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On the Unification of the Foundations of Physics Based on the Ideas of Algebra and Arithmetic

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ABSTRACT

Historically, scientific theory of knowledge relied on the deductive method of thinking, established in Euclid's geometry. Since the era of Descartes, there has been an evolution in the method of thinking based on the principles of algebra and arithmetic. This study analyzes the contribution of algebra and arithmetic to modern scientific philosophy, demonstrating their significance in forming the universal foundations of theoretical physics.

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Investigation of the Problem of Unification using the Ideas of Geometry and Analyzing its difficulties

As is well known, Einstein, who in his work [1] wrote: 'We revere ancient Greece as the cradle of Western science. There, for the first time, a miracle of thought was created — a logical system, whose theorems flowed from each other with such precision that each of the propositions it proved was absolutely indis-putable: I speak of Euclidean geometry...', highly valued the basic ideas of geometry, as they laid the foundation for the deductive method of thinking. He also highly appreciated the ideas developed by Gali-leo, who, in turn, highly valued the ideas developed by Archimedes. Einstein also highly esteemed the ideas developed by Newton, who, in turn, highly esteemed Galileo's ideas. Therefore, Einstein wrote in [2] that: '...Galileo is the father of modern physics and indeed of modern science in general'. In my opin-ion, of all the papers published by Einstein on the problems of relativistic theory, the paper [2] from 1953 holds particular value. In this paper, in §5 titled 'General Remarks Concerning the Concepts and Methods of Theoretical Physics', he clearly articulated his views on the essence of the fundamental ideas of theoret-ical physics, writing:

"The aim of physics can be formulated as follows: to provide an objective (in principle, complete) description of physical systems and to establish the structure of laws connecting the concepts in-volved in this objective description. By 'objective description', we mean a description that can claim validity and meaningfulness without reference to any acts of observation. The only differ-ence between physical theories and mathematical constructions lies in the following. A physical theory must provide a substantially complete and reproducible correspondence between the reality described in certain terms and direct sensory perceptions. The question of how to establish this correspondence can only be resolved intuitively and cannot be expressed within the framework of a logically formulated theory."	(1)

Then he summarized the ideas present in his reflections with the following metaphor:

"One theory differs from another mainly in the choice of 'bricks' for the foundation, i.e., the irre-ducible basic con-cepts on which the entire theory is built."	(2)

Of course, he further elaborated on his understanding of the basic concepts, which he calls 'bricks':

1. "In classical theory (mechanics), such fundamental con-cepts are the material point, the force of interaction between material points (potential energy), and the inertial system (the latter consist-ing of a Cartesian coordinate system and a time coordinate). With our growing knowledge about the electromagnetic field, the concept of the field, considered as a second carrier of energy, was added to the basic concepts alongside the material point (substance)."	(3)

2. 'The special theory of relativity changed this scheme only in the sense that it had to include the "fact" (actually a hy-pothesis, based on a number of experimental facts, without which it seems impossible to manage) of the constancy of the speed of light into the structure of the inertial sys-tem. The theory further assumes that we can discard the concept of the material point and deal only with the field concept. This is related to the fact that the relativity of simultaneity makes it impossible to further maintain the concept of action at a distance and potential energy.'	(4)

3. "Even deeper changes in theoretical foundations were introduced by the general theory of rela-tivity, which completely discarded the concept of the inertial system. In previous theories, space, mathematically expressed by the inertial system, was considered as an independent element of physical reality. This element could be regarded as something absolute, as it determined the be-havior of point masses or fields, which themselves did not act upon it. However, in the general theory of relativity, the inertial system is replaced by a displacement field, which is a part of a unified field representing the only means of describing the real world ... "	(5)

After developing the foundations of the General Theory of Relativity in 1915, Einstein began working on creating a Unified Field Theory. His goal was to unify gravity and electromagnetism within this theory. It is also known that, parallel to Einstein, scientists such as H. Weyl, A. Eddington, T. Kaluza, O. Klein, and others were working on a similar task. However, as is well known, a complete solution to this problem was never found. At the end of his life, in 1955, Einstein summarized his thoughts on this matter in his work /3/, where he wrote the following: "It can be convincingly argued that reality cannot be represented by a continuous field. From quantum phenomena, it apparently follows that a finite system with finite energy can be completely described by a finite set of numbers (quantum numbers). This seems incompatible with the theory of the continuum and requires a purely algebraic theory to describe reality. However, at pre-sent, no one knows how to find a basis for such a theory."

