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The Quantum Brain and the Topological Consciousness

Since the discovery of quantum physics many scientist have tried to answer the question, whether quantum mechanics has any role in the function of the human brain? And if the answer is yes, than is the quantum theory of the brain could help us answering the great mystery surrounding the phenomenon of consciousness? In the following article these two questions will be examined through the latest discoveries among which I would like to draw attention to a new logic theory which could help us to lay down the foundations of the physics of the conscious brain and consciousness.

For a quantum theorist the brain is part of the physical world and since the world is obeying the laws of quantum physics, so should the brain at the bottom. The extraordinary success of quantum mechanics leaves no doubt in anyone's mind about its validity. We have grown accustomed to, if not indoctrinated by, the all-powerful dogma of the wavefunction. It is viewed as a primary concept of quantum physics and by some even of physics in general, which would then include the physics of the thinking brain too. But beside of its success, all the epistemological problems brought to light by quantum theory are as valid and unanswered as it was 85 years ago. Since the introduction of the concept of the wavefunction in the 1920s much effort has been invested in understanding the meaning of it. The majority of physicists believe that wavefunction is the foundation for resolving fundamental physical problems. The question of concern to us is not whether quantum mechanics is complete or incomplete in encompassing all of reality but whether it is complete or incomplete in encompassing the reality of logic and the thinking brain in particular [3, 4].

As we know many quantum concepts seem absurd when related to the classical realm of experience. For example when the linear superposition of quantum mechanics is extrapolated to the macro level, we are confronted with counterintuitive 'cat' states. This clash between common sense and the prediction of quantum theory gives rise to the question whether logic is incorrect or wavefunction is not universally applicable. To retain the validity of quantum theory some suggest that quantum decoherence is responsible for the absence in the macroworld of the Schrödinger's cats. Decoherence results from an irreversible coupling of the quantum system to the macroframe. In this case the off-diagonal elements of the density matrix are consequently cancelled, making information on the system classically interpretable. Quantum coherence, distinguished by the nonzero off-diagonal elements in the density matrix, in contrast, makes a classical interpretation impossible. This approach has advantage, but leaves unresolved the question, whether quantum mechanics can provide true description of reality.

After the development of quantum mechanics many physicists were caught up in the excitement and the belief that quantum theory might also explain the mystery of the mind and consciousness. The striking similarities found between the thought process and the general quantum process gave rise to the quantum hypothesis of the brain functions which claims that consciousness reflects quantum-mechanical aspects of matter of which our brains are made. In this way, such distinctly quantum-mechanical features as indeterminism, spontaneous transitions, interference, tunnelling and quantum chaotic effects are equally well applicable to quantum processes as to the brain [3]. Logical process appears to be to the general thought process what the classical limit is to the general quantum process. But with all of this in hand we must admit that the quantum concept of the brain has fallen short of the physicists expectations. A legitimate concern of the opponents of the quantum model of the brain is that it has failed to formulate meaningful predictions that could either vindicate or disprove the quantum approach.

Do we really need the quantum hypothesis to understand the brain? Since the birth of quantum mechanics many physicists have thought consciousness as being quantum mechanical in its nature. These ideas came with such physiological experiments which showed that the human eye, when it is fully adapted to darkness, is able to detect one quantum of green light. From this came the conclusion that if sensory perceptions are sensitive to quantum effects than the subtler thought process and hence consciousness should necessarily be quantum-mechanical in its nature. At issue is a nontrivial question: can the laws of the logical brain be formulated without reference to wavefunction? The idea that there might be a reality, which is not necessarily described by wavefunction, has been rejected since Albert Einstein lost in the famous debate with Niels Bohr. It is also a general consensus that coherent superpositions, which lay at the heart of quantum mechanics, necessarily require the formalism of wavefunction. An unexpected bombshell, showing that this commonly held view is incorrect, exploded when August Stern introduced his matrix logic theory. In this case the superposed mode of thought process can be adequately accommodated without reference to wavefunction [1, 2].

