

Universal Symmetry of Complexity and Its Manifestations at Different Levels of World Dynamics

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The unreduced, universally nonperturbative analysis of arbitrary interaction process, described by a quite general equation, provides the truly complete, “dynamically multivalued” general solution that leads to dynamically derived, universal definitions of randomness, probability, chaoticity, complexity, fractality, self-organisation, and other properties, extending their axiomatic introduction in the conventional, dynamically single-valued theory. Any real system emergence, structure, and behaviour can be expressed now by the universal law of conservation, or symmetry, of complexity that unifies extended versions of any (correct) symmetry, law, or “principle”. Particular applications of the universal symmetry of complexity, from fundamental physics to biology and theory of consciousness, provide old mysteries solutions and new research perspectives.

1 Introduction: the unreduced symmetry of nature

The *conventional symmetry* idea used in physics and mathematics (see e.g. [1–3]) assumes the existence of *previously determined* (eventually postulated) structures and properties that appear as dynamical laws relating “variables” \mathcal{X} and “parameters” \mathcal{P} : $\mathcal{C}(\mathcal{X}; \mathcal{P}) = 0$. A formal symmetry, or “invariance” of the law, is introduced usually through the symmetry transformation “operator”, $\hat{\mathcal{S}}$, whose action is compatible with the law in question, $\hat{\mathcal{S}}[\mathcal{C}(\mathcal{X}; \mathcal{P})] = 0$. This fact can be used to reduce the law expression to a desired particular form, including the explicit, functional relation between *separated* variables and parameters, or “(exact) solution” of a problem: $\mathcal{X} = f(\mathcal{P})$. However, application of this symmetry concept to the real world dynamics reveals irreducible *ruptures* between various known symmetries and systematic *violations* of almost every exact symmetry, accounting for the real world irregularity, which leads to the “(spontaneously) broken symmetry” concept with quite fundamental consequences.

A much more general interpretation of symmetry is possible [4, 5], within which the *real* world structure *explicitly emerges* as *inevitable realisation* of the *universal dynamic symmetry*, or “conservation law”, $C = \text{const}$, where *all* observed entities, properties, and measured quantities are *derived* as forms or manifestations of that universal symmetry, remaining thus *always exact* (unbroken), but producing all the observed *irregularities*. Any (correct) dynamical law, $\mathcal{C}(\mathcal{X}; \mathcal{P}) = \mathcal{C}_0$, as well as the *unreduced* problem solution, $\mathcal{X} = \mathcal{F}(\mathcal{P})$, is also obtained now, in its essentially extended, *causally complete* form, as a *rigorously derived* (rather than postulated), *totally realistic* manifestation of that single, *intrinsically unified* symmetry. We show that the role of such unified symmetry belongs uniquely to the *universal symmetry (conservation) of dynamic complexity*, where the latter quantity is rigorously derived from the *unreduced* (non-perturbative) analysis of arbitrary (real) *interaction process* [4, 5]. This unreduced complexity, giving rise to the unified dynamical “order of the universe”, is essentially different from conventional complexity versions which do not originate from the unreduced problem solution, but reflect a strongly reduced (zero-dimensional) *projection* of real system dynamics.

2 Unreduced dynamic complexity of arbitrary interaction process, its conservation and internal transformation

Mathematical expression of dynamics of a vast variety of interaction processes can be generalised in the form of “existence equation” [4–7] that actually only fixes the fact of interaction within a system of a given configuration:

$$[h_g(\xi) + V_{eg}(q, \xi) + h_e(q)] \Psi(q, \xi) = E \Psi(q, \xi), \quad (1)$$

where $\Psi(q, \xi)$ is the system “state-function”, which totally determines its configuration and depends on the degrees of freedom, ξ and q , of the system components, $h_g(\xi)$ and $h_e(q)$ are “generalised Hamiltonians” of the free (non-interacting) components (i.e. measurable functions eventually expressing dynamic complexity, defined below), $V_{eg}(q, \xi)$ is (arbitrary) interaction potential, E is the generalised Hamiltonian eigenvalue for the whole system, and any number of interacting components can actually be implied behind equation (1), leading to the same results below [5].

