From Space and Time to a Deeper Reality
as a Possible Way to Solve Global Problems

Galina Korotkikh∗ and Victor Korotkikh†

School of Information and Communication Technology
CQUniversity, Mackay
Queensland, 4740, Australia

To deal with global problems we suggest to consider complex systems not in space and time, but in a possible deeper reality, i.e., the hierarchical network of prime integer relations. Encoded by arithmetic through the self-organization processes the hierarchical network appears as the mathematical structure of one harmonious and interconnected whole. Remarkably, the holistic nature of the hierarchical network allows to formulate a single universal objective of a complex system defined in terms of the integration principle. We propose that by the realization of the integration principle the Earth system could be transformed to become an integrated part of a larger system with more capacity and energy to sustain life. Significantly, based on integers and controlled by arithmetic only the hierarchical network has a unique potential to provide an irreducible common ground fully trusted by different parties and helping to reveal a higher collective purpose.

PACS numbers: 89.75.-k, 89.75.Fb, 89.65.Gh

I. INTRODUCTION

Paradoxically, in the world experiencing rapid progress in science and technology the understanding of growing problems is limited. They become numerous and affect us all. For example, the recent financial crisis has sharply revealed that the global financial system shaped and entangled into a complex entity lacks the clarity. Moreover, the longtime debates on the climate change have not resulted in a comprehensive agreement. There is still no common understanding of this complex problem, where experimental evidence can convince different parties. Despite that, we can hope for a better future.

An approach aiming to provide a solution may lead to an interesting speculation. To be of practical interest it has to meet strong requirements. In particular, the approach has to be able to explain the observed phenomena and at least be based on an irreducible foundation. Once the approach is in agreement with observation and calls for a collective action to solve global problems, the proposed action could be accepted and fully trusted by different parties. In this context we suggest to consider complex systems not in space and time, but in a possible deeper reality, i.e., the hierarchical network of prime integer relations. Encoded by arithmetic through the totality of the self-organization processes, the hierarchical network appears as the mathematical structure of one harmonious and interconnected whole. Remarkably, arithmetic and geometry are unified together, yet play the different roles. For example, while the arithmetical form sets the relationships between the parts of a complex system, the geometrical form makes possible to measure their effects on the parts.

In the arithmetical form the hierarchical network comes into existence by the totality of the self-organization processes. Once the hierarchical network appears as the mathematical structure of one harmonious and interconnected whole, where not even a minor change can be made to any of its elements.

Moreover, the holistic nature of the hierarchical network allows to formulate a single universal objective of a complex system defined in terms of the integration principle [2]-[8]. We suggest that by the realization of the integration principle the Earth system could be transformed to become an integrated part of a larger system with more capacity and energy to sustain life. We also discuss how the integration principle of the Earth system could be effectively realized.

II. THE HIERARCHICAL NETWORK OF PRIME INTEGER RELATIONS AS A POSSIBLE DEEPER REALITY

To introduce the hierarchical network we present results based on the description of complex systems in terms of self-organization processes of prime integer relations [1]-[5].

Rather than in space and time, the description suggests to consider complex systems on a new stage, i.e., the hierarchical network of prime integer relations. The hierarchical network can be defined by two equivalent forms, i.e., arithmetical and geometrical. Remarkably, in the hierarchical network arithmetic and geometry are unified together, yet play the different roles. For example, while the arithmetical form sets the relationships between the parts of a complex system, the geometrical form makes possible to measure their effects on the parts.

In the arithmetical form the hierarchical network comes into existence by the totality of the self-organization processes of prime integer relations. Starting with the integers the processes build the hierarchical network under the control of arithmetic as one harmonious and interconnected whole, where not even a minor change can be made to any of its elements.

In its turn, a prime integer relation of a level is also built by a process first from integers and then from prime integer relations of the levels below. Notably, a prime integer relation can be seen not only as an indivisible whole

∗Electronic address: g.korotkikh@cqu.edu.au
†Electronic address: v.korotkikh@cqu.edu.au
but as a complex system itself. Indeed, a prime integer relation is made of integers as the ultimate building blocks with the relationships set by arithmetic, where each and every element in its formation is necessary and sufficient for the prime integer relation to exist. That is why we call such integer relations prime.

