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QUANTUM GEOMETRY. NONTRIVIAL TOPOLOGY. GEOMETRIZATION OF PHYSICS.

The quantum world conceals a geometry whose foundation is essentially universal. This geometry governs and synchronizes all processes in the quantum world. Based on this geometry, Nature further constructs itself, creating stable blocks—atoms—from which the observable material world is constructed. The observable world, like a fractal, reflects all processes occurring in the quantum world. Based on this logic, the geometry of the quantum world can be comprehended both theoretically and experimentally, opening the door to an understanding of the original geometric foundation, subsequently the deepest mysteries of Nature, resolving the difficulties of physics itself and giving new impetus to technical development, studying what Nature shares with us.

Quantum materials, whose electronic, magnetic, and optical properties are determined not only by the structure of the crystal lattice but also by the quantum mechanical effects that arise within them, help us understand the geometry of the quantum world. [154]

In quantum materials (superconductors and quantum Hall effect systems), quantum mechanical effects manifest themselves on a macroscopic scale as a collective action in the crystal lattice of the matter at low temperatures or high magnetic fields.

«The Berry curvature is part of the quantum geometry of a material. The QHE is the archetypical demonstration that quantum geometry is one of the key quantities that make a material a quantum material. As we will discuss in the remainder of the review, the Berry curvature turns out to be the anti-symmetric part of a tensor Q, the quantum geometric tensor (QGT) [2]. In recent years it has become apparent that the symmetric part of this tensor, the quantum metric, g, also plays a key role in making a material, quantum. In a loose sense, the quantum metric appears to be the key quantity to understand the properties of materials in which both interactions and quantum geometry lead to macroscopic manifestations of quantum mechanics». [5]

Quantum geometry plays a key role in various physical phenomena in quantum materials, particularly optical responses, Landau levels, and fractional Chern insulators. Its influence on superfluid weight, spin stiffness, exciton condensates and electron-phonon coupling is also studied and discussed. Taking these aspects into account, quantum geometry has a pervasive significance for understanding the emergent behavior of quantum material structures, which explains its rapid development in the current period. [5]

The tool of quantum geometry, characterized by the quantum geometric tensor, is a set of mathematical rules for describing physical phenomena (changes in the shape of internal structures and properties in a material) which occur on sub-micro-scales, but in its macro-effects, when exposed to external fields. From a practical standpoint, the laws of change studied provide the key to controlling the properties of semiconductor materials and to creating new ones with superconductivity. These aspects are also important for both energy supply and the creation of quantum computers. Quantum geometry also serves as the basis for the theory of quantum gravity, which aims to unite quantum mechanics and general relativity into a single, unifying theory of everything.

A group of scientists from the Massachusetts Institute of Technology (MIT), Seoul National University, and their colleagues have proposed a new approach to measuring quantum

geometry in crystalline materials [1]. Their method can be considered groundbreaking. Based on photoelectron spectroscopy (ARPES), it opens new horizons in the study of quantum states. A quantum state can be represented as a landscape. The map of this landscape is the quantum geometric tensor (QGT), which shows how the landscape changes when various factors influence a substance, reveals the behavior of the material, and allows insight into the structural essence of matter and the factors that shape its properties. This new method opens up promising possibilities for materials research and enables the linking of theoretical calculations with real experimental data.

In the news [2] Elizabeth Thomson introduces the details of the experiment [1] and provides a number of quotes, in particular from the project leader Riccardo Comin, an associate professor of physics at the Massachusetts Institute of Technology (MIT).

The work done is based on the description of the wave hypostasis of the electron."You can think of it like a surface in a three-dimensional space, - says Comin. - There are different types of wave functions, ranging from the simple to the complex. Think of a ball. That is analogous to a simple, or trivial wave function. Now picture a Mobius strip. That's analogous to a complex, or non-trivial wave function. And the quantum world is filled with materials composed of the latter". [2]

"Until now, the quantum geometry of wave functions could only be inferred theoretically, or sometimes not at all. And the property is becoming more and more important as physicists find more and more quantum materials with potential applications in everything from quantum computers to advanced electronic and magnetic devices". [2]

The results of the previous experiment by the same group are published in [3][4]. Other detailed information about this experiment [1] can also be found in the publication Shalma Wegsman in Quanta Magazine. [10]

"Topological materials are no longer so mysterious: Physicists commonly use them to discover new phases of matter and are exploring their potential for quantum computing. But only recently have they come to appreciate the fuller picture of quantum geometry that includes not only the Berry curvature but also the quantum metric – the shape of the rugged landscape that can exist on top of a torus-shaped map. A couple of years ago, the quantum metric helped researchers understand what was going on in a 2D crystal that hosted an exotic new form of superconductivity – the flow of electricity with no resistance.

The physicist Riccardo Comin and collaborators recently mapped the full quantum geometry of a crystal for the first time. Päivi Törmä helped show how quantum geometry can explain exotic material behaviors such as superconductivity". [10]

Recent publications on quantum geometry in the literature: [5]-[8][11][152]-[155]
The tutorial review [5] introduces the concept of quantum geometry and highlights its implications in various fields, including optical responses, Landau levels, fractional Chern insulators, superfluid mass, spin stiffness, exciton condensates, and electron–phonon interactions. "By integrating these topics, we emphasize the broad significance of quantum geometry in understanding emergent behaviors in quantum systems and conclude with an outlook on open questions and future directions". [5]

The review [6] examines how quantum geometry influences materials properties and describes recent experimental advances that have paved the way for the study of quantum geometric effects in various condensed matter platforms. Scale separation, which allows one to appreciate the significance of quantum geometry in various response functions, is also discussed.

In the publication [7], it is demonstrated within the framework of density functional perturbation theory "that the Berry curvature of electron-phonon coupling (EPC) plays a pivotal role in the interatomic force matrix. A subsequent model analysis shows that external strain can reverse the polarity of the EPC Berry curvature in (quasi)degenerate electronic subsystems through band inversion, thereby directly leading to phonon softening. The general theory is then applied to the BiOCl monolayer as a benchmark, which offers an accurate description of the density-functional theory calculations. This mechanism is further observed across a broad range of materials through ab initio calculations, providing an insightful perspective on EPC quantum geometry in lattice dynamics and FE phase transitions".

The review [8] examines the influence of quantum geometry on the properties of materials and describes recent experimental advances that have paved the way for the study of quantum geometric effects in various condensed matter platforms. Scale separation, which allows one to assess the significance of quantum geometry in various response functions, is also discussed.

"Electronic properties of quantum material solids are often well understood via the low-energy dispersion of Bloch bands, motivating single-band approximations in many metals and semiconductors. However, a closer look reveals length scales and timescales introduced by quantum dipole fluctuations due to interband mixing, which are reflected in the momentum-space textures of the electronic wavefunctions. This structure is usually referred to as quantum geometry. These new scales not only qualitatively modify the linear and nonlinear responses of a material but can also have a vital role in determining the many-body ground state at low temperatures. In this Perspective, we explore how quantum geometry affects properties of materials and outline recent experimental advances that have begun to explore quantum geometric effects in various condensed matter platforms. We discuss the separation of scales that can allow us to estimate the significance of quantum geometry in various response functions."[8]

In [153] researchers focus on the next: "Topological quantum materials (TQMs) have symmetry-protected band structures with useful electronic properties that have applications in information, sensing, energy and other technologies. In this Perspective, we present an overview of recent progress in topological quantum catalysis. We describe the open problems and the potential applications of TQMs in water splitting, batteries, supercapacitors and other prospects in energy conversion and storage".

In a recent publication [152] "**How quantum is quantum geometry?"** the authors mentioned: "**The quantum geometric tensor** – the Berry curvature together with the quantum metric – now underlies a long list of observables, from the anomalous Hall effect to the superfluid weight of a flat band. We ask which of these observables actually require quantum mechanics". [152]

Their final conclusion is: "Two consequences of quantum geometry are inherently quantum mechanical. The first is the magnetization as a thermodynamic property. The single-particle orbital moment of Eq. (12) is classical, but by the Bohr–van Leeuwen theorem [25] the equilibrium magnetization is quantum mechanical. The second is superconductivity as a Bose condensate of pairs. Our two particles acquire a joint inertial mass and hence a Drude weight in the absence of scattering, but nothing in Eq. (20) produces off-diagonal long-range order, phase rigidity, or a Meissner effect. The flat-band statement that the superfluid weight is bounded by the integrated metric thus splits into a classical part – the inverse mass – and a quantum part – the condensation. Beyond these two consequences, quantum mechanics also introduces the

periodic Brillouin-zone structure to momentum space, which underlies the topological consequences of quantum geometry.

To summarize, our analysis shows that most phenomena associated with quantum geometry are in fact of a classical origin, and originate from the interplay between slow and fast degrees of freedom of a dynamical system." [152]

In a recent essay, "**Where Can Quantum Geometry Lead Us?**" [9], Päivi Törmä, a professor of physics at Aalto University, Finland, notes many important aspects of quantum geometry and also identifies current issues in this new science:

"**It has been theoretically predicted that quantum geometry governs a variety of physical phenomena.**

Once a few smoking-gun experiments on quantum geometry effects have been achieved, the focus should swiftly shift from showing that "quantum geometry is there" to **how can we utilize this concept to better understand nature and, eventually, to create new technologies**.

To proceed on the quantum geometry road, we should implement the extraction – and smart visualization – of quantum geometric concepts as a standard functionality of these tools.

Despite challenges, our goal should be that the most powerful numerical methods of condensed matter physics will provide the essentials of the quantum geometry of the bands, properly visualized, as easily as they give the energies. Once this becomes a routine, we will start seeing things from the perspective of quantum geometry, like we now do from the band structure's, and this will be a source of understanding and discovery.

A whole new theory framework is needed to capture the physics-relevant quantum geometry aspects even in cases where the standard concepts cannot be used. Inspiration for this search can be found from the effective mass tensor of a two-body bound state in a system of multiple nonisolated bands where the quantum geometric contributions and band dispersions intertwine [30].

Finally, widening means also that we condensed-matter–quantum-geometry enthusiasts should make friends with the communities that have been studying quantum geometry for a long time—high energy physics, cosmology, and quantum information—and dive into their literature [31]. The danger of drowning there is of course considerable, but the embarrassment of reinventing too many wheels is an even more daunting prospect.

It remains to be seen whether quantum geometry, including both quantum metric and the Berry curvature and thus **topological physics**, will play an equally large role in our world. What is clear is that the world needs out-of-the-box discoveries: world energy production and consumption are literally burning questions, as are scarcity of materials and several other gut-wrenching problems. Innovations as big as the transistor are much more urgently needed now than at the time transistor was invented. Therefore, we should try all possibilities.

Perhaps the most notable prospect from quantum geometry is to guide the way to room temperature superconductivity. The interplay of light, electronic transport, and quantum geometry intrigues me as well, because photovoltaics is another area where major technological advances can have world-changing impact. There may be other equally important goals for which quantum geometry can provide guidance, but my imagination stops here.

I give the floor to the reader who probably has a different background and can thus come up with different ideas". [9]

Well, if the floor is given to a reader with a different background and the potential to offer new ideas, then perhaps it's simply impossible not to take advantage of it. My thanks to Professor Päivi Törmä for this suggestion. And if I'm not alone in this intention, then we can

expect a kind of brain injection of other experiences and ideas that undoubtedly exist and could be a worthy contribution to the overall perspective.

Whether my ideas and experiences are directly related to the format of quantum geometry and the experiments guiding its development, as well as to the construction of a general theory, will naturally be answered at the end of this essay. I believe that the model of the atom I proposed, based on the nontrivial topology of magnetic dipoles, their geometry, and the interrelationships that hold the atomic structure of atom together, is directly relevant to the issues of quantum geometry, which studies macro-effects in quantum materials.

First of all, my ideas and research results concern the issues of atom structure, which is geometrically determined, and the reasoning begins from the structure of the cosmic medium and the initial geometry of its matrix unit as a **physical point of space**, and, accordingly, the geometry of quanta, and then the subatomic geometry that determines the properties of matter. In accordance with this, logic moves toward questions of energy extraction, as well as fundamental theoretical generalizations. It's worth discussing how all of this is connected.

Wave geometries are mediated by the structure of the cosmic medium and are determined by the processes occurring within it. If we take into account the work of our predecessors regarding the structure of the cosmic medium, as well as the achievements of our contemporaries [17][18][19][20][21][22][23][24][25][26][79][80][83][84][85], then the cosmic medium can be called the **Quantum Medium** with all its contents, the basis of which is a matrix of dynamic spinning units [19-21][22][23-25]. The nature of these units is magnetic and represents a living cosmic plasma according to how Nobel laureate H. Alfvén defined it [12][13][14][15], and Nobel laureate F. Wilczek also expressed related thoughts about the magnetic ingredients of the cosmic medium. [16]

In my proposed self-consistent concept [89][90][91][92][93], such a living plasma is called **magneto-plasma**, the magnetic units of which perform continuous and unceasing oscillations (spinning), caused by the geometry of their complementary structure and its properties. [90][31]

According to my new ideas presented in the proposed concept based on the ontology of the **principle of complementarity**, these magnetic units are magnetic loops that include inversion, in other words, a 180-degree reversal. Such a geometric representation of the original magnetic loop in the format of the nontrivial topology of the Möbius strip as a starting point for an entire conceptual framework has not yet been proposed by any scientist.

