ELASTIC MEMBRANE BASED MODEL OF HUMAN PERCEPTION

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INTRODUCTION

Undoubtedly the Penrose-Hameroff Orch OR model may be considered as a good theory for describing information processing mechanisms and holistic phenomena in the human brain [1-3]. The theory explains both physical and biological aspects of consciousness such as

1. Non-computability of consciousness;
2. Relation of consciousness to space-time geometry;
3. The role of microtubules as suitable candidates for information processing;
4. Mechanisms for macroscopic quantum computing – dendritic webs.

But the theory doesn't give us satisfactory explanation of human perception. Perception cannot be explained in terms of elementary particles: interactions between separate entities - the elementary particles of our bodies cannot establish a feeling of having perceptual experience, because the notion of "elementary particle" is very abstract and is derived from our perceptions. And there may be objects of higher priority around us. Obviously, such fundamental processes as the processes of perception should be explained using objects of the highest priority.

A more fundamental object which incorporates all physical objects around us is our Universe. We explore it from inside and, therefore, our knowledge about it is incomplete. The empty space we see from the inside may be only the result of internal observation. Einstein's full theory of space-time, called General Relativity can be extended easily to higher space dimensions. This fact is a good argument in favor of the multidimensional science concept. Modern physics is not truly multidimensional – we don't know how universes of different dimensionalities (I mean here the number of large dimensions) and different physical parameters can be embedded one into another. In order to create multidimensional physics we firstly should create multidimensional geometry.

This will be done in the next section.

DUAL METRIC MODEL OF MULTIDIMENSIONAL GEOMETRY

The concept of multidimensional geometry itself has a dualistic meaning: each surface may be embedded into a higher dimensional bulk and at the same time it may contain lower dimensional surfaces embedded in it. Multidimensional geometry is tightly connected with the basic rules of human perception and depends on how we explain the terms "dimension", "embeddance" and "space".

Traditionally, under the term "space" we imply a set of zero-size points on which a metric can be defined. Under the term "dimensionality" we understand a minimal number of real numbers needed to describe this set unequally. An elementary geometrical object "point" itself has no dimensionality and is the same for all dimensions. This understanding of dimensions tells nothing about their true nature. Why do compositions of points have different number of dimensions?

In this work a new approach to multidimensional geometry based on smooth infinitesimal analysis (SIA) is proposed. An embedded surface must be considered from two sighting points, namely, for internal and external observers. For the internal observer we have a picture we are used to (for example, the space-time we are living in), but for the external observer the picture is quite different (when we try to imagine a 2-dimensional surface we act like external observers).

According to this approach n-dimensional spaces and surfaces are composed of n-dimensional elementary 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. In other words, an n-dimensional "point-connection" has two elements: first – a "point" to be connected, and second – a "connection" which connects the "points."

Smooth infinitesimal analysis is a mathematically rigorous reformulation of the calculus in terms of infinitesimals. It views all functions as being continuous and incapable of being expressed in terms of discrete entities [4]. The *nilsquare* or *nilpotent* infinitesimals are numbers ε where $\varepsilon^2 = 0$ is true, but $\varepsilon = 0$ need not be true at the same time. In SIA every function whose domain is R, the real numbers extended by infinitesimals, is continuous and infinitely differentiable. Intuitively, smooth infinitesimal analysis can be interpreted as describing a world in which lines are made out of infinitesimally small segments, not out of points. These segments can be thought of as being long enough to have a definite direction, but not long enough to be curved.

The standard point of view postulates that lines are made of points. This point of view and SIA are complementary and give us a basis for a new multidimensional geometry: each manifold in this geometry will look different from the points of view of external and internal observers. From the point of view of an external observer it will be a set of infinitesimal segments and from the inside – a set of points equipped by a metric.

Another interesting feature of SIA is its **elasticity**: different segments make different contributions into the length of a curve, depending on the angle between a segment and the OX axis. The curve ADB may be considered as a result of stretching of the curve ACB. Infinitesimal segments have no length but they may be stretched (See Fig. 1).