In the hierarchical network a complex system is defined by a number of global quantities, which remain invariant under certain self-organization processes. As a result, a complex system can be characterized by the hierarchical correlation structures determined by the self-organization processes of prime integer relations. The correlation structures operate through the relationships emerging in the formation of the prime integer relations. Since a prime integer relation expresses a law between the integers, the complex system become governed by the laws of arithmetic realized through the self-organization processes of prime integer relations.

A hierarchical structure of prime integer relations can be produced by a system of Diophantine equations. When a hierarchical correlation structure become operational, a corresponding solution of the Diophantine equations simultaneously gives rise to the prime integer relations.

In the geometrical form the processes a complex system is defined by are isomorphically expressed in terms of transformations of two-dimensional patterns. As a result, the hierarchical correlation structures of the complex system become represented by the hierarchical structures of the geometrical patterns. Importantly, this geometrizes the correlations as well as the laws of arithmetic the complex system is determined and opens a way to characterize the correlations and the laws of arithmetic by space and time as dynamic variables. Therefore, the geometrical form allows to transform the laws of a complex system in terms of arithmetic into the laws of the system in terms of space and time.

In our description a complex system is nothing but a manifestation of the underlying processes in the hierarchical network as well as a transitory entity in the realization of the prime integer relations. Since a prime integer relation can be fully represented by its geometrical pattern, the elementary parts of a complex system come into existence in the expression of their geometrical patterns.

The geometrical pattern of an elementary part can be defined by its area and boundary curve. Once the boundary curve is specified by the space and time variables of the elementary part and the area is associated with the energy, the dynamics of the elementary part become determined by its geometrical pattern. Therefore, an elementary part may be seen as a boundary curve supplemented with a corresponding number.

In the description the boundary curve of an elementary part at level \( l \) is given by a polynomial of degree at most \( l \). The coefficients of the polynomial, except the last one, can be seen as the quantum numbers of the elementary part. Notably, the quantum numbers of the elementary parts in a hierarchical correlation structure are all conserved.

Surprisingly, in the hierarchical network of prime integer relations a complex system works harmoniously well. In particular, once a hierarchical correlation structure of a complex system become operational, then through the corresponding prime integer relations all parts become instantaneously connected and move to realize the prime integer relations simultaneously. The effect of the correlations may be different for the elementary parts, but for each elementary part it is exactly as required to preserve the system. Namely, the clocks of the elementary parts may tick differently, yet precisely as determined by the prime integer relations.

Remarkably, the elementary parts of a correlation structure act as the carriers of the laws of arithmetic with each elementary part carrying its own quantum of a law fully determined by the geometrical pattern. Therefore, the quantum of arithmetic law of an elementary part defines the local spacetime and the energy of the elementary part. This suggests an important perspective to use elementary parts in the hierarchical network as fundamental entities to construct different laws. For example, as the quanta of arithmetic laws of elementary parts would be combined to take a form in terms of the same number of space and time variables, a global spacetime of the elementary parts could be produced.

Therefore, in the hierarchical network the laws of a complex system are entirely given by laws of arithmetic and whatever form these laws can take, they will still remain a manifestation of pure arithmetic.

As a prime integer relation and thus its geometrical pattern can not be changed even a bit, the hierarchical network may be viewed as two-dimensional rigid bodies interconnected by their transformations.

Significantly, all forces in the hierarchical network are managed by the single "force" - arithmetic. It serves the special purpose to hold the parts of a system together and possibly drive its formation to make the system more complex. Therefore, in the hierarchical network the forces do not exist separately, but through the self-organization processes are all unified and controlled to work coherently in the preservation and formation of complex systems.