It will be convenient to express the problem in terms of the internal system states by performing expansion of the state-function $\Psi(q, \xi)$ over the complete system of eigenfunctions, $\{\phi_n(q)\}$, for all free-state degrees of freedom but one (described here by the ξ variable and usually representing the global system configuration, such as spatial coordinates of its structure):

$$\Psi(q, \xi) = \sum_n \psi_n(\xi) \phi_n(q), \quad h_e(q) \phi_n(q) = \varepsilon_n \phi_n(q). \quad (2)$$

Substituting expansion (2) into the existence equation (1), multiplying it by $\phi_n^*(q)$, integrating over q variables (or using other “scalar product” definition), and assuming the orthonormality of eigenfunctions $\{\phi_n(q)\}$, we get a system of equations, which is equivalent to the starting existence equation and includes all its particular cases (e.g. nonlinear or time-dependent forms):

$$\begin{aligned} [h_g(\xi) + V_{00}(\xi)] \psi_0(\xi) + \sum_n V_{0n}(\xi) \psi_n(\xi) &= \eta \psi_0(\xi), \\ [h_g(\xi) + V_{nn}(\xi)] \psi_n(\xi) + \sum_{n' \neq n} V_{nn'}(\xi) \psi_{n'}(\xi) &= \eta_n \psi_n(\xi) - V_{n0}(\xi) \psi_0(\xi), \end{aligned} \quad (3)$$

where $\eta_n \equiv E - \varepsilon_n$,

$$V_{nn'}(\xi) = \int_{\Omega_q} dq \phi_n^*(q) V_{eg}(q, \xi) \phi_{n'}(q),$$

and we have separated the equation with $n = 0$ from the system (3), so that other $n \neq 0$ (also below) and $\eta \equiv \eta_0$.

Expressing $\psi_n(\xi)$ from equations (3) through $\psi_0(\xi)$ by the standard Green function technique [8, 9] and inserting the result into the equation for $\psi_0(\xi)$, we restate the problem in terms of *effective existence equation*, formally involving only the selected degrees of freedom ξ :

$$[h_g(\xi) + V_{\text{eff}}(\xi; \eta)] \psi_0(\xi) = \eta \psi_0(\xi), \quad (4)$$

where the *effective (interaction) potential (EP)*, $V_{\text{eff}}(\xi; \eta)$, is given by

$$\begin{aligned} V_{\text{eff}}(\xi; \eta) &= V_{00}(\xi) + \hat{V}(\xi; \eta), \quad \hat{V}(\xi; \eta) \psi_0(\xi) = \int_{\Omega_\xi} d\xi' V(\xi, \xi'; \eta) \psi_0(\xi'), \\ V(\xi, \xi'; \eta) &= \sum_{n,i} \frac{V_{0n}(\xi) \psi_{ni}^0(\xi) V_{n0}(\xi') \psi_{ni}^{0*}(\xi')}{\eta - \eta_{ni}^0 - \varepsilon_{n0}}, \quad \varepsilon_{n0} \equiv \varepsilon_n - \varepsilon_0, \end{aligned} \quad (5)$$

and $\{\psi_{ni}^0(\xi)\}$, $\{\eta_{ni}^0\}$ is the complete set of eigenfunctions and eigenvalues for an auxiliary, truncated system of equations (where $n, n' \neq 0$):

$$[h_g(\xi) + V_{nn}(\xi)]\psi_n(\xi) + \sum_{n' \neq n} V_{nn'}(\xi)\psi_{n'}(\xi) = \eta_n\psi_n(\xi). \quad (6)$$

The general solution of the initial existence equation (1) is then obtained as [4–8]:

$$\begin{aligned} \Psi(q, \xi) &= \sum_i c_i \left[\phi_0(q) + \sum_n \phi_n(q) \hat{g}_{ni}(\xi) \right] \psi_{0i}(\xi), \\ \psi_{ni}(\xi) &= \hat{g}_{ni}(\xi) \psi_{0i}(\xi) \equiv \int_{\Omega_\xi} d\xi' g_{ni}(\xi, \xi') \psi_{0i}(\xi'), \\ g_{ni}(\xi, \xi') &= V_{n0}(\xi') \sum_{i'} \frac{\psi_{ni'}^0(\xi) \psi_{ni'}^{0*}(\xi')}{\eta_i - \eta_{ni'}^0 - \varepsilon_{n0}}, \end{aligned} \quad (7)$$