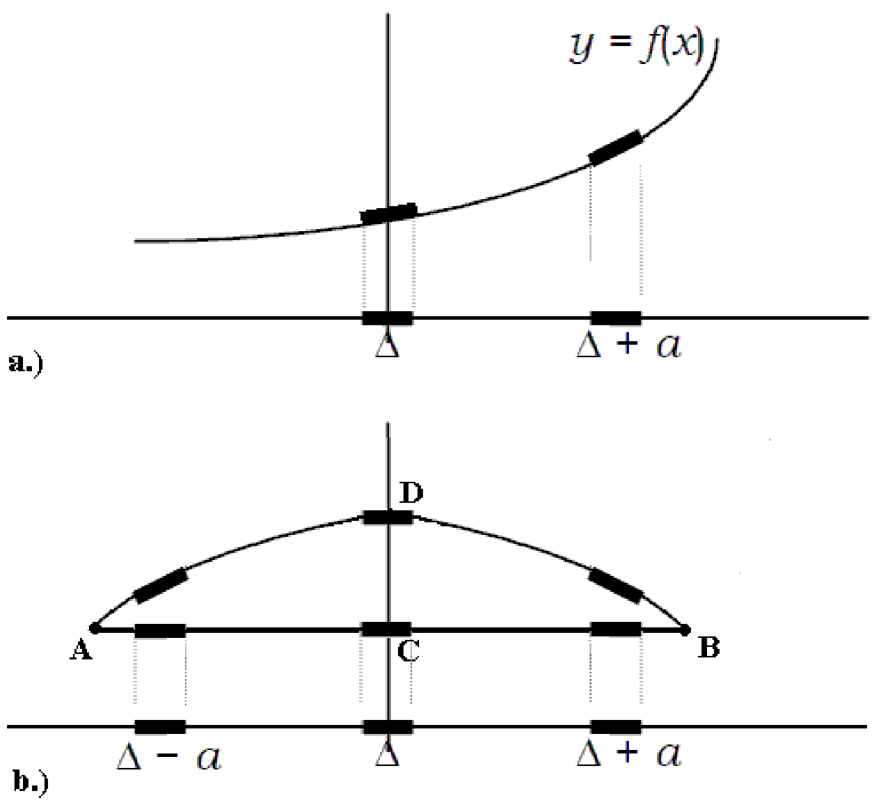


FIGURE 1. Infinitesimal segments and their contribution into the length of a curve.

An infinitesimal segment cannot be considered as a separate entity, it can exist only as a part of the line: we'll call it a **connection**. One and only one point of the manifold will correspond to each infinitesimal segment. But there may be an infinite number of connections passing through the selected point. From the point of view of the external observer each manifold may be represented as a set of connections which connect the points of the manifold. A holistic manifold (our Universe-like) will be composed from holistic elements – "point-connections". Proceeding from general considerations, we will use closed connections, because they are suitable for both finite and infinite manifolds. In the case of isotropic and continuous manifolds connections will have spherical form.

Speaking formally, for any set of points X we can define a function $c:X\times X\times X\rightarrow\{0,1\}$ such that $c(x_0,x,y)=1$ means that points x, y are connected by the connection corresponding to the point x_0. In this case we will call the points x, y *directly connected.* We say that points x, y are not directly connected if $c(x_0,x,y)=0$ for $\forall x_0\in X$. We call two points x, y *indirectly connected* if there exists a succession of points $\{x_1, x_2, \ldots, x_{n+1}\}\in X$ such that every two subsequent points are directly connected and $x_1=x$, $x_{n+1}=y$. It is supposed that $c(x_0,x,y)=c(x_0,y,x)$ and $c(x_0,x,x)=c(x, x_0,x_0)$ for $\forall x_0,x,y\in X$ (symmetry) and each pair of points $x, y \in X$ may be connected (connectivity). We can define a metric $\rho(x,y)$ on X as a minimal number n of connections needed to connect points x, y:

$$\rho(x, y) = \min n, \quad \rho(x, x) = 0 \qquad (1)$$

If we have two sets X, Y and $Y\subset X$, where Y is a subset of X, and a function c_{int}: $Y\times Y\times Y\rightarrow\{0,1\}$ describes the structure of "point-connections" of Y, when for $\forall x,y\in Y$ we can define two metrics: internal $\rho_{int}(x, y)$, derived from c_{int} and external $\rho_{ext}(x, y)$ which depends on $c(x,x,x)$.

