***point of space*** is located ***inside the neutral pellicle***, which is ***space case 8C***, then the geometrical representation of the interaction is given Figure 13.

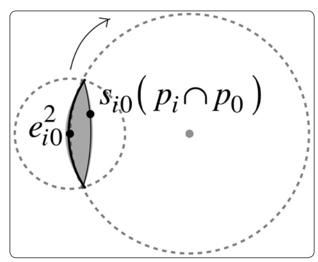

Figure 13: Electron of type 2 with its spin particle in space case 8C

Space zip $z_3(\mathbf{x})$ describes a dot particle, having the shape of a cap and a point of space in its middle. According to the mark zip, it has a charge located in this point (the left black dot) and the object moves with a constant velocity through the larger neutral pellicle around the right grey dot at the right, with a radius larger than atomic. This is identified as an ***electron of type 2***, indicated by e^2_{i0} .

Space zip $z_2(\mathbf{x})$ describes the intersection of pellicles, transforming into a ***spin particle***, written as $s_{i0}(p_i \cap p_0)$ producing a spin ***up or down***. These two phenomena appear only in ***time case 4***.

Electron of type 4

If the distance between the points of space of interaction $H_i^- * H_0$

is larger than the sum of the radii of the minor spaces (so the minor spaces do not intersect), up to the radius of the marked major space, we have ***space case 7C***. After transforming $z_2(\mathbf{x})$ and $z_3(\mathbf{x})$ into real time and space, a point and a space are described. The mark zipper adds a charge to the point and a magnetic field to the space. The resulting phenomena are identified as an ***electron of type 4***, written as e^4_{i0}, and a ***magnetic macrospace*** $\Theta_{i0}^{\mathbf{B}}$ (see Figure 14).

According to the time zipper, they can appear only in ***time case 3***; the electron moves with a constant velocity around the non-appearing grey point, together with the magnetic macrospace. The dotted circles indicate the non-transformed pellicles.

Like the electron of type 2, it has no spin particle. In principle the magnetic macrospace, revolving together with the electron, could produce a ***spatial spin***. However, if the radius of moving is of astronomic size, which is possible for the electron of type 4, then the track resembles a straight line and so ***no spin*** will appear in real life experiments

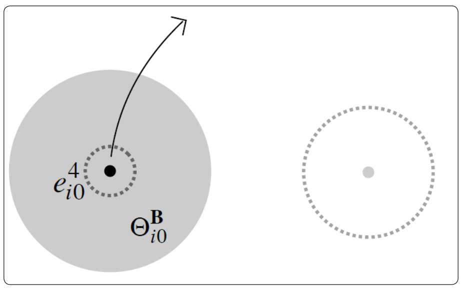

Figure 14: Electron of type 4 with its magnetic macrospace in space case 7C

Nano structured material

In section 4 we described one type of proton, two types of neutrons (of which only one will be considered here), and two types of electrons. These particles can be generated by two marked H-units at appropriate relative distances. In section 5 we replaced one marked H-unit by a neutral one and considered similar interactions as in section 4. It turned out that one type of proton, one type of neutron and two types of electrons can be generated, having different features as a consequence of the deviating spatial characteristics of the neutral H-unit.

In this section we explore the possible implications for nano structured materials. Because all marked H-units have identical spatial proportions and all neutral H-units have identical ***much larger*** spatial proportions, the difference between particles generated by two marked H-units or by one marked and one neutral H-unit will be relevant at a nano scale, which we will explain below.

We consider the transition of space and matter in a schematic representation (see Figure 15). At the left side many spaces, generated by interactions $H_{0i} * H_{0j}$, are overlapping in some way or another into the indicated 'space'. In reality $H_i * H_j$ interactions also will play a role, for instance by generating gas atoms, but we suppose that this space anyhow will be dominated by $H_{0i} * H_{0j}$ interactions, so we ignore the role of marked H-units in space. At the right side many particles generated by interactions $H_i * H_j$ are forming some structure of protons of type 1, neutrons of type 2 and electrons of types 1 and 3, together indicated as 'matter'. The particles cannot overlap each other. In reality $H_{0i} * H_{0j}$ interactions also will play a role, for instance to link elementary particles to each other (an example can be found in the hydrogen atom, see Backerra, 2018b) [6]. Anyhow we suppose that this matter is dominated by $H_i * H_j$ interactions and so we ignore also the role of neutral H-units in matter.

Obviously at the interface of space and matter is a transitional region, dominated by mixed interactions $H_i * H_0$.