where $\{\psi_{0i}(\xi)\}$ are the eigenfunctions and $\{\eta_i\}$ the eigenvalues found from equation (4), while the coefficients c_i should be determined by state-function matching on the boundary where the effective interaction vanishes. The observed system density $\rho(q, \xi)$ is given by the squared modulus of the state-function $\rho(q, \xi) = |\Psi(q, \xi)|^2$ (for “quantum” and other “wave-like” levels of complexity), or by the state-function itself $\rho(q, \xi) = \Psi(q, \xi)$ (for “particle-like” levels) [4].

Although the “effective” problem formulation of equations (4)–(7) forms the basis of the well-known optical, or effective, potential method (see e.g. [9]), it is actually used in its reduced, perturbative versions, where the “nonintegrable”, nonlinear links in the above EP and state-function expressions are cut in exchange to the closed, “exact” solution. However, this reduction kills the *essential, dynamic nonlinearity* of the real system, together with its intrinsic complexity and chaoticity, and thus replaces the natural symmetry of complexity by an artificial, simplified symmetry of perturbative solutions [4–8]. Indeed, it is not difficult to show that the unreduced “effective” problem has *many* locally complete and therefore *incompatible* solutions, *each* of them being equivalent to the *single*, “complete” solution of the reduced problem, usually attributed also to the initial formulation of equations (1), (3). If N_ξ and N_q are the numbers of terms in sums over i and n in equation (5), then the total number of eigenvalues of equation (4) is $N_{\max} = N_\xi(N_\xi N_q + 1) = (N_\xi)^2 N_q + N_\xi$, which gives the N_ξ -fold redundancy of the usual “complete” set of $N_\xi N_q$ eigen-solutions of equations (3) plus an additional, “incomplete” set of N_ξ solutions. Each redundant solution, *intrinsically unstable* with respect to system transitions to other solutions, can be called system *realisation*, since it represents a completely determined system configuration. The total number of “regular”, complete system realisations is $N_{\mathfrak{R}} = N_\xi$, whereas the mentioned additional set of solutions forms a special, “intermediate” realisation that plays the role of transitional state during system jumps between the regular realisations and provides thus the universal, *causally complete* extension of the quantum *wavefunction* and classical (*probability*) *distribution function* [4, 5].

Thus rigorously derived, qualitatively new property of *dynamic multivaluedness* of the unreduced problem solution is confirmed by its “geometric” analysis and particular applications [4–8]. It provides the intrinsic, omnipresent, and irreducible source of *purely dynamic, or causal, randomness*: the incompatible system realisations, being *equally* real, should *permanently* replace one another, in a *causally random* order, so that the observed density of any real system should be presented as the *dynamically probabilistic* sum of the individual realisation densities, $\{\rho_r(\xi, q)\}$, obtained by solution of the effective existence equation (4):

$$\rho(\xi, Q) = \sum_{r=1}^{N_{\mathfrak{R}}} \oplus \rho_r(\xi, Q), \quad (8)$$

where summation is performed over all (observable) system realisations, numbered by r , and the sign \oplus serves to designate the special, dynamically probabilistic meaning of the sum derived above and consisting in *permanent change* of regular realisations in *dynamically random (chaotic)* order by transition through the intermediate realisation. The dynamically obtained, *a priori probability* of the r -th realisation emergence, α_r , is determined, in general, by the number, N_r , of elementary, experimentally unresolved realisations it contains:

$$\alpha_r(N_r) = \frac{N_r}{N_{\mathfrak{R}}}, \quad N_r = 1, \dots, N_{\mathfrak{R}}, \quad \sum_r N_r = N_{\mathfrak{R}}, \quad \sum_r \alpha_r = 1. \quad (9)$$

According to the “generalised Born’s rule”, obtained by dynamical matching in the intermediate realisation (wavefunction) phase, the dynamic probability values are determined by the generalised wavefunction obeying the causally derived, *universal Schrödinger equation* [4, 5] (see below).

