# THE CONCEPTUAL BASIS FOR MULTIDIMENSIONAL PHYSICS

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**Abstract.** In this work a conceptual basis for multidimensional physics (MD physics) is proposed. The new physics is based on the elastic model of multidimensional geometry [1]. Reality may be considered as the process of time evolution of holistic macro objects - elastic membranes. An embedded membrane in this multidimensional world will look different for the external and internal observers: from the outside it will look like a material object with smooth infinitesimal geometry, while from the inside our Universe-like space-time fabric. When interacting with elementary particles and other membranes, a membrane will transform their energy into its elastic energy (a new form of energy) - the energy of stretching of the infinitesimal segments. For example, living organisms play the role of internal observers of the Universe, and at the same time they serve as external observers for 2D membranes embedded into our Universe. A new explanation of gravity and cosmological aspects are also discussed.

## INTRODUCTION

In 1912 thirty-four prominent German scientists signed the general manifesto appealing to researchers in all fields of science to combine their efforts in order to "bring forth a comprehensive Weltanschauung (a world picture)." Among the signatories were Ernst Mach, Sigmund Freud, David Hilbert and then still little-known Albert Einstein [2].

From Einstein's works, one can see his inspiration to create that world picture, that universal conception, which would explain every empirical fact – not only of physical science, but also of living world.

Throughout his scientific career Albert Einstein demonstrates virtuous use of two powerful tools:

1. Universalism: the postulation of universal formal principles.

2. Generalization: the discovery among phenomena of a unity through generalization of the basic theory.

He also was among the first scientists who realized the role of the novel geometrical methods in physics. His interpretation of Riemannian curved geometry led to creation of General Relativity which still remains the most reliable theory of gravitation. Remarkably, General Relativity can be extended easily to higher or lower space dimensions.

Proceeding from general considerations we conclude that science also must be multidimensional. Such science should have explanation how universes of different dimensionalities are embedded one into another. It also will provide us with possibility to describe the processes as birth and collapse of universes and from the point of view of the external observer.

Unfortunately, modern physics isn't multidimensional – according to most Multiverse theories multiple universes may exist only in different space-time framework, so in principle they cannot be observed. Another problem is that we haven't really multidimensional geometry: embedded manifolds are considered as being simply subsets of points of the higher dimensional manifolds. This point of view contradicts our understanding of the universe we live in as being an indivisible wholeness where no signals from higher dimensional space-times have been observed. True multidimensional geometry should provide us with a concept of embeddance which will allow manifolds of different dimensionalities be embedded one into another. Such geometry has been proposed recently by the author [1].

The geometry is based on smooth infinitesimal analysis and allows embedded manifolds to have two metrics – internal and external. The embedded manifold can change its external metric without changing the internal one. Another advantage of the geometry is that it looks differently for internal and external observers: from the point of view of the internal observer it is a set of points equipped by a metric as we have used to and from the point of view of the external observer it is a set of spherical connections formed by infinitesimal segments. According to this approach n-dimensional spaces and surfaces are composed of n-dimensional holistic objects "point-connections." The number of dimensions of a manifold depends on how its points are connected. So, an n-dimensional object "point-connection" has a dual nature: in addition to being a point of a manifold, it plays a role of connection within a certain set of points of a manifold.

On the basis of this geometry we can create intuitively very simple multidimensional physics.

## ELASTIC MEMBRANE CONCEPT

Let's us consider a material point-like object in the 3+1 space-time – a point-like elementary particle. Obviously, it may have material properties in some directions and have not material properties in other directions. In the directions where the object hasn't material properties it will not be observable for three dimensional observers. In Figure 1 a.), b.) and c.) you can see 1, 2 and 3 dimensional point-like objects embedded in 1, 2 and 3 dimensional spaces correspondingly. The dimensionality of an object cannot exceed the number of dimensions of the space it is embedded into. Lines here mark the directions along which the object has material properties and the length of a line reflects the density of matter in this direction.