To understand this we should get some knowledge about two fundamental functions of probability: quantum probability amplitude, which is complex-valued, and tensor probability, which is real valued:

$$\left|\Psi\right\rangle \text{ és } \left|\text{Ç}\right\rangle$$

For two-state systems we then have two different rules of normalisation. A quantum system, such as a spin-1/2, obeys the quadratic rule for complex amplitudes:

$$|\alpha|^2 + |\beta|^2 = 1$$

A classical two-sate system obeys the linear rule of normalisation:

$$q + \bar{q} = 1,$$

where $\bar{q}$ and q are ordinary probabilities. While in quantum mechanics, one deduces probabilities from probability amplitudes, in matrix theory they are explicit, making calculations unnecessary. In this scheme quantum and logical phenomena differ by the criteria whether the quadratic or nonquadratic rule on normalisation applies. Why would nature choose two different rules of normalisation? Perhaps there are even other rules we are not aware of!

The question, which naturally presents itself, is: what is the relationship between the two probability functions we are considering? Which function, if any, should be regarded as primary or fundamental? By answering these questions we can better understand the relation between logic and the Hilbert space of quantum theory as well. In a sense quantum physics is the theory of complex probability amplitudes. Since

$$\Psi\Psi^* = p,$$

one can define Ψ as the complex square root of probability:

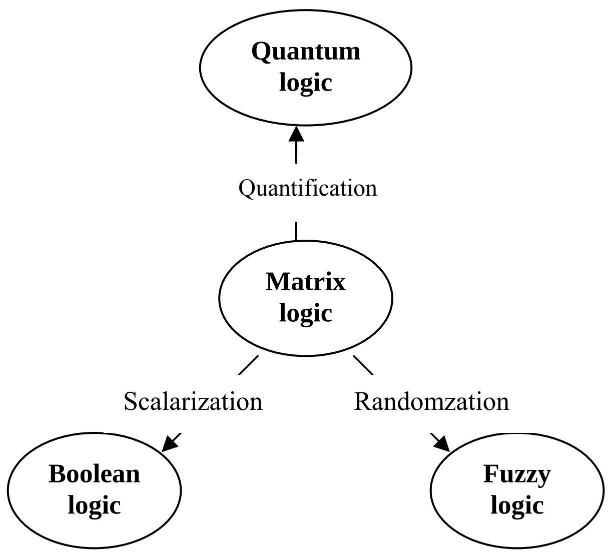
$$\Psi = \sqrt[i]{p} \ ,$$

and choose the logical function to be primary concept. But the components of |Ç > can be obtained as the inner product which reverses the priorities, giving reasons to consider Ψ more fundamental:

$$|Ç\rangle = \begin{pmatrix} \langle \Psi | \Psi \rangle \\ \langle \varphi | \varphi \rangle \end{pmatrix}$$

Serious issues emerge in this framework. Thus far quantum mechanics has been exclusively concerned with the implication $\Psi \rightarrow p$. But for the theory of cognition we are concerned with the converse implication $p \rightarrow \Psi$, or more generally with the symmetry that exchange truth-values and complex amplitudes $p \leftrightarrow \Psi$. Such symmetry becomes instrumental if we accept the idea that the wavefunction of the cognitive brain can be altered by the faculty of the mind. Inadvertently one reduces the problem of the thinking brain to the fundamental physical problem of quantum/classical interface. The symmetry which exchange Hilbert-space with Ç must connect quantum states to the continuum. A transition from the quantum to the classical level explains how discrete states merge into the continuum of consciousness. A close analogy may be found in the motion picture where the effect of motion results from presenting to the eye fixed images, each slightly different from the other. The stream of consciousness in this sense a quantum illusion, similar to a motion picture, collecting the quantized inputs, from the outside and from within, into a continuous cognitive motion. From the new discoveries we could say that the principle of consciousness, the transformation which connects the images, is dominant when consciousness is self referral, which state is known as pure consciousness.

