Grand Unification of Nature: Particles and Universes. Quark Confinement and Galaxy Escaping

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Abstract. *The paper presents the foundations of a new physical theory called 'Grand Unification of Nature' (GUN). The hierarchical structure of Nature that consists of many universes embedded in themselves has been depicted. New physical transformations — similar to the Lorentz and Galileo ones but breaking a symmetry between observers — have been introduced. Using the tools, we are finally able to prove that quarks and gluons cannot leave protons and neutrons inside nuclei. It is shown that this is associated with the wave-particle duality, which explains why it is needed in Nature. A simple and very effective explanation of the hadronization phenomenon has been outlined. Using the unifying power of the theory, we deal also with galaxies. We indicate they can be older than our Big Bang. A new understanding of the energy conservation principle, taking into account this fact, has been given. We reveal the dominant reason for the accelerated cosmic expansion, and using Main Theorem of GUN once again we forecast the fate of our universe. Finally, we show that in the entire Nature space and time are exactly the same.*

1 Introduction

The work has been created as the result of the author's conjecture that seemingly as different phenomena as quark confinement and galaxy escaping can have the same cause. This supposition has been exactly confirmed; a common reason for both of these phenomena is the hierarchical structure of Nature that consists of many universes embedded in themselves. They are described and studied in a new physical theory called 'Grand Unification of Nature' (GUN).

The idea of multiple universes is not new; a lot of brilliant minds [1-13] believed that this conception could be useful. There are many reasons why the humans failed to make it to the top. The most important ones are listed below:

- ‼ They have been unable to give any concrete, available through experience, example of a universe different from ours.
- ‼ Transformations between cosmoses, similar to Lorentz ones which are the cornerstone of modern physics, have not been defined.
- ‼ They have not presented any method of transferring energy or at least information between distinct universes.
- ‼ They have not shown that in their theories one may obtain very useful results unattainable in existing ones.

GUN removes all the deficiencies, and that is why it should not be confused with those unsuccessful attempts. This does not mean that they were unnecessary, but you have to realize that they were woven from dreams.

In Section 2. we define a few basic concepts and formulate Down and Up Postulates that enable us to quickly get many examples of universes. These are, in particular, protons and neutrons. This statement may seem surprising, but it leads to the most important applications of the theory. On the other hand, from Up Postulate it follows that our Big Bang must have been preceded by our Super Bang that was responsible for the creation of the superuniverse containing our world. This allows us to use GUN in cosmology, and in this manner tiny particles and huge cosmoses are unified, which inter alia justifies the name of the theory.

Section 3. brings the definition of universe (termed also intercosmic) transformations. It is thanks to them that GUN becomes a fully scientific theory in which we can prove nontrivial theorems. In addition, a portion of GUN can be treated as a mathematical theory of such mappings.

In Section 5. we associate universes with some universe transformations. The latter are called normal, and they enjoy a mathematical property that has not yet been used in this physical context. Consequently, we are able to explain why you cannot see from Earth — even with the best telescopes — celestial bodies that circulate outside our universe, and also why no gravitational influence of other cosmoses on ours has ever been detected [14].

Unlike Lorentz and Galileo transformations (which are intercosmic as well), normal transformations are not reversible, which enables us to divide relativistic observers into external and internal ones. Nevertheless, this division is not fixed. For instance, an observer in our universe is internal with respect to that in our supercosmos, but external with respect to that in a hadron. Obviously, that is what relativity should be about. That is why GUN is, in fact, a relativity theory in which not only movement but also size is relative.

The relativity of magnitude has significant consequences. It is generally accepted that quantum mechanics is suitable for the study of small objects, whereas classical physics is more appropriate for larger ones. However, since something tiny can become huge and vice versa, quantum approach gains new vast areas of activity. This is clearly visible already on the example of our Main Theorem. Though its evidence takes place in the central part of quantum physics, the result goes for galaxies as well.

In Section 6. we give examples of normal transformations, and using somewhat in advance Main Theorem we carry out an intercosmic analysis on the futile search of proton decay [15]. It has been going on for a very long time, and GUN can help there.

In the next section we discuss our version of the energy conservation principle. It is destined for Bang-initiated universes, since they cannot have time translation symmetry of [16]. Our principle may be violated, but only if the external observer bombs the internal one (outside the region of bombing it still holds). This possibility has practical consequences: If you have found a galaxy that is older than the Big Bang, it does not necessarily mean you have made a mistake.

Section 10. brings Main Theorem of GUN. It states that, roughly speaking, if a universe has a regular — according to the external observer — shape, then it is stable (at least until when bombed). In other words, energy cannot leave the region of space-time. This involves, in particular, protons and neutrons inside nuclei and implies that quarks and gluons cannot leave them. This fact, termed ‘color confinement’, is well confirmed experimentally, but none of its analytic evidence has been provided to date.

Our proof is fully relativistic and purely quantum-mechanical. Its core is rather short, but it uses several lemmata and auxiliary formulas. The proof is based on the following three prime principles of quantum reality:

- ▣ The hierarchical structure of Nature.
- ▣ The wave-particle duality.
- ▣ The uncertainty principle.

It is worth paying special attention to the second of the above items. Until now, it is not been known why the wave-particle duality actually exists in Nature. It has been something that is, but doesn't have to, or even bothers a bit [17]. GUN shows that the duality is a fundamental phenomenon that ensures that everything around us works fine. Therefore, we take for granted that even enormous objects are de Broglie waves [18]. This means that Nature, in fact, consists of probabilities.

In this context the presence of the uncertainty principle should not come as a surprise, since the stability of atoms is implied by it as well. The first item is needed so that the next two can play their part. Nevertheless, if you are only interested in hadrons and do not believe in the existence of cosmoses that are parallel to ours, you may assume that our universe is the greatest (even if the work shows that this is not very wise).

Main Theorem is much more general than that sought in quantum chromodynamics (QCD). As color confinement is caused by the ▣ reasons, we do not have to assume that strong interaction is always attractive. A suggestion to use this possibility has been presented in Sections 14. and 15., whereas in Sections 13. and 16. we have outlined a simple albeit very effective explanation of the hadronization phenomenon.

In Sections 18. and 19. we deal with problems related to cosmic expansion, both with and without acceleration. Let us recall that observations of very distant galaxies indicate that Hubble's law ceases to hold for them [19, 20]. Thus classical cosmological models [21, 22] are no longer true, and new reliable ones have not been presented. We show that the existence of our supercosmos can explain a lot about this matter.

GUN gives answers to questions such as whether an initial singularity had to occur, where the missing antimatter is, what was before the Big Bang or what interactions caused it. In our opinion, a reply like "There was nothing" is no reply, especially when someone is unable to credibly clarify what happened from the Big Bang to today [23]. For this raises the suspicion that we should necessarily know what was earlier.

In the final part of the work we consider some metaphysical (i.e., concerned with the most basic properties of Nature) issues. For instance, in Section 22. we come to the conclusion that parallel worlds cannot have completely different laws of physics. In GUN their algebraic formulas can be distinct, but should be similar in a topological sense.

The most interesting problem is, obviously, that of time's arrow. We all know that Lorentz transformations treat space and time on a par. Nonetheless, the latter remains a distinguished dimension of space-time, and some processes are time irreversible. In Section 24. we show that at the most general level of Nature the Minkowski space-time (which does not physically exist anyway [24]) can be replaced by the Euclidean $\mathbf{E}^4$. The speed of massive objects remains bounded, although the traditional inequality should be replaced by (33). Our explanation is much more general and simpler — we do not need imaginary numbers — than given in the known paper [25].

Therefore, space and time are exactly the same. The dichotomy between spatial and temporal dimensions and the arrow of time appear only during Super Bangs. This should end the discussion on this topic (but our Super Bang will, of course, be examined in this regard).

2 Universes

The main purpose of this section is to quickly obtain a lot of *universes* called also — entirely equivalently — *cosmoses* or *worlds*. By them we mean complex objects that can be represented by sets of events and have some additional properties. If a universe U is included in U', we say that U is a *subuniverse* of U', and U' is a *superuniverse* of U. If the cosmoses are distinct, they are termed *proper*. The intersection U' of all proper superworlds of U is called the *immediate superworld* of U whenever $U \neq U'$.

Although below we refer to such notions as interaction or its strength, no precise definitions are needed. We assume that all universes have the same physical interactions, comparison relations between their strengths remain unchanged, but the features 'fundamental' and 'residual' can vary. The latter term means, of course, that the force acts between objects that do not carry a charge but do contain components that enjoy the charge, whereas the former field works directly.

We start with the following recursive dual postulates

- (DOWN POSTULATE.) *If in a universe an interaction is the weakest residual stronger than all fundamental ones, then it acts between objects of its subworlds, and applying Up Postulate to them the former cosmos can be obtained.*

- (UP POSTULATE.) *If an interaction is the strongest fundamental one of a universe, then its immediate superworld exists, the interaction works in it, and applying Down Postulate to them the former cosmos can be obtained.*

Let us try to use first Down Postulate. Because the strong interaction is short-distance in our universe, we suppose that it is residual. As it is stronger than electromagnetism and gravity, it should act between objects of worlds contained in our cosmos. We know that the worlds are termed hadrons, and the objects are quarks and gluons.

The only new thing here is just to say that hadrons are universes. As a justification, we may mention that — in probably unanimous opinion of nuclear physicists — the particles are very different from nuclei and atoms. For instance, there are sea quarks [26], but there are no sea protons, neutrons and electrons. Nonetheless, you may object by saying that hadrons are tiny, and cosmoses should be large. You are absolutely right, but you ought to wait for further developments.

Now let us concentrate on the latter postulate. In our universe the only long-distance interactions are electromagnetism and gravity. This condition is not sufficient to be fundamental, but they operate without restrictions on electric charges and energies. In addition, the former interaction is stronger than the latter. Thus applying Up Postulate we get the existence of a very important universe — hereinafter referred to as 'our supercosmos' — that contains our world. Note that the use of the word 'immediate' implies that the new cosmos is unique.

At this point, you can protest again by saying that astronomers currently enjoy excellent telescopes, so if the superuniverse really existed, they would see it. Well, the situation is that even the best devices — capable of measuring various physical quantities — would not help them, and that is why, among other things, the paper has been written. Nevertheless, below we shall show that there is indirect evidence of its existence.

In the postulates the recursion has been used for the sake of simplicity and can be easily eliminated. For example, in the iterative version of Up Postulate the clause 'and…' should be replaced by: *and the interaction is the weakest residual one stronger than all fundamental interactions of the superworld.* This means that if an intelligent observer were in our supercosmos, using Down Postulate they could deduce our existence.

Similarly, in the final part of Down Postulate we would have: *the interaction is the strongest fundamental one in the subworlds, and the former cosmos is their immediate superworld.* Thus if a researcher lived inside a hadron, they could suppose by virtue of Up Postulate that our universe might be.

In the paper we omit weak nuclear forces because it has been discovered that at distances about 10^{-18} meters the weak and electromagnetic interactions enjoy comparable strengths [27]. The exact equality is to be correct, and the difference at larger distances is being explained by the mass of intermediate bosons. Hence our postulates, based on strength analysis, cannot distinguish between them, and we have to include the former interaction in the latter. Nonetheless, we will be able to get back to this issue if they measure that weak forces are stronger than electromagnetic ones (because the hammer blow hurts more than the flashlight beam).

On the other hand, we take into account a new field with the working name 'baryonic'. If it exists, it is stronger than all the interactions known so far. That is what can make quarks and even electrons cosmoses.

The following proof is very easy, but we give it here because these things are completely new.

PROPOSITION 2.1. *The only fundamental interaction of our superuniverse is gravity.*

Proof. According to Up Postulate, in the cosmos electromagnetism should be the weakest residual interaction stronger than all its fundamental ones. Hence the baryonic, strong, and electromagnetic interaction cannot be fundamental.

Now suppose that gravity is residual. Then it is the weakest residual force stronger than all fundamental ones, a contradiction. ■

The number n of fundamental interactions that work in a cosmos is said to be the *degree* of the world, and the universe is often denoted by Un. Thus our universe has a degree of 2; it will be frequently referred to as 'our $U2$'. From Proposition 2.1. it follows that our $U2$ is contained in our $U1$, and applying Up Postulate to the latter we get that all cosmoses are subuniverses of $U0$, i.e., the only world that has a degree of 0. On the other hand, hadrons are worlds of the third degree, that is, $U3s$.

This is where you might ask: How do all these cosmoses come into being? The answer is simple. With the exception of $U0$, which always exists, all the others are created by a collision (decay of another universe, maybe). This term is being used in particle physics, while cosmologists, etc., say 'Big Bang'. These names may continue to be used, but it can be noted that this is our Big Bang. In the case of $U1s$ a natural term is 'Super Bang'. In particular, before our Big Bang our Super Bang must have happened. Other suggestions are given in Fig. 1.