The basis for this concept is the scientifically established fact of the all-encompassing nature of the principle of complementarity, which is the primary principle. The ontological essence of this primary principle is the dual complementary interrelationship of two mirror-asymmetric opposites within a single whole, traditionally illustrated by the ancient Yin-Yang symbol. As the ancient pictorial symbol visualizes, the complementary relationship is the original natural **duality**, organized by a mirror-asymmetrical interrelationship of interconnected components in their mutual cyclical movement.

Magnetism is the physical embodiment of the principle of complementarity and is also comprehensive in nature. The magnetic loop must be displayed with the inclusion of the designated **complementary duality** in its representation. This is achieved geometrically using a Möbius strip with one 180-degree turn initially.

The complementary principle of combining the geometric image of a cyclical closed movement of energy with its mirror-asymmetric image, which underlies the construction of a one-sided Möbius strip, allows it to be considered an analogy to the Yin-Yang symbol, which

reflects the principle of complementarity in a two-dimensional format, and the Möbius strip, respectively, in a three-dimensional format.

In the concept I propose, the ontology of the complementarity principle is the starting point from which all subsequent conceptual reasoning proceeds, and its geometric analogue – the Möbius strip – and its topological properties provide the necessary visualization of all transformations of a dynamic physical unit in space on such a nontrivial topology.

What is the connection between this proposal and the General Theory of Relativity? General Relativity (GTR) considers not the acting forces, but the curvature of space itself, and motion in such space occurs along its **curved geodesic lines**.

The Möbius strip is the geodesic line of the shortest distance in which a magnetic loop (magnetic flux) makes a two-cycle revolution, creating in space the dynamics of the interaction of complementary opposites, as a result of which portions of energy are released, in other words, quanta are emitted. The magnetic circuit, closed in such a geodesic line, mediates the original dual complementary relationship of magnetism, which underlies all movement and construction of the manifested world.

"The one-sided Mobius strip and its derivative, the two-sided strip with a node connecting two loops, are material symbols that reflect the fundamental principle of creation – the interaction of primordial energy with its mirror image. This principle underlies the construction of a cosmological model of the Universe of Light, where the dual nature of the Universe is predetermined." [101]

A **geodesic line** in the form of a magnetic loop with inversion is a line of movement of two mirror-asymmetric flows of magneto-plasma with the effect of generating **energy quanta**. In other words, **magnetic geometry induces quantum geometry.** As a consequence, **the spatial geometry of emitted quanta replicates the shape of their emitter**. And this is a direct connection between General Relativity and the concept of Quantum Mechanics.

Thus, the geometric approach based on the Möbius strip topology provides General Relativity with the **initial geometry of space-time curvature and visualization of the form of a closed elemental** as a space-time matrix unit, and Quantum Mechanics with the **initial form of a quantum phenomenon** determined by the geometric structure and magnetoelectric properties of such a matrix unit, inducing quanta in vortex motion. In this regard, within a single **physical unit of space**, in the initial form of the nontrivial Möbius strip topology, it is possible to combine the formats of two fundamental theories at the **very starting point** of the discussion and carry out the process of geometrization.

If we look at the graphic representation of the ancient Yin-Yang symbol from the discussed perspective, it geometrically visualizes a closed circuit of two complementary opposites and the release of an energy quantum at the points of their junction (the wave function in the middle of the circle). When the sinusoidal front of the emitted discrete wave quantum closes, a Möbius pattern is always obtained.

The Yin-Yang symbol. When the ends of the sinusoid are brought together, the Mobius Pattern is formed.

In the current period, in the experimental part of physics, using digital holography and the interferometric method, an image of the wave function of two entangled photons has been obtained, which in the image graphic coincides with the symbol of “Yin and Yang”. [142][91] This fact directly speaks in favor of my geometric proposal.

The geometry of the Möbius strip is the geodesic line of the spatial structure that extremizes the movement of magnetic flux in the form of two mirror-asymmetric opposites in a closed magnetoelectric circuit. [90] As a complete circular revolution is completed, simultaneously creating a 180-degree inversion, the end result of the interaction of the two resulting opposites of this circuit release of discrete portions of energy with simultaneous absorption. In other words, the **geodesic line in the geometry of the Möbius strip** is the minimum distance traveled in the vortex motion of magnetism to release an energy quantum. In [90] this process is reflected geometrically using a simple "***origami-twist***" method for a Möbius strip with a minimum aspect ratio.

The space bounded by such a geodesic line, due to constant magnetoelectric reconnections, is a dynamic vortex unit of the Quantum Medium matrix and defines the discrete-continuous structure of space-time. This closed magnetic Mobius circuit is the sought-after relativistic “particle”, geometrically determined by a limited non-trivial surface, the structure of which was sought and graphically attempted to be depicted in the works of K. Schwarzschild, and then A. Einstein together with N. Rosen, and which remained in the history of science as the well-known “**ER bridge**” with the help of the geometry of which the authors at that time were unable to fully solve the problem of visually displaying the original spatial cell (elemental).

The simultaneous execution of two cyclorotations, mediated by a non-trivial topology – rotation around its own axis and rotation around an external center – is a universal form of motion that is demonstrated throughout the entire cosmos. [90]

I will cite a related proposition from the work [74], in which the author speaks of "the existence of a heterogeneous Primary Medium of the World, constantly changing its properties and states. The law of this change is from the initial property/state to its opposite and back to the opposite again (law of negation of the negation), but quasi-similar, due to a shift in parameters at each step of change. Directionality, cyclicity, and a spiral-vortex nature of movement emerge. The trace of one cycle of such a movement has the **form of a Möbius strip**. An indefinitely large number of such cycles, perceived as waves of the Medium, form wave structures of varying scales – poly-vortices”.

W.K. Clifford clearly stated that in the "hydrodynamic" picture of the world he intended to construct, literally everything we perceive The author of the work [75] expresses the opinion that "the fundamental principle of the infinite diversity of objects in the Universe is not some universal elementary particle of matter (substance), but an elementary form of space-time motion. The elementary geometric form of this universality, expressing the true essence of the geometric form of space-time motion (from the photon field of an electron to the stellar field of the Universe inclusive), is a "string," rotating, twisting and folding torus of space-time in the form of a "Möbius strip," or "torsion," which not only rotates, twists, stretches and compresses, but can also fold (intensify exponentially)." [75][76][77]

In current scientific research, the change in direction caused by the underlying topology is called the Berry phase, and the way this phase accumulates on a closed path is called the Berry curvature, indicating a curved shape. For a long time, the Berry phase was invisible to

experimenters. Physicists first observed the emergence of the Berry phase during the propagation of polarized radiation through a resonator shaped like a Möbius strip. [35][122][124]

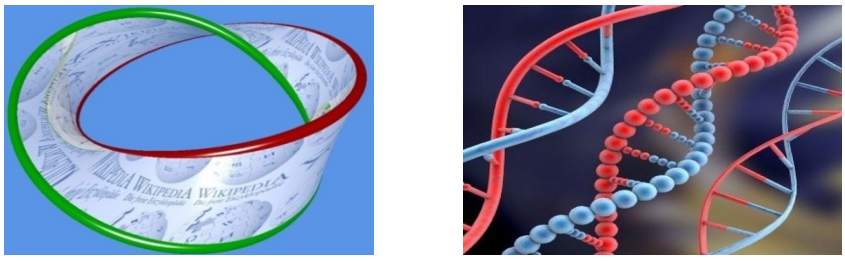
With regard to geodetic lines, the experiment with a microlaser in the form of a Möbius strip and its results are of interest, although the experiment itself is aimed at studying whispering gallery modes (WGM). [130]

That the nontrivial topology and geometry of the Möbius strip are directly related to the structure of the quantum world is already a well-known scientific fact. Regarding the structure of the spatial fabric, it is worth returning to the ideas of W. Clifford [27][28][29][30], which stood at the origins of questions regarding the geometrization of physics and it was he who proposed to consider the spatial fabric as curvatures, which he represented in the form of parallels, called "***Clifford parallels***".

In elliptic geometry, two lines are Clifford parallel or paratactic lines if the perpendicular distance between them is constant from point to point. The concept was first studied by William Kingdon Clifford in elliptic space and appears only in spaces of at least three dimensions.

The English mathematician and thinker as reality and its physics of diversely interacting objects ultimately turns out to be "curvatures in the geometry of space and their wave-like displacements." [27][30]

"This explains the laws of electric and magnetic attraction/repulsion, the action of electric currents on magnets and on each other, the laws of induction, the derivation of the velocity of charges and the polarization of light, the rotation of the plane of polarization by a magnetic field. All these things must be deduced from a knowledge of the **geometric forms of atoms** and their relationships with the ether, which thus indicates the relationship between the kinetic theory [of particles] and the wave theory [of the ether]." [27][30]



Clifford`s parallels in the Möbius strip and in DNA.

The representation of Clifford's parallels in the realm of cell biology is the double-stranded form of DNA. By the same logic, the mutual representation of a combination of magnetic lines and alternating current lines of motion will have the same topological structure. While this representation is not yet used in textbooks and scientific papers, the time is coming to look at this issue from a new perspective.

The ontological essence of the principle of complementarity generates a spatial topology in the form of dual Clifford parallels, which imbue the spatial fabric of living cosmic plasma with corresponding magnetic properties, substantiating a universal type of torsion-rotation, as evidenced by the entire cosmos. In essence, all of outer space is a matrix of non-trivial topological forms of varying orders, the geometry of which determines universal life activity. Closed "Clifford parallels" represent the topology of a Möbius strip.

Closed solutions of Maxwell's equations were found by Antonio Fernández–Rañada in 1989, based on Hopf fibrations [83]. In 2008, physicists William Irvine and Dirk Bouwmeester showed that among the closed solutions there are also stable ones [85]. And in 2014, in a joint

work by A.F. Rañada and A. Tiemblo [84], it was noted that the goal of their article is to continue the development of a model of topological electromagnetism and their ideas relate to the field of topology, which is likely to play an important role in the future of fundamental physics.

The entire logic of my further reasoning about the fundamental principles of physics will be based on the essence of the original cell of the spatial fabric in the non-trivial topology of the Möbius strip.

In the concept I proposed [89][90][91][92][93] the initial state of a magnetic loop with inversion in the nontrivial topology of a Möbius strip is connected with the concept of a "***magnetic monopole***". [90][31] [94][95]

This geometric representation of a magnetic monopole does not fundamentally contradict the fact that n 1974 G. 't Hooft [79] and A. Polyakov [80] simultaneously showed that a magnetic monopole could be regarded as **topological excitations** in a quantum field theory due to the spontaneous symmetry breaking mechanism. The quantized magnetic charge was interpreted as the **topological charge of the magnetic monopole.**

In the concept I proposed, a **magnetic monopole** is a **physical magnetic unit** in which the initial **complementary duality** is realized and from which all other forms and types of dualities are generated through the process of bifurcation/fibration with a doubling of its framework parameters. And it is precisely the 180-degree inversion that mediates the automatic transmission of the original infogenetics to all the creations in this method of growth of matter from the inside out.

When closed in a ring through inversion, a magnetic monopole has no external magnetic field and, according to this property, may represent the type of unmanifested matter currently defined as "dark matter." [90][31]

A **monopole** does not imply unipolarity, as is explained in modern concepts. Magnetism is always bipolar due to its dual complementary nature, and a monopole is an initial state of duality in which the magnetic field and its complementary polarities are not externally manifested as dipoles. The polarities are internally inversely closed upon themselves, and the magnetic monopole acquires the property of magnetoelectric "invisibility." [90][94][31]

In physics, Yakov Zeldovich's anapole is well-known, which also lacks the manifestation of an external magnetic field, that is, it has the same property of "invisibility." And currently, there is a theoretical proposal to consider Zeldovich's anapole as a candidate for explaining "dark matter." [32] [90]

However, in addition to the absence of an external magnetic field, to confirm the anapole's candidacy for this role, it is necessary to demonstrate how baryonic matter, which exists in a dipole state, is generated on its basis. That is, it is necessary to demonstrate how the anapole is transformed into a bipolar dipole and, subsequently, how a structure of atom is formed on this basis. It is also necessary to demonstrate the interrelations by which the atomic structure is held together and remains stable.

Let us examine these identified questions, as well as the logically following ones, from the perspective of applying the nontrivial topology of the Möbius strip and its topological properties to magnetoelectric phenomena since the Quantum Medium, consisting of a matrix of magnetic units, is a magneto-plasma.

"A useful method of studying many of these phenomena [of cosmic plasma] is to draw an electric circuit in which a current flows and study its properties. A number of simple circuits are analyzed in this way." [13]

As already noted, the new conceptual proposal takes as its starting point the fundamental principle of complementarity, and the defining feature is the representation of a magnetic loop (flat or toroidal) as a loop with an inversion, that is, a 180-degree reversal. This representation of a magnetic loop allows us to visualize the geometric principle of combining the closed motion of magnetic flux with its asymmetric mirror image, which will be the counterflow. Taking into account recent research in plasma physics [33][34][90], two opposing plasma flows, when converging, produce a reconnection effect with the release of energy.

Thus, two mutually opposing magnetic fluxes in a closed magnetic monopole structure produce a sparking effect, which is the release of monopole radiation, in other words, electricity or energy quanta. It logically follows that the dynamic process of magnetic loop reconnections with inversion is the cause of continuous and unceasing **oscillations** that occur with the release and absorption of quanta and are inherent in all objects in space. And while physics still lacks a concrete explanation for the cause of these oscillations, applying Möbius strip geometry to this question helps to get the answer.