Considering quantum states and corresponding logical statements, our goal is to determine the interface at which the state and statements merge into cognitive *state-ments* – as Stern puts it. So Stern's matrix logic theory reveals that uncertainty and coherent superposition in logic are macrophysical and can be adequately dealt without wavefunction. Matrix logic mixes classical and quantum theories, macrophysical and microphysical, in an unusual way. It is quantum-mechanical in form but classical in essence [1]! Because logical operations are presented by definite integer matrices, one may expect that every Boolean state is taken to another Boolean state and not to a superposition of states. However, our intuition is grossly at fault here. The interim logical states often disobey the classical law of probability normalisation, giving rise to coherent superpositions. As a result matrix logic allows new type of intelligent processing with unique and more powerful features, which are unattainable of the brain, is to be controlled exclusively by classical laws. To see this in function let us create a matrix logical



equation in which the Boolean 0 and 1 logical states are represented by normalised logical vectors and the logical connective by a matrix operator – henceforth the name matrix logic:

$$\langle 0 \mid \vee \mid 1 \rangle = (1\ 0)\begin{pmatrix} 01 \\ 11 \end{pmatrix}\begin{pmatrix} 0 \\ 1 \end{pmatrix} = (1\ 0)\begin{pmatrix} 1 \\ 1 \end{pmatrix} = 1, \text{ where } \begin{pmatrix} 1 \\ 1 \end{pmatrix} \text{represents the superposed state.}$$

The important thing in this case is that here we have put classical Boole states into superposition which is not available in the quantum formalism.

Above we have already showed how to derive quantum mechanics from logic by complex square rooting. It may be hard to accept such an abstract foundation of physical theory. Few physicists would like to see consciousness dictating the laws of physics and quantum mechanics cannot simply be argued away because of an axiom. There must be unique predictions stemming form Stern's matrix logical approach which one is able to test in physical laboratory or in the 'cognitive laboratory' of the conscious brain. To abandon such an effective and successful theory in favour of another, one must have very serious reason indeed. One such reason is the deviation from purely unitary evolution in the operations of the brain – says Stern -, where linearity has to be given up. Whereas the macroscopic Schrödinger cats remain the elusive and frustrating goal of quantum experimentalist, in the brain coherent superpositions abound and easily available on request, demonstrating that in the logical brain the essence of quantum principle is unravelled, perhaps even more clearly then in quantum physics itself. Thirdly, and most importantly, noncommutating matrix logical coordinates provide the effective formalism for the third quantization, closing a major gap between the quantum formalism and spacetime. With the help of the third quantization formalism we are able to express time in a canonical commutation relation and so it becomes an observable [1, 2]. Rising time to the status of a dynamical observable is an important finding of Stern's matrix logic theory. So as geometry connects points in space, spatially – suggests Stern –, noncommutative matrix logic connects points in time, causally. This formalism sheds light on the asymmetry of the conscious processes – as it was suggested by Roger Penrose as well [4] - , which means that the thought process runs forward, understanding runs backward!

The dynamical equations of a physical system concern the possible states to which the system may evolve. The dynamical equations of a cognitive or logical system concern the possible statements the system may yield. Physicists are very reluctant to accept dependence of a physical state on cognitive statements. In spite of much evidence to the contrary, it is tacitly assumed that these are independent. The advantage of matrix logic, easing the psychological barrier, is that it is a theory in which the statements are at the same time the states of the system, becoming dependent and intertwined in a fundamental way. The duality principle, relating logical statements and physical states, casts new light on the problem of the connection between the brain and phenomenal experience. So in this regard, to achieve a scientific understanding of consciousness it is not enough to gather information about the physical states of the brain. There also can be no full understanding of the mind which relies solely on the logical machinery of manipulating cognitive statements. The fundamental theory must embrace the states and the statements in one integral whole. The above mentioned duality principle is closely related to the duality found in string theories, which shows the fundamental role of consciousness in creation (see details in the next paragraph). Because the physical basis of the brain at core is quantum-mechanical, it was compelling to think that the cognising effect goes with its roots in the quantum domain, which would then make consciousness a derivative of the quantum. But the possibility of obtaining wavefunction as the complex square root of the logical function entails on explanation of quantum mechanics as derived concept. On completely different grounds matrix logic reopens the debate which began with Einstein-Podolsky-Rosen's seminal paper of 1934. Wavefunction does not provide a complete description of reality, not only due to quantum nonlocality and inseparability, as revealed by the Bell theorem. An even greater challenge comes from the study of topological consciousness, which is essentially nonlocal and singular. The thinking brain delivers a major blow to the existing theory of physics.