We see that structures composed of holistic elements – "point-connections" have a metric embedded in them: from the inside the metric has a discrete character and it will be continuous from the outside.

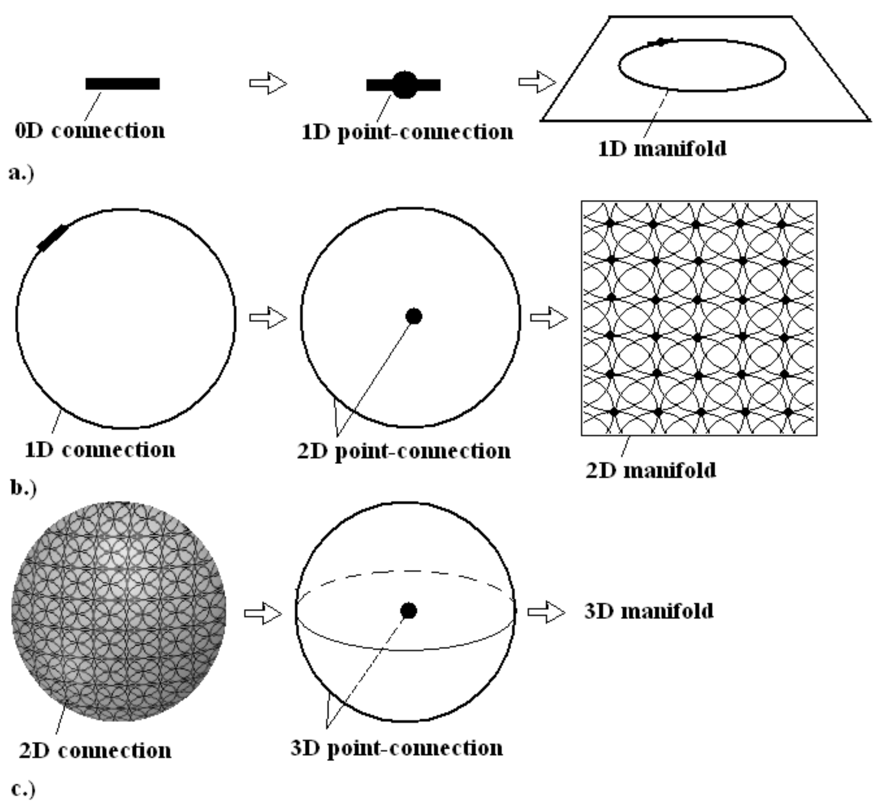


FIGURE 2. Structure of 1, 2, 3 - dimensional point-connections and spaces.

Figure 2 shows 1, 2, 3 – dimensional point-connections and how they form 1, 2, 3 - dimensional spaces (each space is shown as a discrete set of points only for clarity; the model implies a continuous set of points). We can see that a 1-dimensional point-connection is a combination of a point and a 0-dimensional connection – two infinitesimal segments; a 2-dimensional point-connection is a combination of a point and a 1-dimensional connection – points connected by it form a circle which, in turn, can be decomposed into 0-dimensional connections; a 3-dimensional point-connection is a combination of a point and a 2-dimensional connection – points connected by it form a sphere which can be decomposed into 1-dimensional connections. By analogy, an n-dimensional point-connection is a combination of a point and an (n-1)-dimensional connection – points connected by it form an (n-1)-dimensional sphere which can be decomposed into a set of (n-2)-dimensional connections.

