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The Origin of Freedom, Uncertainty and Randomness in Strictly Formal Disharmonized Phenomena

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Abstract. The paper investigates the deduction of derivative metaconcepts of Freedom, Uncertainty and Randomness from the earlier obtained metaconcept of Chaos by means of special conceptual Universe's Model that takes into account the highest properties of the Universe. It is shown that deformalizing properties of Freedom, Uncertainty and Randomness naturally arise in any even strictly formal phenomena and are absolutely necessary for their development and further harmonization. The universal definitions of these metaconcepts are offered, and the mechanisms of their origin are classified. The natural instability of chaotic phenomena which is applied to control them is shown. The use of potentials of connectivity in the space of phenomena states for the synthesis of phenomena with the required characteristics of stability and controllability is substantiated. The obtained definition can serve as a conceptual and methodological tool in specific research and development.

Keywords: Universe's Model, Metaconcept, Harmony, Chaos, Freedom, Uncertainty, Randomness.

1 Introduction

In the paper [10] a hypothetical definition of the Chaos metaconcept was given. It was deduced from the highest properties of our Universe by means of the Universe's Model (UM) [9]. According to general ontological ideas, metaconcepts should further generate concepts that follow from them. Those are close to Chaos and among themselves concepts of Freedom, Uncertainty and Randomness which are often used in many scientific disciplines under different particular names and definitions. There naturally arises the problem of obtaining uniform universal definitions of these concepts which then can be transformed

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into different applications, which offers the potential for fundamentally new opportunities of Universe's phenomena formalization.

The deduction of derivative universal concepts must be also made by means of the UM. However, it presupposes strict and exact formality of the Universe, which is contrary to the chaotic concepts of Freedom, Uncertainty and Randomness. Hence, there arises a natural question of compatibility of both opposite properties, obviously observable in the surrounding world from physical microcosm to global natural and social phenomena.

Many papers are directly or indirectly dedicated to the problems of unity of understanding, formalization, definition and compatibility of universal concepts in general and the above-mentioned chaotic concepts in particular [12]. However, no radical uniting results have been achieved so far, and the process of division of concepts is expanding all the time with further development of science. Modern science is strongly separated and applies different systems of concepts and ways of formalization which, in fact, eliminates the possibility of their unification. Therefore, it is necessary to address these questions fundamentally, first of all, with the use of the uniting UM.

In this paper it is substantiated that our strictly formal Universe is quite compatible with Freedom, Uncertainty and Randomness of phenomena and, moreover, they are absolutely necessary for its existence and development. Freedom, Uncertainty and Randomness naturally arise in all the disharmonized phenomena, and all the universal phenomena are such phenomena.

The main manifestations of Chaos in phenomena are classified and their universal definitions, which are approximated to the generally accepted understanding, are given, and they are subject to general scientific discussion. Their proximity to mathematical understanding of Chaos, including fundamental instability of the chaotic phenomena, is shown. The role of Chaos in the control and development of universal phenomena is substantiated. General recommendations for the synthesis of chaotic phenomena with the required characteristics are obtained. The obtained definition can serve as a conceptual and methodological tool in more specific research and development.

2 The Initial Universal Concepts and Definitions

Definition. The UM is a representation of the Universe as a single whole, in which external (with the Universe) and internal (with itself) contradictions are absent.

The UM is a new scientific concept which arose in the intensively developing information and intellectual technologies for the improvement in formalization of the Universe's phenomena. It contains necessary components for the elimination of contradictions and represents the uniform universal formalism allowing the deduction of derivative particular consistent formalisms of phenomena from the highest properties of the Universe.

The UM creates absolutely new opportunities for formalization, and it is a tool for the solution of major scientific problems that are insoluble in a different way. The general concept of the UM together with the methodology of its

application is variously substantiated and described in many papers for different applications and has been developed further. But even now it allows (in the traditional manual (brain) mode) to solve many important problems, including the research into the Chaos concept, the important sense of which is clarified by universalization.

Universalization radically changes the general paradigm of cognition. Particular axiomatic (dogmatic) formalization is carried out according to the following scheme (Figure 1a) [8]: 1) an empirical supervision of a phenomenon; 2) a heuristic hypothesis of a phenomenon formalism; 3) an experimental comparison of the hypothesis with a real phenomenon; 4) coordination of a formalism with an axiom of a corresponding subject area.