As we saw - according to Stern - the quantum features of the brain functions are direct consequences of the fact, that the mind and its intelligent logical processes, because of their noncommutative matrix logical interpretations, are essentially quantum-mechanical in their nature. From this we came to the conclusion that the nervous system, expressing this kind of special logic structure, must inherit these features in its physical functions. We also showed that a unified physical framework, which unites the existing theories and the matrix theory of consciousness, is accomplishing this with a duality symmetry principle which connects the geometrical brain and the topological consciousness. This principle is the principle of the conscious awareness, which could be analysed more thoroughly with the detailed understanding of the connection between geometry and topology. Let us now see how with the help of Stern's matrix logical approach we could show the topological features of consciousness or self-awareness.

The Topological Consciousness

With the matrix logical analysis of the laws of the conscious mind Stern arrived at a hypothesis that the cognitive degrees of freedom are actually the degrees of freedom of vacuum [2]. These findings could be expressed quantitatively with matrix logical expression of implication and converse implication as follows:

$$\rightarrow^{a} = \rightarrow^{0} \qquad\qquad \leftarrow^{a^*} = \leftarrow^{0}$$

The a and a^* operators are the well known annihilation and creation operators form quantum field theory. With these conclusions at hand a natural question raised in Stern's mind: can matrix logic consciousness harness the non-Hermitian properties of the vacuum through the detection of the ground state or virtual oscillations? As we know, the vacuum forces are not just virtual, in fact they have been recently detected and measured – examples of this kind is the Cassimir-effect, which could be manifest, as a process, in the brain in the synaptic gaps. The theoretical analysis has led Stern to conclude that consciousness is an information vacuum singularity violating parity symmetry. To elucidate this situation Stern suggested that consciousness is a nonoriantable topological phenomenon and in this respect it 'violates' the laws of 'oriantable' physics. In actual three-dimensional space 'oriantable' means 'bilateral'. In a laboratory a topological surface has two sides and information is collected by oriantable 'bilateral' measuring devices which have the input and output 'sides'. The left ant the right vector products are symmetrically defined, and a mirror functions properly, swapping the left and the right. But when we consider consciousness, we have to imagine a world from which the mirror symmetry had been banned. Somehow it must perform rotations that appear impossible to our geometrical brain. Consciousness is a singularity, which can meaningfully be treated as a topological 'defect' with one side, in which mirror does not revert, and self-measurement becomes possible. Parity symmetry is responsible for the symmetry of the left and right attributes of matter. Prior to the discovery of the chilarity of the neutrino filed, physicist saw no reason for the non-equivalence of the left and right. While in the innate physics there is a balance between left and right molecular isomers and crystals, biological molecules always inexplicably curl left. There are possible projections to the macrolevel: the majority of us are right-handed. There are the left and the right hemispheres with asymmetric functions. Living systems consistently violate parity symmetry, reaching its ultimate degree in the thinking brain. In quantum field theory the conservation law is recovered with the combined charge-parity symmetry. But consciousness fundamentally appears to have one „side" only and is essentially asymmetric. While a fully symmetric balanced system cannot evolve, and sooner or later falls into a steady state of equilibrium, consciousness is endlessly in motion, in a state of permanent disequilibrium.

The phenomenon of the thinking brain forces us to consider another fundamental paradigm, one which is neither classical nor quantum. To explain consciousness infophysics must look for a new framework beyond existing physical theory. According to Stern such a new framework is provided by topology. In science we have learned that there are different form of energy and information: classical and quantum, physical and biological. There are also topological energy and information which appears not to be constrained by finite speed of propagation of interactions. Topological properties are „tachyonic" and could propagate instantly. This might be clear from the following gedanken experiment, close in spirit to the EPR quantum paradox. Consider a two-dimensional strip universe with both ends extended to an absolutely remote area. If someone at infinity twisted and glued the ends of strip the entire universe would instantly change from orientable to nonorientable, Möbius strip like shape. In these topological phase transitions we see the seeds of a new physical theory which should provide the basis for consciousness. In laboratory physics we understand by taking things apart; to understand the brain we mast put things together!

