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Discrete space and the underlying reality of Quantum Mechanics

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Recently there is some new interest in understanding the physical reality behind the formalism of quantum mechanics. This paper relates the known "quantum mysteries" of QM with the properties of the underlying structure of discrete space.

Introduction

The subject – understanding the physical reality of QM – is not easy to grasp because at the moment we have no realistic model of physical reality. The consequence is that we want to translate the formalism of QM into a conceptual framework that actually doesn't exist.

Because of the existence of the problem one can get the impression that QM cannot be described in normal language. But that is not true like an article in Scientific American (2001) shows.[1] Actually, it is really simple to ask comparable questions. For example, understanding the physical reality behind the formalism of the theory of Relativity. Or the Standard Cosmological model and – of course – the Standard model of elementary particles and forces. That is why I have to conclude that in physics some formalisms are more favourite that others. Because an all-inclusive concept about the universal properties of physical reality is described by the universal conservation laws, the universal constants and the universal principles. This in contrast to phenomenological reality. So it seems that the problem to understand the formalism of QM questions the phenomenological reality of QM. Although it was the interpretation of phenomenological reality – the outcome of the experiments – that created the formalism of QM.

References:
1. Max Tegmark, John Archibald Wheeler (2001), "*100 Years of Quantum Mysteries*" (https://space.mit.edu/home/tegmark/PDF/quantum.pdf).

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Physical reality

In physics, physical reality represents the mutual relations between the observable/detectable phenomena. All these mutual relations are detectable if there is a change of position and therefore a change in time. So I can state that all the observable and detectable phenomena – inclusive the amplitudes of the electromagnetic field in vacuum space – represent physical reality. Phenomena that represent concentrated energy ($E = m\,c^2$).

If the total amount of energy in our universe represents physical reality, I can write: $E = 1$. But all the mutual changes between the distributed total amount of energy are conserved, therefore: $\sum \Delta E = 0$.

Both "observations" represent different points of view. The first one describes the whole "open box" we have termed *universe* and the second one describes the mutual relations between "the contents in the open box".

It seems obvious that $E = 1$ but it doesn't answer the question: "*How large is the total amount of energy of the universe?*"

The question seems directly related to the equation $\sum \Delta E = 0$ because the continuous redistribution of all the energy within the volume of the universe determines the total amount of energy. It is easy to imagine that at one moment during the evolution of the universe nearly all the energy of the electromagnetic field is concentrated in "one point": an enormous black hole that is the result of the concentration of all the "tangible" phenomena. Although this imaginative picture seems to be a "natural" concept it ignores the fact that the local surplus of energy – the enormous black hole – isn't created with the help of an enormous local deficit of energy, a corresponding negative "hole". So we can concentrate energy from around but we cannot *create* energy with the help of a local symmetrical surplus/deficit of energy.

Actually, the existence of the zero point radiation[2] shows that there exist no volume in the universe that can be manipulated to give away its energy. Because energy is not only the detectable change itself but also the capacity to create change. There is no indication that there are regions in the microcosm and the macrocosm where the capacity to create change are minor in relation to other regions. In line with the statement that space in our universe shows a high degree of uniformity and isotropy.

Now there is only one conclusion possible: energy – the amount of change itself – is conserved but the capacity to create change is a constant everywhere within the volume of the universe. A constant that seems to be infinite because of the ability of our universe to concentrate huge amounts of energy.

References:

2. *H.B.G. Casimir (1948), ["On the attraction between two perfectly conducting plates](#)". Proceedings of the Royal Netherlands Academy of Arts and Sciences. **51**: 793–795. Retrieved 19-10-2016.*

Discrete space

Replacing a model of our universe with another model doesn't mean that the main conclusions of the first model are no longer valid. That's why it is reasonable that the framework of discrete space must affirm the conclusions in the previous paragraph.

Figure 1 shows a *schematic* picture of a volume of space that has a structure. That is why the volume is composed by units with identical basic properties. All the units together tessellate the large volume, the composed cube. The metric of the units – the minimal length scale – is l_c.

Although the image of the structure is only schematic it is possible to derive some universal "laws" from the picture. For example the shape of every unit must be the result of a basic property of every unit. Let's say "*an internal cubical shape forming mechanism*". And if one unit changes its shape all the other units around have to change their shape too because the amount of volume of every unit is invariant.

The consequence is that all the units have to change their shape synchronously. During this change of shape every unit within the large volume has changed its shape with the help of the transfer of exactly the same amount

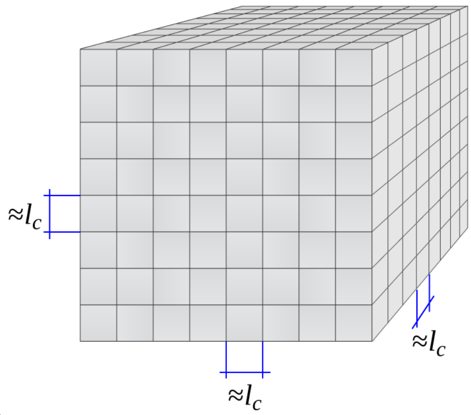

figure 1

of volume within its boundary. Because the change of the shape with an invariant volume needs the transfer of a flux of infinite small amounts of volume inside the boundary of the unit. This type of continuous topological transformations (deformation) is a kind of homeomorphism.