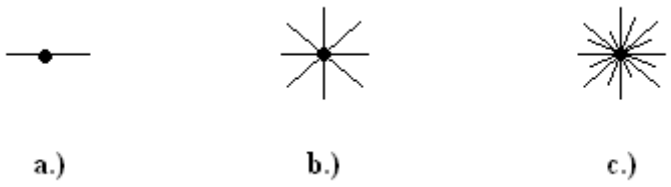


**FIGURE 1.** 1, 2 and 3 dimensional point-like objects.

In addition to multidimensional point-like objects there may exist macroscopic surface-like objects composed by elementary physical objects "point-connections" which are similar to geometrical "point-connections" introduced in the elastic multidimensional geometry. Physical "connections" have material properties only in the directions not tangent to the surface. From the point of view of the internal observer "connections" will not have material properties – they will define a metric on the surface as it was explained in the multidimensional elastic geometry. From Figure 2 you can see how a two dimensional "point-connection" contributes to the material and geometrical properties of a two dimensional surface-like object. Space is represented as interweaving of connections; each point exists only in the context of the background space, which may be understood as indivisible whole just like our Universe is. From Figure 2 b.) we see that connections 3 and 5 define a metric between points 2, 4 and 6 and connections 2, 4 and 6 are not involved in this procedure. Similarly, connections 2, 4 and 6 define a metric between points 1, 3, 5 and 7. In other words, we can define a metric on a set of points of the surface without using connections corresponding to these points. This means that we can separate geometrical and material properties of a surface-like material object from each other.

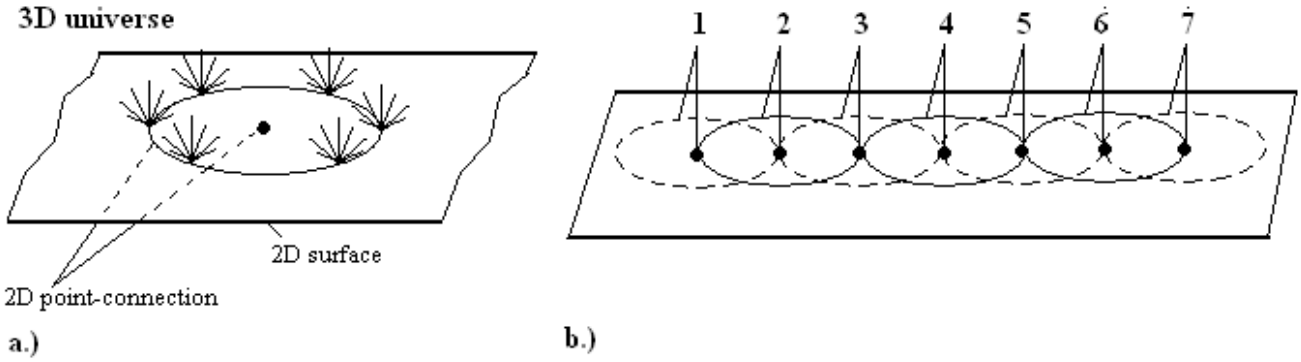


**FIGURE 2.** Two dimensional surface-like material object composed by two dimensional "point-connections".

According to the multidimensional elastic geometry surface-like material objects have elastic properties: they can change their form in the higher dimensional space without changing the internal metric: the internal observer cannot detect these deformations.

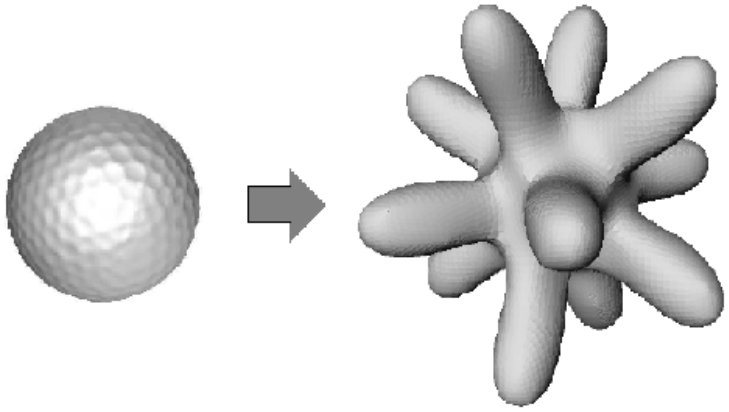

**FIGURE 3.** Elastic stretching of a two-dimensional spherical membrane.

We will call these objects elastic membranes. When interacting with elementary particles and other membranes, a membrane will transform their energy into its elastic energy (a new form of energy) - the energy of stretching of the infinitesimal segments (Figure 3). The internal observer will not observe elastic deformations of the membrane.