In the current state of elementary particle physics, a search is underway for unipolar monopoles, and experiments conducted within the framework of condensed matter research are aimed at confirming this theoretical assertion. This is addressed in the work [90], from the given number of experiments on searching for structures that imitate monopoles, experiment [146][147] is highlighted, which shows a result that most closely correlates with the magnetic monopole geometry I proposed in [89][90] and here.

As can be seen from the illustrations of experiment [146] (Extended Data Figure 2 j Additional representative images of Dirac monopoles), the quantum behavior of the monopole under study is analogous to Möbius ladder graphs, which, in two variants, reflect a peculiar Möbius topological reversal. [90]

In my view, despite the criticism that these are not monopoles, Möttönen is correct in his belief that “Dirac famously said that he would be "surprised" if nature had made no use of such an elegant idea as the magnetic monopole. Physicists are still looking for natural monopoles, including in rocks and lunar samples, and in experiments using particle accelerators. Simulated monopoles provide a stronger foundation for these searches, says Möttönen. “You could ask, is this structure Dirac predicted actually possible? Now we have seen that it is possible, there’s one more reason why the magnetic monopole as a fundamental particle should exist.” [147]

Given the fact that researchers are searching for a unipolar magnetic monopole, the question of finding one may drag on for an indefinite period. In turn, the proposal to consider a magnetic monopole with the application of a non-trivial Möbius strip topology and to consider the experiment [146] on this basis can shorten this search and help to understand that the structure of the magnetic monopole is dual.

An analysis of monopoles based on Möbius geometry is proposed in a theoretical proposal [144], which deals with a monopole magnetic field geometrically determined by the non-trivial topology of the Möbius surface and its relationship with the quantum spin Hall effect.

“For a relativistic particle confined to the nontrivial surface, we give the effective Dirac equation in the thin-layer quantization formalism, and we find a geometric gauge potential that results from the rotation transformation of the local frame moving on Möbius strip, and an effective mass that is from the rescaling transformation. The effective magnetic field is monopole that is determined by the single face of Möbius strip. In the presence of monopole effective magnetic field, the spin-outward particles and the spin-inward ones are completely separated as full spin polarization. The pure spin current is also determined by the geometry of

Möbius strip due to the coupling of geometry and spin. As a conclusion, the nontrivial topological properties of Möbius strip entirely determine the emergences of the monopole magnetic field and the quantum spin Hall effect". [144]

The examples of theoretical and experimental results presented above correlate with my proposed explanations of aspects of physics based on the nontrivial topology of the Möbius strip. And, as can be seen from experimental observations and theoretical conclusions, the presence of the Berry phase [35][122][124] and the spin Hall effect [144] are geometrically determined by the non-trivial topology of the Möbius surface.

Taking as a starting point the Clifford parallels as a characteristic geometry of space and taking into account a number of theoretical and experimental conclusions above, we next consider aspects of the application of Möbius strip geometry to intractable questions of theoretical physics. The answers obtained will lead to a conclusion about the extent to which Möbius strip geometry satisfies both the criterion of elegance and can serve as a starting point for the geometrization of physics. [104][105]

Why is the magnetic monopole aspect so important? Because the magnetic monopole is a kind of seed in the matrix structure of the Quantum Medium and from it originates the growth of matter from the inside out through bifurcation and doubling. And the next aspect of application after magnetic monopole is a universal scheme for the process of bifurcation of a magnetic loop-monopole with the doubling of its infogenome and the formation of new symmetries. The process of division by symmetrical bifurcation is a hydrodynamic property that is inherent in vortex formations and will be characteristic of the cosmic medium, which is a kind of magneto-plasma fluid.

At one time, W. Heisenberg asked W. Pauli why he attached so much importance to the process of bifurcation (bifidity), and received the following answer from W. Pauli: "... The process of bifurcation, or bifidation, as I imagine it, could explain a lot to us here, because it somehow very naturally expands the space of nature, thereby creating the possibility of new symmetries. In the ideal case, one could think that all real symmetries arose as a consequence of such bifurcations." [36][37][61][62]

W. Pauli explained to Heisenberg that he attached profound importance to "bifidity" (or dichotomy/division) because it is inherently linked to the **principle of complementarity**. He viewed this binary division (the breaking of wholes into complementary opposites) as a foundational epistemological structure. Pauli argued that such dichotomy was far more than a mathematical trick or an arbitrary split. For Pauli, this dualism was a structural necessity of nature, giving **shape and meaning to quantum states**.

Considering that the geometry of the Möbius strip frequently visited W. Pauli's imagination, appearing in his night dreams, and that he was also shown a diagram of a topological reversal, a kind of dance in which diagonally opposite points at the corners of a square swap places (the "***Pauli square***"), it can be argued that W. Pauli was very close to unlocking the secret of the universal process of **bifurcation, or bifidation with doubling**, which can be visualized based on the topological properties of the Möbius strip geometry. As will be shown below, this universal method of expanding space is fractally-identically reflected both in the sphere of cell biology, and in the quantum sphere, and in the sphere of magnetohydrodynamics.

This opens the possibility of building interdisciplinary bridges, the importance of which was emphasized by the mathematician M. Atiyah in his conference presentations. [39][40][41] At the conference, [40] M. Atiyah delivered a lecture in which he emphasized that mathematics

requires interdisciplinary interaction with biology, chemistry, and philosophy, otherwise it will "die." In fact, this question touches on an even broader aspect and is currently becoming increasingly relevant in the construction of a unifying Theory of Everything given the view that all matter is alive. Accordingly, cosmic space and the quantum realm are characterized by the same processes that are inherent in the biological world – quantum respiration, quantum metabolism, and quantum symbiosis, as well as the process of generating matter from within through bifurcation with a doubling.

The universal bifurcation/fibration scheme with doubling has been fairly well studied in the field of cell biology – it is a method of DNA replication in which DNA bifurcates into two strands and, as a result of copying, its infogenome is duplicated, resulting in the generation of a new cell and thereby doubling the number of cells.

In the field of magnetohydrodynamics, suggested by me the application of this same universal bifurcation scheme with doubling to the self-generating hydromagnetic dynamo phenomenon can help more clearly to explain and present the process of magnetic flux doubling and the formation of atomic structures.

Currently, two models of magnetic flux doubling exist: the slow dynamo model of H. Alfvén and the fast dynamo model of Ya. Zeldovich. [13][42][43][44][65]

In both models, the initial magnetic loop is considered to be a loop in the geometry of a "doughnut" torus, for which its stretching is used in the descriptions of the models. That is, the geometric representation of a magnetic loop with an inversion and the process of its bifurcation along the line of curvature were not considered in either model.

Along with these two models, I have proposed a new model scheme for doubling magnetic flux based on the bifurcation of a magnetic loop represented in the geometry of a Möbius strip, or Möbius torus, with one inversion (magnetic monopole). The bifurcation of such a loop is the process of its filamentary stratification **along the line of Möbius curvature**, in other words, the process of its **fibration.** [30][93][96][97]

What result does this produce? It is the process of loop fibration with inversion that automatically doubles the original infogenome (frame parameters) and alters its geometric shape: the loop's length doubles and the inversion doubles. Due to the presence of two inversions, the new loop takes on the geometry of a twisted figure-eight. The arms of this figure-eight are mirror-asymmetric and possess the property of coaxially nesting within each other, forming a double Möbius pseudo-ring. Thus, the magnetic flux undergoes doubling. In this case the topological properties of the Möbius strip produce natural spatial-geometric transformations, while the formation of a double “eight” in the model of Ya. Zeldovich is difficult to explain, although it is depicted correctly. [65]

The hydromagnetic dynamo is nothing more than the formation of baryonic matter based on magnetic monopoles, that is, the process of converting magnetic monopoles into magnetic dipoles with the formation of atomic elements based on the **topological link-like interrelationship** between the dipoles. [91][92][95][96]

When considering a magnetic monopole in the nontrivial geometry of a Möbius strip, this process can be visualized using a simple paper experiment, demonstrating three phases of fibration. (**Fig. 1, Fig. 2, Fig. 3, Fig. 4**)

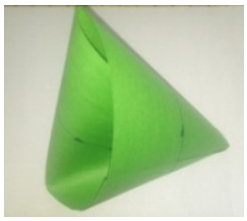
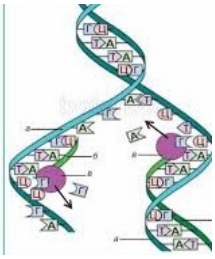
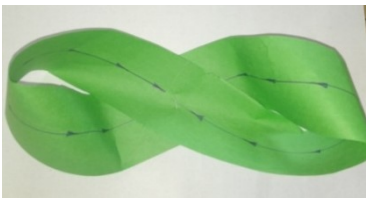


Figure 1. Monopole



1st phase of fibration.

Figure 2. Dipole.



The second & third phases of fibration.

Figure 3. Two knotted dipoles,

Figure 4. Four Dipoles

The process of magnetic loop fibration along its Möbius curvature results in doubling of symmetries, organizing combinations of mirror-asymmetric components into a single whole. It is precisely this mirror-asymmetry that is responsible for the dynamics of the continuous oscillatory process, as visualized by the ancient Yin-Yang symbol: when one component of the topological whole reaches its maximum, it coincides with the minimum onset of motion of the component, mirror-asymmetrically opposite it, the maximum of which corresponds to the onset of the first.

This oscillatory process continues continuously. And, as noted above, such a complementary interrelationship in the nature of magnetism underlies self-motion [78], namely, continuous and unceasing oscillations.

Oscillations are inherent in all objects of the cosmic environment and this property is transmitted to them infogenetically in the method of generating matter from the inside out through the bifurcation of the magnetic loop-monopole with the doubling of its magnetic flux and the original infogenetics.

In understanding the process of fibration or stratification of a magnetic monopole, i.e., its bifurcation, it is worth paying attention to the parallel conclusions of bifurcation theory of magnetic monopoles in a charged two-condensate Bose-Einstein system, where the evolution of magnetic monopoles is studied based on the topological properties of a three-dimensional vector field. The authors note that all the results in their article were obtained solely from a topological perspective, without the use of any specific models or hypotheses. [143]

Also, in the theoretical approach to classical quantum field theory based on the geometry of locally conformally flat space-times [145], significant simplifications are made precisely by considering structures (LMCSs) that have a locally Euclidean topology and, therefore, are Möbius structures. The approach describes the natural structures of principal bundles associated with Möbius structures, and classical quantum field theory (the Dirac equation and Maxwell's equations) is obtained by considering representations of the structure group of the principal bundle associated with a given Möbius structure. The authors focus on the advantages of using only a few natural axioms and the possibility of generalizing classical quantum field theory from the context of Minkowski space to that of arbitrary locally conformally flat space-times. [145]

Continuing to follow the logic of my geometric format, in the description of the magnetic dipole I move on to the fact that the transformation of the magnetic loop with one inversion – a

magnetic monopole – into a two-component magnetic dipole with two inversions is accompanied by the actualization of the crossed interrelationship of the dipole arms, as well as the external magnetic field, charge properties, and mass. A magnetic dipole is the next **closed geodesic line** that represents an optimal distance that a magnetic flux must travel to ensure continuous and uninterrupted operation of a two-arm oscillator.

Figure 5. Möbius Magnetic Dipole.

As can be seen from the illustration **Fig. 5**, the energy circulation in the shoulders is mirror-asymmetrical and moves in both directions simultaneously, entering the center on one side and exiting on the other. This is a new perspective on the nature of magnetism, revealed by a geometric approach. I conducted a simple experiment with a bar magnet, in which the compass needle rotates 180 degrees after the midpoint as the compass moves along and near the magnet.

I believe that the established scientific demonstration of magnetic lines should be treated with much greater attention. There are new proposals for visualizing magnetic lines. As a rule, we study magnetic lines exclusively in baryonic matter, which is a dipole option. The authors' proposal [45] for visualizing magnetic lines using the "Bloch wall" is similar to the option I propose, but differs, requiring not only theoretical justification but also experimental confirmation.

The arms of a magnetic dipole have opposite mirror-asymmetric (complementary) chirality. Such a dipole is geometrically similar to an Archimedes screw, which captures (absorbs) and then releases (radiates) quanta. The chiral direction of the emitted quanta is determined by the dipole transformations occurring in the atom. The helical functioning of a magnetic dipole in the form of a vibrating closed spatial wave on the non-trivial geometry of a Möbius strip with two inversions and an atom based on such dipoles will produce stable line atomic emission-absorption spectra. [92] [38]

The chiral direction of the dipole arms determines the sign of the **charge**. The intersection point of the Möbius curvature line is the point where the charge undergoes a **topological reversal** and becomes its opposite. Thus, in an magneticic dipole, the interrelationship between opposite charges is achieved through geometric crossing created by two inverse reversals, with the two components of the dipole forming an interconnected, indivisible whole.

The Möbius magnetic dipole is the next type of duality, arising from the bifurcation of a magnetic monopole with the doubling of its infogenome. This is a **basic element** of Nature and a bipolar dual construct in which mirror-asymmetric arms acquire the properties of **opposite charges**. To this day, physics has failed to explain the nature of charge. In a new format, with the application of Möbius strip geometry, this secret of nature is revealed.

"**Charge**" is the helicity formed by a 180-degree Möbius inversion. And this infogenetics, in the copying process, is transmitted and unchanged. Based on this, it can be argued that charge is a topological invariant that is conserved and a multiple of the known minimum charge potentially inherent in a magnetic monopole.