Particles and fields are solutions to the fundamental equations of physics. Thoughts are solutions to the fundamental equations of logic. The existence of the thinking brain 'proves' that common solutions do exist, and our underlying hypothesis is that these solutions are topological. The language of topology is the new language for brain science, as well as for physics. Since Einstein the majority of physicists believe that physical forces can be explained using pure geometry, if necessary, the geometry of higher dimensions. Because the development of geometry preceded the development of topology, and due to historical reasons and education our concept of the world, including the brain, was and continues to be primarily geometrical. However, looking at a moving amoeba or considering the liquid flexibility of a developing embryo, one gets a strong feeling that for living matter and for biology in general the concepts of geometry are not enough. Geometry is concerned with the properties of figures in space and with the properties of space itself. A notion of invariant distance is essential for geometry. Mathematically a set of points is a metric space if there is a metric ρ which gives to any pair of points x, y a nonnegative number $\rho(x, y)$, their distance or separation, and is such that:

1, $\rho(x,y) \geq 0$ and $\rho(x,y)=0$ iff $x=y$,
2, $\rho(x,y) = \rho(y,x)$,
3, $\rho(x,y) \leq \rho(x,z)+ \rho(z,y)$

With the concept of metric the geometrical or distance invariant properties of a given space could be expressed, which found its most interesting application in physics in the general theory of relativity. According to general relativity the gravitational effects of matter are due to the curvature of spacetime or to the distortions of the spacetime metric. The geometry of curved spacetime is described by means of Riemann geometry. A description of spacetime in terms of Minkowsky and Riemann geometries and the fundamental link between geometry and physical laws in general gained greater clarity after Emi Noether in 1917 proved a theorem showing that the conservation laws of physics are in fact consequences of more fundamental laws of symmetries. According to this theory the conservation of energy and momentum follow from the symmetry (isotropy) of time and space. The conservation of electric charge follows from the symmetry of a particle's wavefunction, the so called gauge-symmetry. In general, we say that a particle such as the electron and proton carry Noether charges, the attributes that are maintained because of geometrical symmetries. But the attributes and properties of objects may also stay invariant under topological deformations. The corresponding conservation laws are topological as opposed to conservation due to geometry. Unlike the geometer, who is typically concerned with questions of congruence or similarity, the topologist is not at all concerned with distances, shapes and angles, and will for example regard a wedding ring or torus and a tea cup as equivalent, since either can be continuously deformed into the other if their constituent matter is adequately plastic. Because of this, topology is usually called as rubber-sheet science.

A set, together with sufficient extra structure – the so called open sets – to make sense of the notion of continuity, is called a topological set. More formally, a set X is a topological space if a collection T of subsets of X is specified, satisfying the following axioms:

1, the empty set and X itself belong to T

$$\varnothing \in T \text{ and } X \in T,$$

2, the intersection of two sets in T is again in T

$$X \in T,\ Y \in T \Rightarrow X \cap Y \in T,$$

3, the union on any collection of sets in T is again in T

$$X \in T,\ Y \in T \Rightarrow X \cup Y \in T$$

The sets in T are called open sets and T is referred to as a topology on X. According to the latest geometrical researches a well-known correspondence exists between algebraic geometry and physical objects. A space gives rise to function algebra; a vector bundle over the space corresponds to a projective module over this algebra; cohomology can be read off as the de Rham complex; and so on. With Stern's discovery we can establish a different type of correspondence, the correspondence between the elements of logic and the elements of topology. The main objective of this approach is to show that the laws of topology hold the key to the laws of the thinking brain and that information physics of consciousness is rooted in topology. So what we want is to understand the topological brain and its intelligence-supporting logic. Many attempts to explain the cognising phenomenon and to understand consciousness neurophysically lead to a dead end. No knowledge about the neural or biophysical processes in the brain can satisfactorily answer the hard question: what is the actual mechanism of consciousness? Those who try to answer this fundamental question in the mechanical framework of the interaction of neurones, the brain's electricity, neurochemistry or quantum mechanics are often as unproductive as those who offer purely philosophical, spiritualistic or theological explanations only. Somehow human thought, even though connected to processes in the brain matter, seems to be intractable, almost immaterial. Abstraction, on the other hand, often has great physical power. Words and thoughts alone can induce measurable changes in the brain can alter the states of consciousness as it can be seen in the states of hypnosis or with mantras used in different meditation practices.