<table>
<tr><th colspan="4">Universes</th><th colspan="4">Interactions</th></tr>
<tr><th>Degree</th><th>Symbol</th><th colspan="2">Origin</th><th colspan="2">Strongest fundamental</th><th colspan="2">Weakest residual</th></tr>
<tr><td>*0*</td><td>$U0$</td><td colspan="2">—</td><td colspan="2">—</td><td colspan="2">*Gravity*</td></tr>
<tr><td>*1*</td><td>$U1$</td><td colspan="2">*Super Bang*</td><td colspan="2">*Gravity*</td><td colspan="2">*Magnetism*</td></tr>
<tr><td>*2*</td><td>$U2$</td><td colspan="2">*Big Bang*</td><td colspan="2">*Electromagnetism*</td><td colspan="2">*Strong*</td></tr>
<tr><td>*3*</td><td>$U3$</td><td>*Small Bang*</td><td>*Tiny Bang*</td><td>*Strong*</td><td>*Baryonic*</td><td>*Baryonic*</td><td>—</td></tr>
<tr><td>*4*</td><td>$U4$</td><td colspan="2">*Tiny Bang*</td><td colspan="2">*Baryonic*</td><td colspan="2">—</td></tr>
</table>

Fig. 1. The hierarchical structure of Nature.

Concluding the section, let us consider if there can be universes whose existence cannot be derived with use of our postulates. You may ask, for example, whether there is a universe parallel (i.e., disjoint) to $U0$. We prefer to leave the issues open. We could easily formulate additional postulates that would limit the family of cosmoses, but what for? Perhaps someday someone will find important reasons to introduce other worlds into GUN. Nevertheless, as we would not like to duplicate misguided ideas [28-33] made in creating the so-called multiverse [34-37], this should be done in a scientific way.

3 Universe transformations

Suppose that U and U' are two universes (or, alternatively, O and O' be observers that exist in them correspondingly). Let n and n' be the numbers of their spatial dimensions. By an *intercosmic* or *universe transformation* from U to U' (or from O to O') we mean a map

$$(\sigma, \tau)\colon \mathbf{E}^n \times \mathbb{R} \to \mathbf{E}^{n'} \times \mathbb{R}$$

that assigns to every event $(\boldsymbol{r}, t)$ in U (of O) an event

$$\big(\sigma(\boldsymbol{r}, t), \tau(\boldsymbol{r}, t)\big) = (\boldsymbol{r}', t')$$

in U' (of O') in such a manner that the following condition is satisfied:

✱ (i) (*Topology*.) (σ, τ) is a homeomorphic embedding.

The mappings σ and τ are termed *space* and *time transformations* respectively.

The simplest examples of universe transformations (the most important of them will be marked as above) are Galileo and Lorentz ones. In those cases we have $n = n' = 3$, but in general we allow even that n and n' are infinite. We assume that $\mathbf{E}^{\infty}$ is a real vector space with countably infinite basis. It consists of vectors that have almost all components equal to 0, which implies that the metric is well-defined.

(i) means that both of these observers go in for, essentially, the same physics, although the numerical results of their measurements can be completely different. How to check this condition is demonstrated in the proof of Proposition 12.1. From (i) we get immediately

COROLLARY *3.1. A universe transformation is injective*. ■

COROLLARY *3.2. The image of a universe transformation is open*. ■

Other properties of the set will not be needed in this work.

(i) can be reformulated in the following fashion: (σ, τ) is continuous, one-to-one, and the inverse transformation defined on the image is continuous as well. Let us note that we do not require (σ, τ) to be onto and differentiable; we shall see that there are intercosmic transformations that have a physical meaning, but are not differentiable at some events.

Since we already have transformations, we should consider the speed change caused by them, but there is a problem here. As the current theory is quantum, we cannot speak of particles that have a velocity at an event (it is well known that, because of the uncertainty principle and wave-particle duality, quantum particles do not have trajectories). For this reason, we introduce the mathematical notion of a *path* that is any mapping from an open real interval to $\mathbf{E}^n \times \mathbb{R}$. For convenience, you may always assume that its domain (note that it is no time) contains 0. This is possible, since two paths p and q such that we have $p = fq$ for a continuous monotone function f can be regarded to be identical.

We say that a path $p(x) = (\boldsymbol{r}(x), t(x))$ has a velocity $\boldsymbol{v}$ at a point x_0 (or at the event $p(x_0)$ whenever this does not lead to a misunderstanding) if

$$\lim_{x \to x_0} \frac{\boldsymbol{r}(x_0) - \boldsymbol{r}(x)}{t(x_0) - t(x)} = \boldsymbol{v} \tag{1}$$

and the path is continuous at x_0. This condition is essential because the limit of (1) can exist even if it is not fulfilled. We reject such cases, since they have no physical meaning. On the other hand, if a particle could travel along a path, their velocities would be the same.

Now using differential calculus one can easily prove that if $\boldsymbol{v}$ is the velocity of a path at an event $(\boldsymbol{r}, t)$, and a transformation (σ, τ) is differentiable at it, the image of p — i.e., the path $p'(x) = \big(\sigma p(x), \tau p(x)\big)$ — has at $(\boldsymbol{r}', t')$ the speed

$$\boldsymbol{v}' = \frac{\dfrac{\partial \sigma}{\partial \boldsymbol{v}} + \dfrac{\partial \sigma}{\partial t}}{\dfrac{\partial \tau}{\partial \boldsymbol{v}} + \dfrac{\partial \tau}{\partial t}}. \tag{2}$$

The directional derivative of a vector function that occurs above should be defined by coordinates. Remember also that $\partial f/\partial \boldsymbol{v} = |\boldsymbol{v}|\partial f/\partial \boldsymbol{v}^\wedge$. You can verify (2) applying it to Galileo and Lorentz transformations; then you will obtain the classical and relativistic composition law for velocities correspondingly. We shall see that if the transformation is not differentiable at an event, in some cases the transformed velocity can be still determined with use of continuity.

In the case of accelerations (defined analogously to velocities) we have

$$\boldsymbol{a}' = \frac{\dfrac{\partial \boldsymbol{v}'(\boldsymbol{v})}{\partial \boldsymbol{a}}}{\dfrac{\partial \tau}{\partial \boldsymbol{v}} + \dfrac{\partial \tau}{\partial t}}, \tag{3}$$

whenever the derivatives exist at $(\boldsymbol{r}, t)$, and $\boldsymbol{v}'$ is treated as a function of $\boldsymbol{v}$.

There is a basic dichotomy that divides the mappings between universes. A space transformation is termed *synchronic* if it does not depend on time, and *diachronic* otherwise. The same terminology involves intercosmic transformations. Obviously, Galileo and Lorentz transformations are diachronic, whereas in this work synchronic ones are more important.

Let us add that in GUN you can also consider transformations between cosmoses, which do not meet (i), but are, e.g., continuous. Nevertheless, the need for their introduction should be well justified from a physical point of view.

4 Motionless transformations

A universe transformation is called *motionless* if

✱ (ii) (*Motionlessness.*) The transformation preserves angles between location vectors and changes their magnitudes in a continuous manner.

In the case of space transformations that satisfy the condition we say also that they are *motionless.* For instance, a Lorentz or Galileo transformation is motionless if and only if the relative speed vanishes.

(ii) implies that there are $\mu: \mathbf{E}^n \times \mathbb{R} \to \mathbb{R}^+$ and an isometry $\iota: \mathbf{E}^n \to \mathbf{E}^{n'}$ preserving the magnitudes of vectors such that

$$\boldsymbol{r}' = \mu(\boldsymbol{r}, t)\iota(\boldsymbol{r}^\wedge). \tag{4}$$

In the simplest case it suffices to check the extremely short condition

$$\boldsymbol{r}' \parallel \boldsymbol{r},$$

that is, $n = n'$, and ι is the identity. We will assume this, as a rule, in the following proofs because ι does not matter.

Frequently, instead of μ it is more convenient to use the mapping $\mu^\wedge$ defined by

$$\mu^\wedge(\boldsymbol{r}, t) = \frac{\mu(\boldsymbol{r}, t)}{|\boldsymbol{r}|},$$

where we take into account continuity if $\boldsymbol{r}$ vanishes (from the clause 'and…' in (ii) it follows that this is always feasible). Note that this gives three possible positions of the character ^ in (4). Both of these functions may enjoy limited or modified domains, for example, if they do not depend on time or they depend solely on the magnitude of vectors. In GUN μ and μ^ play a role similar to the role of the relative observer speed in special relativity.

A time transformation τ is said to be *full* if it satisfies $\tau(\boldsymbol{r}, \mathbb{R}) = \mathbb{R}$ whatever $\boldsymbol{r}$ is. A universe transformation with a full time transformation is termed *full-time*. For example, Lorentz and Galileo transformations are full-time. We have the following important

THEOREM 4.1. If a motionless synchronic transformation is full-time, then for every vector $\boldsymbol{r}$ the mapping $\mu(.\boldsymbol{r})$: $\mathbb{R}^+ \to \mathbb{R}^+$ is increasing.

Proof. We prove first that the map is injective. Suppose that $\mu(x\boldsymbol{r}) = \mu(y\boldsymbol{r})$ for distinct nonzero x, y (it is sufficient thanks to continuity). As $(x\boldsymbol{r})$^ = $(y\boldsymbol{r})$^, by virtue of (4) $(x\boldsymbol{r})' = (y\boldsymbol{r})'$ whatever time instants are. According to (i) τ has to be continuous, so the sets $\tau(x\boldsymbol{r}, \mathbb{R})$ and $\tau(y\boldsymbol{r}, \mathbb{R})$ are connected. From Corollary 3.1. it follows that they are disjoint, whence τ cannot be full.

By continuity of σ, if $\mu(.\boldsymbol{r})$ were decreasing, the limit of $\sigma(x\boldsymbol{r}, t)$ with x that tends to 0 would be equal to a nonzero vector, whereas from (ii) it follows that it should be equal to $\mathbf{0}$. ■

In the case of synchronic transformations σ will frequently be treated as a unary map defined on $\mathbf{E}^n$. Applying this convention we get

COROLLARY 4.2. If a motionless synchronic transformation (σ, τ) is full-time, then σ is one-to-one. ■

5 Normal transformations

A universe transformation is called *normal* if it fulfills the following, breaking symmetry, condition

✱ (iii) (*Normality*.) The transformation is motionless, τ is full, and σ is bounded.

This terminology may be, not too seriously speaking, justified by the facts that finite and non-zero size appears to correspond to person's normal weight (infinite size to overweight, and zero one to underweight), and from Corollary 3.2. it follows that the image of σ is open. We will see that the two last conditions of (iii) are, in a sense, complementary.

Instead of σ, in (iii) you could use μ equivalently (and by continuity from (ii) μ^ also enjoys this property). Note that the counterpart of the latter, i.e., the relative observer speed is bounded as well, and we shall see that both of these types of boundedness lead to very similar effects. Of course, due to the last condition, (iii) is no longer satisfied by any Lorentz or Galileo transformation.

We assume that

❖ (SUBWORLD FORMULA.) *If U is a proper subuniverse of U', then there is a normal transformation of U to U', whereby its domain is finite-dimensional.*

This postulate explains why an internal observer O that exists in U cannot see U' and other subworlds of U'. The astronomers of O direct telescopes on all sides of their universe, but (since their space is $\mathbf{E}^n$) nowhere can they discern any boundaries. At first they think that their world is static, but — as technology develops — they find that neighboring objects, called by them 'galaxies', escape into space.

The experimenters of O may try to use other devices to detect a gravitational flow caused by matter with a mass M_1 in a parallel cosmos. Suppose that in the universe of O there is an object with a mass M_2. The interaction between them would be proportional to

$$\frac{M_1 M_2}{r^2}.$$

You should put $r = \infty$ here, which explains why the experiments described in [14] did not yield any positive results. (Obviously, this solves Olbers' paradox as well.)

Simultaneously, an external observer O' sees U as an object of finite size. One of further possible scenarios could be as follows. Initially, O' thinks that U is a point and calls it an elementary particle. As science progresses, the researchers of O' find that U has nonzero sizes. They also see 'galaxies', but call them 'sea quarks'. The scientists do not believe that quarks are fleeing; their thought rather is that the particles are confined. We will come back to these problems later.

Since, according to Subworld Formula, a normal transformation always exists, we will define some notions that use it. For instance, the subworld is *synchronic* if so is the transformation. Furthermore, in such contexts the prefix 'sub' may be omitted whenever this does not lead to misunderstanding.