Universal formalization is carried out according to the other scheme (Figure 1b) [9]: 1) preliminary obtaining of the UM; 2) classification of a cognizable phenomenon in the universal system of concepts; 3) the deduction of a universal formalism of the phenomenon from the UM; 4) comparison of the universal formalism with the real phenomenon and 5) elimination of divergences.

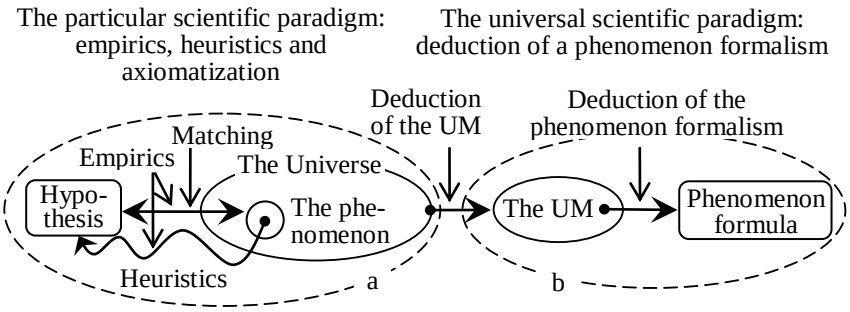

Fig. 1. The schemes of particular (a) and universal (b) paradigms of phenomena formalization

Both paradigms produce particular formulas of phenomena (as parts of the Universe), but the first one – from axiomatic conceptions, and the second one – from universal conceptions with a higher level of generalization, increasing the level of definition of concepts and opening up fundamentally new opportunities for phenomena formalization.

The UM is defined by the concepts of entity-relation and is illustrated by the modified ER-diagrams, the arches of which correspond to the copies of entities (unambiguously converted into effective for machine execution formalisms of the sets theory) because such is the Universe and all of its parts are special infinite enclosed structures. The following starting definitions are applied for this purpose (Figure 2).

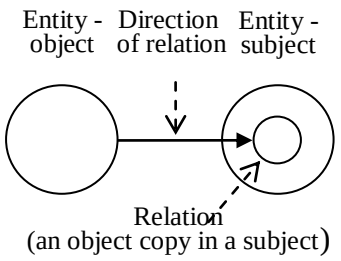

Fig. 2. The scheme of entity and relation

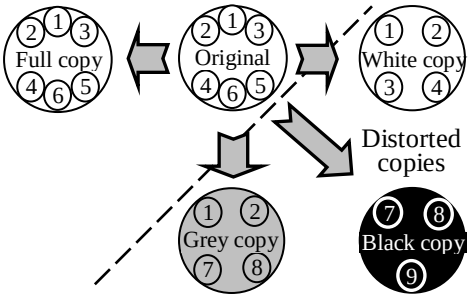

Fig. 3. The scheme of relations classification

Definition. The Universe is a complete set of directly or indirectly related entities.

Definition. Entity is a part of the Universe singled out by a certain relation as a single whole.

Definition. Relation is a mapping (copy) of one entity (object) in another entity (subject).

Definition. Property is the structure of relations.

Relations have a natural classification (Figure 3, Table), generating hypothetically all the infinite diversity of the Universe.

Class* of *relation	***Property* of *class***
Full	Copy is equal to the original
Distorted	Copy is not equal to the original
White	Copy contains only part of the original
Grey	Copy contains original parts and wrong parts
Black	Copy does not contain the original

Table. Description of relations classification

The UM is divided into the Abstract (AW) and Real (RW) worlds. Hypothetically, the structure (formalism) of the RW entities (phenomena) is created by the AW entities (abstracts, categories, concepts) forming a hierarchically enclosed system of sequentially deduced concepts (the Universe's Abstract Pyramid (UAP)) from the initial concept of Harmon (the Universe's Axiom (Dogma)), the formula of which is offered in [9-10].

Definition. A formalism is a system of concepts of an entity.

It can be assumed that all the concepts of the UAP 1) are unidirectional from the Universe's Axiom to the RW, 2) are the formal code of the Universe's construction, 3) do not contain Time and are invariable, and 4) are strictly and precisely executed (because there is no reason to deviate from them). As the

specific physical construction of these worlds is unknown, metadefinitions of the above-mentioned concepts are forcedly used instead of constructive definitions.