As we mentioned earlier the laws of conservation in physics are consequences of corresponding symmetries: the conservation of energy follows from the symmetry of time, the conservation of momentum is due to the isotropy of space. These attributes and others like mass or charges of elementary particles are conserved due to geometric properties, and can be defined as metric charges. Mental or logical attributes – as Stern puts it - are maintained not as geometrical but as topological objects. According to this view, the field line of a logical exciton ties a knot in cognitive space which cannot be smoothed out. As a result, it is prevented from dissipating and will behave much like a particle. A parallel example from physics is a magnetic monopole – the isolated pole of a magnet – which has not been detected in nature but shows up as twisted configuration in field theory. In the traditional view, particles such as electrons and quarks, which carry geometric or Noether-charges, are seen as fundamental, whereas particles such as magnetic monopoles, are derivative particles, to which we can assign topological charges. What is important to mention here is that a topologically nontrivial field configuration, such as solution, exchanges roles with ordinary quanta. In this case Stern points out that to describe consciousness one does not really need spacetime, or more radically, does not really have spacetime any more, but just a tensor product of two-dimensional topologies, much as with string theory where one does not have a classical spacetime but only the corresponding two-dimensional theory describing the propagation of strings. Worldlines are replaced by worldsheets, the interaction vertices in the Feynman diagrams are smoothed out, and spacetime exists only to the extent that it can be extracted from that two-dimensional filed which encodes information – as it can be seen in the so called holographic principle.

Although we are all familiar with notion of thoughts, in reality we never observe an isolated thought in particular locations of the brain. It is everywhere and nowhere. A thought for the brain is like a neutrino for the universe. The organisation of the brain is distinguished by extraordinary plasticity, with one region of the brain smoothly taking the role of the other if the need arises. Following an immediate reflex, one is tempted to connect thoughts with quantum nonlocality. But there is a more fundamental concept, the concept of the topological charge, which brings greater clarity to the question of nonlocality of thoughts. To understand that we must understand a key difference between topological and Noether charges. A topological charge is a knot which is essentially nonlocal. It is a defect on the field line which characterises it as a whole. A geometrical or Noether charge, in contrast, is local. It can be localised in a particular spacetime point, to a degree allowed by the uncertainty relation. We can in principle localise an electron in the brain, but we cannot, even in principle, localise a thought. When a thought is emerges, a (topo)logical knot is tied up, and the knot by its very definition is a spatially extended object. This (topo)logical approach to the problem of consciousness offers a new understanding of the phenomenon. Nature obeys mathematical laws, but while for the physical brain these laws are primarily geometrical, both in the commutative and noncommutative spaces, for the cognitive brain the underlying mathematical theory is essentially and fundamentally topological. Stern pursues this viewpoint to an even greater extreme and states: geometry cannot be used to describe logical consciousness! Thought is essentially a topological effect, connected to the brain by means of duality, much as the magnetic monopole, a collective excitation, is related to the dual electric charge. In the actual brain there are Noether charges and these are converted into (topo)logical excitons that move freely through the neuronal medium, decaying into their constituent parts and recombining back. A (topo)logical exciton emerges as a fundamental quantum of consciousness, forming coherent waves that run through the brain matter. However, unlike electrons, (topo)logical energy, and in spite of almost classical propagation regime, their spectra remain highly coherent, because a coherent superposition of true and false underscores the very existence of a topological exciton.

Application of this model to the brain/mind duality offers a fundamental explanation of consciousness. It suggests that there exist two equivalent formulations of the logical brain in which the roles of geometric charges and (topo)logical charges are reversed, just as we exchange electric charge and magnetic charge in field theory! In such a dual picture of the brain either charge, (topo)logical or geometrical, can be taken as elementary, and then a dual charge arises as derivative. In quantum field theory a fundamental particle with charge *e* is equivalent to a soliton particle with charge 1/*e*. This leads to a vast mathematical simplification. For instance, in the theory of quarks we can hardly make any calculation when the quarks interact strongly. But monopoles in the theory must interact weakly, and by doing calculations with a theory based on monopoles one automatically gets all the answers for quarks as well.

This duality principle, when it is applied to the problem of the thinking brain, provides a promising theoretical framework. For a very long time we have been struggling to understand the intractable mechanism of consciousness which somehow converts physical to mental and mental to physical. The duality between (topo)logical and Noether charges removes the impediments to understand how the thought process is able to induce controlled changes in the brain matter. When we think, the brain transforms (topo)logical charges, which are fundamental primitives of thoughts, interacting weakly. When such a transformation is completed – says Stern – we automatically gain the answers for the 'strongly' interacting neurological brain.