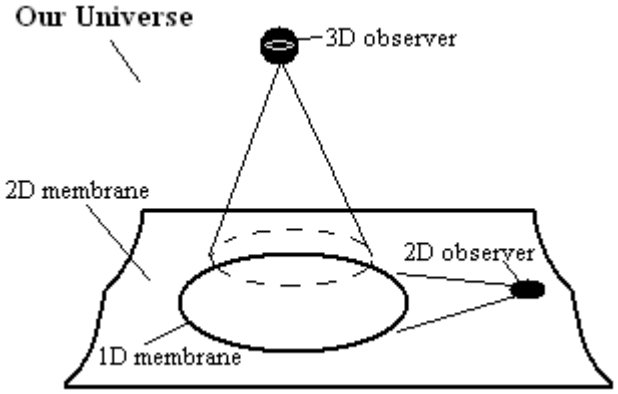


**FIGURE 4.** 3D and hypothetical 2D observers.

From Figure 4 you can see how 3D and hypothetical 2D observers play the role of internal observers in the elastic

membrane they are living in and the role of external observers in relation to the lower dimensional membrane.

For example, our Universe is a three dimensional elastic membrane embedded into the higher dimensional space-time. Living organisms play the role of internal observers of the Universe, and at the same time they serve as external observers for 2D membranes embedded into our Universe.

Spherical form of connections is the result of isotropic and homogeneous nature of elastic membranes and this is why "points" occupy central positions within spherical connections.

The model explains why we don't observe signals coming from the higher dimensional space-time. The interaction between the particle coming from the higher dimensional space-time and the elastic membrane of our Universe will transform energy of the particle into the elastic energy of the membrane. The particle passing through the elastic membrane will not have material properties in the directions tangent to the membrane representing our Universe and, therefore, cannot be detected by 3D observers (see Figure 5).

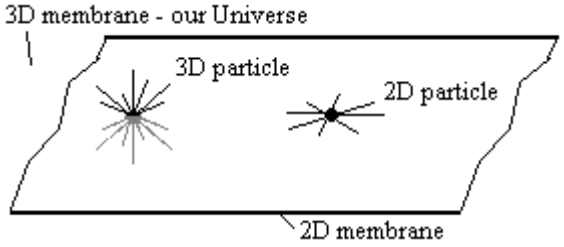


**FIGURE 5.** 3D particle passing through 2D elastic membrane.

Under certain conditions interactions between elastic membranes and particles may cause the Big Bang like event inside the membrane and birth of a new elastic membrane embedded into it (see Figure 6). After the collapse of the new elastic membrane its energy will return to the bulk it came from. In multidimensional physics the Big Bang singularity isn't an exclusive event: it has multidimensional character and may happen inside any universe.

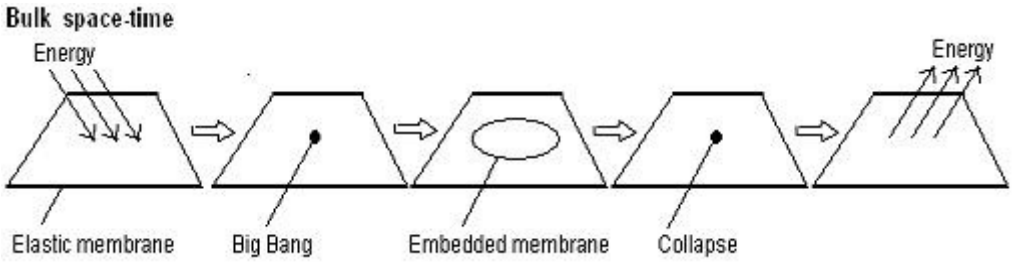


**FIGURE 6.** Birth and decay of an embedded elastic membrane

Reality may be considered as the process of time evolution of holistic macro objects - elastic membranes. An embedded membrane in this multidimensional world will look different for the external and internal observers: from the outside it will look like a material object with smooth infinitesimal geometry, while from the inside our Universe-like space-time fabric. According to the proposed model, reality has hierarchical structure where lower dimensional universes are embedded into higher dimensional universes (See Figure 7). The hierarchy may have an infinite or finite number of levels. An infinite hierarchy of universes is a logically complete structure with an infinite number of universes. On the contrary, a finite hierarchy has a finite number of universes finally embedded into the infinite dimensional Absolute space-time with different physical laws.