These all explain our motivation to advocate the hierarchical network as a possible deeper reality. Indeed, built on an irreducible foundation the hierarchical network could be a reality that demonstrates through the processes the power to create and control complex systems. By recognizing this transformative power it would be then important to understand whether this power can be harnessed and used to solve global problems in particular.
III. INTEGRATION PRINCIPLE AS THE MASTER EQUATION OF A COMPLEX SYSTEM

Because the forces acting in space and time as well as their meaning remain unknown, it is not clear how a single objective of a complex system could be formulated there. By contrast, the holistic nature of the hierarchical network allows to formulate a single universal objective defined in terms of the integration principle of a complex system $\mathbb{G}$, $\mathbb{S}$:

In the hierarchical network of prime integer relations a complex system has to become an integrated part of the corresponding processes or the larger complex system.

Significantly, the integration principle determines the general objective of the optimization of a complex system in the hierarchical network.

The geometrical form of the description plays a special role in the realization of the integration principle. In particular, the position of a system in the corresponding processes can be associated with a certain two-dimensional shape, which the geometrical pattern of the optimized system has to take to satisfy the integration principle. Therefore, in the realization of the integration principle it is important to compare the current geometrical pattern of the system with the one required for the system by the integration principle. Since the geometrical patterns are two-dimensional entities, the difference between their areas can be used to estimate the result.

Moreover, the fact that in the hierarchical network processes can progress level by level in one and the same direction and, as a result, make a system more and more complex, may suggest a possible way for the realization of the integration principle. In particular, as the complexity of a system increases level by level, the area of its geometrical pattern may monotonically become larger and larger. Consequently, with each next level $l < k$ the geometrical pattern of the system would fit better into the geometrical pattern specified by the integration principle at level $k$ and deviate more after. In its turn, the performance of the optimized system could also increase to attain the global maximum at level $l = k$.

Therefore, as the area of the geometrical pattern of a system and its complexity would increase with each level $l$, the performance of the system might behave as a concave function of the complexity with the global maximum at level $k$ specified by the integration principle.

Computational experiments have been conducted to test this prediction. Remarkably, they support the claim and show that the integration principle of a complex system could be efficiently realized. Moreover, the experiments indicate that in the hierarchical network NP-hard problems could be avoided $\mathbb{G}$, $\mathbb{S}$.

According to the description the Universe we observe through the ordinary senses may be just a projection of certain self-organization processes defining a complex system in the hierarchical network $\mathbb{H}$. This projection of three dimensions of space and one dimension of time may be effective to achieve certain objectives, yet not sufficient to solve global problems. Therefore, we suggest to consider the Universe directly in the hierarchical network with the Earth system $\mathbb{E}$ as its integrated part.

In the hierarchical network the integration principle can be seen as the master equation of a complex system. It specifies the position of a complex system in the corresponding processes and could determine the forces acting on the system, its physical constants and parameters. Consequently, we suggest to consider the solution of global problems through the realization of the integration principle of the Earth system. In particular, we propose that through the integration of human activities and the Earth itself with the Universe as a complex system in the hierarchical network global problems could be resolved.

In the realization of the integration principle of the Earth system two main questions arise: first, how to specify the Universe by self-organization processes in the hierarchical network and second, how to characterize the Earth system.

Remarkably, self-organization processes of prime integer relations demonstrate properties of scale invariance. In particular, we have discovered a process where all levels can be subdivided into the groups of three successive levels, so that in a group the process can be characterized by a series of approximations specified at the lower groups of levels $\mathbb{I}$.

Therefore, once scale invariant properties of the processes the Earth system belongs to would be established, the characterization of the Earth system could be effectively simplified to realize the integration principle.

To this end, the information about the processes at the lowest group of levels would be very important. To specify the processes at the lowest group of levels we suggest to represent the standard model of elementary particles $\mathbb{M}$ in terms of the hierarchical network. For this purpose, the large symmetry of the hierarchical network and data on the energies of its elementary parts could be used.

As under the processes the Earth system could be involved in the formation of a more complex system, it would be then important to understand whether the transformation takes place and, if it does, specify it. Significantly, according to the description, in the formation of a complex system the energy may increase $\mathbb{E}$. Therefore, if the Universe experiences a further formation, the description predicts that the new energy would be generated and this could result in the acceleration of the Universe.