The sign of the charge is the direction of helicity. Therefore, the sign of the charge changes depending on whether it is left-handed or right-handed.

The magnitude of charge is the amount of magneto-plasma that the arm of the magnetic dipole transforms, or the amount of electricity involved in the electromagnetic interaction of magnetic atomic dipoles with the Quantum Medium.

The measure of energy is related to the level of vibration, spinning, cumulative helicity.

The Möbius magnetic dipole is an automatically synchronized oscillator that implements the dynamics of self-motion based on the complementary property of magnetism and the described properties of the magnetic dipole are geometry-induced.

Considering the structure of the magnetic dipole and the presence of a topological flip of the chirality of its arms (charges), one can cite as an example an experiment in which a dynamic inversion of the topological charge of an optical vortex was first observed as it propagated in free space. [98][92] The laser experiment demonstrated that a dynamic flip of chirality is possible in nature. But I would put it differently: what initially exists in nature has become technically possible to replicate experimentally.

The main value of this experimental result is that the dynamic reversal of the vortex's topological charge holds the key to understanding how the dual world always remains orientable, since a magnetic dipole is a one-sided orientable surface. [92]

The second phase of fibration and subsequent phases of fibration lead to an increase in the number of dipoles with the formation of dipole topological nodes, forming a "Center-Periphery" structure due to the polarization orientation of magnetic dipoles in the radial direction. **Figure 3, Figure 4**.

This growth process demonstrates the principle of formation of the Periodic Table of Chemical Elements and, along with it, the principle of **charge quantization**. [92][94][111]

The formation of topological nodes is one of the amazing properties of Möbius strip geometry. And it is this property that reveals Nature's secret in the formation of stable blocks – atoms – and the interrelationships within them.

In topology, the "Clifford-Hopf fibration" **Fig. 7** [103] is known, derived from the elementary nontrivial knot "Hopf link." **Fig. 6**

What is the difference between the Clifford-Hopf fibration, based on the "Hopf link," as it exists in mathematics, and the fibration of the Möbius strip, presented in the proposed concept as a special case of Clifford parallels? The difference is that the nontrivial "Hopf link" is a virtually artificial mathematical construct. One might wonder how such a link of two circle-shaped rings can be obtained using natural geometrical transformations, if it is based on the original duality of closed ***Clifford parallels***?

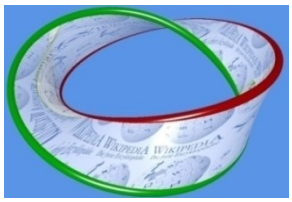
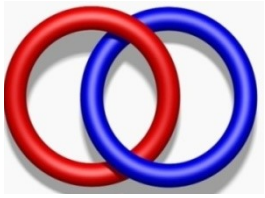

Mobius strip

Fig. 6 Hopf link.



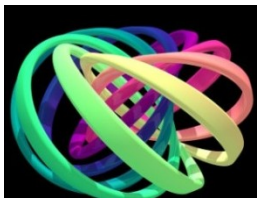


Fig. 7 Hopf fibration.

What's missing in this plan? A crucial element is missing, indicating that the fibrillation of a closed element based on Clifford parallels and containing a natural complementary duality (inversion) does not form interconnected circles, as in the "Hopf link," but rather intersecting "figure eight" rings with two inversions and crossing of the curvature line (Fig. 2, Fig. 5), which reveals Nature's secret regarding **gravity**.

The geometric transformation of the magnetic monopole loop and the resulting magnetic dipole geometry demonstrates a crisscrossing interrelationship, which is identified as a **gravitational interrelationship** that regulates the balance between the dipole arms (charges and masses) – their tension and balancing – ensuring their mutual support.

That is, the actualization of gravity in the process of bifurcation of the magnetic monopole (spatial stratification) is the manifestation of changes in the geometric structure of space-time, which, due to the doubling of the frame parameters, is caused by a new redistribution of energy and momentum, and is associated with the manifestation of an external magnetic field, charges and mass in the magnetic dipole.

The mirror-asymmetric arms of the dipole, despite their opposite charges, do not stick together or fly apart, but remain in a balanced magnetoelectric state. [30] [38] [90][91][92]

Gravity is the manifestation of spatial curvature that is caused by the shortest geodesic line when creating a magnetic flux in a dipole form. In the proposed monistic concept, the intersection point of this geodesic line is called the **gravitational tensor**.

In the magnetic dipole structure, gravity operates on the principle of a balance beam with a **movable axis**. When the parameters of the arms change, the center of balancing and tension (CBT) shifts, and the entire structure undergoes mutual displacement. **Fig. 8, Fig. 9**

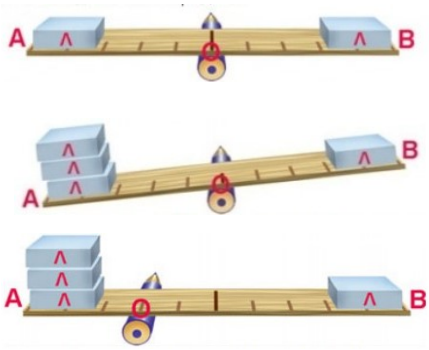


Fig. 8 Lever balance with movable axis.

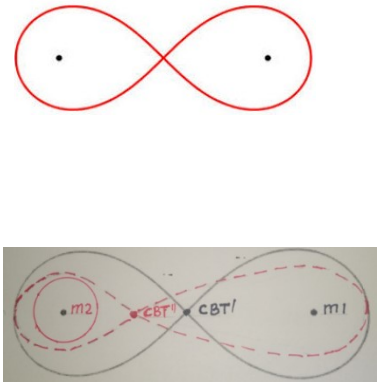


Fig. 9 “Proton (m2)–electron (m1)” dipole coupling.

Neither classical nor quantum electromagnetism explain why the "electron" in a hydrogen atom never falls onto the "proton," despite their opposite charges. The explanation for this "non-fusion" phenomenon lies precisely in the wave-dipole magnetic nature of the unified physics of the "proton-electron" pair, where they form a single entity in a geometrically mirror-asymmetric arrangement relative to each other, ensuring a dynamically stable gravitational interrelationship. Fractally, gravity has the same place between the planet and the star.

Possessing a gravitational balancing mechanism, the dipole structural formation of two asymmetrically coupled oscillators as a whole possesses antigravitational properties and hangs unsupported in space, as evidenced by the entire cosmos.

The geometry of the Möbius strip, by elegantly shaping the magnetic monopole, consequently elegantly "squeezes" gravity into the microscopic world and provides the basis for its explanation in the macroscopic world, since the worlds are homologous based on a fractal-holographic structure. The planet-star interrelationship has the same dipole configuration, and the Lagrange points (libration points) are directly related to this. **Fig. 13, Fig. 14**

Gravitational interaction is a consequence of geometry and is determined by the nature of the initial complementary interrelationship that mediates this geometry in the phenomenon of magnetism in the process of implementing spatial transformations of magnetic geodesic lines.

Revealing the essence of the gravitational interrelationship through geometric topological transformations of the curvature of space and its visualization may be of great importance for the further development of the theory of quantum gravity, as well as for questions of quantum geometry.

The three phases of fibration with the formation of a magnetic dipole, two quantum-entangled dipoles, and a "Center-Periphery" dipole scheme, demonstrate the process of matter growth through bifurcation with doubling. **Fig. 10, Fig. 11, Fig.12, Fig. 13**

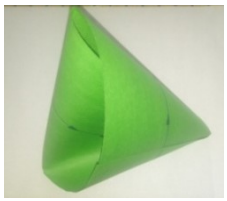


Fig. 10 Monopole.

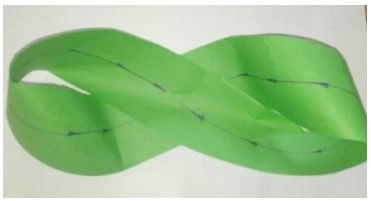


Fig. 11Dipole. Gravity

Fig. 12 Two dipoles. Quantum entanglement.

Fig.13 Topological dipole knot in the atom.

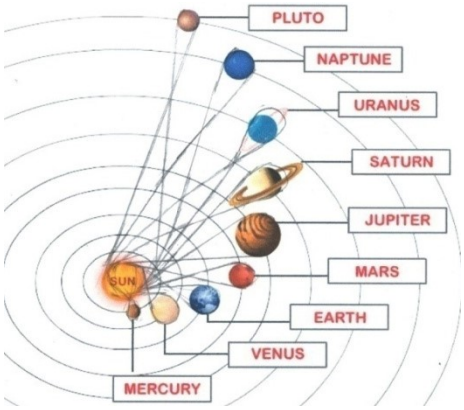


Fig. 14 Dipole knot in the stellar-planetary system.

As can be seen from the illustration, the indicated interrelationships are identical in the homologous structures of the micro- and macro-worlds and are geometry-induced.

The formation of topological knots during subsequent fibrations demonstrates that newly formed magnetic dipoles remain quantum entangled. This is the role of quantum entanglement in atomic structure. All magnetic dipoles of an atom have a common origin; they were potentially present in the same quantum system of a magnetic monopole. During the process of magnetic monopole fibration, the dipoles remain quantum entangled, and therefore instantly synchronized in the dynamics of all internal movements.

Thus, during the generation of atoms (baryonic matter) based on transformations of the spatial geometry of magnetic monopoles, complementary interrelation mediates the integrity of system formation, the instantaneous synchronization of its components and the actualization of fundamental interrelationships based on magnetism: gravity and quantum entanglement. These interrelations are equally inherent in the micro- and macro-worlds, perform different functions, and are not interchangeable, as the worlds are fractally identical and are constructed according to a single Image and Likeness, that is, according to a single universal template. [30][38][91][92]

As illustrated in Figures 10-14, the microcosm of the atom and the macrocosm of cosmic systems share a single, universal type of motion, based on the nontrivial topology of the main geodesic lines of magnetism: a monopole geodesic line, a dipole geodesic line, and the connection of dipole geodesic lines into a "Center-Periphery" topological node, forming stable, oscillating systems of atoms in the microcosm and stellar-planetary systems in the macrocosm.

Currently, the new scientific field of Quantum Geometry, using QGT methods (quantum metrics and Berry phase), will be able to successfully confirm, based on a landscape map of the wave function of motion in the crystal lattice of a quantum material, that this motion occurs along a curved trajectory, and that when traversing a closed circuit, this motion exhibits a reversal. Essentially, in a quantum material, as a type of baryonic matter in a dipole state, motion along a closed circuit should exhibit a double reversal. If this is true, then the trajectory of motion within the crystal lattice is mediated by the wave structure of the atom and is a dipole geodesic line. The material is topological, and this becomes a fact that confirms the logic of the concept I proposed based on the nontrivial topology of a Möbius connection.

Based on this logic, the geometric approach based on the nontrivial topology of the Möbius strip allows us to answer the theoretical question: whether the "ER bridge" and the "EPR" effect should be equated? [92][95]

In 2013, a paper by J. Maldacena and L. Susskind was published proposing the equivalence of two completely different phenomena: the "EPR" effect and the "ER bridge." [48] This proposed equivalence currently exists as a **hypothesis** and is attractive because it has led to repeated attempts to prove the equivalent nature of the "EPR" effect and the "ER bridge" using the mathematical apparatus of algebra. [49] [50] [51] [52] [53]

Algebra can be used to model and prove many things, as exemplified historically by the mathematician Ptolemy. As appealing as the idea of equating the two might be, a geometric approach based on the nontrivial topology of the Möbius strip does not support this hypothesis. It points to the fact that, although both the "ER bridge" and "EPR" belong to the category of dualities, they are distinct phenomena that perform distinct functions, as originally indicated by the original works [46][47].

Regardless of the scaling level of the interrelations, gravity and quantum entanglement, are fundamental and perform distinct functions in holding the structural formation of a system together. This applies equally to the world of our consciousness, which physicists are attempting to link with aspects studied in the world of matter. Ultimately, gravity has a broader meaning than that implied and understood in the current period. [30][90][92][95]

The worlds are fractally similar, and the same fractally similar dual interrelations operate within them. Understanding their identity is only possible with a geometric approach, which provides visualization and helps to resolves difficult questions.

The next application of Möbius strip geometry concerns the fact that in his lectures [81], R. Feynman drew the attention of his audience to the striking similarity between the formulas of Newton's Law of Universal Gravitation and Coulomb's Law, noting a surprising paradox: mathematical equations describing completely different phenomena (the attraction of masses and the interaction of electric charges) look absolutely identical. He wondered why nature uses the same mathematical structure for such different physical entities. In this regard, he famously remarked that "no one has yet succeeded in conceiving of gravity and electricity as two different manifestations of the same entity." [81]

The answer to this question is already evident in the universal "Center-Periphery" diagram shown above. (Fig. 13, Fig. 14) What logic could be here? As can be seen from the

illustration, the general dipole diagram has its own identifications in the microcosm of the atom (Fig. 13) and in the stellar-planetary system (Fig. 14). In this general diagram, complementary dipoleity ensures the balance of dual components, the parameters of which in both laws can be expressed as masses or charges. It is precisely the unified dipole diagram, as a single entity, that determines the identical mathematical structure of these laws.

In experiments with charged objects that do not belong to the one intire "Center-Periphery" structure, the law of charge interaction has two particular one-sided manifestations: the law of repulsion between external objects with charges of the same sign, or the law of attraction between external objects with charges of the opposite sign. The meaning of charge is practically analogous to the meaning of mass.