The internal coherence of such hypotheses assumes the presence in the Universe of two high-level contrary metaconcepts of Harmony and Chaos.

Definition. Harmony is the presence of relations.

Definition. Chaos is the absence of relations.

These concepts are present everywhere in the Universe and reveal the universal superlaw of Harmony that explains many properties by phenomena tendency to increase their Harmony (connectivity):

$$Harmony(phenomenon(state(Time))) \rightarrow max \quad phenomenon(state(Time)) \text{ as a part of the Universe} \tag{1}$$

Accordingly, Chaos (disconnectivity) of a phenomenon decreases as an addition of a phenomenon to a local harmon as a complete subgraph on its components, on which such additions are also recursively built (Figure 4).

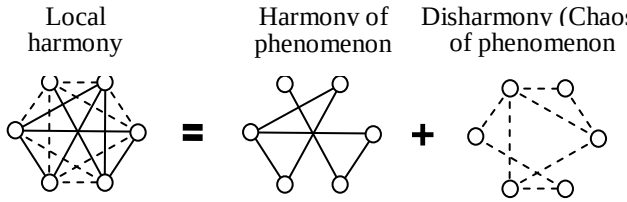

Fig. 4. The example of phenomena separation into Harmony and Chaos

Joint harmonization of phenomena formulates the Universe as a harmonic optimization problem (UHOP), in which the right part of formula (1) is replaced by the Universe's (absolute) Harmon that possesses the utmost degree of harmonization, the achievement of which is obligatory according to the universal hypothesis:

$$Harmony(Universe(state(Time))) \rightarrow Absolute\ Harmon \tag{2}$$

Consequence. Any phenomenon different from Harmon is disharmonized.

The Universe is fundamentally heterogeneous by its entities. Therefore, this problem is infinitely multiextremal with the necessity of guaranteed achievement of the global extremum, otherwise the Universe loses the sense of its existence [11]. This is ensured owing to the chaotic properties.

An important method of the UM forming is consecutive concretization of hypotheses, allowing application of temporarily underdetermined hypothetical concepts in order to eliminate any external and internal contradictions. It should be done until their discrepancy, which forces to change hypotheses, is proved.

Successful building of such a UM, especially in the sphere of difficult to understand high-level concepts, consistently increases its reliability and brings closer to the Universe which remains the only possible thing in the extreme difficult to understand areas. Therefore, the UM often uses unconstructive metadefinitions of the highest concepts of the Universe, the traces of which are conceptually observed, but cannot be concretized so far owing to unclearness of the real organization and mechanisms of movement of the Universe.

The UM has two basic subjectivities: 1) the heuristic selection of uniting concepts that eliminate external and internal contradictions, and 2) the heuristic search in the RW for the analogues of the deduced from the UM universal concepts by the smallest divergence among them. These subjectivities are consistently overcome by the increase in conceptual complexity of the UM. Owing to a usual divergence of multiple subjective definitions and their understanding, item 2 presupposes discussion on the uniform sense of concepts on the basis of the universal idea.

All subjectivities are smoothed over by a fundamentally hypothetical character of any knowledge, both conceptual and factual, owing to universal tautology of obscurity of the invisible, which always presupposes the possibility of existence of the unknown entities, even when they are actually absent, which can radically change the sense of knowledge.

3 Criticism of Strict Predetermination of the Universe

The hypothesis about strict predetermination of the Universe presupposes mutual precise deduction of all of its last, present and future real states according to Laplace's demon [3]. However, it does not coordinate with both modern science [2, 5, 13] and universal ideas.

The main contradictions of strict predetermination of the Universe:

- The Universe in its development continuously generates uncountable internal contradictions that must be resolved by the built-in mechanisms of prevention of their increase and catastrophic self-damage, which is impossible to take into account and execute with strict predetermination.
- It is difficult to assume a consistent trajectory of movement of the infinite Universe throughout its existence, coming from the initial extremely contradictory singularity.
- Strict predetermination generates insoluble, infinite total multiextremality of the UHOP according to formula (2), the uncountable local extremums of which will stop any movement of the Universe [11];
- Why did the Universe arise if it does not create anything new?