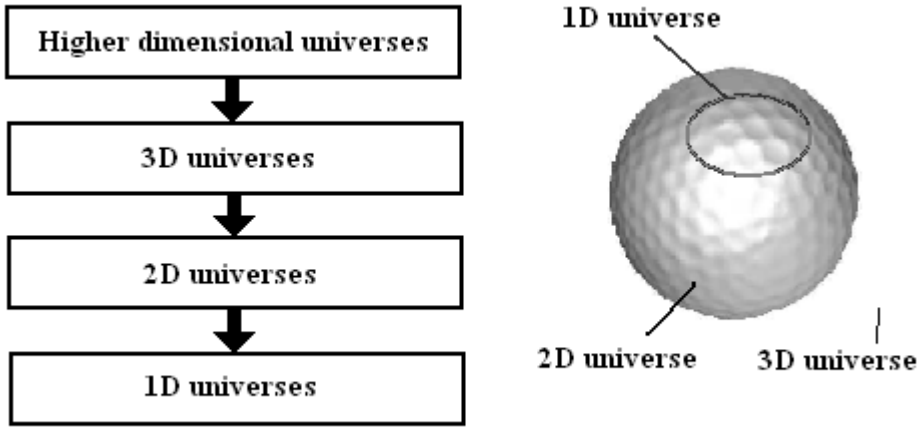


**FIGURE 7.** a.) Hierarchical structure of the multidimensional world, b.) scheme of 1D-2D-3D embeddance.

The model is non-local and requires a preferred space-like foliation of space-time. In the next section we will show that this is possible in the framework of the proposed multidimensional physics.

## MD PHYSICS AND HEISENBERG'S UNCERTAINTY PRINCIPLE

The model will require a preferred foliation of space-time because elastic membranes should be considered instantaneously. While this is in conflict with the standard interpretation of relativity, the preferred foliation, if unobservable, does not lead to any empirical conflicts with relativity.

Theories of relativity postulate that space and time cannot be separated from each other. In both special (SR) and general (GR) relativity a 'moment of time' corresponds to a single space-like hypersurface in the space-time. Time itself appears as the parameter that labels the elements of a one-parameter foliation of space-time by such surfaces. In the case of special relativity the space-like surfaces are hyperplanes which are mapped into each other by actions of the Poincare group. The situation in general relativity is more complex. One says that a hypersurface is space-like if the vectors tangents to each point of the surface are space-like. Unlike in SR, in GR we cannot define a unique time according to which we evolve a system. When we get to Planck scale physics, space-time geometry could be subject to Heisenberg's uncertainty principle, varying about quantum mechanically. In other words the GR metric tensor $g_{\mu\nu}$ could have fluctuating components! How could one define a light cone and hence a space-like, light-like, or time-like separation under such circumstances?

The uncertainty principle states that in order to observe a small region of space–time we need to concentrate a large amount of energy and momentum. However, general relativity implies that if we concentrate too much energy and momentum in a small region, that region will collapse into a black hole and disappear [3].

We know that Einstein could not accept a probabilistic theory as the final word. He yearned to produce a complete, causal, deterministic description of nature. He tried to develop thought experiments whereby Heisenberg's uncertainty principle might be violated.

Heisenberg’s uncertainty principle will work in the new physics only from the point of view of the internal observer. For the external observer each embedded elastic membrane may be stretched and even a very small region will become observable. The theory postulates that these elastic deformations (stretching) will not be observable from the point of view of the internal observer (see Figure 8).