On the Successful Solution of The Problem of Unifying the Fundamental Principles of Physics Using the Concepts of Algebra and Arithmetic

It is known that in his time, Descartes, laying the foundations of science and philosophy of the Modern era, proposed an idea that led to the creation of a system known as the Cartesian coordinate system. Des-cartes realized that if as a foundation.

for the theory of thinking	(6)

to lay

algebraic equations, arithmetic equations	(7)

and then solve the problems

a) of geometry; b) of kinematics; c) of physics	(8)

it would be possible in a more optimal way to develop the foundations

a) of theoretical geometry; b) of theoretical kinematics; c) of theoretical physics.	(9)

This, in turn, leads to the formulation of the fundamental equations of

a) algebraic geometry and arithmetic geometry; b) algebraic kinematics and arithmetic kinemat-ics; c) algebraic physics and arithmetic physics.	(10)

Therefore, Descartes understood that the development of the foundations (9) is only possible with a cor-rect understanding of the philosophical essence of the key results, namely 10a, 10b, and 10c. Given that algebraic and arithmetic equations (7) were adopted as initial results, this underscores the need for a deep understanding of the nature of algebra and arithmetic, as well as the essence of differential equations

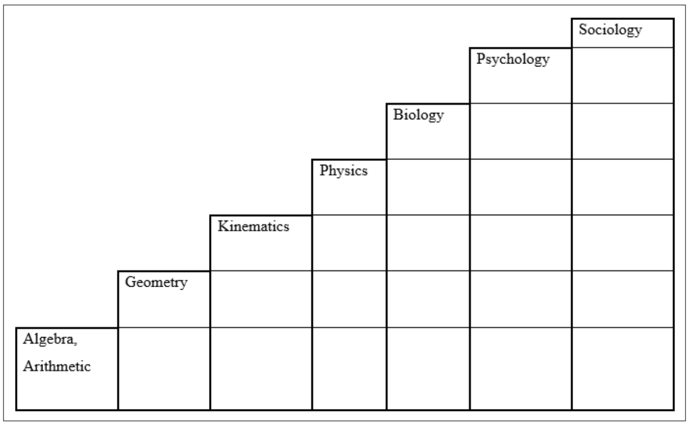
for a) one geometric point; b) one kinematic point; c) one physical particle.	(11)

Subsequently, the task arises to solve such equations for:

a) a set of geometric points subject to a relationship, the number of which tends towards infini-ty; b) a set of kinematic points subject to a relationship, the number of which tends towards infini-ty; c) a finite number of physical particles, whether subject to a relationship or not.	(12)

It is also necessary to consider the quantity and characteristics of the main objects when solving the equa-tions. It is important to emphasize that in the process of solving this part of the task, I utilized the possibil-ities of ideas based on the works of Descartes. In this regard, special attention was paid to his understand-ing of ideas, which can be systematized in a hierarchical order according to Scheme-1.

Scheme No. 1:



This means that after adopting algebraic and arithmetic equations (7) as the basis of the theory of thinking (6), it becomes possible to solve problems that go beyond the scope of geometry, kinematics, and physics (8), and also encompass the fields of biology, psychology, and sociology. Additionally, it should be noted that through the combined analysis of the ideas considered in Scheme-1, and the results obtained since the time of Descartes in various fields of science, it has been realized that theoretical physics has devel-oped results that can be systematized using Schemes-2 and 3:

Additionally, based on probabilistic physics, results are formed that can be integrated and evaluated using

Additionally, based on probabilistic physics, results are formed that can be integrated and evaluated using

Scheme No. 2:

			$\dot{q}_i = \frac{\partial H}{\partial p_i}, \quad \dot{p}_i = -\frac{\partial H}{\partial q_i}$ (13)
		Algebraic Kinematics (10c)	$\frac{\partial S}{\partial t} + H\left(q_i, \frac{\partial S}{\partial q}, t\right) = 0$
	Algebraic Geometry (10a)	Algebraic Geometry (10c)	$H\left(q_i, \frac{\partial S}{\partial q}\right) = E,$ $\Delta\psi + \frac{8\pi^2 m}{\hbar^2}(E-V)\psi = 0$ (14 а в с)
Algebraic equations, Arithmetic equations (7)	Arithmetic Geometry (10a)	Arithmetic Kinematics (10c)	?