Because in normal transformations σ is bounded, we can say about the shape of a subuniverse. By the *shape at* t' of a transformation we mean the subset of $\mathbf{E}^{n'}$ that consists of all vectors $\boldsymbol{r}'$ such that

$$\sigma(\boldsymbol{r}, t) = \boldsymbol{r}',$$
$$\tau(\boldsymbol{r}, t) = t',$$

for some $\boldsymbol{r}$ and t. Thus the image of σ is the union of all shapes. We have

PROPOSITION 5.1. *All shapes of a synchronic and full-time transformation are identical.*

Proof. Let $\boldsymbol{r}'$ belong to the shape at t'. Fullness implies that for every real u' there is u such that $\tau(\boldsymbol{r}, u) = u'$. From synchronicity it follows that $\sigma(\boldsymbol{r}, u) = \boldsymbol{r}'$. ■

We see that synchronic subcosmoses have a fixed shape, whereas diachronic subworlds can, e.g., pulsate.

By the *edge* of a subuniverse we mean the topological boundary (closure minus interior) of the image of (σ, τ). We shall use this definition even if the transformation is not normal. For instance, an external observer may move with respect to the normal one.

We shall say that a particle (object, etc.) *occurs arbitrarily close to* (*approaches to, recedes from,* etc.) the edge if there is a sequence $\{\boldsymbol{r}_k, t_k\}$ of its events under the internal observer such that the limits

$$\left(\lim_{k\to\infty} \boldsymbol{r}'_k, \lim_{k\to\infty} t'_k\right) \tag{5}$$

exist, and the event belongs to the edge. From Corollary 3.2. it follows that you may equivalently require the event not to belong to the image of (σ, τ). We have

PROPOSITION 5.2. A particle occurs arbitrarily close to the edge of a synchronic subuniverse if and only if there is a sequence $\{\boldsymbol{r}_k\}$ *of its locations inside the subworld such that the limit* $\lim_{k\to\infty} \boldsymbol{r}'_k$ *exists, but it does not belong to* $\sigma(\mathbf{E}^n)$.

Proof. Sufficiency follows from fullness; we may assume that $\{t'_k\}$ is constant. Now suppose that the event (5) exist and does not belong to the image of (σ, τ). As $\lim_{k\to\infty} \boldsymbol{r}'_k$ does not belong to the shape of the subworld at $\lim_{k\to\infty} t'_k$, by Proposition 5.1. it does not belong to $\sigma(\mathbf{E}^n)$. ■

This suggests that by the edge of a synchronic subuniverse we may also mean the boundary of $\sigma(\mathbf{E}^n)$, whereby the second limit of (5) may not exist. Then in Proposition 5.2. one might replace the final clause 'does…' by 'belongs to the edge of the subcosmos'.

The synchronic case is the most important, and it is completely consistent with the principle of uncertainty because we do not need to consider the particle times. If an external observer moves with respect to the normal one, we have to take into account the times, at least in theory. Nevertheless, Proposition 5.2. indicates that the edge remains, as a matter of fact, a spatial mechanism. Note that it could be untrue if a normal transformation were not full-time (as then leaving the subuniverse could be caused by temporal reasons).

Of course, in a cosmos there are observers moving with relative velocities. They can be constant, but this is not necessary; we may assume that there is a universe transformation between each two of them. Therefore, (i) gives

COROLLARY 5.3. If an observer in U states that a particle occurs arbitrarily close to the edge of a subuniverse, then every observer in U finds the same.■

6 Regular transformations

The rationale for this terminology can be the fact that ordering is connected with regularity. Therefore, a transformation is called *regular* if

- ✱ (iv) (*Regularity*.) The transformation is normal, and $\mu^\wedge$ is weakly monotonic with respect to vector magnitudes.

The latter condition should be understood in the following way: $\mu^\wedge$ either preserves or reverses the relation $\leq$ between vector magnitudes. Let us note that by virtue of normality $\mu^\wedge(\boldsymbol{r}, t)$ converges to zero when $|\boldsymbol{r}|$ tends to infinity. Thus the relation $\leq$ has to be reversed, and the regularity condition takes the form

$$|\boldsymbol{p}| \leq |\boldsymbol{r}| \;\;\Rightarrow\;\; \mu^\wedge(\boldsymbol{p}, s) \geq \mu^\wedge(\boldsymbol{r}, t),$$

whatever $\boldsymbol{p}, \boldsymbol{r}, s, t$ are. This immediately implies that a regular transformation is synchronic, and even that $\mu^\wedge$ depends only on the magnitude of vectors. Therefore, $\mu^\wedge$ can be treated as a mapping defined on $\mathbb{R}^+$, and it is non-increasing. Conversely, if you have found a non-increasing continuous function $\mu^\wedge\colon \mathbb{R}^+ \to \mathbb{R}^+$ such that $r\mu^\wedge$ is bounded and increasing (cf. Theorem 4.1), you have got a regular transformation (possible time transformations are given in Section 12.).

Transformations described by formulas

$$x' = x\mu^\wedge(r),$$

$$y' = y\mu^\wedge(r),$$
$$z' = z\mu^\wedge(r),$$

where $r = \sqrt{x^2 + y^2 + z^2}$, and $\mu^\wedge$ is continuous on $\mathbb{R}^+$, are motionless. They were the first universe transformations considered by the author.

If the mapping $\mu(r) = r\mu^\wedge(r)$ is bounded and increasing on $\mathbb{R}^+$, the transformation is normal. If, in addition, $\mu^\wedge$ is non-increasing, it is regular. A cosmos with this transformation has the shape of an open ball with the radius $\lim_{r\to\infty} \mu(r)$. All the conditions are satisfied by, in particular, an *antilinear* transformation, i.e., such that

$$\mu^\wedge(r) = \frac{1}{Z + Ar},$$

where A and Z are positive. Most frequently, Z is equal to 1, which means that both of these observers use the same units.

Another transformation can be defined by

$$x' = x\mu^\wedge(x, y, z),$$
$$y' = y\mu^\wedge(x, y, z),$$
$$z' = z\mu^\wedge(x, y, z),$$

where

$$\mu^\wedge(x, y, z) = \frac{1}{Z + \sqrt{A^2x^2 + B^2y^2 + C^2z^2}},$$

and A, B, C and Z are positive. The transformation is normal. A subuniverse that enjoys it has the shape of an ellipsoid with the principal semi-axes $1/A$, $1/B$, and $1/C$. Of course, this concept can be generalized to n dimensions with n parameters under the square root. If all they are equal, we obtain an antilinear transformation again.

We assume, like probably the majority of physicists, that protons and neutrons have a spherical shape, especially when they are tightly packed inside nuclei. Thus they can be regarded as regular universes, and — as we shall see — Main Theorem of GUN states they are stable. On the other hand, free neutrons can be irregular, which causes that they are unstable. Only when strong interaction binds them in a nucleus, their transformations are changed to regular.

Experiments [38] have been done showing that under certain conditions (produced by, e.g., quarks that travel nearly at light speed) protons seem to enjoy a non-spherical shape. However, we have to be careful because the fact that somebody is running around the room does not imply yet that there is a hole in the floor. In other words, the region where quarks occur can be inscribed in a sphere. Those results should be able to be explained after developing an improved theory of strong interaction.

In addition, we advise to investigate what is the lifetime of protons of [38], for if they have actually changed shape, they can be irregular and therefore unstable. Here it is worth doing the intercosmic analysis of why, in spite of serious experimental effort, no proton decay has been observed [15, 39] so far.

Suppose that hydrogen atoms are stable. Because hydrogen ions are formed by the electromagnetic field, which cannot create proper subcosmoses of our $U2$, their transformations remain unchanged, i.e., regular, and this fact is more important than any conservation principle. Even if $B - L$ holds, the antilepton and pion [40] will not be able (especially the former) to leave the space-time region that contains the subuniverse.

Only if protons are processed using strong interaction, there is a chance that they will become unstable.

7 Energy

By *energy* we mean the ability to be subject to gravity (we omit the details here). Since universes (apart from $U0$) are formed during their Bangs, they do not have time translation symmetry. Thus the conservation of energy cannot be introduced by using Noether's theorem [16]. Instead we formulate the following

- *(ENERGY CONSERVATION PRINCIPLE.) The average total energy contained in a universe is equal to its initial value.*

The word 'average' has been added due to the uncertainty principle; it means that if you could perform many measurements in a time unit, the mean would tend to a value satisfying the equality. Of course, the relation should be considered from the viewpoint of an inertial observer located in the world, since there is no universe transformation in this context (the same goes for the next postulate).

One thing should be emphasized: in GUN this principle is neither a postulate nor a theorem. This is just a condition that can be fulfilled or not. However, we have two following postulates associated with energy.

- (GROUND STATE.) *The average total energy of a universe is constant during an initial time interval.*

This postulate ensures that there is an initial value of energy. Furthermore, the energy conservation principle is satisfied right after the Bang of the cosmos.

- (FINITE ENERGY.) *The energy of a proper subuniverse cannot tend to infinity within a finite time interval, according to both internal and external observers.*

Obviously, both of these observers assign distinct values of energy to the subcosmos. For instance, the external one takes into account the binding energy, while the internal one knows nothing about it. Indeed, the latter can, in principle, calculate the sum of all the constituent parts of their world, but they are not able to compare the result with something else.

Now we can prove the following, very important for practice,

THEOREM 7.1. The average total energy of an isolated system included in a universe of nonzero degree remains constant whenever in the world either the conservation of energy holds or the principle is violated by processes situated outside the system.

Proof. Suppose that there is a process of the system, which permanently increases its energy by L different from zero, and the principle has been met so far. As the system is isolated, the probability that the energy of the rest of the world is increased by $-L$ vanishes. By virtue of the postulate of Finite Energy, the total energy of the whole universe is finite. Thus it is increased by a nonzero value, and the energy conservation principle of the world is violated.

Now suppose that the principle has been already violated by processes located outside the system. Since it is isolated, it does not receive information about the fact. As the current theory is quantum, we believe that there are probabilities of the results of experiments being performed in the system. If they were changed, it would mean (also in line with information theory) that the information had been sent. Thus we have to assume that the probabilities remain unchanged, and — taking into account the postulate of Ground State — the system works as if the energy conservation principle was still fulfilled. ■

We see that our formulation would imply the classical understanding of this principle if we accepted it as a postulate (this would impoverish the conception). Note that the clause 'of nonzero degree' cannot be omitted here. This follows from the fact that we have to assume that the total energy of $U0$ is infinite. Indeed, otherwise we would have a strange primary parameter (we discuss these matters in more detail in Section 11.). Therefore, although the principle of energy conservation is always met in $U0$, Theorem 7.1. does not hold; energy can disappear and arise from nothing.

According to the postulate of Ground State, Nature begins to try to maintain a constant energy value of a cosmos right after its creation. Usually this is successful, at least on average, but there are situations in which Nature has to give up. This can happen when, e.g., the experimenter bombards hadrons with leptons or our $U2$ assimilates galaxies (sometimes older than our Big Bang) from our $U1$. Then the principle of energy conservation is violated, but later it can be restored.

Instead of saying that the principle holds, in GUN you may say that the universe is in the *ground* state. Furthermore, it can be in an *excited* (*underground*) state if its energy is greater (less) than the initial one. (It is possible that our universe used to have energy less than the initial one, but notwithstanding this fact it did not decay).

If an object of our $U1$ has got inside our universe, it does not have to affect experiments that are being performed on Earth (unless the meteorite has hit the lab). This is implied by the clause that begins with 'or' in Theorem 7.1. We have assumed in its proof that it is impossible to exchange not only energy but also information (since GUN is a quantum theory) with an isolated system. You can create such an approximate system on your desk. By virtue of Ground State it will adhere to the principle of energy conservation, although in our universe it has already been, most probably, violated. To behave differently, your system would have to receive a piece of information, but — even if there was a special message — there is no one to transmit it.

8 Matter wave uncertainty

In the proof of Main Theorem we will need a formula that we derive in the section. Suppose that an experimenter measures the location of a massive object using an optimum apparatus, whereby they completely do not know the momentum of the object and do not attempt to measure it. The time of the experiment does not matter either. Let us try to estimate the maximum error ΔL (displacement in any direction) that they can make. At first sight

$$\Delta L = \varepsilon + \lambda, \tag{6}$$

where ε is the maximum deviation caused by the apparatus, and $\lambda = h/p$ is the de Broglie wavelength of the object. However, (6) is incorrect. For example, macroscopic objects are often almost stationary (they perform vibrations). Their momentum p is then extremely small (sometimes zero), whence their wavelength is enormous (infinite correspondingly), but no shifts are observed. Of course, the reason is simple: we have not taken into account the difference between phase and group velocity.

Let us admit that if phase propagation carried energy, (6) would hold. Nevertheless, we know that this is not the case; de Broglie and other authors [41-43] emphasize that the phase does not transfer energy, and we should identify the particle speed with the group speed v_g of the particle's wave. Speaking more precisely, the latter is the highest possible speed of transferring energy.