According to quantum field theory a charge is a measure of the strength of an interaction but physical and logical charges obey opposite laws of attraction and repulsion. Identical Noether charges, like those of two electrons repel, while identical logical charges gravitate towards each other and merge, as the absorption law expresses it:

$$x \wedge x = x.$$

The opposite physical charges, like those of an electron and proton attract, but the opposite logical charges are mutually excluding and repel each, as the contradiction law expresses it:

$$x \wedge \bar{x} = 0.$$

As we know from the famous Pauli exclusion principle, no two identical Fermi particles, such as an electron or proton, can ever be in the same quantum state, but 'logical fermions' would not follow this principle. This example touches on fundamental aspects of brain/mind duality, which connects the strong coupling of one theory with weak coupling of another – much the same way as in string theory which led to the discovery of M(Mind)-theory! From all of these findings Stern derived the following conclusion: *consciousness is a topological effect; the brain decides geometrically; the mind decides topologically*! In this way topology is not a matter of choice but is fundamental. Consequently, there are two dual theories of the brain: the geometrical theory which we used until now and the topological theory as it is formulated by Stern. When the brain is describes in terms of the Noether charges, the dual (topo)logical charges emerge as derivative. Quite symmetrically one can choose the (topo)logical charges to be fundamental, and then to treat the biophysical electrophysiological brain as derivative, which can be expressed mathematically like this:

$$\text{Topológikus töltés} \Leftrightarrow \frac{1}{\text{Noether - töltés}}$$

The notion of topological charges as the physical basis of consciousness naturally leads to the notion of topological waves or currents which carry the charges. The charges are nontrivial dynamical topological configurations that exchange with ordinary quanta. A (topo)logical current propagating along a closed information loop (knot) manifests itself as the thought process. The knot may have various configurations, but a particular geometry of knot is irrelevant, as long as it retains the same (topo)logical charge. The (topo)logical currents are effectively isolated from the outside universe and cannot be subjected to ordinary physical measurement. The most we can achieve with state-of-the-art Hermitian devices is to measure the dual Noether currents, and the attempt to do so is made indirectly when we measure the electrical and neurochemical activity of the brain in the laboratory (with EEG, fMRI, PET etc). However, as we have seen earlier, (topo)logical charge maps to a corresponding Noether charge and vice versa. Making use of this duality we can influence the (topo)logical current and with it the inner content of consciousness. The laboratory and experimental application of these effects are not as far-fetched as it may seem!

As it has been mentioned earlier, Stern's duality theory is strongly related to the duality principle which connects the different string theories and M-theory, and also to those extended objects or (mem)branes which are natural outcomes of this principle. In this way the only requirement to include the principle of consciousness into the unified theories of physics is to embed the logical or **L**-branes into M- or Matrix theory. This would shed new light on the fundamental role of consciousness in nature, and will open up completely new avenues in science as a whole. This embedding procedure can be achieved, with the help of matrix logic, by extending the holographic principle of string theory to Matrix theory which could lead us to formulate the logical- or consciousness-holomatrix principle, which is capable to unify holographically the topological matrix logic theory of consciousness with the geometrical theory of the brain physiology. This new theoretical achievement is very important for mathematics as well, because in this way the logical manifolds are unifyable with topology and geometry in much the same way as it was done with noncommutative rings in K-theory. Like this, form the logical degrees of freedom we would be able to derive topological and geometrical laws and vice versa. This discovery was expressed by Stern in his conversion postulate which says [1]:

Any well-formed quantum theory with annihilation and creation operator can be converted into a logic calculus.

Any covariant logic theory can be converted into a quantum field theory with annihilation and creation.

Because of the above mentioned duality, and if we extend the quantum holographic approach of field theories to **L**-branes, Stern's conversion postulate can be expressed holographically as well, leading to the concept of holographical matrix or holomatrix, which idea and concept was formulated and embedded in matrix logic by this article's author. One of the aims of our group at the Institute for Strategic Research is to work out the fine details of the logical holomatrix projection and manifold analysis principle which, in the future, could help us to formulate the Final Theory. For the interested readers we would like to mention that further developments in our researches will be available on the Institute's websites (like INCO) and in those books which will be published soon by the Institute as well.

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