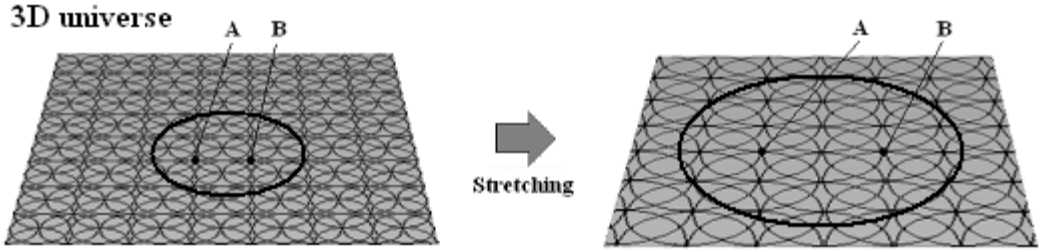


**FIGURE 8.** Stretching of a two-dimensional elastic membrane.

Particles of the embedded membrane cannot be observed from the bulk using traditional techniques accepted in quantum physics because the embedded membrane is a holistic object and particles are its internal objects. The external observer cannot directly interact with lower dimensional particles sending particles from the bulk. Two methods can be used in order to obtain information about particles of the embedded membrane:

1.) The external observer can interact with the embedded membrane. If particles of the membrane affect its material properties (the energy of the surface of the membrane) when the change can be detected by a higher dimensional particle coming from the bulk;

2.) Another technique allows to collect information about internal objects of the elastic membrane using Big Bangs: signals from the bulk cause Big Bangs on the surface of the membrane and new lower dimensional membranes-universes will born in the universe living on the surface of the membrane (See Figure 6). These new membranes will interact with the particles and membranes embedded into the parent membrane. The parameters of the collapse of the new membranes (time, coordinates and energy) will depend on these interactions and will contain information about the internal objects of the parent membrane.

Of course, after stretching the membrane will be energetically weaker than before stretching and we will need very sensitive techniques to investigate such weak structures. Generally, elastic membranes are supposed to be energetically very weak objects when observed from the point of view of the external observer because really multidimensional objects look different for internal and external observers. For example, massive objects – stars and planets that we observe around us will produce just weak excitations on the surface of the membrane of our Universe. As it was demonstrated in the recent works [4] these objects may be useful for explaining processes in living organisms. And we can expect that various indirect and direct experimental techniques and theoretical methods for studying elastic membranes are to be developed.

## MD PHYSICS AND GRAVITATION

In Einstein's theory, any object that has mass causes a warp in the structure of space and time around it. This warping produces the effect we experience as gravity. Sir Roger Penrose's points out that tiny objects, such as dust specks, atoms and electrons, produce space-time warps as well. According to the elastic membrane concept gravity is the result of internal elastic deformations of a membrane caused by elementary particles which don't change the membrane's form in the bulk.

Elastic membranes are indivisible objects: elementary particles which are internal objects of a membrane cannot be separated from the membrane and, therefore, there must be some kind of interaction between particles and the membrane. This interaction is different from interactions between elementary particles and changes internal elastic properties of the membrane. Just like an elastic membrane has a coefficient of external stretching or squeezing it has also a coefficient of internal stretching or squeezing caused by elementary particles. Elementary particles accumulate the energy of the surface of the membrane and cause the phenomenon we call gravity. This is possible because connections of the membrane can

undergo elastic deformations (stretching and squeezing) not only in the directions tangent to a connection but in other directions as well. While the first changes the length of the connection the second changes its material properties.