We see that each connection itself may have an internal structure: it is also to decompose into subconnections. The process of decomposition of a manifold into subconnections will stop when all subconnections will consist only of 0-dimensional connections. Under dimensionality of a manifold we will understand the number of different levels of subconnections encountered during the process of decomposition including the first (connections themselves) and the last (0-dimensional subconnections) levels.

Let's consider a simple case: a two-dimensional plane imbedded into Euclidean space R^3. We can apply to this plane two different transformations which don't differ from the traditional point of view:

1. Expansion: increases k times the distance between every two points on the plane, but radii of the connections stay the same;
2. Stretching: proportionally increases both the distance and radii of the connections (from the sighting point of the external observer).

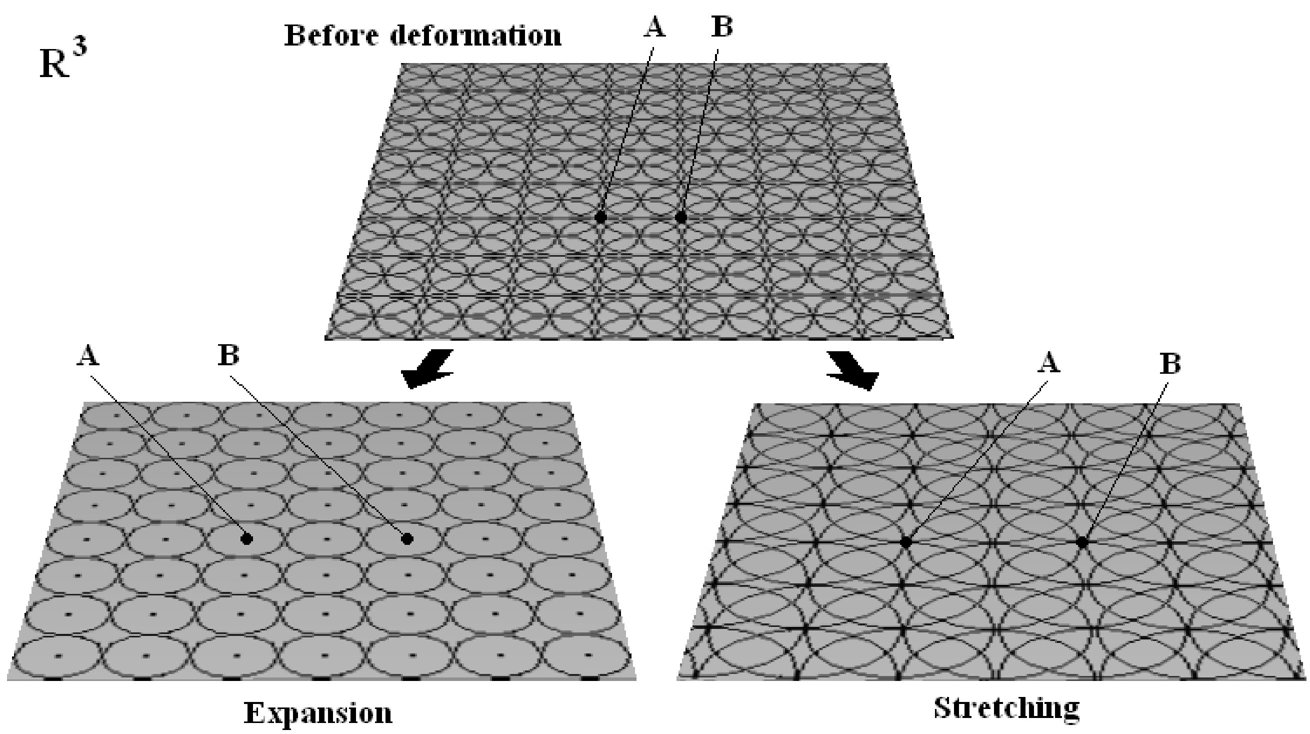


FIGURE 3. Expansion and stretching of a two-dimensional plane.