Scheme No. 3:

			$\dot{q}_i = \frac{\partial H}{\partial p_i}, \quad \dot{p}_i = -\frac{\partial H}{\partial q_i}$ (13)
		Algebraic Kinematics (10c)	$\frac{\partial \rho}{\partial t} - [H\rho] = 0,$
	Algebraic Geometry (10a)	Algebraic Geometry (10c)	$[H\rho] = 0, \quad \rho_i = \exp\frac{F - \varepsilon_i}{kT},$ $\rho_{i,n} = \exp\frac{\Phi + \mu n - \varepsilon_i}{kT}$ (15 a,b,c,d)
Algebraic equations, Arithmetic	Arithmetic Geometry (10a)	Arithmetic Kinematics (10c)	?

Scheme No. 4:

				Molecular Sociology
			Molecular Psychology	
		Molecular Biology		
	Theory of the Structure of Matter			
Probability Theory				

Scheme No. 5:				Physico-Chemical Sociology
			Physico-Chemical Psychology	
		Physico-Chemical Biology		
	Physical Chemistry			
Theory of Probability				

Now, I find it important to note the following: in the process of deriving differential equations for cases 11(a, b), multidimensional spaces with a number of dimensions tending towards infinity were used. At the same time, in the derivation of the equations of algebraic physics (14 a, b, c) and (15 a, b, c, d) from the Hamiltonian equations (13), it was proposed to use 3N+1 and 6N+1 dimensional spaces. Thanks to this approach, it was possible to achieve results in the form of:

$$E_i = \alpha + k\beta_i, \quad \psi_i = \sum_{ir} C_{ir} x_r, \qquad (16)$$

$$n_{\dot{A}}^0 = \frac{n^0}{\frac{1}{n_{\dot{A}}} \exp\frac{\varphi - f}{kT} + 1}, \quad n_{\phi}^0 = \frac{n^0}{\frac{1}{n_{\phi}} \exp\frac{\varphi - f}{kT} - 1}, \qquad (17)$$

When analyzing the data, it is possible to enrich even the lowest and most extreme elements of Scheme-2 and Scheme-3 with content. These latest results find their logical application in traditional three-dimensional space, with the conclusions reached for (9a, b, c) also being successfully interpreted in the context of (12a, b, c), gaining meaning within the frameworks of:

a) quantum geometry; b) quantum kinematics; c) quantum physics.	(18)

Furthermore, these results have led to the conclusion that the work on the problem of unifying the foun-dations of physics has been successfully completed.

It is also widely known that significant results have been achieved in the field of the theory of the struc-ture of matter and physical chemistry, presented in the following form:

$$\text{a) } E = -\frac{me^4}{2\hbar^2} \cdot \frac{1}{n^2}, \quad \text{б) } 2\pi r = n\lambda; \qquad (19)$$

$$\text{a) } K = \frac{n_{AB}}{n_A \cdot n_B}, \quad \text{б) } \theta = \frac{bn_A}{1 + bn_A}. \qquad (20)$$

as proof of the main results. The results presented in forms (16) and (17) can be considered as a justifica-tion for the results (19) and (20), derived with the precision of probabilistic physics. Thus, taking these aspects into account, we can combine the results obtained using Scheme-2 and 4, as well as Scheme-3 and 5. Ultimately, this will lead to the realization of the existence of results that can be systematized using Scheme-6 and 7.