Denote by T is the duration of the measurement. The object can travel the maximum distance $v_g T$ during this time (if the speed changes, we take its maximum). It may be detected at every point of this path whenever $\lambda \geq v_g T$. This gives

$$\Delta L = \varepsilon + \min(\lambda, v_g T),$$

instead of (6).

It remains to find T for the optimum apparatus. Let us recall that the uncertainty principle for time and energy is frequently interpreted as the fact that the measurement of energy with an accuracy ΔE requires (at least if we do not attempt to measure time simultaneously) a time ΔT that satisfies

$$\Delta E \Delta T \geq \frac{\hbar}{2}.$$

This implies that to detect an object with an amount of energy E the time $T = \hbar/2E$ should suffice. Thus we obtain

$$\Delta L = \varepsilon + \min\left(\lambda, \frac{\hbar v_g}{2E}\right).$$

If we do not know the group speed, we may assume that it is equal to c, which gives

$$\Delta L = \varepsilon + \min\left(\lambda, \frac{\hbar c}{2E}\right). \tag{7}$$

We see that, since $E \geq mc^2$, ΔL remains small when λ tends to infinity, in line with experience.

9 Quantum transfers of energy

We say that a particle (or a physical object) is *infinite-distance* (or it makes such a leap) if according to the normal internal observer it occurs only in a bounded spatial region, whereas the external observer states that it exists also outside the subuniverse. This obviously means that the energy conservation principle of the subworld ceases to hold, and using Theorem 7.1. the internal observer can detect it. If they know GUN, they agree that from the viewpoint of the latter (whose space is equal to $\mathbf{E}^n$) the particle must travel an infinite distance. Of course, this is possible due to the fact that quantum particles do not have trajectories.

We assume the following postulate

- ❖ (SUPERLUMINAL BAN.) *No infinite-distance transfer is possible unless the energy approaches the internal observer or their energy conservation principle has been earlier violated.*

The first part of this postulate is related to the fact that during an infinite-distance transfer the energy either approaches or recedes from the internal observer, regardless of where they are. In the former case the energy of the subworld grows, whereas in the latter it decreases.

In terms of states, the postulate of Superluminal Ban means that the energy of the ground state can merely be increased this way, whereas that of an excited or underground state can also be decreased. We get

COROLLARY 9.1. *No infinite-distance transfer can decrease the energy of a universe unless its energy conservation principle has been earlier violated.* ■

We can explain how Nature accomplishes Superluminal Ban. Note that the speed of an infinite-distance transfer under the internal observer is equal to

$$\frac{\infty}{e-b},$$

where b and e are the begin and end times of the process. Suppose we introduce two following postulates

- (STRICT SUPERLUMINAL BAN.) *No infinite-distance leap is possible unless the energy conservation principle of the subuniverse has been earlier violated.*

The next one makes sense because the internal observer does not control passage times in any way; they only get the final result.

- (NEGATIVE SPEED.) *The speed of an infinite-distance transfer is negative if and only if the energy approaches the internal observer.*

Strict Superluminal Ban does not provide for any exceptions; the principle has to be violated before b. However, the speed is negative if and only if $e < b$, so a process that enjoys it can accomplish the violation for itself before b. We see that the postulates imply Superluminal Ban as a theorem. They are more elegant, but we strive to minimize their number.

We shall now examine some properties of infinite-distance particles. The following lemma will be needed also in the proof of Main Theorem.

LEMMA 9.2. *If $\sigma: \mathbf{E}^n \to \mathbf{E}^{n'}$ is continuous, $n < \infty$, and a subset S of $\mathbf{E}^n$ is bounded, then*

$$\overline{\sigma(S)} \subset \sigma(\mathbf{E}^n). \tag{8}$$

Proof. Suppose that the condition is not satisfied. This means that there is a sequence $\{\boldsymbol{r}_n\} \subset S$ such that $\{\sigma(\boldsymbol{r}_n)\}$ converges to a vector that does not belong to the image of σ. It suffices to show that $\{\boldsymbol{r}_n\}$ is unbounded. Indeed, otherwise we could — as $n < \infty$ — choose a convergent subsequence from $\{\boldsymbol{r}_n\}$. Thus we may assume, without loss of generality, that the latter would be convergent, whence — by virtue of continuity — $\{\sigma(\boldsymbol{r}_n)\}$ would do the same, and the limit of the latter would have to belong to the image of σ, a contradiction. ■

By virtue of Proposition 5.2. and the further discussion, the set S of all locations of a particle under a synchronic internal observer satisfies (8) if and only if the particle does not occur arbitrarily close to the edge of the subworld. We use this in the proof of

THEOREM 9.3. A particle occurs solely in a bounded spatial region under the synchronic normal internal observer if and only if it does not occur arbitrarily close to the edge of the subworld according to the external observer.

Proof. Necessity follows from Lemma 9.2. Now suppose that (8) holds. By (i) the inverse of the mapping σ of Corollary 4.2. is continuous, and $\sigma(S)$ is finite-dimensional. Suppose that S is an unbounded sequence. As $\sigma(S)$ is bounded, we can choose a convergent subsequence from it. By (8) its limit belongs to $\sigma(\mathbf{E}^n)$, whence a subsequence of S should be convergent, a contradiction. ■

COROLLARY 9.4. A particle contained in a synchronic subuniverse is infinite-distance if and only if the set S of all its locations under the normal internal observer satisfies (8) and the external observer sees it also outside $\sigma(S)$. ■

10 Color Confinement

In the section we present the proof of Main Theorem of GUN. Before that, we have to prove certain facts of a purely mathematical nature. Lemma 10.1. — which consequently introduces a new relativistic length contraction — is crucial, but it is used only in the proof of Lemma 10.2.

Suppose that we have a regular transformation. Let L be a family of line segments contained in E^n. (The segment with end points $\boldsymbol{p}$ and $\boldsymbol{q}$ will be denoted by $\boldsymbol{p} \leftrightarrow \boldsymbol{q}$, whereas the angle between vectors or segments x and y by $x \sphericalangle y$.) Define a map ρ by

$$\rho(L) = \sup_{s \in L} \frac{\#s'}{\#s},$$

where # returns the length of a segment, and in this context s' is the segment $\boldsymbol{p}' \leftrightarrow \boldsymbol{q}'$ in $\mathbf{E}^{n'}$ whenever $s = \boldsymbol{p} \leftrightarrow \boldsymbol{q}$. It is easy to see that

$$\lim_{k \to \infty} \rho(L_k) = 0, \tag{9}$$

where L_k consists of all segments that start from $\mathbf{0}$ and enjoy a length greater than k. We prove a similar equality for other families of segments.

LEMMA 10.1. If M_k is the family of all segments that connect two end points located at distances from $\mathbf{0}$ greater than k, then $\lim_{k \to \infty} \rho(M_k) = 0$.

Proof. Let $\boldsymbol{p}$ and $\boldsymbol{q}$ be such end points, and $s = \boldsymbol{p} \leftrightarrow \boldsymbol{q}$. Denote by α the angle $\boldsymbol{p} \sphericalangle \boldsymbol{q}$, whence also $\boldsymbol{p}' \sphericalangle \boldsymbol{q}'$. We have

$$\#s^2 = p^2 + q^2 - 2pq \cos \alpha, \tag{10}$$

where p and q are the magnitudes of the vectors. Let us put

$$P = \mu\hat{}(p) = \frac{p'}{p},$$

$$Q = \mu\hat{}(q) = \frac{q'}{q},$$

whence we get

$$\#s'^2 = P^2 p^2 + Q^2 q^2 - 2PQpq \cos \alpha. \tag{11}$$

Suppose first that $Q = P$. From (10) and (11) we obtain

$$\#s'^2 = P^2 \#s^2,$$

$$\frac{\#s'}{\#s} = P,$$

and the lemma follows from (9).

Now let $Q < P$. Consider first the case of $\alpha = 0$. By regularity

$$p < q.$$

Using Theorem 4.1. we have

$$\#s' = \mu(q) - \mu(p),$$

whence applying (iv) we get

$$\#s' \leq \mu\text{^}(q)q - \mu\text{^}(p)p \leq \mu\text{^}(p)(q-p) \leq \mu\text{^}(p)\#s \leq P\#s,$$

and the lemma again.

Finally, suppose that $\alpha > 0$. Denote by u the segment $\boldsymbol{p} \leftrightarrow p\boldsymbol{q}\text{^}$. From the first part of the proof it follows that

$$\frac{\#u'}{\#u} = P. \tag{12}$$

Let $\beta = u \sphericalangle (\mathbf{0} \leftrightarrow p\boldsymbol{q}\text{^})$. Since β is also equal to $u \sphericalangle (\mathbf{0} \leftrightarrow \boldsymbol{p})$, we get

$$\beta < \pi/2.$$

The lengths of the three last segments are increased P times, while α remains unchanged, which implies that $\beta' = \beta$. Let $w = \boldsymbol{q} \leftrightarrow p\boldsymbol{q}\text{^}$. By (12) we have

$$\#s'^2 = \#w'^2 + P^2\#u^2 - 2\#w'P\#u\cos(\pi - \beta). \tag{13}$$

Note that $p + \#w = q$ and $p' + \#w' = q'$, whence (as $p' = Pp$) we get

$$Q = \frac{Pp + \#w'}{p + \#w}.$$

If we had $\#w' \geq P\#w$, we would have $Q \geq P$, a contradiction. Thus we have $\#w' < P\#w$, and by (13), using the fact that $\cos(\pi - \beta)$ is negative, we obtain

$$\#s'^2 < P^2\#w^2 + P^2\#u^2 - P^2 2\#w\#u\cos(\pi - \beta),$$

that is,

$$\#s'^2 < P^2\#s^2,$$

$$\frac{\#s'}{\#s} < P,$$

which concludes the proof. ■

It turns out that using normality the lemma can be further strengthened; it is enough to check the location of only one end of the segments.

LEMMA 10.2. If N_k is the family of all segments that begin at a distance from $\mathbf{0}$ *greater than k, then $\rho(N_k)$ vanishes when k tends to infinity.*

Proof. Suppose that we have a sequence of segments $\boldsymbol{b}_k \leftrightarrow \boldsymbol{e}_k$ such that $|\boldsymbol{b}_k|$ tends to infinity, and

$$\lim_{k\to\infty} \frac{|\boldsymbol{b}'_k - \boldsymbol{e}'_k|}{|\boldsymbol{b}_k - \boldsymbol{e}_k|} > 0.$$

According to Lemma 10.1., $\boldsymbol{e}_k$ have to lie within a bounded set. But then $|\boldsymbol{b}'_k - \boldsymbol{e}'_k|$ has to converge to infinity, which implies that σ is not bounded, a contradiction. ■

We can now prove our basic result. Note that the observers may be arbitrary (as we have used 'an external' instead of 'the…'), and only a pair of them must be regular.

MAIN THEOREM 10.3. *If an object that carries a minimal nonzero amount of energy under the regular internal observer approaches or recedes from the edge of a universe according to an external observer, the latter finds that energy is arbitrarily large.*

Proof. Suppose first that a transformation (σ, τ) between the internal and external observer is regular. Approaching or receding from the edge means that — as we have noted in Section 9. — for the set $S \subset \mathbf{E}^n$ of locations of the object (8) does not hold. Thus by virtue of Lemma 9.2. S is unbounded. Next, Lemma 10.2. implies that for sufficiently large elements of S all lengths associated with the object are reduced at least k times, where k tends to infinity. In particular, this involves wavelengths.

Thanks to the works of Planck [44], Einstein [45], de Broglie [18], Thomson, Davisson, Germer [46], Okino [47] and others, we know (or at least we may assume) that the momentum p of the object satisfies the relationship

$$p = \frac{h}{\lambda}, \tag{14}$$

where λ is its wavelength, and (14) is valid in the universe as well as in the subuniverse (maybe with different Planck constants). If the rest mass m of the object equals zero, by the formula

$$E^2 = p^2c^2 + m^2c^4, \tag{15}$$

we infer that its momentum is equal to E/c, and E cannot decrease to zero by our assumption. Otherwise, we may assume that the locations of S have been defined by an optimal apparatus in line with Section 8. Thus, by virtue of (7), their accuracy ΔL satisfies

$$\Delta L < \varepsilon + \frac{\hbar c}{E_{\min}}, \tag{16}$$

where $\mathrm{E}_{\min}$ is the minimal amount of its energy. Hence by virtue of Heisenberg's uncertainty principle [48] the momentum of the object cannot be precisely determined. In particular, it cannot be equal to $\mathbf{0}$, and even cannot — since the right side of (16) remains constant — converge to zero.