We can see that the points connected before deformation stay connected after stretching, but they may become unconnected after expansion (See Fig. 3). An example of an expansion is what happens in our Universe after the Big Bang. The standard Big Bang cosmology assumes that the Universe began expanding from the state that was very hot, very small, and very highly curved. This inflationary model agrees very well with observations. Stretching is not observable for the internal observer because it doesn't change the structure of the embedded surface: the internal metric $\rho_{int}(x,y)$ defined by the equation (1) doesn't change after stretching. But the external one does; $\rho_{ext}(x,y) \approx k \cdot \rho_{int}(x,y)$ after stretching, because the external metric depends on the different set of connections-the connections of the bulk. After expansion $\rho_{int}(x,y)=\rho_{ext}(x,y)$.

Clearly any multiple of an infinitesimal is also an infinitesimal. For set Δ of infinitesimals and any positive real number k we can define a function $f: \Delta \to \Delta$ as $f(x)=k*x$. This function translates Δ into Δ, but $f(x) \neq x$ if $x \neq 0$ and $k \neq 1$. We'll call this function stretching of Δ with parameter k.

The embedded surface may be treated in two ways: as a subset of the points of the bulk or as a set of lower dimensional connections added to the bulk. During expansion and stretching points of the embedded manifold change their positions the same way, but the connections don't.

As was shown, n-dimensional connections (n>1) are composed of 1-dimensional connections – circles. These circles according to SIA are made of infinitesimally small straight lines. Stretching of such a circle may be understood as stretching of these infinitesimal segments (1-dimensional connections introduced earlier are the analogs of those segments). The internal observer doesn't feel the deformations if they act like stretching or compressing because any set Δ of infinitesimals the infinitesimal segments are associated with will be translated into itself. But stretching of Δ changes the its relative position in respect to the bulk.

The proposed model shows that the classical approach based on the notion of a limit and smooth infinitesimal analysis are rather complementary than conflicting: if the former describes the world from the sighting point of the internal observer, the latter is more suitable when investigating an embedded surfaces from the sighting point of the external observer.

Obviously we will have two different metrics for the embedded surface - internal and external. In the context of the proposed geometrical model an embedded surface may change its form in the bulk, undergo vibrations, but its internal structure stays unaware of these changes if they act as stretching or compressing. In other words, such geometry is an elastic one. It is just like inflating a balloon with a pattern on it: during the inflation process everything grows bigger and bigger, but when the air is out everything is restored.

MULTIDIMENSIONAL PHYSICS

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 tangent 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?

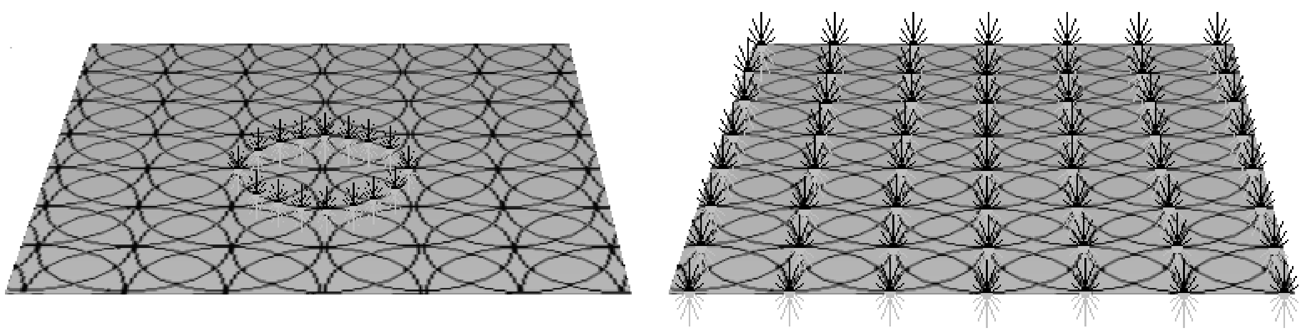
The uncertainty principle states that in order to observe a small region of space–time we need to concentrate a large amount of energy and momentum. However, general relativity implies that if we concentrate too much energy and momentum in a small region, that region will collapse into a black hole and disappear [7].