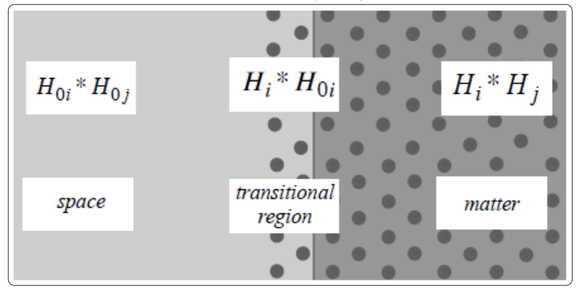

Figure 15: Schematic representation of the transition between space and matter

By removing the matter generated by $H_i * H_j$ interactions, only matter dominated by mixed interactions $H_i * H_0$ will remain and this is considered as ***nano structured material*** (see Figure 16). It contains protons of type 2, neutrons of type 3 and electrons of types 2 and 4. These ***protons and neutrons*** have no spin particles; they are accompanied by finite, spherical magnetic fields (see Figure 12). If one of these particles is revolving around some other particle, this field will produce a spatial spin, presumably different from that of a spin particle, and if the particle does not rotate, it has no spin. Anyhow this finite magnetic field, which is absent in the bulk of matter, will ***influence the magnetic features*** of the nano structured material.

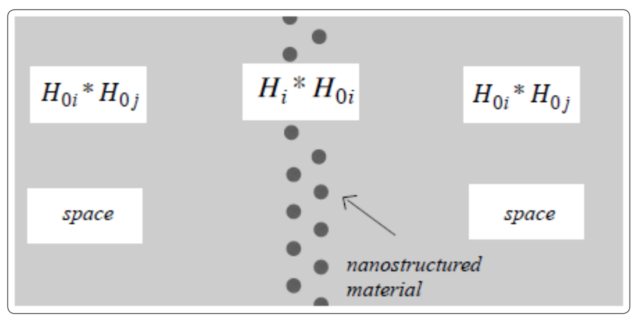

Figure 16: Schematic representation of nano structured material

To get an impression of the possible consequences of the occurrence of ***electrons of types 2 and 4*** in nano structured material, instead of the types 1 and 3 in the bulk of matter, we combined the four types in one picture (see Figure 17). The upper two are characteristic for bulk matter.

The electron of type 2 is similar to that of type 1, but it has a larger turning radius; we expect it to be molecular instead of atomic. Moreover its shape is flatter and larger, so the turning radius of the spin particle is larger. We expect that electrons of type 2 in combination with protons and neutrons will have a ***larger distance*** to them, which will influence the features of the material.

The electron of type 4 may rotate at an astronomic radius, but it may also have a smaller radius, with minimum the sum of the radii of the minor spaces, and so participate in nano structured material. In that case it may have a still larger radius than the electron of type 2.

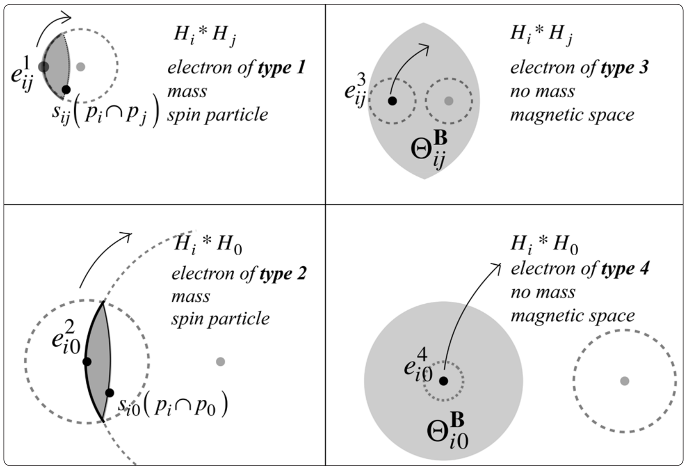

Figure 17: Overview of the four types of electrons

Conclusion

We described particles generated by two marked H-units in a geometrical way, being one type of proton, two types of neutrons (of which one is not considered), and two types of electrons. The same kind of particles can be described by a mixed interaction, between one marked H-unit and one neutral H-unit. This second series of particles has different features, as a consequence of the different spatial characteristics of the neutral H-unit. Because mixed interactions are expected to dominate nano structured material, this might be the reason for the occurrence of deviating electric and magnetic features [13,14].

The aspects which might cause these deviations are shown in Figure 17 (the lower two types of electrons). The turning radii for types 2 and 4 are larger than for types 1 and 3; we expect that the mobility of these electrons is higher. The electron of type 4 has the largest radius; it may reach to an astronomic distance and not be involved in nano structured material. We cannot yet give an estimation of its possible actual distances. If this electron actually is involved, a second deviation can be found in the different shape and larger volume of the magnetic macrospace, compared with that of the electron of type 3.

To find out more about these influences, we need more experimental data to back up the theory. So far we only known that the radius of the marked minor space is equal to the radius of a proton and the radius of the neutral major space has an astronomic size. The sizes of the two other spaces, the marked major space and the neutral minor space, are in between of them, roughly estimated as molecular or larger but not astronomic. The next step will be the search for two crucial proportions of H-units, being those between the major and minor spaces of one type, and those between the neutral and marked major (or minor) spaces of mixed types. In twin physics we supposed that these dimensions and proportions are constants of nature and if this is true, they are decisive for the dimensions in which phenomena appear to us in the experimental reality. These investigations could be carried out by comparing experimental results with possible mathematical representations of interacting H-units and relating experimental values to the obtained geometrical items.

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