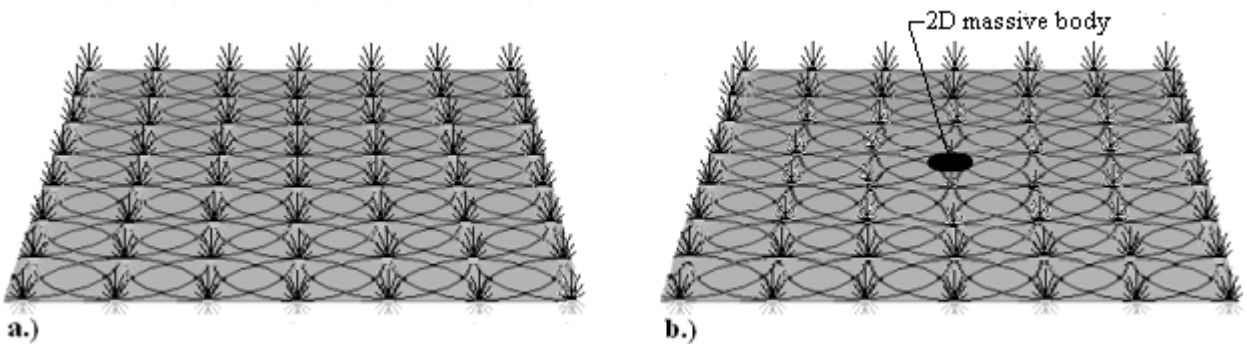


**FIGURE 9.** Change of material properties of an elastic membrane caused by a massive body. Bundles of lines here mark the directions along which the object has material properties and the length of a line reflects the density of matter in this direction.

Elastic deformation may be described by $k(\bar{d})$ - the coefficient of stretching of the membrane along the direction $\bar{d}$ or by $k$ - the average coefficient of stretching of the sphere S with center in the selected point and radius r.

$$k(\bar{d}) = l_{str} / l \quad , \quad k = (V_{str} / V)^{1/n}$$

Where $l$ is the distance between the selected point and the point of the sphere S corresponding to the direction $\bar{d}$ and $l_{str}$ is the same distance after stretching, V is the volume of a sphere S measured from the bulk and $V_{str}$ is the volume of this sphere after stretching measured by the external observer. We suppose that coefficients of stretching do not change significantly inside the sphere S along the selected direction.

Let's define $M(\bar{d})$ – a parameter describing the energy of the surface of the membrane in the selected point in the direction $\bar{d}$ . This parameter doesn't consider gravitation effects which may be described by the following formula:

$$M_{gr}(\bar{d}) = k_{gr}(\bar{d}) \cdot M(\bar{d})$$

Where the coefficient $k_{gr}(\bar{d})$ encapsulates gravitational effects and $M_{gr}(\bar{d})$ is a parameter describing the surface energy of the membrane under the influence of gravitation. External elastic deformation changes the area of the surface of the membrane but it doesn't change surface energy $M(\bar{d})$ in the selected point.

In Figure 9 we see how a massive body changes material properties of the elastic membrane, elementary particles of the body bind the surface energy of the membrane so that $M_{gr}(\bar{d})$ decreases when approaching the massive body. This deformation is elastic – when the body moves away the energy of the surface restores. At the same time motion of the particles will be governed through their interaction with the transformed field of the surface energy. Particles will move towards the positions with minimal surface energy (where $k_{gr}$ is maximal).

The idea that gravity is the result of elastic properties of space-time is not new among theoretical physicists. For example, it has been shown that the extension of the elasticity theory in more than three dimensions allows a description of space-time as a properly stressed medium, even recovering the Minkowski metric in the case of uniaxial stress [5]. From Figure 10 a.) you can see a typical representation of space-time curvature caused by a massive body - it is very similar to elastic deformation of a surface. In Figure 10 b.) a cross-section of a 2D elastic membrane is shown. We can see how the surface energy of the membrane decreases towards the massive body.

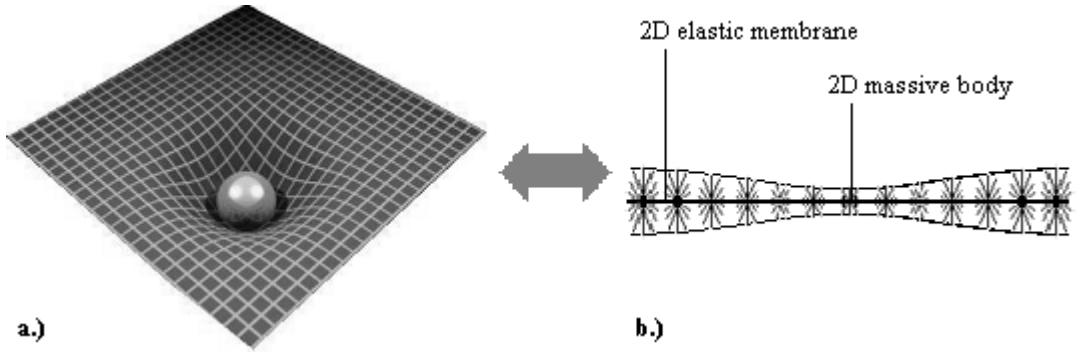


**FIGURE 10.** a.) Space-time curvature and b.) internal elastic deformation of the surface energy of the elastic membrane caused by a massive body.