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. In 1930, Einstein argued that quantum mechanics as a whole was inadequate as a final theory of the cosmos. Whereas he was once regarded as too radical in his quantum theories, he now appeared to be too conservative in his defense of classical Newtonian ideas.

The proposed multidimensional geometry allows us to create a new multidimensional physics in which things may look different from the point of view of internal and external observers. And what seems to be valid from the point of view of the internal observer may not work from the point of view of the external observer.

Heisenberg’s uncertainty principle will work in this 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.

In other words, reality may be considered as the process of time evolution of holistic energetically very weak macro objects - elastic membranes with the geometry based on smooth infinitesimal analysis. 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.) b.)

FIGURE 4. a.) a connection is a set of excitations of the bulk, b.) an embedded membrane is a holistic excitation of the bulk.

In this physics a material object – an embedded elastic membrane or an elementary particle may be considered as a set of defects in the structure of the bulk, for example, collapses of parts of infinitesimal segments. These defects will produce the internal elastic deformation of the membrane that we call gravity.

The difference between elementary particles and elastic membranes is that the first produces point-like excitation of the bulk (in the string theory a string may be considered as a set of interconnected point-like excitations of the bulk) and the second has the holistic nature and is undivided whole. In this case an embedded membrane will not produce excitations of the bulk in the directions tangent to the membrane or having small enough deviation from the tangent vector in each point of the embedded membrane. From the point of view of an external observer excitation produced by the embedded membrane is a holistic superposition of excitations produced by the connections (See Fig.4). In the context of the proposed physics connections are elementary excitations of the bulk which form the embedded membrane.

ELASTIC MEMBRANE BASED MODEL OF HUMAN PERCEPTION

The new multidimensional physics may be useful for explaining our perception. It is supposed that our perception may be considered as the result of elastic oscillations of two dimensional (2D) elastic membranes with closed topology embedded in our bodies. Only one elastic membrane responsible for its perceptions will correspond to the selected organism, but there may be other membranes, even at the cell level. We can observe our 2D self-membranes through our perceptions, which are encoded in elastic oscillations of the elastic membrane.

The model explains some features of our perception which cannot be explained using other models:

1. quasi two dimensional character of our perceptive experience;
2. feeling of self awareness as being one whole;
3. active character of our perception: we aren't zombies – in our brains physics of perception is separated from the information processing physics [5]. But at the same time both mechanisms are tightly connected and under certain conditions can affect each other.

According to the new approach elastic membranes occupy energetically favorable positions around microtubules involved in ORch OR (See Fig. 5). During gamma synchronization an elastic membrane starts stretching and propagating along the direction of attentive focus. Stretched regions have lower density and are less sensitive. When ORch OR happens the membrane occupies energetically steady positions around ORch OR region and starts squeezing in order to keep the position of steady equilibrium. The squeezed regions of the membrane have greater density and are more sensitive. This explains why during conscious attention our perception in the direction of the attentive focus becomes more vivid, while in other directions our perception has a damping character.