Historically, Newton's law of universal gravitation has been understood as a force of attraction between bodies, although ideas regarding a universal repulsion have also been advanced throughout the history of science. But the obvious thing is that this association with attraction is based solely on terrestrial experience, when observing any object falling from a height to the ground. In reality, what the entire cosmos demonstrates to us, and what the universal dipole diagram with crossing visualizes, is the essence that determines the mutual balancing of "weights" or masses, providing their mutual spatial "favor". (Fig.8, Fig.9)

(**gravity,** c. 1500, "weight, dignity, seriousness, solemnity of deportment or character, importance," from Old French *gravité* "seriousness, thoughtfulness" (13c.) and directly from Latin *gravitatem* (nominative *gravitas*) "weight, heaviness, pressure," from *gravis* "heavy" (from PIE root ***gwere-** (1) "heavy").

***gwere- (1)** Proto-Indo-European root meaning "**heavy.**"

***gwere- (2)** Proto-Indo-European root meaning "**to favor**."

Thus, the action of the law of universal gravitation is determined not by the attraction or repulsion of masses, but by **mutual balancing** in the general structure of magnetic dipole based on the properties of magnetism.

From the general dipole scheme, it follows that the "striking similarity of the formulas" of both laws is based on the same **geometric dipole essence**, and both laws are "two different manifestations of this essence." If I have succeeded in answering the questions posed by R. Feynman, then we can move on to the next application of Möbius strip geometry, namely, the question of **charge quantization**.

In 1931, P. Dirac mathematically proved that if a magnetic monopole exists in the Universe then the electric charge must be quantized, which is an absolutely correct line of thought for a talented physicist. P. Dirac believed that the existence of a magnetic monopole in nature explains why all electric charges in the Universe are multiples of the minimum charge.

However, in hypothetically predicting the existence of a magnetic monopole in nature, P. Dirac assumed it to be **unipolar**, that is, with a single magnetic pole. This would be an erroneous judgment, since (as noted above) magnetism is the physical embodiment of the principle of complementarity, and the nature of magnetism is always dual and has two poles. Along with this magnetism can have phases: a monopole, when the external magnetic field and charge have no external manifestation (nonpolar), and a derivative phase – a dipole (bipolar), which has a manifest magnetic field, charges, and mass.

Although the mathematical structure of modern field theories requires particle charges to be multiples of each other, which ensures consistency in the equations of quantum electrodynamics and conservation of energy, the current state of physics lacks a rigorous

mathematical explanation for why charge is quantized in this way. There are explanations in quantum mechanics and particle physics, but they are based on the concept of unipolar magnetic units. Scientists are still actively searching for unipolar magnetic monopoles in nature (in cosmic rays and lunar rocks), but their existence has not yet been proven.

The concept proposed by me shows that a magnetic monopole is a unit with hidden polarity on a nontrivial Möbius strip topology. In the process of magnetic monopole fibration and its transformation into a magnetic dipole, the minimal charge manifests itself along with the external magnetic field and is replicated—quantitatively doubled (quantized). Each magnetic dipole arm inherits a **minimum charge**, which has been calculated to date to be **1.602 176 634·10−19 C.** The quantization process continues in subsequent phases of fibration in doublings of dipoles and leads to a periodic table of chemical elements in which the total charge of each element will be a multiple of the minimum, since it is obtained through a series of doublings.

In quantum mechanics, there is a consistently derived chain:

"Avoiding the construction of any visual kinematic models, Pauli introduced the doubled Hilbert space H2⊗H (the space of wave functions), whose vectors are two-component **spinors**. Thus, two-component spinors and the first doubling appeared for the first time in physics. The subsequent doubling **(bispinors**, H4⊗H space) was proposed by Dirac in 1928. The next doubling leads to **hypertwistors** in the Hilbert space H8⊗H.

Hypertwistors are vectors of the fundamental representation of the Rumer-Fet group SO(2,4)⊗SU(2)⊗SU(2), which provides a group-theoretic interpretation of the periodic table of elements. Spinors, bispinors, and twistors are special cases of a hypertwistor." [61] [62]

Parallel to this chain, in the concept I proposed on the nontrivial topology of the Möbius strip, the process of bifurcation with doubling also geometrically demonstrates a chain: from a magnetic **monopole** to a magnetic **dipole** and then to the **topological nodes of magnetic dipoles**, which provides a visualization of the formation of the periodic table of chemical elements.

As can be seen, the chain in quantum mechanics: spinor, bi-spinor, hypertwistors, which gives an interpretation of the periodic table of elements, **coincides with the geometric chain**: monopole, dipole, topological nodes of dipoles, leading to the visualization of the periodic table of elements. This is a good focus for the appropriate conclusions. Model diagrams of atomic elements from hydrogen to fluorine were made by me personally and are presented in the work [92], as well as in others.

The proposed explanation and visualization of the quantization process based on the fibration and topological properties of a magnetic monopole (Fig. 10 – Fig. 13) points to the fact that in Nature there cannot be a charge less than the minimum, since the quantization process occurs by doubling the minimum charge through the universal method of fibration with doubling the parameters of the magnetic monopole. The minimum charge known to date is a **topological invariant**. [92][94]

Thus, the proposed approach based on the nontrivial Möbius strip topology excludes the possibility of further charge fragmentation, while in the EPP approaches, each nucleon consists of three quarks with charges fractional to 1/3 of the known minimum. In [90][92] it was shown geometrically that in the non-trivial topology of the Möbius strip there are **three dynamic regions** that can have different **quantum parameters** and can be algebraically calculated and treated as three quarks. These three regions also make up the quark confinement, which is essentially not divisible into three separate particles, but thanks to the non-trivial properties of the Möbius strip can create this illusion.

By uncovering the inner essence of the Möbius Magnetic Dipole and it`s secrets, we can go next to Dirac's **relativistic equation**.

Dirac's equation mathematically combines the wave properties of a (so-called) "particle" with the phenomenon of spin and the curvature of spacetime. Dirac described this "particle" as four interconnected wave functions, grouped "two by two" and reflecting opposing right- and left-handed chirality and (conditionally) positive and negative curvatures. In other words, this equation revealed that the elementary "particle" of matter (in a manner inexplicable at the time) contains opposing components in its description, which are in a state of constant oscillation of mutual transformations.

Among the first theorists to deeply analyze Dirac's relativistic equation as early as 1929 was G. Weyl [54]. It was Weyl who first noted that the structure of the equation points to the dual nature of the "particles" at the core of matter. Weyl demonstrated through transformations and solutions of the Dirac equation that the mathematical structure of a particle decomposes into two massless components – one with right-handed rotational chirality, the other with left-handed rotation. The particle's mass arises through oscillations during transitions from one chirality state to another. And since mass, according to Einstein's General Theory of Relativity, is inextricably linked to the geometry of space, Weyl noted that it was precisely this mystery of the Dirac equation that held the key to unifying quantum physics and the theory of gravity.

Since at that time the components "proton" and "electron" had already entered the scientific worldview as "particles," the insightful W. Heisenberg, who was pondering the opposite components of the equation and the problem of their equal charges but vastly different masses, told P. Dirac that this riddle would only be solved after the creation of a "***unified theory for the physics of the proton and electron together***." [61][62] However, at that period in history, the discovery of the positron turned scientific thought onto a different path of reasoning.

Considering these facts and the above-described geometric approach, it can be confidently stated that the basic element of nature – the magnetic Möbius dipole – and the dual components in P. Dirac's equation are one and the same dual object, described both algebraically and represented geometrically. The mirror asymmetry of the magnetic dipole arms and topological bends (Fig. 5) allow us to understand what exactly was taken as positive and negative curvatures and how one chirality state transforms into another through a **topological flip**.

At the time of its creation, Dirac's equation was not fully understood by either the author himself or the quantum mechanics community. This was because the understanding of atomic physics was firmly established on the basis of the then-known proton and electron, which were considered separate particles.

E. Majorana managed to rewrite Dirac's equation in real-number form, eliminating imaginary units, imaginary time, and other features of modern physics equations operating in the domain of complex numbers.

An elegant new solution to Dirac's equation – the "Majorana fermion" – has not yet been discovered in nature. However, this object has become a stable basis for qubits in quantum computers.

As a consequence of the incomplete understanding of Dirac's equation, it is not included as a basis in the Standard Model of particles or in the famous textbooks of R. Feynman. [55][56] Dirac's equation is also not included in the widely known textbook of Nobel laureate S. Weinberg. [57]

Along with this, there are informative works on the fundamental importance of P. Dirac's equation not only for the foundations of physics, but also for mathematics, including M. Atiyah's review lecture "Dirac Equation and Geometry." [58]

If discoveries related to Dirac's equation were occurring in the current period of scientific development, the phenomenon of dual components, hitherto unexplained in the equation, could be called the emergent phenomenon of dual "particle breathing," which arises as an effect of the **collective behavior of the components of a dipole pair.** And if we understand that dual components are not particles, but a single, unified, magnetoelectric and instantly synchronized wave structure, then Dirac's relativistic equation points directly to a **new unified physics of the basic element of Nature in the form of a magnetic dipole** on the nontrivial topology of a Möbius strip with two inversions. (Fig. 5)

Despite the fact that Dirac's equation was not understood at the time, I believe that a geometric approach based on the nontrivial topology of a Möbius strip will encourage scientists to return to it at a new turn in the spiral of understanding.

The result of applying the Möbius strip geometry shows that the dipole nature of baryonic matter is essentially a single and automatically synchronized entity, and this is precisely the meaning of the "**unified theory for proton-electron physics together**" which was designated by W. Heisenberg.

So, how is the question of the masses of the "proton" and "electron" resolved and why has the "Majorana fermion" as a solution to the relativistic Dirac equation still not been found in nature? The answer lies in understanding that Dirac's equation describes the basic element of nature in its original **symmetrical stage.**

The basic element – a magnetic dipole – obtained by dividing a magnetic monopole with a doubling of its parameters becomes the first chemical element, protium, as the symmetry between the arms decreases and the center of balancing and tension (CBT) shifts toward the arm with the greater mass. (Fig. 8, Fig. 9) This forms a universal "Center-Periphery" structure.

In 1957, in a letter to W. Heisenberg, W. Pauli wrote his historic phrase: "***Bifidusion and reduction of symmetry – that's where Faust's poodle is buried!***" [36]

Other variations of this historical phrase can be found, for example, it is actually translated from German as ***"Duplication and reduction of symmetry – that is the kernel of the matter"*** (or ***"crux of the matter"***) which in meaning is a complete analogy. Attempts to decipher this phrase are still being made.

Pauli's phrase referred to his belief that the universe's fundamental particles and forces are produced by two sequential cosmic principles:

Duplication/Doubling: The splitting of a single, unified state or particle into multiple, opposing states.

Reduction of Symmetry: The subsequent breaking of perfect, underlying symmetries to produce the varied, complex, and observable universe.

Whatever the interpretations, the geometric approach under consideration makes it clear that if a single and unified state of magnetism is **complementary** and contains an inversion in its nature (monopole in geometry of the Möbius strip), then the **natural property** of this state with inversion is such that upon splitting/fibration, the parameters of the original state will **automatically double**. It is precisely in this essence of magnetism, not yet revealed to science, that the secret of the growth of matter from the inside out is hidden and together with this the secret of gravity, the secret of quantization, and so on.

Although the concepts of symmetry breaking and duplication form the basis of the Standard Model of particle physics, it nevertheless lacks a concept of the geometric shape of the original magnetic unit (monopole) in the non-trivial topology of the Möbius strip, and does not consider the properties of the Möbius strip to double its frame parameters in the method of fibration along the line of curvature, which is the process of growth of matter from within with the actualization of fundamental interrelationships – gravity and quantum entanglement.

After the first phase of bifurcation/fibration of the magnetic monopole and when the symmetry between the arms of the magnetic dipole is broken, the magnetic dipole arm with the greater mass becomes the "proton" component, playing the role of the center-nucleus, while the second arm with the lower mass becomes the component further from the center and forms the peripheral region of the atom – an atomic vibrational membrane through which quanta are emitted and absorbed, and chemical interactions occur. Fig. 8, Fig. 9

The proposed geometric approach brings new detail to the question of constructing an atomic model due to the topological properties of magnetic dipoles based on the non-trivial topology of the Möbius strip with two inversions and also includes the previously established scientific fact of the planetary structure of the atom. [38][59][60][92]

I have personally created a diagram of the wave dynamics of the hydrogen atom based on the Möbius magnetic dipole (Fig. 15). Also in the work [92] and others, diagrams of the atomic elements of the first two periods of the Periodic Table of Chemical Elements are presented, including the element fluorine, built on a non-trivial topology of magnetic dipoles.