In other words, if the momentum of the object under the internal observer converged to zero, the uncertainty of its position would have to tend to infinity. But this is ridiculous because if no other quantity (especially momentum and time) is measured simultaneously, an object with a minimum amount of energy should be detected after a finite time dependent on the energy and the properties of the apparatus, and during that time the object is able to travel a limited distance. Note that in classical physics the object could permanently reduce its momentum to zero.

Therefore, in both of these cases it is possible to take an unbounded subsequence of S such that at the locations of the former the momentum p of the object is greater than p_0 distinct from 0. Hence, by virtue of (14) and the length contraction, the corresponding momentum p' of the object under the external observer meets

$$p' > \frac{kh'p_0}{h},$$

where h' is their Planck constant. As k tends to infinity, the momentum p' does the same, and for the energy this follows from (15).

Now suppose that another external observer O' moves with respect to the regular external one, denoted below by O. If the former states that the assumption of the theorem is satisfied, by virtue of Corollary 5.3. the latter finds the same. If the relative velocity V is constant, we may use Lorentz transformations. Therefore, we have

$$E' = \gamma_V(E - Vp_x).$$

As $p_x \leq p$ and by (15) $p \leq E/c$, we get

$$E' \geq \gamma_V\left(1 - \frac{V}{c}\right)E.$$

This shows that E' tends to infinity whenever so does E.

If the velocity is not constant, but it does not exceed a $W < c$, we may use the so-called locality hypothesis that says that ”an accelerated observer is equivalent to an infinite sequence of hypothetical inertial observers along its world-line, each momentarily co-moving with the accelerated observer,” [49, 50]. Finally, when such a speed W does not exist, the entire subuniverse moves at a velocity arbitrarily close to c with respect to O', so its energy is arbitrarily large. ■

Main Theorem and the postulate of Finite Energy imply that in a regular universe no particle can, in fact, occur arbitrarily close to the edge unless it loses all its energy. The above proof shows that according to an external observer energy must be arbitrarily growing, and this has been accurately confirmed in experiments. This phenomenon is very similar to the acceleration of particles in accelerators, and we see that in both of these cases the major causes are relativistic (they are related to transformations).

Of course, Main Theorem does not mean that if we move the object closer to the edge, energy is generated. On the contrary, just we must supply this energy. Similarly, an accelerator does not produce energy, but only it shows that the relativistic formula is true.

If the object remains all its energy in the subuniverse, it can reach the edge. Then, however, it is difficult to say that it leaves the subworld. If the external observer saw a nonzero amount of energy, their energy conservation principle would be violated.

This does not mean, nevertheless, that a particle cannot get inside the subuniverse or leave it at all. In order to do this, under no circumstances must it come close to the edge, that is, the set S of all its locations under the regular internal observer ought to satisfy (8), and before or after the particle should make a quantum jump seen by the external observer. Thus by virtue of Corollary 9.4. it has to be infinite-distance. Using Corollary 9.1. we get

Corollary 10.4. No energy can leave a regular universe unless its energy conservation principle has been earlier violated at a causally connected event. ■

Here, the clause 'at a causally…' requires additional clarification. Although from the viewpoint of the internal observer some transfers are infinite-distance, according to the external one they are finite-distance. Thus they controlled by usual quantum probabilities. As we have stated in Section 7., they remain unchanged in the space-time regions in which the local conservation of energy still holds (cf. Theorem 7.1.). That is why we have used the final clause in Corollary 10.4., whence it is more informative than Corollary 10.5. below. For example, our universe has probably long since ceased to be in the ground state, but that does not mean that Earth may suddenly move to our $U1$.

COROLLARY 10.5. (Color Confinement.) No object that carries energy can leave a regular universe in the ground state. ■

This is enough in many cases. In particular, if protons and neutrons within nuclei are in the ground state, quarks that cruise inside the nucleons cannot leave them. The situation can change when the experimenter bombards the hadrons with, e.g., electrons. Such a particle can get into a proton, causing that the energy conservation principle of the latter is violated, and then everything may happen. For example, the electron is able to leave the proton in the same way it has got inside, and the baryon can return to the ground state ("elastic scattering"). In another scenario, the lepton might settle in the hadron ("bound state"). In the case of higher energy, the proton starts to decay, i.e., new universes are created. The pair can be transformed into a neutron and neutrino or the proton can decay into a bunch of outgoing hadrons ("deep inelastic scattering").

Questions arise as to why a similar result has not been proved in QCD and whether this is still possible. Well, in that theory it is assumed that the integrity of protons and neutrons is ensured by the strong interaction instead of the universe constraints used in GUN. However, as quantum particles do not enjoy trajectories, they are able to overcome any — perhaps with a very small probability — barrier in the universe (by contrast, our solution is based on those facts). This is a fundamental — unknown in classical physics — feature of quantum reality. Therefore, as long as QCD remains a purely quantum theory, it has no right to contain an analogous theorem. To make matters worse, quantum chromodynamics is logically contradictory [51].

An important element of our approach is wave-particle duality. In the proof of Main Theorem, when it comes to quarks inside hadrons, it suffices to assume that (14) holds for quarks in our universe and its subuniverses. We believe, nevertheless, that the formula is valid in every universe and applies to objects of any size. Note that in GUN this cannot lead to any contradiction, since we have the signal encapsulation principle [24].

The proof of Main Theorem explains why wave-particle duality is needed. It is to some extent a misunderstanding to say that "We are faced with a new kind of difficulty. We have two contradictory pictures of reality…" [17]. In our opinion, there is only one true and correct picture with particles devoid of trajectories and with the probabilities of their occurrence. The wave-particle duality is no whim of Nature, but it is a basic phenomenon that ensures that regular universes are stable, and consequently, e.g., humans can exist. Similar remarks apply to Heisenberg's uncertainty principle (whose positive role has been known before).

11 The speed of light

In the proof of Main Theorem we have not made any special assumptions about time transformation; merely fullness has been required. The condition is satisfied by

$$t' = kt, \tag{17}$$

where k is a nonzero constant. Then, however, Main Theorem is to some extent unnecessary, although the phenomenon of energy growth remains. Indeed, objects that travel at velocities that do not exceed c reach the edge (defined by the condition of Proposition 5.2.) after infinite time under both of these observers, whence the objects will never leave the subcosmos anyway. The reason is, of course, that (17) is not relativistic; it does not refer to c and c', and dramatically reduces all speeds of the subworld. In the next section we correct this disadvantage.

Using the c' symbol above is not a mistake, for in distinct worlds the constants need not be identical, and it is not a matter of changing units. Consider, e.g., $U0$ and its two subuniverses of degree 1; their interactions can be, after all, algebraically different. However, all the subworlds of our $U1$ enjoy the same electromagnetic field, and that is why we may take for granted that their constants c coincide.

In this context, the question arises: What does the constant c mean in $U0$ if there is no light there? Well, some massive objects move there, and their velocities cannot be, of course, arbitrarily large. Thus we may assume that their speeds neither exceed nor even are equal to a constant c_0, and it equals to the least upper bound of the speeds.

The next question is: What is the value of c_0? At this point we must say clearly that because $U0$ represents all Nature, we should not introduce sophisticated constants in it (they can occur only in its proper subcosmoses). The admissible values are 0, 1, and ∞ (the latter two, maybe, with a minus sign). Therefore, we have to put $c_0 = 1$, which means that in $U0$ two distinct events at which the centers of an object are (it has, as a rule, a spherical shape) satisfy

$$|\boldsymbol{p} - \boldsymbol{r}| < |s - t|. \tag{18}$$

Let us add that the number of the objects has to be infinite because otherwise it would be a strange primary parameter as well (even if it were to change over time).

12 Simple time transformations

A simple time transformation is defined by

$$t' = |N|t + \frac{\operatorname{sgn}(N)c|\boldsymbol{r}'| - Nc'|\boldsymbol{r}|}{cc'}, \tag{19}$$

where N is a nonzero constant. We have

PROPOSITION 12.1. *If σ is synchronic, τ is simple, and the former is a homeomorphic embedding, then (σ, τ) is a universe transformation.*

Proof. As (19) is a composition of continuous operations, τ is continuous. Now suppose that

$$(\boldsymbol{p}', s') = (\boldsymbol{r}', t'). \tag{20}$$

From (19) it follows that

$$t = \frac{cc't' - \mathrm{sgn}(N)c|\boldsymbol{r}'| + Nc'|\sigma^{-1}(\boldsymbol{r}')|}{|N|cc'}, \tag{21}$$

and similarly for s. By virtue of (20) and the fact that σ is injective we get that $s = t$. Since (21) is a composition of continuous operations as well, $(\sigma, \tau)^{-1}$ is continuous. ■

As the synchronicity of σ implies the fullness of simple τ, we infer that (19) gives a possible time transformation for all synchronic normal transformations.

A problem with simple time transformations consists in that they do not have to be differentiable at some events even if the corresponding space ones are. Nevertheless, in some cases the transformed velocities can still be obtained using continuity. This is shown in the proof of

THEOREM 12.2. If σ is synchronic, motionless, and differentiable, and τ is simple, then (σ, τ) preserves $\boldsymbol{c}$ at location vectors parallel to the velocity whenever N is positive, and at antiparallel ones otherwise. If, in addition,

$$|N| = \frac{\mu^\wedge(\boldsymbol{0})c}{c'}, \tag{22}$$

then $\boldsymbol{c}$ is preserved at vanishing location vectors whatever N is.

Proof. By virtue of (2), (4) and (19), at an event $(\boldsymbol{r}, t)$ such that $\boldsymbol{r}$ does not vanish we have

$$\boldsymbol{v}' = \frac{cc'\left(\mu^\wedge(\boldsymbol{r})\boldsymbol{v} + \boldsymbol{r}\frac{\partial\mu^\wedge}{\partial\boldsymbol{v}}\right)}{\mathrm{sgn}(N)c|\boldsymbol{r}|\frac{\partial\mu^\wedge}{\partial\boldsymbol{v}} + (\mathrm{sgn}(N)c\mu^\wedge(\boldsymbol{r}) - Nc')\boldsymbol{r}^\wedge\boldsymbol{v} + cc'|N|}. \tag{23}$$

If $|\boldsymbol{v}| = c$, $N > 0$, and $\boldsymbol{r}\|\boldsymbol{v}$, we obtain

$$\boldsymbol{v}' = \frac{c'\left(\mu^\wedge(\boldsymbol{r})\boldsymbol{v} + \boldsymbol{r}\frac{\partial\mu^\wedge}{\partial\boldsymbol{v}}\right)}{|\boldsymbol{r}|\frac{\partial\mu^\wedge}{\partial\boldsymbol{v}} + c\mu^\wedge(\boldsymbol{r})},$$

and it is easy to see that $\boldsymbol{v}'$ has the same direction and sense as $\boldsymbol{v}$, but its magnitude is equal to c'. The case of a negative N and antiparallel vectors is analogous.

The time transformation may not be differentiable at events with $\boldsymbol{r} = \boldsymbol{0}$ (if, e.g., $\mu(\boldsymbol{r}) < \mu(\boldsymbol{0})$ for nonzero $\boldsymbol{r}$), but $\boldsymbol{v}'$ can be determined using (22) and continuity. Indeed, from (23) we get for $\boldsymbol{r}$ with small magnitudes

$$\boldsymbol{v}' \cong \frac{\mu^\wedge(\boldsymbol{r})\boldsymbol{v}}{|N|}, \tag{24}$$

where the accuracy increases as $|\boldsymbol{r}|$ decreases. This implies that

$$\boldsymbol{v}' = \frac{\mu^\wedge(\boldsymbol{0})\boldsymbol{v}}{|N|}.$$

We see that (23) can be applied here assuming that $\boldsymbol{0}^\wedge = \boldsymbol{0}$. From (22) it follows that $\boldsymbol{c}$ is preserved. ■

Now we see that Main Theorem is essential. Indeed, if the assumptions of Theorem 12.2. are satisfied, $N > 0$, and a particle moves towards the edge, without Main Theorem the object could reach it after a finite amount of time under the external observer. Note also that Main Theorem cannot be replaced by a postulate connected with the energy conservation principle. It is not violated here because from the viewpoint of the internal observer this process takes infinitely much time.

We see that intercosmic transformations provide examples of the hitherto unknown huge time dilation. Indeed, a clock of the external observer can record finite elapsed time, while that of the internal one is able to tick so slowly that the duration of the same process will be infinite. In particular, the lifetime of our cosmos can be infinite (or very long) according to inhabitants of Earth, but finite (even short) by the watch of an observer in our $U1$. This implies that we should not be too worried about the possible collision of our $U2$.