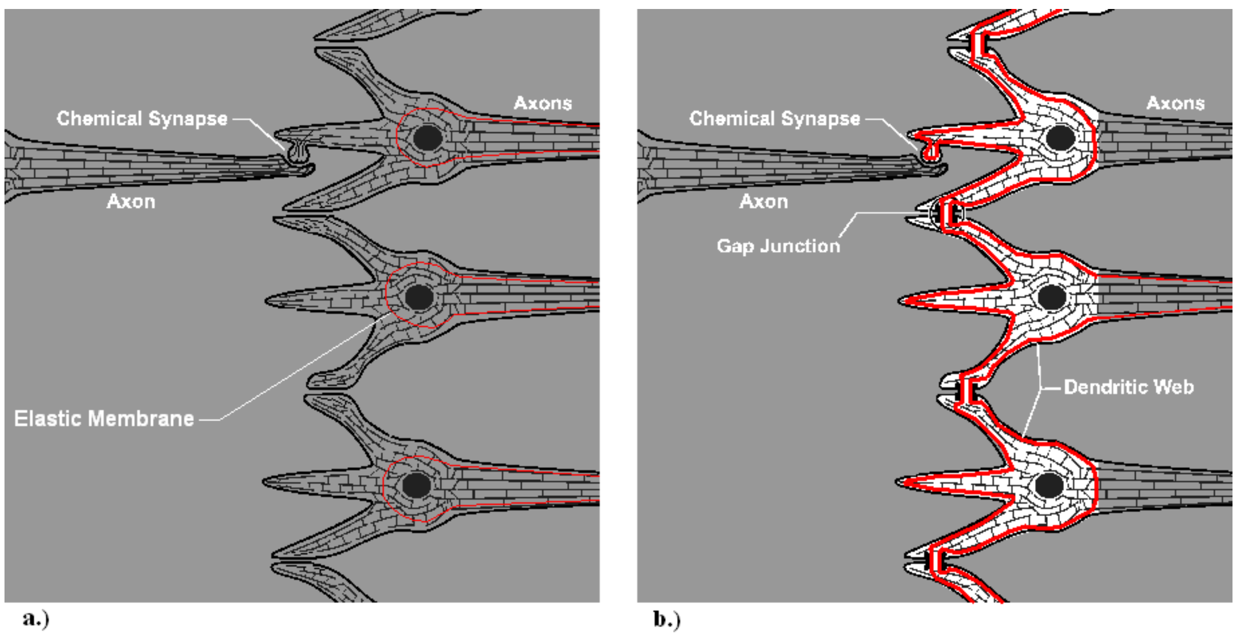


FIGURE 5. a.) The elastic membrane is stretched along the direction of the attentive focus, b.) The elastic membrane is squeezed around microtubules involved in ORch OR.

The new approach takes into account the fact that scientific investigation of living organisms is essentially different from that of inanimate world, because we know from our perceptual experience what it means to be a living organism. Consequently, we can understand some laws of our perception directly from our perceptions. Just like Gestalt psychologists do [10, 11].

The proposed model may help us understand not only the physics of perception, but the intrinsic features of perception as well. The method also gives us explanation of energetically very weak processes – under certain conditions elastic membranes influence the consciousness processes and become experimentally detectable.

STRING THEORY AND LOOP QUANTUM GRAVITY

String theory emerged from the particle physics community and was originally formulated as a theory that depends on a background space-time, flat or curved, which obeys Einstein's equations. This is now known to be just an approximation to a mysterious and not well-formulated underlying theory which may or may not be background independent – M-theory [6, 7].

In contrast, LQG was formulated with background independence in mind. Thus, LQG and string theory seem somewhat complementary. String theory easily recovers classical gravity, but so far it lacks a universal, perhaps background independent, description. LQG is a background independent theory of something, but the classical limit has yet not proven tractable [8].

In the context of the new approach these theories are complementary: Loop Quantum Gravity represents the point of view of an internal observer, String Theory, when powered by elastic features and being really multidimensional, will describe the point of view of an external observer. In other words, it may be something like multidimensional elastic version of M-theory which will describe both – inanimate physical and animate conscious worlds.

HOLOGRAPHIC PRINCIPLE

The Holographic Principle holds that the information in any region of space and time exists on the surface of that region. The proposed theory has a lot in common with the ideas of David Bohm – one of the creators of the Holographic theory. In Bohm's conception of order, then, primacy is given to the undivided whole, and the implicate order inherent within the whole, rather than to parts of the whole, such as particles, quantum states, and continua. Bohm 1980, p. 11 said: "The new form of insight can perhaps best be called Undivided Wholeness in Flowing Movement. This view implies that flow is, in some sense, prior to that of the 'things' that can be seen to form and dissolve in this flow". Thus, according to Bohm's view, the whole is in continuous flux, and hence is referred to as the holomovement (movement of the whole) [9].

The elastic membrane concept is in full agreement with these insights, elastic membranes which are undivided wholes may be considered as two dimensional elastic holograms: our feeling of being three dimensional organisms is encoded in the oscillations of two dimensional elastic membranes.