Since all this is not observed, then an alternative hypothesis about harmonic combination of partial predetermination by means of the AW (quasiHarmony) and partial Freedom, Randomness and Uncertainty of the RW (quasiChaos) which are sufficient for the achievement of a final target state of the Harmon is accepted. The first quality is inherent in Harmony, and the second one – in Chaos. Both qualities are present in each phenomenon.

Qualitative meta-analysis of the UHOP:

- The achievement of a target state of the Harmon presupposes a harmonizing trajectory of movement of the Universe through internally consistent conditions at each point of Time, the deviation from which disharmonizes and destroys the Universe instead of harmonizing it.
- The condition of consistency of such states is the existence of at least approximate balances on the borders of relations, which generate an infinite system of corresponding equations of the Universe existence (UEES), the structure of which is continuously changing in the process of harmonization.
- Such a system contains three types of formalisms: 1) invariable concepts, 2) variable phenomena (that are temporarily singled out by relations) and 3) variable relations among them.
- Since entities are recursively enclosed structures that are mobile in general case, there arises an infinite variable structural Universe's formalism, for the description and an explanation of which it takes more than the existing concepts of modern science and its UM, demanding further development and more precise definition.
- However, the metaproperties of such formalism can be estimated by means of universal ideas.

Qualitative meta-analysis of the UEES:

- According to the generally acknowledged principle of a homotropy, the system of concepts of the AW can be considered as general, and, consequently, identical and invariable for the entire Universe.
- Therefore, formalisms of phenomena and relations among them in the RW remain variable in the system of existence equations in terms of these concepts.
- It follows from this that harmonization of the Universe is carried out by the change of relations formalisms, which can be both harmonizing (development) and disharmonizing (degradation).

Since in the UEES 1) all Universe's relations must be represented, and 2) all of them influence its decision, 3) the Universe, as a single whole, naturally generates new hidden system-wide controlling formalisms 4) that are different from obvious formalisms of its components. They affect the entire Universe and are latently manifested in its separate components as a source of systemic conceptual Chaos.

4 The Mechanisms of Derivative Chaotic Concepts

The relations as directed mutual copies of entities (concepts and phenomena) in conditions of quasiChaos form infinite variety of configurations. Standard structures arise among them giving phenomena corresponding properties. The combination of standard structures forms complex properties of phenomena.

The relations arise 1) in the AW (formation of complex concepts), 2) between the AW and the RW (formation of phenomena) and 3) in the RW (harmonization of the phenomena). Hypothetically, relations in items 1-2 are absolutely strict, and in item 3 – distorted ones according to the Table (Figure

3).

The unary classes of relations of phenomena. The classes of external relations of phenomena relating to phenomena themselves are the simplest (internal relations of a phenomenon and the relation of a phenomenon with itself are considered as an internal structure of a phenomenon) (Figure 5).

Definition. Determinism (dependency) is the presence of incoming relations of phenomena.

Definition. Freedom (Independence) is the absence of incoming relations of phenomena.

Definition. Existence (Act, Influence) is the presence of outgoing relations of phenomena.

Definition. Nonexistence is the absence of outgoing relations of phenomena.

Consequence. Free non-existent phenomena are deleted from the Universe by its definition.

The combination of these classes generates complex configurations of external relations of a phenomenon with the inheritance of corresponding properties.

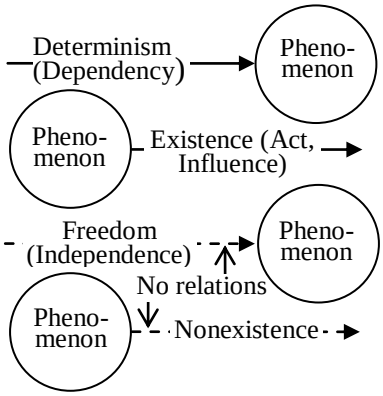

Fig. 5. The schemes of Determinism, Freedom, Existence and Nonexistence of phenomena

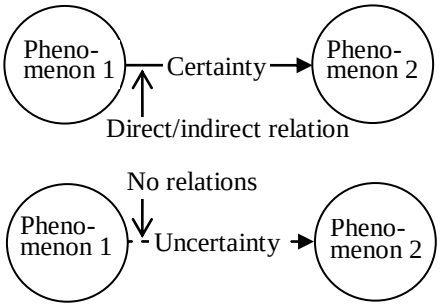

Fig. 6. The schemes of Certainty and Uncertainty of phenomena

The binary classes of relations of phenomena. The binary classes of relations among phenomena are the next in complexity (Figure 6).