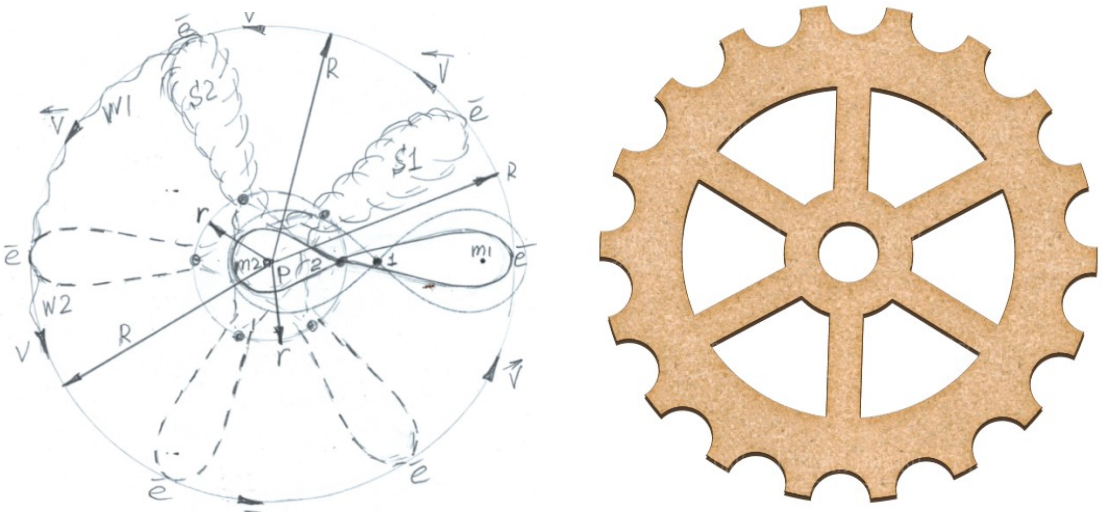


Fig. 15 Diagram of the wave dynamics of the hydrogen atom. [92][38]

R – atom radius,
r – radius of center of balancing and tension (CBT),
e – “electron” arm,
p – “proton” arm,
V – orbital vibration speed (orbital rotation),
W1, W2 – orbital wave vibration (atomic membrane),
m1, m2 – “centers of mass” of hydrogen dipole,
S1, S2 – lemniscate spinning (rotation around the middle of curvature line)

- Dipoles indicated by dash-dotted lines conventionally show local positions of the peripheral dipole component during its motion along the orbit during rotation around the "center of mass m2".

- Dipoles indicated by arcs display wave spinning S1, S2.

- Numbers 1 and 2 at the points of intersection of the curvature line mark the CBTs, respectively, before and after the reduction of symmetry.

- Dots along the circle of small radius ***r*** mark the intersections of the Mobius curvature line of each dipole.

As it is indicated in the description and in the illustration, the mutual spinning of the dipole components forms a radial movement, and the orbital wave-like movement of the **m1** arm forms peculiar «hills» and «hollows», the alternation of which is the vibrational membrane, a kind of "**gear**" with the help of which the quantum symbiosis of the atom with the supporting Quantum Medium is carried out, as well as **chemical interactions** with other atoms, forming chemical compounds.

As one scientist once said: "To adequately describe any natural phenomenon, we need a mechanical model to make the gears turn..." [61][62]

To more fully describe the wave structure of the atom using a geometric approach, it is necessary to uncover Nature's secret regarding the "proton" and "neutron."

In 1920, E. Rutherford proposed the existence of an electrically neutral particle, a bound pair of a proton and an electron, and proposed the name "neutron."

Following the discovery of the neutron in 1932 by D. Chadwick, W. Heisenberg and D. Ivanenko proposed the proton-neutron model of the atom. Heisenberg published a series of fundamental papers in which he "showed that, from an 'intranuclear' point of view, the proton and neutron can be considered different states of the same 'particle.' To describe them, he introduced a new quantum number, which was formally a complete analogue of electron spin." [121]

The secret of this "same particle" lies in the topological property of the Möbius magnetic dipole: it exists in two mutually inverse states that are geometrically transformed into each other.

One of the states is shown in Fig. 16 and Fig. 5 – this is a "figure eight" magnetic dipole, in which the external magnetic field and opposite charges are actualized. This state underlies a unified physics for the "proton-electron" together.

The second state is the Möbius pseudo-ring (Fig. 17), when the dipole arms are coaxially nested inside each other and the dipole folds and becomes neutral. This state underlies the physics of the "**neutron**." A magnetic dipole can exist in this state only within the structure of an atom. Outside the atom, dipole unfolds again and acquires a figure-eight proton-electron configuration.

Fig. 16 Magnetic Dipole.

Transformation.

Fig.17 Mobius pseudoring.

Also this transformation physics can quite simply explain and visualize the **beta-decay** process. [92][111] **Beta-plus** is the transformation of the “proton-electron” dipole state into the

“neutron” state with the emission of a positron quantum and a neutrino, while **beta-minus** is the reverse transformation of the “neutron” state into the “proton-electron” state with the emission of an electron quantum (chirally opposite to the positron quantum) and an antineutrino, which is nothing more than a different phase of the neutrino. In principle, both beta decay processes can be explained in a single way, without invoking antipodes.

What in the current paradigm is called “an electron leaving an atom” is an energy quantum formed by the atomic dipole structure and emitted via an inverse Möbius flip of the outer arm on the peripheral membrane. These quantum formations (virtual electrons, photoelectrons) are a regular product of the rhythm and energy dynamics of the atom. The positron, which is mirror-asymmetric to the electron, is also such a quantum emitted during the reverse rotation of the atomic dipole's arm (the "neutron") during its transformation into the proton-electron state (beta decay). In this case, the emitted positron-quantum will have a chirality opposite to that of the emitted electron quantum. These two quanta annihilate, and this property is the basis of positron emission tomography.

It is precisely because the "electron" and "positron" are reciprocally annihilating quantum formations that attempts to create an atom from them have failed. This attempt was motivated by the fact that these emissions were, and still are, considered particles with opposite charges and equal masses, which could be compressed into an atom by unknown forces. However, as experience has shown, this is not the correct logic. The opposite components of an atom must be balanced by a gravitational interaction, and in this regard, it is necessary to engage the logic of Nature and the process of generation based on the universal method of bifurcation with doubling, in which complementary opposite components of an atom and the interrelationship that bind them together are formed.

As illustrated, during the fibration of a dipole magnetic loop in the second and subsequent fibration phases, coupled dipole pairs are formed (Fig. 3 and Fig. 4). In this pair, one dipole remains in the "proton-electron" state, and the other in the folded "neutron" state. I believe that the **Pauli exclusion principle** is relevant to this, which for fermions means that identical "particles" with half-integer spin cannot simultaneously exist in the same quantum state; they must differ by at least one quantum number.

In the general scheme of the arrangement of the atomic nucleus that I have proposed, “protons” and “neutrons” alternate, respectively, which is illustrated in the atomic models in [92]. This alternation, in general view, creates the "Flower of Life" symbol. Regarding the presence of proton-neutron pairs, there are some theoretical proposals in the current period of 2026 [119][120].

With regard to the spin of the components indicated above, the following can be said. P. Dirac demonstrated the spin of an electron (fermions) using a belt, twisting it twice. At that time, the "general concept of spin" originated in the "ambiguity of the electron, which defies classical description. As it is well known, all attempts at a classical (mechanical) description of electron spin, beginning with the work of Uhlenbeck and Goudsmit, have been unsuccessful." [62]

However, taking into account what was said above about the magnetic dipole, this spin belongs to the entire dipole structure. This doesn't contradict the fact that, in current physics, the spins of fermions – the electron, proton, and neutron – are equal to 1/2. That is, for the "unified physics of the 'proton-electron' together," it remains the same value, since the entire interconnected structure rotates (spins) as a single entity and has the specified spin of 1/2. In current physics, this spin value has been assigned to the components of this entity separately, which doesn't change the spin value, but fundamentally alters the understanding of the

components, which in the new atomic model have a non-trivial wave topology with corresponding geometry of one single whole and its characteristics.

The atom is not the result of the fusion of particles through abstract forces acting between them. This method of describing the dynamics of the atom has proven untenable.

The atom, as a stable structure, is a unified construct as the result of spatial transformations in the act of generating matter from within through fibration, similar to how a cellular biological organism is generated through the fibration of DNA strands. This is a universal method, and it is precisely in this method that the natural actualization of those interrelations and the forces based on them occurs, preserving this structure as a holistic system-formation. No abstract forces with attempts to explain them can create an atom or a stellar-planetary system as a unified whole, just as it is impossible to create a biological object by compressing cells into organs, or organs into a whole organism. These structures are created through the process of generation from within through bifurcation with doubling, which is universal and **occurs initially in the quantum world**, then in the biological world, and then in the macrocosm.

The atom is a stable quantum-mechanical system with a wave-like rhythmodynamics of vital activity, conducting quantum exchange with the Quantum Medium and maintaining the stability of matter, as well as entering into chemical interactions with other atoms based on frequency-vibrational characteristics. During their activity, atomic dipoles perform continuous and unceasing oscillations, releasing and absorbing quanta through the atomic membrane; in other words, they carry out the process of **quantum breathing and quantum symbiosis with the Quantum Medium.** In the current paradigm of physics, this is explained by virtual electrons or photoelectrons. The need for new names is dictated by the fact that these emitted formations have no direct relationship to the components of the intra-atomic structure. These are quantum atomic radiations. And the geometry of the quanta emitted by an atom is the same nontrivial topology, since that is what emitted has a shape determined by the geometry of the emitter, and the emitters are atomic non-trivial dipoles.

The overlapping understanding of the essence of electrons as intra-atomic "particles" and the essence of electrons as quantum radiation occurred at the birth of quantum mechanics and the interpretations given to the experiments conducted at that time by J.J.Thomson and E. Rutherford (Geiger-Marsden).

I have made a kind of forced march to the origins of quantum science. In this return to the very beginning, I have revised the interpretations of these experiments and provided new explanations for them based on the proposed new wave model of the atom. [31][88][92]

I have also given other interpretation to a recent experiment (2013) in which laser radiation impacts a hydrogen atom. [63]

In this experiment, the results are explained based on the Copenhagen Interpretation and are aimed at confirming it. Nevertheless, the proposed new approach to the structure of the atom based on geometry of Möbius strip allows us to look at the results from a different perspective and based on the non-trivial topology of the wave dipole model of the atom. [92] [38]

If we consider the atom outside of this experiment, then the sub-micro-quantum flash is constantly present around the atom (Fig. 15), not as a random or probabilistic phenomenon, but as a result of the atom's precisely synchronized and stable wave rhythmodynamics, reflected by its line emission-absorption spectrum. [38] In the experiment [63], the intensity of the flash depended on the degree and duration of exposure to laser radiation, which induced a more

intense response from the atomic radiation in the form of a flash of the emitted quantum, which in the experiment was called a photoelectron.

Given the above, we can say that the nontrivial topology of the Möbius strip reveals Nature's secrets both in the atom's construction and in its internal structure, which remains planetary and is fractally similar to the structure of the stellar-planetary system. This was and remains the correct line of thought.

However, on the particle paradigm and with the introduction of additional postulations, further development of the planetary model presentation did not justify itself. It contradicts the laws of electrodynamics and does not correspond to line spectra of atoms. One can defend this model, created on particles by the authorities of that time.

But then I will ask the most important question regarding this mode. How is the combined functioning of the growing number of intra-atomic "particles" indicated by the Periodic Table of Atomic Elements synchronized within an atom? What is the principle of the overall synchronization of all particles in the atomic structure? The answer is simple if the atom is the result of the process of generation through the bifurcation of a magnetic monopole with a doubling of its framework parameters. Actualization of the gravitational balancing interrelationship automatically achieves dipole balance; actualization of quantum entanglement synchronizes all dipoles instantly, since they were all in the same magnetic monopole system. There is no need for unnecessary postulations.

Unlike Bohr-Rutherford's previous particle model of the atom, the proposed planetary model of the atom based on the non-trivial topology of wave magnetic dipoles finds its correspondence with line spectra, can point to new ways of obtaining energy, and provide many other comprehensive explanations of the structure of matter.

The new atomic model on non-trivial topology may be of great importance for a better understanding of natural phenomena, for the creation of new technologies, opening up new prospects for the design of new electronic devices through geometric engineering, as well as for describing aspects of quantum geometry, the tool of which is the creation of a kind of topographic map of the movement of the wave function in a matter when the effect of a magnetic field on it changes.

"A nontrivial topology always implies a nontrivial quantum geometry, since topology is also related to the properties of the wave function." [102]

As a result, the geometric approach based on Möbius strip topology brings together the structures of the micro- and macro-worlds, which share a common universal "Center-Periphery" scheme and the same structural interrelationships: gravity and quantum entanglement. Gravity is responsible for the dipole interrelationship between a peripheral object and the Center, and quantum entanglement is responsible for the interrelationship of all dipole objects in the system's formation into a single topological node, which acts as the Center-Nucleus.

After applying Möbius strip geometry to questions of atomic structure and, fractally, to the structure of stellar-planetary systems, we will return to magnetohydrodynamics, to well-known hydromagnetic dynamo models, and build interdisciplinary bridges.

As mentioned above, the main hydromagnetic dynamo models proposed by H. Alfvén and Ya. Zeldovich are based on an initial magnetic loop in a torus-"doughnut" geometry, which does not include an inverse 180-degree reversal. [65]

I have proposed a hydromagnetic dynamo model based on an initial loop with an inverse and a method for bifurcating such a loop along the Möbius curvature line with doubling of the magnetic flux. [93][96]

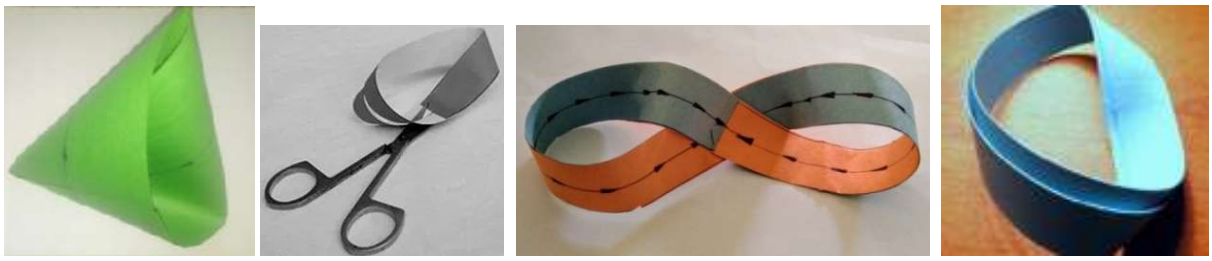


Fig. 18. Möbius Monopole, 1st phase of fibration, Two-loop Möbius Dipole in two states – lemniscate-eight and double pseudoring.