Energy is the change itself and the capacity to create the change. The latter is "the internal cubical shape forming mechanism" en the change itself is the amount of deformation of the shape during a certain period of time.

Suppose figure 1 is a schematic representation of discrete space itself. That means that every unit represents the basic properties of the *back ground* quantum fields. Thus one units has a scalar property (Higgs field), a vector property (the magnetic field) and the property of topological transformations, the change of its shape (electric field).

The consequence is that every unit has a scalar inside (figure 2). If I draw the spatial distribution of the scalars of a couple of units in vacuum space I get figure 3. The flat Higgs field and the electric field can exchange energy, thus the internal mechanism of every unit is not an

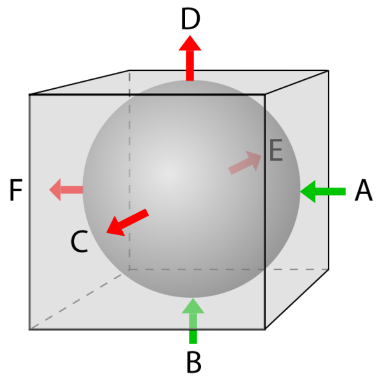

figure 2

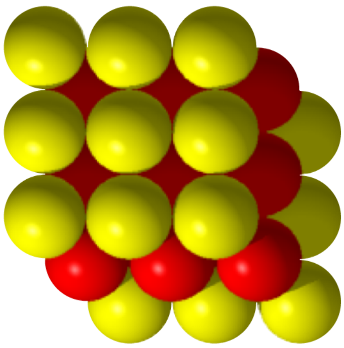

figure 3

internal cubical shape forming mechanism but an "*internal spherical shape forming mechanism*". Actually it is the scalar mechanism and the electric field is the deformed part of the scalar mechanism of every unit of discrete space. In other words, I can interpret the scalar of the Higgs field as the inscribed sphere of the unit of the structure of discrete space (see "*On the construction of the properties of discrete space*" for more details).[3]

The resistance against deforming from around is infinite for a sphere because if the radius decreases, the surface area of the inscribed sphere decreases too. Figure 4 shows the graph (r_{is} = 1,0 represents the radius of the scalar in vacuum space, *Sm* = the scalar mechanism).

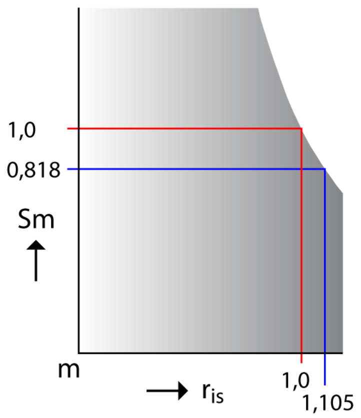

figure 4

The scalar mechanism is the capacity of every unit to change continuously its shape in such a way that the surface area of the unit is minimal (transforming the whole volume into the shape of a sphere).

All the units of discrete space transform their shapes synchronously. The consequence is that the *transformation* is fluently but also quantized. Because quantization is synchronization if space itself has a metric (composed by units with equal basic properties).

Figure 2 shows an example of the deformation of the surface area of a unit (the arrows) in a schematic way. It is obvious that the sum of all these deformations (A, B, C, D, E, F) at a certain moment is zero if the input is positive and the output is negative (or the opposite).

Conclusion: the framework of discrete space leads to the same conclusions ($E = 1$ and $\sum \Delta E = 0$).

References:
3. *S.E. Grimm* (2020), *"On the construction of the properties of discrete space"*.
DOI: 10.5281/zenodo.3909268
https://zenodo.org/record/3909268

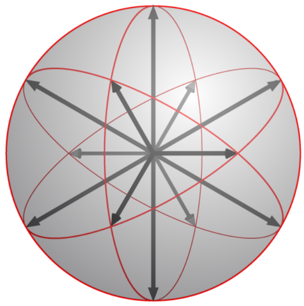

figure 5

The electromagnetic field

The magnitude of the undistorted part of a unit of discrete space – the inscribed sphere – is determined by the size of the other scalars around. A radius of the inscribed sphere that is limited by the mutual points of contact between all the scalars of the Higgs field (figure 5). The consequence is that the scalar mechanism of all the scalars in vacuum space can be interpreted as a network of vectors, the magnetic field. Each units has 12 adjacent units – see figure 3 – thus I can draw the outlines of the shape of one unit if our universe is static and every unit has a symmetrical shape (figure 6).