From the point of view of the internal observer gravitation is a consequence of the curvature of space-time governing the motion of inertial objects. From the point of view of the external observer gravitation may be understood as a result of internal elastic deformation of the elastic membrane. Internal elastic deformation doesn't change the external metric of the membrane. These two interpretations of gravitation are complementary: the second interpretation requires a preferred space-like foliation of space-time with space-time curvature replaced by internal elastic deformation of the membrane.

The elastic membrane concept fully supports Albert Einstein's position on the material properties of space-time. Einstein writes [6]: "We may say that according to the general theory of relativity space is endowed with physical qualities; in this sense, therefore, there exists an aether. According to the general theory of relativity space without aether is unthinkable; for in such space there not only would be no propagation of light, but also no possibility of existence for standards of space and time (measuring-rods and clocks), nor therefore any space-time intervals in the physical sense. But this aether may not be thought of as endowed with the quality characteristic of ponderable media, as consisting of parts which may be tracked through time. The idea of motion may not be applied to it."

Indeed, elastic membranes are holistic objects which exhibit material properties only from the point of view of the external observer, so that from the point of view of the internal observer we have space-time with no aether at all. At the same time material properties of the membrane help us to explain not only the nature of gravity but the nature of elementary particles and space-time as well.

## MULTIDIMESIONAL ELASTIC COSMOLOGY

Another advantage of multidimensional elastic geometry is its possibility to represent infinite surfaces as finite ones with the squeezing point. In this point the coefficient of squeezing is an infinite number. We can apply this procedure to an infinite elastic membrane. This allows us to work with finite surfaces instead of coping with infinite ones which are too abstract for the human mind.

Obviously, when approaching the squeezing point on the finite elastic membrane the membrane's surface energy will grow and become an infinite number in the squeezing point. This infinity may be compensated if there is an infinite amount of matter in the squeezing point. The internal singularity will produce the internal elastic deformation of the membrane which will suppress the growth of the surface energy of the membrane when approaching the squeezing point. In other words, the infinite space-time we experience from the point of view of the internal observer is just a finite elastic membrane with closed topology from the point of view of the external observer. This membrane has an internal singularity in the squeezing point (See Figure 11).