Definition. Certainty of a phenomenon-object relative to a phenomenon-subject is the existence of relations of the first with the second one.

Definition. Uncertainty of a phenomenon-object relative to a phenomenon-subject is the absence of relations of the first with the second one.

Accordingly, Certainty/Uncertainty creates/destroys a copy of a phenomenon-object in a phenomenon-subject. Certainty/Uncertainty are directed properties among phenomena relative to a phenomenon-subject.

Definition. Relativity is belonging of the specified property to the specified phenomena.

Indirect relations of phenomena. Indirect relations of phenomena through intermediate phenomena are the next in complexity. They can lose copies of initial phenomena-objects without the loss of general connectivity (coExistence in the common Universe) with phenomena-subjects, which generates full indirect Uncertainty of phenomena (Figure 7).

It is shown in the example how phenomenon 1 loses indirect Existence for phenomenon 4 (inside the common Universe) which results in full Uncertainty and Freedom of phenomenon 1 for phenomenon 4.

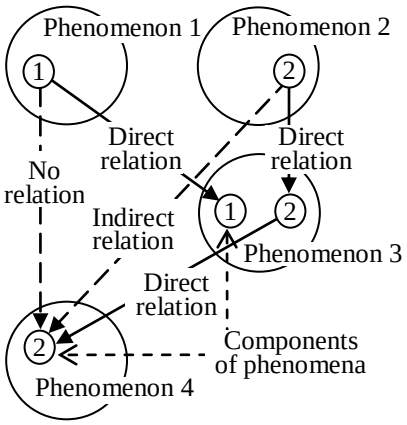

Fig. 7. The scheme of loss of indirect connectivity of phenomena (on the example of phenomena 1 and 4)

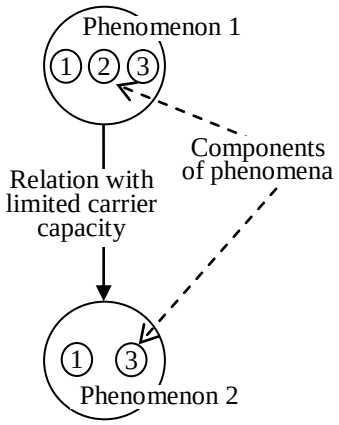

Fig. 8. The scheme of partial Uncertainty of formalization with the restriction on carrier capacity of relations

The restriction on carrier capacity of phenomena relations. The relations with limited carrier capacity transfer only part of a copy of phenomena-objects and generate corresponding partial Uncertainty of phenomena-objects relative to phenomena-subjects that has (structural) measurement (Figure 8).

Division and mixture (distortion) of phenomena relations. Indirect relations can divide copies of phenomena-objects into several different copies or mix copies of different phenomena in one copy. The result is transferred further with the loss of phenomena-objects membership (Figure 9). Such copies are perceived as a reduction and distortion (noise) of relations and, therefore, generate Uncertainty of phenomena.

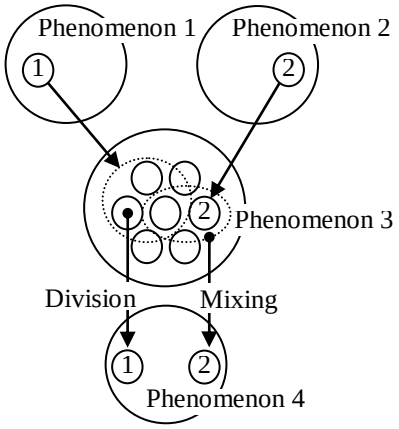

Fig. 9. The scheme of emergence of Uncertainty owing to division and mixture (distortion) of phenomena relations

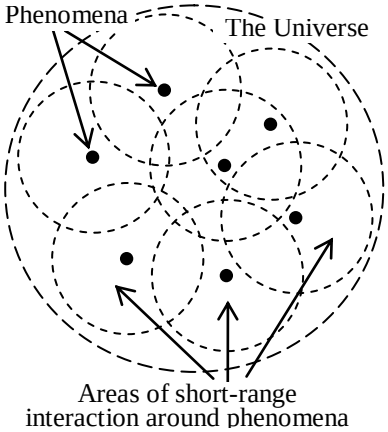

Fig. 10. The scheme of short-range interaction of phenomena

The incompatibility of phenomena formalisms. Phenomena formalisms consist of the unique concepts of the UAP, which can be incompatible among themselves and cause the incompatibility of the phenomena that are produced. The incompatibility prevents the formation of relations and generates Uncertainty of phenomena.