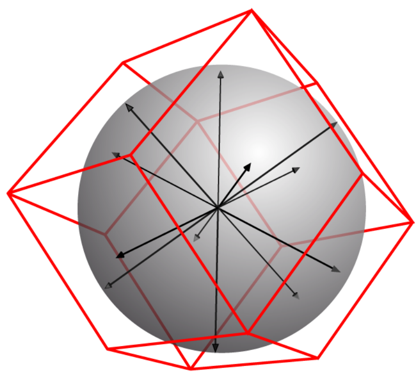

figure 6

The topological transformations of the deformed part of a unit are manifestations of the scalar mechanism of every unit. That's why the vectors in figure 6 will change their magnitude if the shape of the unit isn't symmetrical.[3]

The arrows in the schematic image of a unit (figure 2) represent a change of the shape of the unit with the help of an input deformation (A, B) and a corresponding output deformation (C, D, E, F). The amount of transferred volume within the boundary of the unit is determined by the synchronous change of the shape of all the units in the universe. Thus all the units in the universe will change some or all the input and output planes of their boundary at exactly the same moment. The consequence is that the amount of topological deformation – represented by the red output arrows – is a fixed amount and termed *one quantum* in phenomenological physics. But the topological deformation of the green arrows together represent one quantum too, because the input deformation is equal to the output deformation (every unit has an invariant volume).

In other words, the transfer of one quantum of topological deformation by the scalar mechanism within the boundary of a unit is the quantum of energy of the electric field. And it generates a corresponding change of the vectors within the scalar if the scalar is part of the flat Higgs field (vacuum space). Actually, the vectors of the magnetic field are super positioned on the vectors of the scalar itself in vacuum space (figure 5 and 6).

If the input deformation of a unit – the green arrows in figure 2 – is restricted to one plane (e.g. A) and the output deformation too (F) there is a linear transfer of topological deformation from the unit A to the unit F. All the units in the universe have identical basic properties and change their shape synchronously. The consequence is that the transfer of quanta in the universe – the pass on of fixed amounts of topological deformation – have a universal velocity, known as the constant speed of light.

Basic concepts

The ability to create change by every unit of discrete space is termed "energy" in phenomenological physics but it is the *scalar mechanism* of every unit of discrete space if the topic is about the smallest scale size of the universe. And the quantum of energy – Planck's constant – is the fixed amount of topological deformation of every unit of discrete space during the constant of time (and visa versa). Because time itself is not relative, only the relations between the observable/detectable phenomena show a relative rate of change (Einstein's theory of Special relativity). The rate of change at the quantum level is a constant.

The magnetic field is not a basic quantum field because vectors are mediated by the lattice of the scalars of the Higgs field in vacuum space (the lattice in figure 3).

Vectors act instantaneous and don't transfer energy. A scalar vector – see figure 5 and 6 – only influences the direction of the next transfer of quanta by the electric field.

If there is no matter in the universe the whole universe is vacuum space. Every unit transfers a fixed amount of topological transformation (*h*) thus the total amount of quanta transfer in the universe is conserved. Every quantum generates one or more corresponding vectors within the scalars of the units thus the total amount of vectors in the universe is conserved too (momentum is not a singular property).

Conclusion: there are 2 universal corresponding conservation laws. The law of conservation of energy and the law of conservation of vectors.

$$\sum \Delta E = 0 \text{ and } \sum \Delta V = 0 \qquad [V = \text{vector}]$$

In our universe most of the volume of space is vacuum space. That means that all the scalar vectors that are part of the vector network ("vector space") influence each other instantaneous. An influence that is termed "non-local influence".

Every unit shares its boundary with the boundaries of 12 adjacent units. If a unit transfers volume within its boundary in such a way that the volume related to one joint plane increases with 1 fixed amount of topological deformation (*h*), the adjacent unit shows a change that is the opposite. A decrease of the volume with 1 fixed amount of topological deformation (*h*).

In other words, all the mutual changes within the structure of the electric field show *wave-like* relations because the volume of every unit of discrete space is invariant. Without matter there are only wave patterns.

Quantum “mysteries”

The 2 slit experiment shows only quantum strangeness if the size of every slit is small in relation to the wave length of the photons and both slits must be very close to each other. Without these constraints there will be no quantum strangeness to observe.[4]

Discrete space itself is in rest (Aristotle’s “unmoved mover”) thus the setup of the experiment is propagating in relation to the lattice of the scalars of the units of discrete space. At any moment “vector space” determines the direction of the next quantum transfer by all the units of discrete space (and visa versa).

Every fixed amount of topological deformation that propagates in a linear direction has the speed of light. But in between the constant of time the flux of infinite small amounts of volume that will “fill” the fixed amount of topological deformation determines the constantly changing magnitude of the corresponding vectors.

If there is no forced discrepancy between the vectors and the local wave pattern there is no quantum strangeness. But if we force a discrepancy between the local wave pattern and the corresponding vectors – with the help of the 2 slits – the direct correspondence between the vectors and the local waves is reduced.

The consequence is that the local wave pattern of the electric field and the “local” vector configuration adapt more singly to these forced conditions. In other words, the use of the phenomenological point of view at the lowest scale size of reality is not really helpful.

References:

4. Thomas Young (1804), "*The Bakerian lecture. Experiments and calculation relative to physical optics*". https://royalsocietypublishing.org/doi/pdf/10.1098/rstl.1804.0001