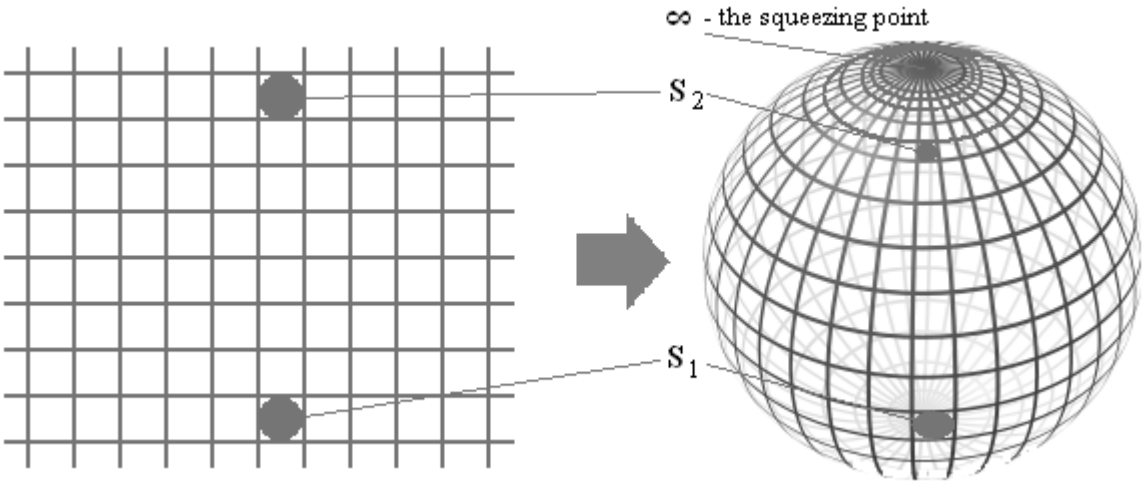


**FIGURE 11.** Elastic transformation of an infinite universe into the finite one with the squeezing point.

The squeezing procedure is similar to the process described in Penrose diagrams — mathematical ways to map infinite space-times onto a simple sheet of paper [7]. Figure 12 gives some impression of what is going on in Lobachevski geometry - as you walk from the centre out to the edge, you have to imagine that, because of the way the picture of the geometry has had to be distorted, the actual geometry there is exactly the same as it is in the middle, so that the geometry all about you remains the same no matter how you move.

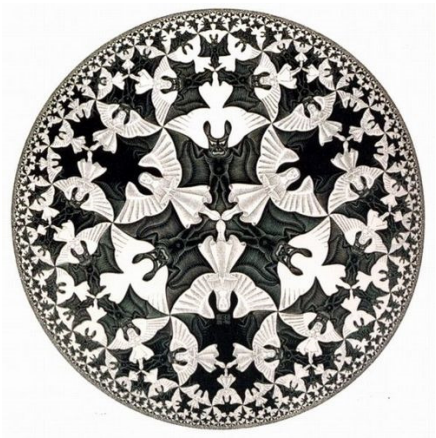

**FIGURE 12.** Escher's “angels and devils” drawing.

This cosmological model exploits the idea that the Big Bang had more complicated nature and explosion didn’t happen at ones. In the beginning only a part of the singularity exploded and the remaining part plays the role of the squeezing point in the expanding universe. And there may be other Big Bangs after the first Big Bang if the singularity will explode part by part. The model has common features with cyclic universe model proposed by Sir Roger Penrose.

The accelerating expansion of the universe that we currently observe is identified as the result of falling of massive objects planets and stars towards the squeezing point under the influence of gravity.

Remarkably, in this model points which seem to be very far from each other from the point of view of internal observer may be very close to each other from the point of view of the external observer. This happens because of two facts: 1.) squeezing towards the squeezing point makes very distant point closer when viewed from the higher dimensional space, 2.) external elastic deformations may change the external metric of the membrane, so that points which seem to be

unreachable from the point of view of internal observer will appear to be very close to him in the higher dimensional bulk space-time.

## CONCLUSION

In this work the possibility of existence of really multidimensional world is investigated. It is shown that our world may have multidimensional structure based on the multidimensional elastic geometry proposed recently by the author of this paper.

Reality may be considered as the process of time evolution of holistic macro objects - elastic membranes. An embedded membrane in this multidimensional world will look different for the external and internal observers: from the outside it will look like a material object with smooth infinitesimal geometry, while from the inside our Universe-like space-time fabric. When interacting with elementary particles and other membranes, a membrane will transform their energy into its elastic energy (a new form of energy) - the energy of stretching of the infinitesimal segments. For example, living organisms play the role of internal observers of the Universe, and at the same time they serve as external observers for 2D membranes embedded into our Universe.

In this physics all objects - elementary particles and elastic membranes may have different number of dimensions. Heisenberg's uncertainty principle will work in the new physics only from the point of view of the internal observer. For the external observer each embedded elastic membrane may be stretched and even a very small region will become observable. The theory postulates that these elastic deformations will not be observable from the point of view of the internal observer.

Gravitation can be explained as internal elastic deformation of the membrane caused by elementary particles. This deformation will not be observable from the point of view of the external observer.

According to the model infinite universes are infinite only from the point of view of the internal observer and may be represented as properly squeezed finite ones from the point of view of the external observer. The accelerating expansion of the universe that we currently observe is identified as the result of falling of massive objects - planets and stars towards the squeezing point under the influence of gravity.

Finally, multidimensional approach allows us to create that unified universal world picture, which would explain not only physical facts, but also phenomenon of life as it was mentioned in the general manifesto signed by Albert Einstein and other prominent scientists in 1912.

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