It is remarkable that the accelerated expansion of the Universe has been recently observed in physical cosmology $\mathbb{C}$. The observational evidence may support the idea of the formation and the transformation of the Earth system itself. Notably, as the acceleration of the Universe is attributed to dark energy $\mathbb{D}$, the description has a potential to explain this energy in terms of the processes and thus arithmetic.

Since the description could characterize the formation
of the Universe as well as the released energy quantitatively, the experimental data on the acceleration of the Universe would be useful to specify the transformation of the Earth system.

In order to realize the integration principle of the Earth system it would be required to convert information about human activities in terms of space and time into the information in terms of the hierarchical network.

Usually, in space and time information about a complex system is given by time series that can be used to characterize correlations through the variance-covariance matrix. Based on computational results [7, 10, 17] we suggest to apply eigenvalues and eigenvectors of variance-covariance matrices to obtain information about a complex system in the hierarchical network from the information about the system in space and time. In particular, this could specify the correlation structure and the geometrical pattern of the Earth system by using corresponding time series.

In this regard our method resonates with the idea in econophysics to characterize a financial system by eigenvalues and eigenvectors of variance-covariance matrices [18–21]. The idea has been motivated by the success of random matrix theory in explaining the statistics of energy levels of complex quantum systems [22, 23]. Although random matrix theory has opened a way to study the structure of a complex system, yet so far it lacks a general framework to define the structure of all possible structures and, more importantly, its geometry. By contrast, in our description the structure of a complex system is an integrated part of the hierarchical network. It is defined by the correlation structures determined by self-organization processes of prime integer relations, while its geometry comes from the corresponding two-dimensional patterns.

IV. CONCLUSIONS

In the paper we have suggested to consider global problems from the perspective of the hierarchical network of prime integer relations as a possible deeper reality and seek their solution in terms of the integration principle of the Earth system.

The practical realization of the integration principle of the Earth system would require the development of a Global Integrating System with two basic components, i.e., the navigation and control systems.

The purpose of the navigation system would be to specify the processes the Earth system belongs to and provide information for the realization of the integration principle. In general, the navigation system could be based on a network of existing particle accelerators, space telescopes and satellites. In particular, they could be used to identify the processes at the boundary levels.

The idea of the control system would be to ensure that human activities are consistent with the integration principle of the Earth system. For this purpose the control system should be designed to convert the information about human activities in terms of space and time into the information in terms of the hierarchical network, then compare the result with the output from the navigation system and make the correction if needed.

The control system could emerge through the development of the global financial system as well as cyber infrastructures of global supply chains and economic production [24–26].

The development of the Global Integrating System would require a new type of international cooperation. Realistically, the cooperation is unlikely unless it is based on an irreducible ground fully trusted by different parties and helping to reveal a higher collective purpose. Remarkably, based on integers and controlled by arithmetic only the hierarchical network of prime integer relations has a unique potential to provide such a common ground.

The practical realization of the integration principle of the Earth system might be viewed as the first attempt to extend human scientific inquiry and experimental activity into the new reality, i.e., the reality, where parts of a complex system could be instantaneously connected irrespective of the distances they may be far apart, the reality, where a complex system could be efficiently managed as one whole with its pasts, presents and futures all united at once.

Significantly, the reality of the hierarchical network of prime integer relations promises new sources of energy. In the hierarchical network it is arithmetic that controls energy to be conserved or generated in the exact amount. This source may be associated with dark energy, yet it would be a completely different story to be able to use it with all technological consequences.

Likewise, the hierarchical network could be seen as a source of laws to achieve different objectives. For a given objective the hierarchical network could be used to generate self-organization processes with relevant laws of arithmetic to be processed into the required form by constructing a corresponding global spacetime.

Finally, we speculate about the existence of a Super Intelligence that thinks well to produce the integers and thus the hierarchical network of prime integer relations, where processes can be comprehensible and efficiently controlled. As soon as the transformative power of the hierarchical network would be successfully tested, humans could become an integrated part of the Super Intelligence consciously operating in the reality.

This promises humans a special role in the reality one day they may call their home.

[1] V. Korotkikh, On Possible Implications of Self-Organization Processes through Transformation of

Laws of Arithmetic into Laws of Space and Time,