The internal Uncertainty of phenomena. Phenomena have an infinite enclosed internal component structure inheriting all the mechanisms of Uncertainty referred to above. Inexact initial arguments x in exact formalisms $f(x)$ of phenomenon components give inexact results of $y \leftarrow f(x)$. In addition to that, as formalisms are controlled by the data, their distortion can unreasonably activate corresponding part of formalisms. All this generates the internal Uncertainty of phenomena.

Definition. Randomness is a deviation of an actual state of a phenomenon from its formalism.

Locality, subjectivity and absoluteness of relations. The restrictions on relations depend on the area provided for their formation in the RW (Space, Time and Matter). A particular area imposes local restrictions that are removed by the expansion of this area up to the whole Universe when the remaining restrictions become absolutely insurmountable. Subjective restrictions arise owing to incomplete use of the copies that are received by a phenomenon-subject.

Short-range interaction of phenomena. Complication of indirect relations increases distortions and mutual Uncertainty of phenomena that form locally defined areas around each phenomenon with an increasing relative Uncertainty in the process of moving away from it (Figure 10). In physics, it is called short-range interaction as one of the forms of Certainty, going beyond the bounds of

which generates Uncertainty. Short-range interaction restricts distant cooperation of phenomena, increases their Independence and decreases multiextremality of Harmony.

Self-formalization of chaotic phenomena. The Universe independently self-determines by a free origin from Absolute Chaos. Such self-formalization can have a set of virtual formalisms with the possibility of transition from one to another like the simplest logical trigger with several internal different steady states. Similarly, chaotic phenomena have a partial abstract and real self-determination with Freedom (Independence) of its formalism, allowing the change of their state. Absolute Certainty comes only with the disappearance of Chaos and, as a consequence, the Universe in Harmon's state.

Thus, according to hypothetical universal hypothesis, the metaconcept of Chaos provides multiple opportunities for natural emergence of Freedom, Uncertainty and Randomness in any (disharmonized) Universe's phenomena.

5 Instability and Controllability of Chaotic Phenomena

It is generally known that the uniform standard theory and definition of the concept of Chaos are absent in modern science [4]. Chaos is usually understood as any disorder in various origins and descriptions. The mathematical formalization of Chaos was substantiated by H. Poincare for a wide range of problems with high sensitivity of solutions to initial conditions in limited areas of general stability [7]. Typical is the classical problem of the movement of three and more bodies in a mutual gravitational field, unsolved in an analytical form (Figure 11) [6].

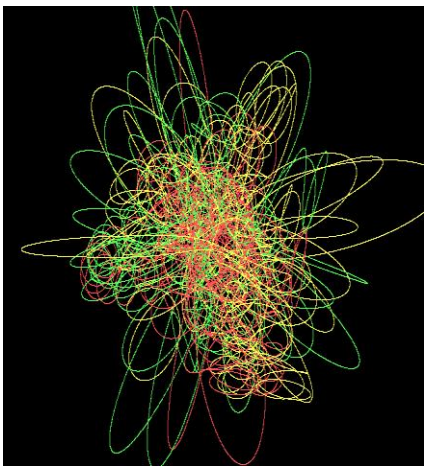

Fig. 11. The typical numerical solution of a problem of the chaotic movement of three bodies (the picture is taken from Wikipedia)