CONCLUSION

1. It is shown that human perception cannot be explained in terms of elementary particles and we should introduce new indivisible holistic objects with geometry based on smooth infinitesimal analysis - elastic membranes. The example of

such a membrane is our Universe which is an indivisible whole. It is shown that our perception may be considered as the result of elastic oscillations of two dimensional (2D) elastic membranes with closed topology embedded in our bodies.

2. The new model of multidimensional geometry based on smooth infinitesimal analysis has been proposed. The proposed geometry has four features, which distinguish it from the existing geometries:

a. It is holistic. 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.

b. It is really multidimensional. Point-connections of different dimensionality have different topology.

c. It is elastic. Embedded surfaces possess dual metric: internal and external. They can change their form in the bulk without changing the internal metric;

d. Structures composed of holistic elements – "point-connections" have a metric embedded in them: from the inside the metric has a discrete character and it will be continuous from the outside.

3. Reality may be considered as the process of time evolution of holistic energetically very weak macro objects - elastic membranes with the geometry based on smooth infinitesimal analysis. 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.

4. 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. The theory postulates that these elastic deformations will not be observable from the point of view of the internal observer. Heisenberg's uncertainty principle will work in this 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.

5. According to the theory an embedded membrane may be considered as a holistic excitation of the bulk, while elementary particles, in contrast, are systems of point-like excitations of the elastic membrane.

6. In the context of the new approach Loop Quantum Gravity and String Theory are complementary: Loop Quantum Gravity represents the point of view of an internal observer, String Theory, when powered by elastic features and being really multidimensional, will describe the point of view of an external observer.

7. According to the proposed model living organisms may be treated as elastic two dimensional holograms embedded into higher dimensional space-time.

8. It is shown that our perception may be considered as the result of elastic oscillations of two dimensional (2D) elastic membranes with closed topology embedded in our bodies. Only one elastic membrane responsible for its perceptions will correspond to the selected organism, but there may be other membranes, even at the cell level.

9. Elastic membranes stretch and propagate along the direction of attentive focus and occupy energetically favorable positions around microtubules involved into ORch OR. In these positions membranes start squeezing and become sensitive enough to produce perceptions.

10. The proposed model may help us to understand not only the physics of perception, but the intrinsic features of perception as well. The method also gives us explanation of energetically very weak processes – under certain conditions elastic membranes have influence on the consciousness processes and become experimentally detectable.

REFERENCES

1. R. Penrose, The Emperor's New Mind.. Oxford University Press. ISBN 0-198-51973-7, (1989).
2. S. Hameroff, The Brain is Both Neurocomputer and Quantum Computer, Cognitive Science 31:1035-1045 (2007).

3. S. Hameroff and R. Penrose, Conscious Events As Orchestrated Space-Time Selections, Journal of Consciousness Studies, 3(1):36-53 (1996).
4. J. L. Bell, A Primer of Infinitesimal Analysis, Cambridge University Press, (1998).
5. D. Chalmers, Facing Up to the Problem of Consciousness, The Journal of Consciousness Studies, (1995).
6. E. Witten, "Reflections on the Fate of Spacetime" in *Physics Today*, pp. 24-30 (April 1996).
7. E. Witten, "Duality, Spacetime and Quantum Mechanics" in *Physics Today*, pp. 28-33 (May 1997).a
8. C. Rovelli, "Loop Quantum Gravity" in *Physics World*, pp. 1-5 (November 2003).
9. D. Bohm, Wholeness and the Implicate Order, London: Routledge, ISBN 0-7100-0971-2, (1980).
10. A. Egoyan, Historical Reasons and Possible Ways of the New Scientific Synthesis, XXIII International Congress of History of Science and Technology, 28 July - 2 August 2009, Budapest, Hungary, p. 649.
11. A.Egoyan, M.Mirtskhulava, D.Chitashvili, The Role of Physics in Science Integration, Albert Einstein Century International Conference, 18-22 June, 2005, UNESCO, Paris, p.12.