As we said in Section 11., you may assume that c is identical in all subuniverses of our $U1$. Thus we can replace (19) by

$$t' = |N|t + \frac{\operatorname{sgn}(N)|\boldsymbol{r}'| - N|\boldsymbol{r}|}{c}.$$

It is best to assume that μ^$(\mathbf{0})$ equals 1 because this means we use the same units in the universe and its subworld. The fact that no speed differences have been observed so far suggests, taking into account (24), that (22) should hold. This gives $|N| = 1$, and we infer that the most probable time transformation for hadrons is

$$t' = t \pm \frac{|\boldsymbol{r}'| - |\boldsymbol{r}|}{c}, \tag{25}$$

or, assuming that $c = 1$,

$$t' = t \pm |\boldsymbol{r}'| \mp |\boldsymbol{r}|.$$

However, the verification of (25) will not be easy because, just according to (24), all speeds at short distances are almost equal, and longer distances require larger energy of particles within hadrons.

To conclude this section it is worth emphasizing that we do not insist on simple time transformations. This issue is open and requires further, both theoretical and experimental, research.

13 A few principles

The strongest fundamental interaction in universes of degree 2 is called *electromagnetism*. In different $U1s$ it can be depicted by distinct algebraic laws, but topologically it is the same. By *electric charge* we mean the ability to be subject to the interaction (we omit the details here). We have

- *(ELECTRIC CHARGE CONSERVATION PRINCIPLE.) The total electric charge contained in a universe remains constant.*

Like the principle of conservation of energy, it can be violated (when, e.g., an electron is shot into a hadron). We call such principles *conditional* (the violation can only happen if a subuniverse is bombed).

Color can be defined analogously (strong interaction is the weakest one stronger than electromagnetism in $U2s$). We get

- *(COLOR CONSERVATION PRINCIPLE.) The total color contained in a universe remains constant.*

Of course, distinct colors are added up separately. It is possible that this principle is unconditional. On the other hand, using the hierarchical structure of Nature we can also formulate the following, undoubtedly conditional,

- *(HADRONIZATION PRINCIPLE.) An object is monochromatic unless it is contained in a universe of degree greater than 2.*

If the principle were unconditional, we would not observe isolated colors. That a principle does not hold temporarily should not come as a surprise; we have seen that in the case of energy this happens often. Nonetheless, Nature's response to the violation is very important; if it were not, no principle would be needed. In this case, a consequence in the form of the collapse of our universe would certainly be too far-reaching. Instead of this, Nature combines quarks and gluons into hadrons; the process of their formation is called *hadronization* (more details are given below). Before this happens, we can observe free quarks [52], and that is why the principle is conditional.

The hadronization suggests the following

- *(NEUTRALIZATION PRINCIPLE.) An object is electrically neutral unless it is contained in a cosmos of degree greater than 1.*

The principle answers the question whether in our $U1$ may appear free electrically charged objects. Well, they can, but this is an exceptional situation similar to the occurrence of free colored objects in our $U2$. When this happens, Nature initiates a process called *neutralization* (of electric charge). It is possible that our universe was created as a result of this phenomenon.

14 Strong interaction

In universes of degree greater than 2 we have n colors

$$x_1, \dots, x_n,$$

and n their anticolors

$$\overline{x_1}, \dots, \overline{x_n},$$

where $n \geq 2$. Apart from $2n$ quarks with these colors, we enjoy $n(n-1)$ gluons that have two colors $x\bar{y}$, where $x \neq y$. Of course, in the proper subworlds of our universe n equals 3. Let us note in passing that in GUN gluons expressed in the form of a superposition are superfluous, since they are not being detected in experiments.

Now we present our model of strong interaction[1] and compare it with QCD. The first two rules coincide with those of QCD. We assume that at sufficiently long distances strong interaction is

- attractive between a color and its anticolor,
- attractive between distinct colors.

In QCD it is taken for granted that strong interaction is attractive whenever it works. Theoretically, you could maintain it in our approach. However, as we have found another reason for quark confinement, we may consider other possibilities. In our model we assume that strong interaction

- changes its sense preserving its coupling and direction if a color is replaced by its anticolor,
- is the sum of interactions if one or both particles have two colors.

Furthermore, in our approach the asymptotic freedom known from QCD [53, 54] can be replaced by

- *(Full freedom.)* The coupling of strong interaction between two identical colors is exactly $(n-1)$ times as big as between distinct colors.

Note that in the second rule we are not talking about anticolors, but by changing the sense twice in it we get that strong interaction is attractive also between distinct anticolors. Similarly, the first and third rule imply that strong interaction is repulsive between identical colors or anticolors. Using the clause about coupling in the third rule, you may extend full freedom to anticolors. Thanks to the fourth rule, r and $g\bar{r}$ attract each other, there is no interaction between r and $g\bar{b}$, and that between r and $r\bar{b}$ is repulsive.

The following result confirms that the above rules make sense (the clause 'spaced sufficiently far' and the case of colliding quarks are discussed in the next section).

PROPOSITION 14.1. *The strong interaction between a gluon and colored particle spaced sufficiently far is attractive if and only if their collision can create a single particle or pair quark-antiquark.*

Proof. We first consider the situation without full freedom. Suppose that the interaction is attractive. If the latter particle is a quark x or $\bar{x}$, by the fourth rule the gluon must be $y\bar{x}$ or $x\bar{y}$ correspondingly, so their collision creates a quark. Otherwise, if two gluons $x\bar{y}$ and $w\bar{z}$ collide, we must have $x=z$ or $y=w$. In the first case the reaction gives $w\bar{y}$, and in the $x\bar{z}$ (if both of these conditions are satisfied, we get a pair quark-antiquark).

Next suppose that $x+y\bar{z}$ gives a single particle. Then we have to have $x=z$, whence $x\neq y$, so the interaction is attractive. The case of $\bar{x}+y\bar{z}$ is analogous. Finally, if $x\bar{w}+y\bar{z}$ gives a single particle, $x=z$ and $y=w$. This, since $x\neq w$, implies $x\neq y$, so we get the same.

Now we take into account full freedom. If the reaction gives a single particle, input ones cannot contain the same color, so the interaction is all the more attractive. Conversely, if the condition holds thanks to full freedom, input particles have to contain a color and its anticolor, so its collision really gives a single particle. ■

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[1] We do not claim that this is definitely true, but some of these considerations could possibly be incorporated into a final theory.

We should justify the term 'full freedom'. Consider two quarks inside a baryon. As quarks constantly change their colors, the probability that they are distinct equals 2/3. Then the particles attract each other, but when the colors are identical, the quarks repel twice stronger and return to their starting position. We see that the average strong interaction between the quarks vanishes.

If we take into account anticolors (e.g., in mesons), sea quarks, gluons, etc., we get the same. Strong interactions play an important role during the creation of a hadron (where there are no quarks with the same color), but later they cease to matter (this involves also quark-gluon plasma and the interior of neutron stars). As we have proved, the universe constraints are entirely responsible for quark confinement.

Experiments exactly confirm our picture of the phenomenon. When the energy of bombarding leptons is high, they reach the centers of hadrons, where the universe constraints are weak, and that is why you can do everything with quarks there. Otherwise, the leptons interact with quarks on the outskirts of hadrons, and there, in line with Main Theorem, those constraints are already strong. Consequently, the quarks resist trying to separate them from others. We must admit that it actually looks as if there were some forces pulling the particles towards the middle.

Obviously, the energy of bombarding leptons cannot be too high because otherwise the target particles will be broken. Instead, let us imagine the scenario of a thought experiment in which leptons with any large energies reach the quarks without destroying the hadrons. Then Main Theorem states that also in this manner you will not be able to push the former out of the latter.

The question arises as to whether repulsive strong interaction does not prevent the creation of exotic hadrons [55] that are, of course, $U3s$ as well. The overall answer is positive, but the needed energy may be greater than predicted by QCD. Consider, for example, a glueball [56] that consists of three gluons (e.g., $r\bar{g}$, $g\bar{b}$, and $b\bar{r}$). Thus we have here 12 elementary interactions of which only 3 ($r\bar{b}, g\bar{r}, b\bar{g}$) are repulsive. In addition, full freedom strengthens three attractive interactions, so glueballs can be created.

15 Coupling dependence on distance

Since we already know that strong interaction does not confine quarks, we do not have to attribute any bizarre properties to it, but we may assume that in hadrons, treated as universes of the third degree, the coupling is proportional to

$$\frac{c_1 c_2 (r-b)}{(r+a)^3}, \tag{26}$$

where r is the distance between particles with colors c_1 and c_2, and a and b are positive constants (equal, e.g., to the Planck length). Its use protects us against contradictions (as (26) never tends to infinity) and allows an x quark to change its color to y and to emit an $x\bar{y}$ gluon. Indeed, we see that at distances smaller than b the coupling changes its sign, so the particles repel each other.

Nevertheless, the question is whether the absorption of gluons is still possible. This requires detailed calculations, but it seems that since the value of (26) at $r = 0$ is finite, the repulsive interaction cannot stop a gluon heading at the speed c towards a quark. On the other hand, quarks with the same electric charge may have difficulty with mutual colliding.

Note that if $r \gg \max(a, b)$, (26) transforms into the well-known

$$\frac{c_1 c_2}{r^2}.$$

This suggests that an expression analogous to (26) could be used for other fundamental interactions. It is a fact, but in the case of electrostatic interaction you should assume that

$$b \leq 0,$$

e.g., $b = -a$. Indeed, since photons do not carry any electric charge, we do not need to change the coupling sign.

(26) explains also the reaction of two colliding quarks

$$x + \bar{y} \to x\bar{y}.$$

They repel each other, but if $r \cong b$, strong repulsion becomes very weak, while electrostatic interaction is still growing. Hence, if they have opposite electric charges, the distance begins to fulfill $r < b$. Then the quarks attract each other, and the reaction holds.

In the paper we cannot explain[2] how Nature accomplishes (26), but for now it will not be necessary. The author once worked at the electrical faculty of a technical university. The scientists there knew nothing about virtual photons, but they had wonderful formulas, using which they had been able to calculate everything about electromagnetism. Something similar can be done with strong interaction provided that a suitable intercosmic transformation is applied.

We encourage physicists to develop a Maxwell-type theory of long-distance strong interaction based on (26) and relativistic foundations. If necessary, (26) can be modified. Although it is associated with a sort of intermediate bosons, do not bother with this issue at all. Of course, do not try to assume that a quark 'knows' the colors of adjacent particles [51]; it should change its color to a new one with the same probability. And it is possible that the emitted gluons create some 'color-magnetic' interaction.

16 Hadronization

The theory of the previous section will have another important application (even without any transformation), for our explanation of the hadronization phenomenon consists of the following assumptions:

- In exceptional situations strong interaction can operate over long distances also in universes of degree less than 3.
- The violation of the hadronization principle is such an exceptional situation.
- All particles that violate the hadronization principle are subject to the long-distance strong interaction.

A metascientific remark is appropriate here. You should not create theories that explain exclusively current experiments because Nature in which we live is unspeakably rich. At present we can observe almost free quarks ('almost' means that their average lifetime is shorter than the QCD time scale of strong interaction and therefore they decay before can hadronize). However, we think that in, e.g., a thousand years experimenters will have better technology that will allow them to keep free quarks for a much longer

[2] This will be done in the next work.

period of time. And notice that then our explanation of hadronization (which will be able to take a long time as well) will still work.

We have said that the color conservation principle seems to be unconditional, but this is quite strange, since all other principles of the paper are conditional. However, if our predictions come true, at some point we will be able to bombard hadrons with the use of free quarks. And then in the former three conservation principles will be violated simultaneously.

17 Residual interactions

In the section we discuss how some residual interactions work. In the case of strong one we suggest a mechanism that could be called *residuality* (as it uses wave-particle duality). Suppose that a gluon g with wavelength λ is created inside a hadron A. Considering only wave-particle duality, after a time T the gluon can be detected at a distance of

$$\min(\lambda, cT)$$

from the point of creation, and it may happen inside another hadron B. Obviously, the detection of energy is impossible due to Main Theorem. However, this situation is somewhat similar to that of virtual particles which have some energy conservation troubles, but fulfill other laws of physics without the help of the uncertainty principle. Thus, although no energy leaves A, we take for granted that g and particles of B are subject to strong interaction in a modified form (this is possible because so far colored particles have been supposed to be seen by the same internal observer).

The seeming occurrence, due to wave-particle dualism, of a particle outside its original world will be called *ghost* (this term is probably well-founded in this context). We assume that

- (*Ghost attraction.*) Strong interaction between a colored particle and ghost is always attractive.

This rule is justified by the fact that a ghost may not carry full color information. We see that a quark of the hadron B is attracted by the ghost of the gluon g. As the number of ghosts within the hemisphere of B closer to A per unit of time is greater than within the other hemisphere, there is an attractive interaction between the hadrons. Assuming that the energy of gluons cannot be arbitrarily small (it is quantized after all), we get that the residual strong interaction is short-distance.