Universalization explains essential sensitivity of chaotic phenomena and specifies the directions of their stabilization / destabilization by means of control of internal Harmony (connectivity). Relative change of Harmony $\Delta H(p)/H(p)$ as an indicator of stability/instability of a phenomenon p (Harmony is a structural concept that can be estimated by scalar expression – number of relations, the sum of their weight coefficients, etc.) asymptotically depends on the value of $H(p)$:

$$\Delta H(p)/H(p) \rightarrow \begin{cases} 0, \text{ при } H(p) \rightarrow \infty \text{ (mainly harmonious phenomena);} \\ \infty, \text{ при } H(p) \rightarrow 0 \text{ (mainly chaotic phenomena);} \end{cases} \quad (3)$$

i.e. tends to zero at great values of *H(p)* (a harmonious phenomenon *p*, stability) and to infinity at low values of *H(p)* (a chaotic phenomenon *p*, instability). Thus, the stability / instability of a phenomenon is a natural consequence of its Harmony / Chaos (connectivity / disconnectivity) respectively. Small change of internal relationship radically changes the properties of a chaotic phenomenon (excluding external relationship).

Mathematical expressions are reducible to the structural forms expressing connectivity by the 1) structure of the system of equations, 2) values of coefficients of the variables and 3) values of the variables. Therefore, for the analysis and synthesis of phenomena with the required characteristics of stability / instability it is reasonable to use connectivity potential in the space of phenomena states.

High sensitivity of simple weakly connected phenomena forces to precisely measure initial data and calculate intermediate results. The increase in the dimension of such phenomena, for example, weather forecasting worldwide, makes it very problematic.

The chaotic internal instability of the Universe according to formula (3) allows to operate powerful phenomena bypassing rough physical laws. Otherwise, for this purpose it would be necessary to use the efforts of similar power, for example of a power station, a dam, a machine, etc. It is an essential property of the Universe allowing the emergence and development of phenomena from their weak initial states, which is observed everywhere and is the evidence of a large degree of a chaotic character of the modern state of the Universe. Harmonization of phenomena increases stability of phenomena and makes their control difficult.

The universal interpretation of Chaos is the evidence of a deep and strong internal mutual coherence of the Universe, in which all the components perform absolutely necessary Universe's functions. The absence of Chaos and a total Determinism stops phenomena and the Universe.

6 Conclusions

In fact, this research conceptually develops K. Gödel's theorem of incompleteness of particular formalism (on the example of the systems of logical equations) [1] for universal formalisms. It is hypothetically substantiated that the Universe contains necessary tools for the emergence of internal Freedom, Uncertainty and Randomness in disharmonized phenomena even under the conditions of strict formalization at the expense of the internal chaotic resources that open up an essential possibility for further development and harmonization of phenomena.

The internal Chaos naturally increases instability of phenomena and facilitates the possibility of their control. The variation of Harmony / Chaos ratio perfectly well allows synthesis of phenomena with the required characteristics of stability and controllability. The specified conceptual

properties are subject to further concretization in special applications, but they can already be applied in problematic developments even now.

References

1. K. Gödel. *On Formally Undecidable Propositions of Principia Mathematica and Related Systems*, Dover, 1962.
2. S. Hawking. *Does God Play Dice?* Public Lectures. http://www.hawking.org.uk/does-god-play-dice.html
3. P. Laplace. *A Philosophical Essay on Probabilities*, New York, 1951.
4. C. Letellier. *Chaos in Nature*, World Scientific Publishing Company, 2012.
5. U. Lucia. Probability, ergodicity, irreversibility and dynamical systems. *Proceedings of the Royal Society A: Mathematical, Physical and Engineering Sciences*, 464: 1089–1104, 2008.
6. R. Moulton. *An Introduction to Celestial Mechanics*, Dover, 1970.
7. H. Poincare. *New Methods of Celestial Mechanics*, American Institute of Physics, 1993.
8. H. Poincare. *The Foundations of Science*, New York: Science Press, 1921.
9. A. Sosnitsky. Beginnings of the Universe Model and Deduction of Initial System of Information Concepts. *Information Theories & Applications*, 19, 1, 56-85, 2012.
10. A. Sosnitsky. The Universal MetaConcept of Chaos. *Proceedings of 8th CHAOS 2015 International Conference*, 831–842, 2015.
11. A. Sosnitsky. The nonconstructivity problem of the classical extrema definitions of and the universal mechanism of global optimization. (In print).
12. *The Unity of Scienc*e. Stanford Encyclopedia of Philosophy, 2007, 2013, http://plato.stanford.edu/entries/scientific-unity/
13. D. Wolpert. *An Incompleteness Theorem for Calculating the Future*, SFI Economics Program, Santa Fe Institute, 1996.