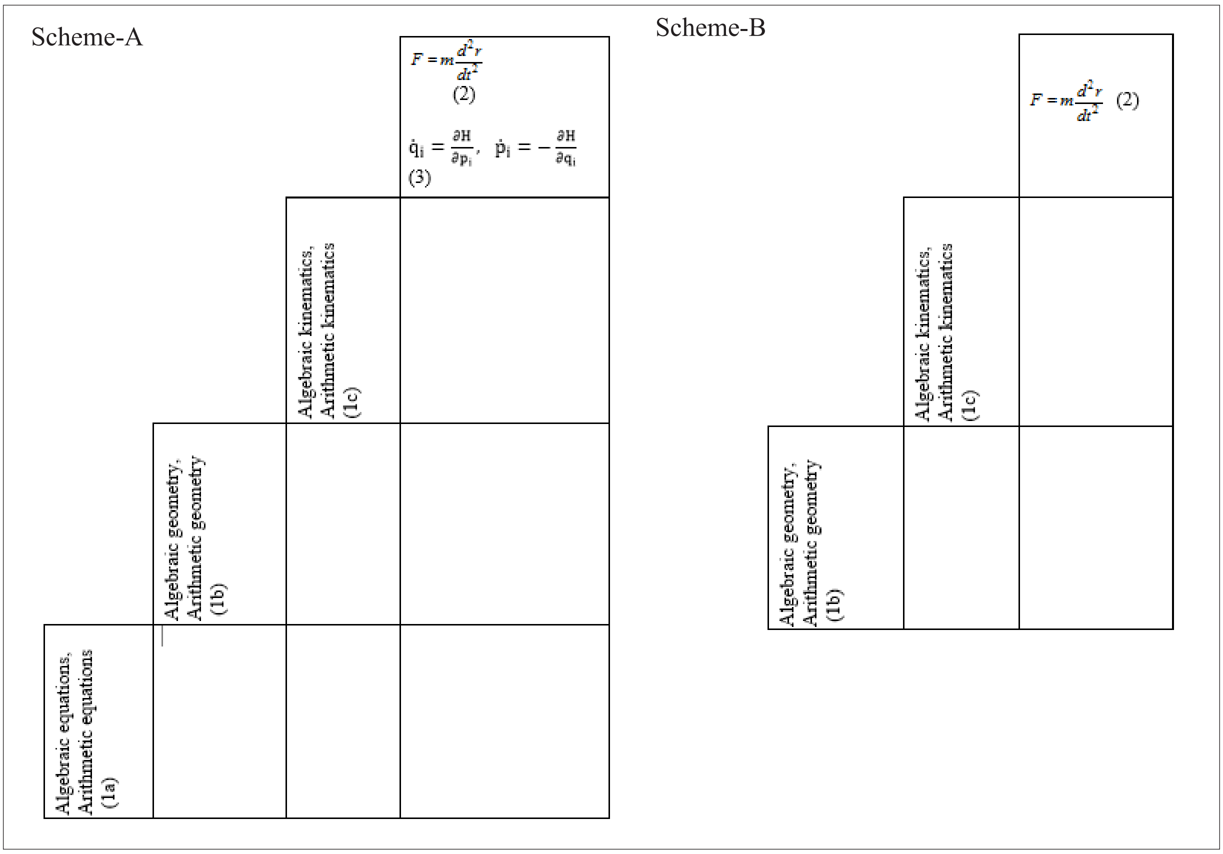
Scheme No. 6:

						Molecular Sociology
					Molecular Psychology	
				Molecular Biology		
			Algebraic Physics, Arithmetic Physics			
		Algebraic Kinematics, Arithmetic Kinematics				
	Algebraic Geometry, Arithmetic Geometry					
Algebraic Equations, Arithmetic Equations						

Scheme No. 7:

					Physico-Chemical Psychology	
				Physico-Chemical Biology		
			Algebraic Physics, Arithmetic Physics			
		Algebraic Kinematics, Arithmetic Kinematics				
	Algebraic Geometry, Arithmetic Geometry					
Algebraic Equations, Arithmetic Equations						

I want to emphasize the following: analysis shows that the results obtained in the process of solving the Hamiltonian equation for a set of particles subject to a relationship, considered in the construction of Scheme-2, can be viewed not only as elements of the basic theory of matter structure but also as part of a new variant of the theory of gravitation. The main differences between this variant of the theory of gravi-tation and the relativistic theory of gravitation can be identified based on the analysis of the results con-sidered in the construction of Scheme-A and Scheme-B:



In the first case, the main results were achieved by adopting (7) as the foundation (6) and then solving the problems (8). Consequently, the results (9) and (18) were obtained on the same basis, which can be con-sidered correct. In the second case, although the main results of theoretical geometry and kinematics were also correctly solved in the same way, the main results of theoretical physics were obtained differently. In this case, the main conclusions of the principle of relativity were adopted as results possessing the poten-tial of (6). Einstein, discussing the nature of the main equation of General Relativity (GR) obtained in this way, used a metaphor, comparing marble and wood. He believed that the strength of the left side of the main equation corresponds to marble, while the strength of the right side - to wood. Presumably, the greater strength of the left side of the equation is due to it being obtained in a way where (7) acts as (6). The lesser strength of the right side, likely results from its derivation in a way where the role of (6) is played by the results of the principle of relativity. Consequently, Einstein's thoughts, as expressed in (2), and Dirac's ideas, considered in the construction of Scheme-1, although similar in form, differ in content. If in the thoughts accounted for in 'Scheme-1', the roles of subject and objects characteristic of each field of science are considered correctly, then in thoughts (2) this part of the task is not disclosed.