As is already clear from the set of illustrations (**Fig. 18)**, this model corresponds to topological transformations of a magnetic dipole from a "proton-electron" state to a "neutron" state Fig. 16 and Fig. 17. And here it becomes clear that the process of a self-generating hydromagnetic dynamo with geometric transformations based on the Möbius strip topology is the physics behind the formation of atomic elements in the bodies of stars and planets. And the transformations of magnetic dipole loops from one state to another demonstrate constant convective processes involving "proton-neutron" transformations. [93][96]

There is a theoretical proposal for stellarator designs that asserts that "flows of conducting fluid along a Möbius strip and its associated surfaces are hydromagnetic dynamos, meaning they can generate an exponentially growing magnetic field from an infinitely small “embryo” (seed)." [64][65]

As described in the proposed concept [89][90][91][92], such “embryo” in Nature are units of the Quantum Medium matrix. These are dynamic magnetic monopole loops in the form of a Möbius strip geometry, which create both the necessary level of medium turbulence and serve as the basis for the emergence of the hydromagnetic dynamo phenomenon, which manifests itself in the collective macro-effect of the bifurcation of magnetic monopole loops with a doubling of the magnetic flux and the formation of baryonic matter.

The theoretical proposal [64] points to the creation of a swirling flow of Möbius configuration due to the geometric shapes of the stellarator equipment, the toroidal shell of which should be rotating, not stationary. The authors also note that the creation of a plasma flow in the form of a Möbius strip using the geometry of the equipment itself eliminates the disadvantages associated with stellarator installations with divertors.

As can be seen, the proposed technical implementation of the authors' original idea [64] is fully consistent with the format of the concept I proposed. The most complex issue for the theoretical proposal [64] remains the question of geometric transformations. Nevertheless, much depends on the goal – whether to obtain only energy release or to synthesize atomic elements.

The described new scheme for doubling magnetic flux in the magnetic loop fibration method builds an interdisciplinary bridge between hydromagnetodynamics and quantum mechanics, as well as between biology and magnetohydrodynamics. The logic of analogies suggests that DNA is nothing more than a "**biological dynamo**," which, according to a universal doubling scheme, generates cells that, according to a predetermined algorithm, are structured into a complete organism.

To these interdisciplinary bridges it is worth adding two more historical facts associated with the names of Ya. Zeldovich and P. Dirac. Ya. Zeldovich, using a trouser belt twisted twice, demonstrated his famous topological trick with a magnetic figure-eight loop from his model of a hydromagnetic dynamo at an international symposium on fluid mechanics [114].

This figure-eight loop in Zeldovich's model is a consequence of transformations in the original magnetic loop, which is considered in the field of magnetohydrodynamics as an infinitesimal magnetic “embryo” in the matrix of the Quantum Turbulent Cosmic Medium.

This same double-twisted trouser belt, known as the "Dirac belt trick," was also used by P. Dirac to demonstrate the spin of fermions. But this spin, as demonstrated above, belongs entirely to the dipole magnetic loop in the configuration of the same "figure eight," which was proposed as the basic element in unified physics for the "proton-electron," formed from the same “embryo” of the Quantum Medium, named the “magnetic monopole”.

Both belt tricks, at different times and in different areas of physics, proved to be quite effective geometric visualizations and entered the history of science as vivid images, demonstrating the same magnetoelectric essence – the basic dipole element of Nature, which is embedded both in the algebra of P. Dirac's relativistic equation and in the geometry of Ya. Zeldovich's "figure eight."

In P. Dirac's equation, this is a description of the basic element as an interconnected two-component "particle" originating from a magnetic monopole, and in Zeldovich's "figure eight" this is a way of forming the same “particle” from the same initial magnetic loop-monopole, that is, essentially from the magnetic "Dirac monopole", which, as P. Dirac believed, should take place in the Nature of things. This is a striking example of how a geometric approach based on the nontrivial topology of the Möbius strip brings various areas of physics to a **common denominator**.

I believe that the applications made sufficiently demonstrate that the geometry of the Möbius strip and its topological properties satisfy the criterion of elegance both in its form and in the way it provides answers to intractable questions in theoretical physics.

I will cite some historical facts that are also worth noting, based on their simultaneity. The simultaneous discovery of the geometry of the Möbius strip by K. Listing and F. Möbius in mathematics was recorded in 1858. It was during this period, simultaneously with this discovery, that J. Maxwell (1831-1879) developed his theory of electromagnetism based on the concept of dynamic rotating "wheels" in the structure of the supporting cosmic medium, and W. Clifford (1845-1879) formulated his geometric approach to the structure of the supporting medium, leaving behind the geometry of "Clifford parallels," on which the "wheels" rotate.

The next fact, a hundred years later, is that the geometric image of the Möbius strip was visited by W. Pauli (1900-1958), and he was also close to revealing the secret of bifurcation with doubling precisely during the period when a group of researchers was working on revealing the secret of the DNA structure (geometrically arranged on the same Clifford parallels), achieving the goal in 1953. Other facts can be added to these historical facts, but these are the ones that frankly speak in favor of the fact that there is a scientific prehistory that preceded the current period, when the geometry of the original magnetic loop with inversion on the non-trivial topology of the Möbius strip reveals the secrets of nature on a larger scale both in the structure of matter itself and in the production of new materials using this same geometry. [100][110][122]-[142]

Applying Möbius strip geometry to theoretical questions of physics, I have also proposed a new visualization of the Earth's magnetic fields based on the Möbius dipole, positing that the Earth's center is not occupied by a metallic core, but rather by a unique quantum generator in the form of a functioning hydromagnetic dynamo, compressed by a dipole gravitational tensor, which injects and converts liquid superconducting magneto-plasma into baryonic matter and continually replenishes the planet's matter, producing the chemical elements necessary for life. A

diagram of the magnetic field lines is presented in [93][96]. In this regard, the planet has a certain percentage of its growth, similar to the growth process of biological organisms.

This new proposal for magnetic field lines also provides an explanation for the previously unexplained fact of the Earth's **counterclockwise rotation**. [93][96]

The interdisciplinary bridge between quantum science and biology, begun above, can be further developed by drawing the following analogy based on the topological properties of Möbius strip geometry. Just as magnetic dipoles are potentially located within the same quantum system of a magnetic monopole and remain quantum entangled during the magnetic monopole's fibrations and the formation of a intire connected atomic structure, so too are the cells of a growing biological organism initially located within the same quantum system of the maternal cell's DNA and remain quantum entangled and synchronized during DNA fibrations.

In this regard, the property of Möbius strip geometry to form topological interrelationships is the basis for instantaneous automatic synchronization between all generated objects that make up a single, coherent organism. The DNA structure has the same topology as the magnetic monopole and magnetic dipole described above. As a result, our entire biological organism is built and synchronized on the fractal synthesis of a single geometry with inversion: the circulatory and nervous systems, the digestive system, brain function and the control of our gait, vision, – everything follows the same intersecting pattern.

The results of research by Yu. A. Arutyunov, a leading researcher at the Russian Federal Scientific Clinical Center for Sports Medicine and Rehabilitation and who studies medical issues and the mathematics of the Möbius strip, demonstrate that the cardiac myocardium unfolds into a "thick, curved-twisted" Möbius strip. He described the application of the results of a study on transverse and longitudinal dissection of the Möbius strip in cardiac surgery and created a topological description of the cardiovascular system and a topological representation of the heart as a duplex sphere. The results of these studies have practical significance for cardiac surgery. [99][90]

The logic of universal uniformity leads to the conclusion that the fundamental processes currently being studied and sufficiently well in biology are **equally inherent in the quantum realm** and have their place there – these include **quantum respiration, quantum metabolism, and quantum symbiosis**, as well as the **generation and growth of matter through bifurcation with doubling.**

By revealing the secrets of Nature in individual fields of knowledge, Möbius strip geometry builds interdisciplinary bridges between quantum mechanics, biology, magnetohydrodynamics, chemistry, medicine, astrophysics, cosmology, quantum geometry, and mathematics, demonstrating unified universal patterns, since our Universe is a single living organism in which all processes at all levels proceed fractally and according to a single template (Image and Likeness) based on the original complementary interrelationship in the phenomenon of magnetism. It is precisely with this approach to questions of physics as the Nature of things and physics as a science that we will be able to achieve the **true breakthrough** we speak of and expect.

I believe I have realized the opportunity afforded to the reader in Professor Päivi Törmä's essay to speak my mind and share something new.

But my imagination doesn`t stops here, since the research I've proposed logically leads to the conclusion that the application of Möbius strip geometry and its topological properties to the aforementioned questions of theoretical physics yields a result called a **monistic conception** on one unified basis, therefore it has a fundamental character.

In this monistic conception, the observed effects or phenomena of the micro-, macro-, and mega-worlds are explained from the perspective of the original principle of complementarity and its universal template of duality, expressed by the geometry of the Möbius strip. This applies primarily to the structure of the Quantum Medium itself – its matrix structure and its physical magnetic essence, which creates a universal type of torsion. And then, it applies to all objects in the medium, small and large, generated by it.

Consequently, the concept is developed from a single fundamental entity – a quantum-mechanical unit of the matrix structure of a medium with a distinct nontrivial topology, a magnetoelectric framework, and the dynamics of two-cycle motion based on magnetism, which is the physical embodiment of the principle of complementarity.

Using the nontrivial topology of the Möbius strip, the initial quantum-mechanical unit of the matrix of the Quantum Medium – the magnetic monopole – is examined. Based on this, a particle of baryonic matter (atom) is described as a derivative of this initial elemental.

In the fibration method, the magnetic monopole is geometrically transformed and forms the basic element of nature for the formation of matter – a magnetic dipole with the actualization of the external magnetic field, gravitational interralationship, charges, and mass. The mutually inverse geometric transformations of the magnetic dipole's states determine the structure of the wave components of the atom, the "proton-electron" and "neutron," as well as the atom itself as the smallest particle of matter.

All the characteristics of such a particle are derived from the geometric parameters of the magnetic monopole, which in this regard serves as the framework. Due to the topological properties of the magnetic monopole, the magnetic dipoles obtained by fibration remain topologically linked into a single node, that is, they are linked by quantum entanglement.

The actualization of system-forming interrelationships, namely gravity and quantum entanglement, the interrelationships themselves, the interactions, and the forces acting on them, are equally inherent in the structure of both the micro- and macro-worlds, which is what constitutes their universality. All of this can become a rather elegant mathematical implementation based on the nontrivial topology of the Möbius strip and its topological properties.

“The true answers must undoubtedly come from the incorporation of the gravitational force. At first sight it may seem difficult to believe that such an extremely weak force could cause so much havoc in a theoretical construction such as the Standard Model. The point is, however, that if gravity really corresponds to the curvature of space and time, as we must conclude from the successes of Einstein’s theory of General Relativity, then Quantum Mechanics predicts quantum fluctuations in this curvature that, at the tiniest distance scales, grow out of control. This means that either gravity theory, or Quantum Mechanics, or both, must be replaced by some superior paradigm when we wish to describe physics at distance scales smaller than 10^{-33} CM. Whatever paradigm this would be, it is likely to entirely reform our understanding of the fundamental interactions, answering all our present questions at one stroke”. [87]

In November 2020, Quanta Magazine published Natalie Wolchover's article "**What Is a Particle?**" [106], which covered the scientific aspects of this question and the general consensus was that science cannot yet provide a definitive answer. In June 2026, Natalie Wolchover returned to covering the topic of particles in Quanta Magazine, but with a different question for scientists: "**How Many Elementary Particles Are There, Really?**" [106] The expected certainty again failed to materialize.

Today, the number of mathematically calculated particles is many times greater than the simplicity allowed by Nature, inconsistent with its rules, and violating the principle of "Ockham's Razor." As the publication demonstrates, this quantitative excess is reaching a critical point of understanding.

In this regard, the geometry of the Möbius strip helps create a logical path to determining what exactly should be called the elementary minimal particle of matter, and what should be classified as quantum formations as radiations that have a short lifespan and are objects of the Quantum Medium and the result of its activity. Specifically, they are products of quantum respiration, quantum metabolism, and symbiotic processes in the Quantum Medium, as well as the product of intra-atomic activity in the quantum symbiosis of the atom with the Quantum Medium.

These quantum formations are emitted and absorbed, but have no direct relation to the structure of the atom as its constituent parts. Understanding the atom as composed of particles is a stage in scientific knowledge from which we must emerge, as interpretations of experiments are conducted through the prism of this lensing. The obvious in experiments can slip from the focus of experimenters, giving way to interpretations that fit existing explanatory patterns, which hinders clarity of understanding.