Of course, residuality will also work in QCD, even without the above rule. It is enough to assume that the ghost color is known and the interaction with the ghost coincides with that occurring for the actual particle. This version also applies to our model as long as we assume that the interaction with the ghost affects the original particle as well. This will cause the gluons of A attracted by the quark of B to occur with greater probability in its vicinity.

We prefer residuality instead of exchanging virtual pions because negative pressure (although theoretically possible) has never been observed for real particles[3]. Therefore, it seems that assigning negative pressure to virtual pions is far-fetched. However, the exchange of virtual pions with positive pressure leads to a repulsive interaction that is contrary to experience.

[3] Moreover, in the next work we will show that the negative pressure of other virtual bosons is also unnecessary.

Residuality cannot be applied in the case of electromagnetism because photons are electrically neutral. Nonetheless, everything is correct. As photons do not violate the neutralization principle, they occur freely in our supercosmos. Therefore, the residual electromagnetic interaction is magnetism.

18 Hubble's law

In the section we explain why objects observed in extragalactic space (at distances of at least ten megaparsecs) enjoy a redshift that indicates that they recede from Earth with relative velocities approximately proportional to their distance from the Earth (that is true for galaxies distant by no more than a few hundred megaparsecs [19, 20]).

Since in the Milky Way most objects rotate, we can take for granted that this goes for our universe in our $U1$ as well. (The rotation was initiated during our Big Bang by electromagnetic interactions, and later it was transferred to newly created objects by the principle of conservation of angular momentum.) Next, we assume that our $U2$ is regular (the external observer sees it in the form of a spinning transparent ball) with $\mu\hat{}(0) = 1$ and the time transformation defined by (25). Thus we have

$$\boldsymbol{v}' \cong \boldsymbol{v}, \tag{27}$$

at events with relatively small magnitudes of location vectors. Note that they may be arbitrarily big if we are taking $\mu\hat{}(r)$ close to one for larger and larger r.

Now consider two galaxies G_1 and G_2 at $\boldsymbol{r}_1$ and $\boldsymbol{r}_2$ correspondingly (the former can be ours). If $|\boldsymbol{r}_1 - \boldsymbol{r}_2|$ is sufficiently large, we may neglect accidental movements. Thus, according to the external observer, their relative velocity equals

$$\boldsymbol{v}_1' - \boldsymbol{v}_2' = \omega \times (\boldsymbol{r}_1' - \boldsymbol{r}_2'),$$

where $\boldsymbol{v}_i$ is the velocity of G_i, and ω is the rotation axis. By regularity we get

$$\boldsymbol{v}_1' - \boldsymbol{v}_2' = \omega \times (\mu\hat{}(r_1)\boldsymbol{r}_1 - \mu\hat{}(r_2)\boldsymbol{r}_2),$$

and using (27)

$$\boldsymbol{v}_1 - \boldsymbol{v}_2 \cong \omega \times (\mu\hat{}(r_1)\boldsymbol{r}_1 - \mu\hat{}(r_2)\boldsymbol{r}_2).$$

If $|\boldsymbol{r}_1 - \boldsymbol{r}_2|$ is not too big, we may assume that $\mu\hat{}(r_1) = \mu\hat{}(r_2)$, whence we obtain

$$\boldsymbol{v}_1 - \boldsymbol{v}_2 \cong \omega \times \mu\hat{}(r_1)(\boldsymbol{r}_1 - \boldsymbol{r}_2).$$

We see that, in fact, the relative speed $|\boldsymbol{v}_1 - \boldsymbol{v}_2|$ is approximately proportional to the distance $|\boldsymbol{r}_1 - \boldsymbol{r}_2|$ between the galaxies.

This example is simple, but it demonstrates that you will be able to create cosmological models with suitable intercosmic transformations, and using them to explain astronomical observations.

Someone might ask: If our universe rotates, why do we not feel centrifugal forces? This question is similar to the one asked in the age of Copernicus: If the Earth is moving, why do not we fall from it? Well, for now no one has proved that the rotation of the entire cosmos with infinite sizes (according to the internal observer) is the source of any fictitious forces. If this is done, we will examine their existence.

There are models of general relativity [21, 22] consistent with Hubble's law and explaining it by geometric reasons. However, they do not clarify why this law ceases to be true for very distant galaxies (a correct geometry or cosmological constant should work better over long distances, where random movements of galaxies can be omitted), while in our approach this fact is the best confirmation. Furthermore, there are a lot of other questions. For example, what was before the Big Bang? What interactions caused the Big Bang? GUN answers all them.

Let us note that the internal observer assigns, as a rule, 0 to the time of their Bang, but for mathematical reasons the normal transformation has to be defined for negative instants as well. In the most important synchronic case this is easy; you may use simple transformations.

It should be emphasized that in GUN there will be no singularities. Our universe was created by the collision of two particles or the decay of a single one. They were similar to hadrons, but they had many times larger masses. Hence, at time zero the minimum nonempty region of our cosmos was already of nonzero size.

Let us add that at the initial time our $U2$, most probably, contained no antimatter at all. Its trace amounts currently observed are of either sea or super origin, that is, they have been either created in the same fashion as sea antiquarks are formed inside hadrons or shot from our $U1$ correspondingly. On the other hand, our supercosmos (like other $U1s$) contains the equal amounts of regular matter and antimatter (and some $U2s$ consist solely of the latter). This solves the well-known problem of the lack of symmetry between them; everything is correct in the entire Nature.

19 Accelerating cosmic expansion

In 1998 [57-59], it was discovered that the expansion of our universe accelerates. Speaking more precisely, the speed at which a distant galaxy is receding from any observer is continuously increasing with time. This discovery raised a lot of confusion and controversy among scientists and others. In GUN the explanation is simple, albeit in this paper merely partial.

Note, first of all, that under the assumptions of Section 18. the denominator of (3) equals 1. If (27) holds in a region, we may assume that $\boldsymbol{v}'(\boldsymbol{v}) \cong \mathrm{id}$, which by (3) gives

$$\boldsymbol{a}' \cong \boldsymbol{a}, \tag{28}$$

where $\boldsymbol{a}$ is the acceleration of a path. Consider the galaxies G_1 and G_2 from the viewpoint of the external observer. Except when

$$\omega \times (\boldsymbol{r}_1' - \boldsymbol{r}_2') = \boldsymbol{0}, \tag{29}$$

their accelerations are different, so their relative acceleration does not vanish, and in addition it is growing.

The probability of (29) is small, and even if this happens, random galaxy movements will quickly invalidate it. Consequently, the observer sees galaxies that diverge with increasing mutual accelerations, and from (28) it follows that the same involves the internal observer, including astronomers on Earth.

The following questions arise immediately: What is the fate of our universe? Will it decay? Well, we have used Main Theorem to quarks and gluons so far, but nothing stands in the way of applying it to galaxies. In this fashion we infer that when $\mu\hat{}(r)$ becomes clearly less than 1, the galaxies will be stopped. They will simply run out of energy.

Now the next question comes to mind: Will gravity crush our universe after this stopping? To answer we must admit that its rotation and/or revolution is not the only reason for cosmic expansion. It is also caused by what we call ‘true dark energy’. It is obviously unable to overcome the powerful universe constraints, but it can inhibit attractive gravity. Therefore, in the end our universe will go into a state of equilibrium; the galaxies will perform merely small movements.

Unfortunately, in this work we cannot say what dark matter and true dark energy are. Nonetheless, it is possible to show in Fig. 2. how introducing the accelerated motion of our universe changes their contribution to the mean energy density.

Component	According to			
	[60]	[61]	[62]	GUN
Baryonic matter	*5%*	*5%*	*5%*	*10%*
Dark matter	*20%*	*25%*	*27%*	*45%*
Dark energy	*75%*	*70%*	*68%*	*45%*

Fig. 2. The composition of our universe.

Now you may understand why there was no symmetry in previous estimates; those researchers did not know that there were two reasons for the accelerating universe. We see also that at present the rotation and/or revolution of our universe works approximately twice as strong as true dark energy (this assumption gives the symmetry in Fig. 2.).

20 Spatial dimensionality of Nature

Our definition of intercosmic transformations takes into account different numbers of spatial dimensions. The question arises whether it is needed. Of course, we believe that the physical space we live in has exactly three dimensions, but GUN introduces the wealth of such spaces.

It is possible that our $U1$ enjoys more than three spatial dimensions, and $U4s$ and some $U3s$ (with baryonic fundamental interaction) contained in our $U2$ are one-dimensional. We think that in the nearest future these matters will be settled theoretically as well as experimentally. Nevertheless, there is a problem that must be solved immediately. Obviously, we mean here the spatial dimensionality of the entire Nature.

Well, suppose that $U0$ is three-dimensional. Then from (i) it follows that the space of every cosmos has got at most three dimensions. Even worse, 3 is a strange primary constant (cf. Section 11.). This implies that replacing the number by a larger one will do nothing; the only way out is to assume that the space of $U0$ is equal to $\mathbf{E}^{\infty}$.

Using Subworld Formula we infer that a proper subuniverse of $U0$ has only finitely many spatial dimensions. Every natural number should be represented here, since the number of distinct $U1s$ has to be infinite as well.

Let's go back to our $U2$. It has three spatial dimensions, and the same goes for all macroscopic objects. Even elementary particles turn out to be three-dimensional at a closer look. In this context, the situation in $U0$ is informative; objects moving in a cosmos may have fewer dimensions than the whole world. Therefore, for example, our $U1$ can have four spatial dimensions, and its objects only three.

21 Residual gravity

In this work we are not able to present the gravity theory as an integral part of GUN, but a few words can be said. Well, a quantum theory of an interaction should be based on its intermediate bosons. In the case of gravitation, they must be called gravitons. In GUN [63] some of them are spin-2 bosons, but their other properties are quite different from those found in literature [64].

The residual gravity is somewhat similar to magnetism, i.e., it is long-distance; gravitons traverse $U0$ like photons do it with our $U1$. However, there is a fundamental difference between them: no field is felt by the objects of $U0$. This is due to the fact that no gravity-magnetic force (between point-like particles) exists. Furthermore, in $U0$ there are no bombing missiles (gravitons cannot be used as such), which implies that there is no counterpart of the hadronization phenomenon. Let us add in passing that the bosons of baryonic interaction behave similarly, and that is why neither they nor gravitons have been detected so far (in the future you will be able to do so using specific methods).

Since even residual gravity does not work, no interactions influence the objects of $U0$. Hence it follows that in this manner we have obtained the best implementation of Newton's law of inertia.

22 Laws of physics

The considerations of the previous section suggest that Newton's first law and the relativity principle, i.e., equivalence of observers (both of these rules do not refer to any numbers) hold in $U0$, but other laws of physics may not be applied there. The question then arises: Don't most of the laws exist in $U0$ at all?

We think that this is not exactly the case. Let us note that in $U0$ there are objects ($U1s$, in fact) that enjoy some structure. Even if their properties are hidden, we must not neglect their existence. It is best to assume — especially taking into account (i) — that in $U0$ the laws of physics are topologically blurred (and they are represented by $U1s$ that exist so far), and only during a Super Bang they take a clear algebraic form. For instance, the number 2 that occurs in Coulomb's law can be replaced by other values in $U1s$ distinct from ours.

Therefore, we take for granted that the laws of observers with the same degree and number of dimensions are topologically equivalent (i.e., they should be transformed by homeomorhisms). If one of the worlds has fewer dimensions, their laws may be a little impoverished, but they should be topologically embeddable in those of the other.

Now one may ask how those laws arise and where they are stored. In quantum approach the answer is simple. The laws of physics are inextricably linked to particles (just mention intermediate bosons), and the latter are created during a Super Bang. They obtain masses and other properties that dictate the algebraic form of laws.

In this context, it is worth quoting the opinion of a known physicist [65]: “The hope of finding a rational explanation for the precise values of quark masses and other constants of the standard model that we observe in our Big Bang is doomed, for their values would be an accident of the particular part of the multiverse in which we live.”

We think this view is too pessimistic. Firstly, Weinberg he did not know anything about our Super Bang. The rational analysis of particles [66] that were formed during it can explain many things including the precise values of quark masses.

Secondly, the existence of many universes should be regarded as a kind of insurance policy in case something could not be clarified. In our opinion explaining that something is accidental ought to be qualified as a valid scientific method (but it would make no sense if there were only one universe). This should be understood especially by quantum physicists, since quantum reality is based on probabilities.

23 Improper universe transformations

Now we introduce a mathematical apparatus that enables us to deal with many temporal dimensions; it will be used in the next section. We will say that transformations defined in Section 3. are *proper*, whereas by an *improper universe transformation with explicit time* we mean a map

$$(\sigma, \tau): \mathbf{E}^n \times \mathbb{R} \to \mathbf{E}^{n'} \times \mathbb{R}^l,$$

where $2 \leq l \leq \infty$, such that there is exactly one $k < l + 1$, called the *time direction* of the transformation, such that the map

$$(\sigma, p_k \tau), \tag{30}$$

where p_k is the projection on the kth coordinate, is a proper transformation.