Philosophical Analysis and Interpretation of The Essence of The Idea of "Gauge Theory"

It is known that Descartes' ideas about the Cartesian coordinate system led to the development of the foundations of analytical geometry [4]. This implied that the main objective becomes solving problems (8) based on an approach in which algebraic and arithmetic equations (7) are considered as initial results (6). This also required a correct interpretation of the philosophical nature of the results inherent in (10), as (7) were taken as initial data (6). Consequently, there arose a need for a deep understanding of the nature of algebraic and arithmetic results, expressed in (10), leading to the realization of the nature of differentiated equations obtained for (11). The next task was to solve these equations for (12). Note that the goal on the Cartesian path was achieved considering the ideas integrated into Schemes-2 and 3, leading to results (16) and (17) and the confirmation of results (19) and (20). Thus, with the attainment of these results, there was confidence that the development of the main results, long developed in the field of particle theory, was indeed successfully completed.

Now, I will outline the general contours of how the task of unifying the foundations of physics has been and continues to be solved based on the principle of relativity (Scheme-B), adopted as the initial basis (6). On this path, key results of the special (STR) and general (GTR) theories of relativity were achieved, con-sidered in the context of theoretical physics and, in particular, field theory. It is known that Einstein then began developing a unified field theory (UFT), the goal of which was to unite the results of the theory of gravity and the theory of the electromagnetic field. In the same period, Weyl also sought to solve this task. He realized that the results obtained by Einstein include the idea that

"...all known physical interactions fundamentally have a unified geometric nature - as effects of the curvature of space. "	(21)

Furthermore, Weyl came to understand that, as shown by the theory of relativity, the geometry of space-time becomes significantly more complex when the scale of observation changes. He argued that if appro-priate mathematical 'gauge' transformations are applied to account for these complexities, essentially the same equations could be used to describe both gravitational and electromagnetic phenomena. According to Weyl:

"If suitable mathematical-'gauge'-transformations are chosen to account for these complexities, then, in principle, the same equations could be used to describe both gravity and electromag-netism."	(22)

Weyl, recognizing the essence of the 'Brazil nut effect,' believed that this path could potentially solve the problem of the interrelation between gravity and electromagnetism. However, as is well known, he failed to achieve this goal, indicating the possible absence of certain key ideas. F. Dyson noted that after this failure, interest in gauge theory among physicists decreased, but in the mid-1950s, the works of Utiyama, Shaw, and Yang-Mills led to important results that laid the foundation for the standard model developed within the field theory framework. At the same time, scientists like Landau and Pomeranchuk, as well as some Western theorists, began to express doubts about the reliability of the results obtained based on quantum field theory, suggesting that the solution might be found in other approaches, such as the S-matrix theory. Nevertheless, soon field theory and gauge theory regained recognition thanks to the im-pressive results of the standard model.

In my opinion, the main reason Weyl failed to achieve his goals based on new ideas lies in the following: In 1928, Weyl did not pay due attention to the profound ideas inherent in the 'Brazil nut effect.' Had he realized the significance of these ideas for the development of theoretical physics, he might have come to understand the necessity of solving Hamilton's equation (13) for a set of particles, both subject to and not subject to constraints, leading to the formulation of equations (14) and (15). Such understanding could have opened a path to solving the problems of the interrelation between gravity and electromagnetism, as proposed in the theoretical derivation of Planck's equation [6]. Moreover, based on the results obtained from considering the chaotic motion of particles, progress could have been made in the field of physical chemistry. It is also important to emphasize that realizing these ideas could lead to the understanding that there are essentially two main forms of particle interaction, which can be achieved by solving Hamilton's equation (13) for particles subjected to external forces and for chaotically moving particles.

Traditionally, it is accepted that there are four types of fundamental interactions in physics. However, in my opinion, this view has formed because the main results underlying such conclusions were obtained in a context where the results stemming from the principle of relativity were taken as the basic assumption (6). A new perspective on the problem, suggesting only two main types of interactions, became possible when algebraic and arithmetic equations (7) were adopted as the basic assumption (6). This approach proved to be more productive, especially when the analysis was based on an absolute frame of reference, allowing for a complete and profound investigation of the obtained results.

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