The integrity of the atom's structure can be destroyed, resulting in a set of individual formations from which the reverse process of atomic formation is impossible, since the atomic components and the interrelationships between them are actualized in the process of generation, – that is, the fibrations of a magnetic monopole and the formation of interconnected magnetic atomic dipoles. Will studying the fragments of atoms broken at colliders lead the scientific community to the primordial knowledge it seeks?

Successful experiments in the new scientific field of quantum geometry are now opening up the possibility of uncovering the structure of matter. Consequently, the time is not far off when improved research methods and ongoing experiments will help us draw the same conclusions about atomic structure that are theoretically proposed and presented in this essay.

A bold fantasy? Perhaps. But, oddly enough, the history of science is replete with examples of daredevils who came up with new ideas and initially labeled dreamers who later became Nobel laureates and mentioned this in their autobiographies.

As can be seen from the results of the applications made, using the geometric approach of the monistic concept, the monistic description gives simplicity and efficiency. All physical parameters originate from a single, unified, universal framework, are its derivatives, and are therefore automatically coordinated and synchronized. This is one of the most important understandings in the concept of a Universe interconnected fractally and holographically, or, in other words, formed according to a single Image and Likeness.

The proposed monistic concept takes as its starting point the geometry of space-time, as well as an explanation of physical interactions and forces based on the topological properties of this geometry, mediated by the original principle of complementarity, physically embodied in magnetism and laying the physical foundation for the dynamics and mechanics of motion. Consequently, such a monistic concept, starting from the geometry of the structure of the medium itself, which mediates the geometry of quanta and the geometry of atomic structure, is a concept of the **geometrization of physics**. [104][105] From the above, a logical conclusion follows that the geometrization of physics can be achieved by taking into account general fractal-like patterns based on unified fundamental interrelationships mediated by the non-trivial

topology of magnetism as the material embodiment of the combination of two mirror-asymmetric flows of energy movement in natural phenomena.

This **geometry of combination** lies at the very foundation of the quantum world and governs all phenomena. It is initially represented by the geometry of the Möbius strip, which conceals the principles of interaction of everything existing in the Universe. It has cosmological significance and it is that "Ariadne's thread" that can connect on a single basis the achievements of the Theory of Relativity and Quantum Mechanics. "The rest are details."

Over the past nearly 100 years, it has not yet been possible to achieve this goal using an algebraic approach. What were the reasons? What have the authorities said and continue to say?

The reason science is experiencing these difficulties undoubtedly lies in the realm of philosophy, as well as in the realm of quantum foundations – the starting points for reasoning and interpreting experiments. And most importantly, the fact that the form of a quantum phenomenon has not yet been defined in quantum physics, and accordingly, there is no figurative representation, which yields the corresponding result. [66][67] [91]

In his essay Academician G.I. Shipov notes the following: "From the very beginning, quantum theory lost its figurative thinking, and the results of experimental calculations were probabilistic. This theory was critically received by A. Einstein and other theorists with a physical perception of reality, which is why A. Einstein, E. Schrödinger, and some other theorists belonging to Einstein's school politely asserted that quantum theory is incomplete." [68]

But that's history. What about the current situation?

In recent years, renowned modern physicists and venerable authorities such as G.`t Hooft, R. Penrose, and L. Susskind have argued that quantum theory is not only incomplete but also moving in the wrong direction. [68][69][70][71][72]

Also, a survey conducted by the journal Nature and published in July 2025 [73] shows that physicists' opinions regarding the state of the quantum science vary widely.

“Quantum mechanics is one of the most successful theories in science — and makes much of modern life possible. Technologies ranging from computer chips to medical-imaging machines rely on the application of equations, first sketched out a century ago, that describe the behaviour of objects at the microscopic scale.

But researchers still disagree widely on how best to describe the physical reality that lies behind the mathematics, as a *Nature* survey reveals”. [73]

The journal conducted its largest-ever survey. Emails were sent to more than 15,000 researchers whose recent work focused on quantum mechanics. The responses, which exceeded 1,100, revealed how widely researchers' opinions differ on the most fundamental features of quantum experiments.

“The Copenhagen interpretation’s philosophical underpinnings have become so normalized as to seem like no interpretation at all, adds Robert Spekkens, who studies quantum foundations at the Perimeter Institute for Theoretical Physics in Waterloo, Canada. Many advocates are “just drinking the Kool-Aid of the Copenhagen philosophy without examining it”, he says. Survey respondents who have carried out research in philosophy or quantum foundations, studying the assumptions and principles behind quantum physics, were the least likely to favour the Copenhagen interpretation, with just 20% selecting it. If I use quantum mechanics in my lab every day, I don’t need to go past Copenhagen,” says Carlo Rovelli, a theoretical physicist at Aix-Marseille University in France. But as soon as researchers apply thought experiments that probe more deeply, “Copenhagen is not enough”, he says.” [73]

These are questions of quantum physics. What about the Theory of Relativity?

At the very beginning of the first stage of the geometrization of physics there is an unresolved problem of the “particle” in the General Theory of Relativity [47] and the imperfection of its geometric image.

As can be seen from the work [47], calculations demonstrated that if physical space is considered as a set of two identical sheets (membranes), then an elementary "particle" of matter is a "bridge" connecting the two sheets. Schwarzschild's solution and its illustration (Fig. 19) were used as a basis for representing the particle as a tube-bridge (Fig. 20) across the fifth dimension, connecting two 4D sheets of parallel spaces.

From the general logic of the proposed construction, it naturally followed that atoms of matter, as systems consisting of a set of such particles, should be represented similarly – as a conventional solution to field equations corresponding to a space consisting of two identical sheets connected to each other through a multitude of "ER bridges."

Furthermore, the facts of history are such that the authors were unable to solve the problem of the multitude of particles, which they left for the future. They also failed to incorporate the experimentally established effects of quantum physics into this two-sheet conception of space and matter. It is precisely because of the undeveloped geometric representation of the original spatial unit (the elementary “particle”) that both Einstein’s theory and quantum science were left without a figurative reference point. [92][95]

As demonstrated in the proposed monistic concept, the essence of the geometric representation of a "particle" is that a particle of baryonic matter – an atom – is derived from the original magnetic elemental, which is represented not as two sheets, but as a single spatial sheet. The element connecting the two sides of this sheet is a topological 180-degree turn, simulating a kind of tube, if we consider the pictorial element. This inverse, which forms the initial duality and reduces the two sides of beingness into one topology, is that **relativistic particle confined to the non-trivial surface** and at the same time it is an **elementary geometric form of space-time motion**, which is based on the complementary property of magnetism. (Fig. 21)

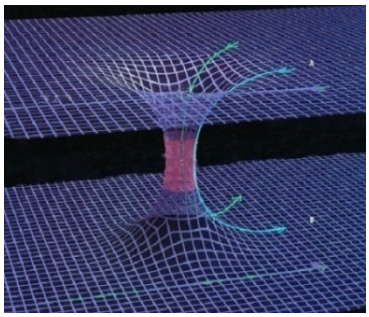


Fig. 19 Schwarzschild geometry.

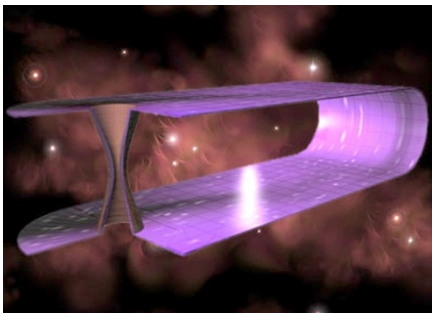


Fig. 20 Einstein-Rosen bridge.

Fig. 21 Möbius strip.

This rotating vortex form of motion has long been present in one form or another in various mathematical propositions: as phase changes of oscillations in the "Pauli square," as a bispinor in P. Dirac's relativistic equation, in the twistor in R. Penrose's theory, in A. Kitaev's staircase, in Joe Polchinski's vortex operator, and in E. Witten's loop operator and others. All that the elements of this form needed was to be geometrically collected into one monistic concept, offering an updated basis for creating a generalized theory.

A simple example can demonstrate that the geometric approach points to a shorter, more direct, and more efficient path, providing visualization and a framework for mental movement.

Everyone is familiar with the algebraic representation of the ratio of the sides of a right triangle as the equation $\mathbf{a^2 + b^2 = c^2}$

To prove this equation, a geometric approach – the Pythagorean theorem – is used. And it's clear that even a child can create an incredible number of known and unknown, as well as the most intricate, geometric figures from such a triangle, including the Penrose tiling, thereby constructing a kind of triangle Theory of Everything based on a single basic geometric figure – the triangle – by varying the ratios of its sides and, accordingly, the angles of inclination.

Now imagine that there is no image of the triangle, only an equation, and you don't know what geometric object it describes. How much time and how many specialists would it take to construct the same triangle Theory of Everything, but from algebraic expressions?

I believe that many have thought about the fact that the geometric format can help to lead everything to significant simplifications. The problem of geometrizing physics has been solved algebraically for about a hundred years, with many complications, using various types of mathematical spaces with regauging, metric manifolds, theories of fibered spaces, string theories up to the 11th dimension, and more. There's no doubt about it – all of this is beautiful mathematics, worthy of attention, respect, and admiration. And some stages of geometrization process have been completed with the participation of brilliant minds in physics and mathematics.

But at the current stage, the issues of geometrization of physics require an understanding of that **nature is structured quite simply**, and that only our thinking, in its quest to understand the true foundations, eventually complicates everything. In this regard, intuitive insights must have their place; they are valuable and always extremely necessary.

After receiving the Yuri Milner Prize, in an April 2025 interview with Scientific American magazine, Nobel laureate G.`t Hooft noted:

“Quantum mechanics is based on a mathematical method used to describe very ordinary physical effects. I think the physical world itself is a very ordinary one that is completely classical. But in this completely classical world, there are still too many things that we don’t know today; there are steps we’re basically missing on our path to deeper understanding”. [69]

“…you have to start from the beginning, like I said about quantum mechanics. … we need to step backward first, and that’s always my message in science in general: before you understand something, just take a few steps back. Maybe you have to make a big march back, all the way back to the beginning”. [69]

“I’m talking about steps that would exploit the fact that the whole world is very simple and straightforward. The trouble is, the world still appears complicated to us now, which is why we’re in this situation”. [69]

“I think it is natural for science that we cannot always have an infinitely continuous stream of discoveries and new insights. There will be periods, like the one we are in now in particle physics, where things seem to be quieter. But I think history shows it won’t always be like this. There will be more fundamental findings that will again change our views on what is going on”. [69]

“We see everybody sending their new ideas first to the preprint server arXiv.org and then to the journals to have them published. And in arXiv.org, you see thousands of papers coming in every year, and none of them really has this great, bright, new, fine kind of insight that changes things. There are insights, of course, but not the ones that are needed to make a basic new breakthrough in our field”. [69]

“I think we have to start thinking in a different way… think differently than your friends, and then you find something new!

The real reason there’s nothing new coming is that everybody’s thinking the same way! People don’t seem to want to make the daring new steps that I think are really necessary”. [69]

I believe that, on the wave of this bold step taken by me to visualize the quantum world with the help of the proposed geometric approach, I could complete my new thoughts and pass the baton to someone else who has different experience and different ideas to help make a long-overdue breakthrough in physics.

"Geometry is celebrated for the very fact that, having borrowed so few principles from outside, it achieves so much." **Isaac Newton**, "Mathematical Principles of Natural Philosophy."

"Geometry exists precisely for this reason: to ensure that knowledge is not divorced from spatial contemplation." **P.A. Florensky** [67]

"Geometry is that field of knowledge that lies between abstract mathematics and reality. It is the mediator that resolves the contradiction between knowledge and error. But if it is completely algebraized, then such geometry takes a person beyond the spatial perception of concrete reality and immerses them in an abstract-virtual reality in which literally everything is possible, including that which is impossible in reality." **P.Ya. Sergienko** [75]

“The fundamental nature of a theory is determined by the degree of its penetration into the mysteries of nature and is not determined by the cumbersomeness of its mathematical apparatus, but by the degree of its connection with materialistic philosophy and its proximity to the boundaries of the knowable.” **Kuligin V.A.** [117]

«Of all the services that can be rendered to science, the introduction of new ideas is the most important». Nobel Prize-winning physicist **J. J. Thomson**. [118]

«The highest mission of physicists is to obtain those universal basic laws, upon which the world system can be established by a simple deductive method. There is no logical path to these laws; only through an intuition based on a resonance understanding of experience can these laws be obtained». **A. Einstein**, a Speech Delivered at the Celebration of Planck's Sixtieth Birthday (1918). [116]

Afterword to the essay.

The self-consistent concept I've proposed falls under the category of intuitive insight (revelation). Therefore, there's no need to search for the stepwise structure upon which scientific works are constructed using the inductive method, namely, from the particular to the general. Intuitive insight in this particular case concerns the deductive method – from the general to the specific. That is, the author grasped the common unified basis and applied it to specific questions.

The applications required an understanding of whether there were authors in the history of science who hypothetically predicted or made related or parallel proposals. These appear in my subsequent works as supporting arguments, but the concept was not built on them. It wasn't initially based on these facts, and this is reflected in the first edition of my monograph, "Substance. Atom. Theory of Everything." The subsequent editions – the 2nd, 3rd, and 4^{th} – are supplemented by the facts identified in my internet search. While searching for related proposals, I realized that the geometric format as a coherent monistic concept had not yet been proposed. In the process of creating applications, searching for evidences and conducting relevant experiments, subsequent works were created, which are published on my personal page. [112].

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