The uniqueness of k is easy to obtain; from Corollary 3.2. it follows that it suffices to put $p_i \tau \equiv 0$ for $i \neq k$. Since the time direction is unique, using (30) all concepts defined for proper transformations can be extended to improper ones.

Finally, by an *improper intercosmic transformation with implicit time* we mean a map

$$\sigma: \mathbf{E}^n \times \mathbb{R} \to \mathbf{E}^{n'},$$

such that there is a versor $\boldsymbol{t}$ of $\mathbf{E}^{n'}$, called the *time direction* of σ, such that

$$(\sigma - (\sigma \cdot \boldsymbol{t})\boldsymbol{t}, \sigma \cdot \boldsymbol{t}) \tag{31}$$

is a proper transformation. Here, in the general case, the uniqueness of $\boldsymbol{t}$ would be difficult to achieve, but supposing that (31) should be normal this is implied by the boundedness and fullness from (iii).

24 Equalization of space and time

Probably all contemporary physicists agree that time's arrow, experienced in our world, is caused by just a few typical processes that are not time-reversible. One of them is that of increasing entropy [67], which can be identified with decreasing free energy [68]. However, in Section 7. we have said that the total energy of $U0$ is infinite. This involves also the free energy, especially that it can be created from nothing.

Many time irreversible phenomena proceed using a plurality of elementary interactions that yield friction or resistance. However, in $U0$ there are no working interactions at all. Thus it would be hard to say that in $U0$ entropy statistically increases with time.

Because $U0$ was not created as a result of a Bang, the cosmological arrow of time does not exist. There are no kaons there either, so their decays [69] cannot establish a time's arrow. The absence of interactions excludes other possibilities of its introduction (causality, quantum wave collapse, propagation of waves) as well.

Massive objects of $U0$ (i.e., $U1s$) can collide creating new objects (if scattering is inelastic), but this reaction is perfectly time-reversible. Gravitons do not even do that. Thus we see that in $U0$ there is no arrow of time caused by the universe itself. Therefore, the question arises if we can negate its time.

To answer let us consider its proper subcosmoses. They are created owing to Bangs, have finite energy, and enjoy at least one fundamental interaction. This explains why they possess the arrows of time. The universes can be observed from $U0$, so together with time negation the normal transformation (σ, τ) from a $U1$ should be replaced by $(\sigma, -\tau)$ which is normal as well.

We see that in $U0$ time can flow backwards without contradiction. Is this the end of time problems in physics? Not at all. Using terminology of linear algebra, we have eliminated the sense of time, but its direction has remained. In fact, you might ask: Why cannot time flow across?

The answer is: It can. It suffices to assume that the space-time of $U0$ is equal to $\mathbf{E}^n \times \mathbb{R}^l$, where $l \geq 2$, or preferably to

$$\mathbf{E}^\infty \times \mathbb{R}^\infty, \tag{32}$$

and for every object of $U0$ there is exactly one natural number k, called its *time direction*, such that just the kth time coordinate of events at which the object exists can be nonzero. The time of objects that have different time directions flows across.

(18) remains true in an obvious manner. A collision of objects can be defined in different ways. For example, as the massive objects of $U0$ have nonvanishing sizes, we may require that they stay in contact during a time set with nonempty interior. This implies that colliding objects have to enjoy the same time direction.

The postulate of Subworld Formula does not have to be changed. By virtue of (32) the transformation to $U0$ should be improper and have explicit time. Its normalness has been defined in the previous section.

Nevertheless, you can still be dissatisfied and complain that (32) introduces an unnatural dichotomy between spatial and temporal directions. You may also ask why time cannot flow at an angle of $\pi/4$.

Well, let us assume that the space-time of $U0$ is simply equal to $\mathbf{E}^\infty$. (Obviously, $\mathbf{E}^4$ is sufficient whenever we agree to the distinction of the number 4.) The most important thing, i.e., a normal improper transformation with implicit time, has been already defined. We see that the dichotomy and time's arrow appear only during a Super Bang, and later they are inherited by lower-level cosmoses.

In this case (18) has to be modified. We assume that for every massive object there is a versor $\boldsymbol{t}$ of $\mathbf{E}^\infty$ such that if the center of the object is at different events $\boldsymbol{p}, \boldsymbol{r}$ of $\mathbf{E}^\infty$, then

$$|\boldsymbol{p} - \boldsymbol{r} - ((\boldsymbol{p} - \boldsymbol{r})\boldsymbol{t})\boldsymbol{t}| < |(\boldsymbol{p} - \boldsymbol{r})\boldsymbol{t}|. \tag{33}$$

Of course, $\boldsymbol{t}$ plays the role of the time direction of the object, and we see that — in a sense — its speed remains bounded. Note that this procedure is somewhat similar to the introduction of proper time in special relativity, but it does not require the existence of a smooth trajectory. The study of further properties of this space-time would require a relativity theory (with implicit time).

25 Intercosmic communication

In this section we consider the following, important for some people, question: Are two observers located in different universes able to communicate with each other?

Suppose that the external observer bombards a subcosmos with use of missiles that have two distinct energies. Choosing them properly, they can send any message. The internal observer finds that the energy conservation principle is violated. They measure the energy of missiles and this way read the message. Next, they cause projectiles to collide with objects of different masses, and consequently the latter objects leave the subuniverse. Thus the external observer can receive an answer.

Nevertheless, there may be a problem caused by the fact that intelligent observers can probably live only in the second degree cosmoses. In this case, you will have to apply artificial intelligence. By using random objects that get into our world, you need to place an intermediate robot in our $U1$. Therefore, the answer to our question seems to be positive, but this will be accomplished rather in the very distant future.

It should be added that no intercosmic transmission can be performed between observers from $U0$ and a $U1$, whence also from different $U1s$. Of course, that is due to the absence of any bombardments in $U0$. This fact should be considered lucky because we have seen in the previous section that they can enjoy opposite time's arrows or even the temporal direction of one of them can be a spatial direction of the other. Therefore, exchanging information between them could lead to a contradiction.

26 Conclusion

In the paper we have presented an unusual theory that identifies, in a sense, the smallest things (particles) with the largest ones (cosmoses). This has enabled us to achieve a number of objectives, the most important of which is expressed in Main Theorem. According to it some universes are stable, and this is caused by relativistic and general quantum-mechanical reasons, not by interactions.

The various predictions and implications of GUN will be able to be verified, both experimentally and theoretically, but one phenomenon, that of color confinement, has already been confirmed. In earlier theories no its analytic proof was found despite the long search, and this failure has suggested that the conceptual framework should be changed. That is what we have done, starting to operate on multiple universes.

The last fact requires additional discussion. For in [70] we may read that 'universe' is "the whole body of things and phenomena observed or postulated." So how can we talk about many universes?

Well, in this definition the word 'observed' is used as intended by those authors. And we have seen in Section 5. that each of our internal observers of the same nonzero degree observes a different infinite world and up to a certain point everyone is convinced that there is nothing but their cosmos. What's more, many of them have distinct laws of physics and even numbers of space-time dimensions. Thus each of them satisfies the condition before the word 'or'.

Now consider the following training postulate

- (Two Universes.) *A physical object X belongs to the universe if and only if the continuum hypothesis is true.*

Because either the continuum hypothesis [12] or its negation can be assumed to be true in set theory, by adding the words ‘or postulated’ the authors of [70] unknowingly became the pioneers of the idea of infinitely many universes. For who would check which postulates are true? Gödel showed that this was fundamentally impossible.

There are still humans that claim that ‘Nature’ and ‘universe’ mean the same thing. In our opinion the difference can be illustrated as follows: When the continuum hypothesis is regarded as a problem, it belongs to Nature; whereas each of its solutions yields a universe. This also goes for physics, since it is based on mathematics (cf. the postulate of Two Universes).

The following quote [71] confirms our opinion. “Although the word ‘universe’ literally means all that exists, the longer we have studied the world, the larger it appears to have become. It is not surprising therefore that the usage of this term has changed as we have progressed from the geocentric to heliocentric to galactocentric to cosmocentric view.” The latter sentence depicts the road we have traveled.

As GUN breaks with cosmocentrism, you may be wondering what should be the next view. We suggest the term ‘topocentrism’ because in our approach all universes are subcosmoses of $U0$ placed at the top of the hierarchy. (You must add the obligatory 'o' to the word 'top', cf. ‘galactocentric’.) In addition, topology plays an essential role in the definition of intercosmic transformations.

Let us note that in this theory the universe $U0$ could be termed Mother Nature. The word ‘Mother’ is very appropriate here because all worlds can be regarded as her descendants (as we have seen, ours is her grandchild). The mother world contains all potential possibilities that are differently implemented in the subuniverses.

Since we are talking about subcosmoses, it is worth paying attention to the fact that treating parts as a whole is an important element of human thinking. Mathematicians study objects (e.g., topological spaces, groups) and subobjects (subspaces, subgroups), engineers use modules, and computer programmers write subroutines and also modules. It is high time that this goes for physics too.

In politics and economics, there are similar rules for international organizations, countries and cities. It may also be relevant that in parts there is often more happening than in the whole. This involves, for example, countries, at least for the time being. In Nature, their counterparts are $U2s$.

It is noteworthy that other second-order universes are not, at least for now, the most important for us. Our cosmos can be compared to a state whose government (mankind in the former case) is interested in relationships and money (energy) flows from/to the international organization (our supercosmos) and in what is happening in cities (hadrons).

In GUN we do not need, in principle, the concept of the multiverse (just like maniverse, megaverse, metaverse, meta-universe, omniverse, or world ensemble) unless we would like to call the family of all universes of the same nonzero degree the multiverse of this degree (and the collection of all second-degree subworlds of our supercosmos could be termed our multiverse). The universes contained in them are able to be very different from ours, but they have been introduced by scientific means.

At this point we may say that GUN is not completely incompatible with general relativity. Each second-order internal observer has the right to introduce non-Euclidean geometry in their world. This is similar to the non-Euclidean geometry of the Earth's surface, except that in the latter case you can easily see that there is something more. Nonetheless, Minkowski space-time, and consequently curved space-time, must collapse [24] sooner or later, and then they are forced to change the conceptual apparatus.

In this work we cannot avoid mentioning God because some maintained that the Big Bang was proof of the existence of this supernatural being. After the emergence of the concept of multiverse they have modified their position by claiming [72] that “God may have designed the whole process that led to a multiverse that includes parts where we exist.”

Unfortunately, I must worry religious people. GUN differs from the multiverse ‘theory’ by, among other things, the presence of $U0$ that exists eternally, so it did not have to be created by anyone. Nevertheless, there is a small probability that an intelligent observer is living in our superworld. They could collide particles in their universe, and this way create ours. Thus they can play the role of God, albeit without miracles.

If we talk about intelligent life, it is worth noting that in this approach we do not have to deal with problems connected with the anthropic principle [73] and fine-tuning [74, 75]. The probability that in $U0$ there are other subcosmoses and planets suitable for living (with arbitrarily high accuracy of necessary parameters and laws) is equal to one. This, of course, means that there are infinitely many Earth-like planets in subuniverses of Mother Nature.

Since GUN is based on probabilities, you could say we are implementing Max Planck's will who was the first one to go that way. The difference between traditional quantum mechanics and GUN is that we are consistent; probabilities must make sense when describing any phenomenon. In our opinion, if instead someone claims that our universe arose spontaneously from nothing, they assume implicitly that a miracle happened. Only many repetitive Big Bangs create science.

In [76] a known skeptic of many universes wrote: “Since Copernicus, our view of the universe has enlarged by a factor of a billion billion. The cosmic vista stretches one hundred billion trillion miles in all directions — that's a 1 with 23 zeros. Now we are being urged to accept that even this vast region is just a minuscule fragment of the whole.”

Yes, that's what we say. What's more, now the number of zeros has to be infinite. This means that we will never be able to explore all Nature. However, mathematicians also once thought that they would be able to prove everything. Then Gödel got it out of their minds, and they somehow live with it.

At the end of his article Davies prophetically recommended: “But caution is strongly advised. The history of science rarely repeats itself. Maybe there is some restricted form of multiverse...”

Well, the history of science is rarely repeated exactly. Our $U2$ certainly performs a translational movement within our $U1$, like the Earth around the Sun. (Note that this is the exclusive feature of this approach; having solely the multiverse talking about the movement of our universe would make no sense.) The main difference is that that medieval scholar had a much easier task because everyone could see the sun. Nevertheless, in the next paper we will try to show definitively that our multi-universe environment is unavoidable.

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