Another important property of the unreduced solution, closely related to the above dynamic multivaluedness, is *dynamic entanglement* between the interacting entities (degrees of freedom) within each realisation, which appears as dynamically weighted products of functions of ξ and q in equations (7) and determines the *tangible new quality* of the emerging interaction results. It leads to the *dynamical system squeeze*, or *reduction*, or *collapse*, to the emerging configuration of each realisation, alternating with the reverse *dynamic disentanglement*, or *extension*, of interacting entities to a quasi-free state in the intermediate realisation (wavefunction), during transitions between realisations [4–7]. The dynamically multivalued entanglement is a totally autonomous *process*, driven only by the system interaction and characterised by the intrinsic *nonseparability* and *irreversible* direction. Nonseparable component entanglement gives rise to the explicitly emerging, physically real *space* (in the form of the squeezed, final realisation configuration, or generalised space “point”), while the irreversible, unceasing and *spatially chaotic* realisation change determines the causal *time flow* [4, 5]. These properties of the dynamically multivalued entanglement between the interacting components are hierarchically reproduced and amplified within the *dynamically fractal* structure of the unreduced problem solution, which can be obtained by application of the same EP method to the truncated system of equations (6) whose solutions are used in the expressions of the first level of solution, equations (5), (7). We obtain thus the causally complete extension of the conventional, dynamically single-valued fractality and the true meaning of (*any* real) system *nonintegrability*, which takes the form of the permanently changing, dynamically probabilistic (“living”) fractal hierarchy of the unreduced problem solution, possessing the rigorously obtained properties of *explicit structure emergence (creativity)* and *dynamic adaptability* (self-consistent configuration of the “effective” solution of equations (4)–(7)) [4, 5, 7].

Now that the *dynamically multivalued* structure of the unreduced interaction process has been *explicitly revealed*, we can provide the unrestricted, *universally applicable* definition of *dynamic complexity*, C , as any growing function of realisation number, $C = C(N_{\mathfrak{R}})$, $dC/dN_{\mathfrak{R}} > 0$, or the rate of their change, equal to zero for the (unrealistic) case of only one realisation, $C(1) = 0$. It is just the latter, unrealistically simplified “model” (zero-dimensional, point-like projection) of reality which is *exclusively* considered in the conventional, dynamically single-valued, or *unitary*, theory, including its concepts of “complexity”, “chaoticity”, “self-organisation”, etc., which explains all its persisting “mysteries” and “difficult” problems, easily finding their dynamically multivalued, causally complete solution within the unreduced complexity concept [4–8] that emerges thus as the direct, qualitative *extension* of the unitary knowledge model to the dynamically multivalued reality. In particular, the properties of dynamic multivaluedness and entanglement show that *chaoticity* is *synonymous to complexity*, in their unreduced, *omnipresent* versions.

In that way the *regular* and *separated* symmetries of the unitary model, *always* (fortunately!) *violated* in the real world (cf. the concept of “spontaneously” broken symmetry), are replaced,

in the unreduced description, by the single, *intrinsically unified, but diverse in manifestations, irregular, but exact (never broken) symmetry of complexity* [4, 5]. Moreover, contrary to the artificially imposed, external origin of the conventional symmetries, mechanistically added to the postulated structures, properties, and “principles”, the universal symmetry of complexity emerges as the unique source of existence giving rise, through the explicitly obtained relations, to *all* real entities and (correct) laws, in their causally extended, complex-dynamical (multivalued) version. At a given level of system complexity (described by the above solution (4)–(9)), this irreducibly *dynamic* symmetry appears as equivalence between all (elementary) system realisations meaning their “equal chances” to emerge and permanent actual change, as reflected in the probability expression (9) (also in its relation to the wavefunction values) and dynamically probabilistic sum of the general solution, equation (8). All realisations *differ* in their detailed structure and are taken by the system in a truly random order (equations (4)–(9)), thus reproducing the *real world irregularity*, but the resulting internally *irregular* symmetry between them is *exact* as such (unbroken) and can be expressed simply as fixed realisation number for any given system (interaction process).

However, the universal symmetry of complexity does not stop there: it involves a *qualitative* change of the *form* of complexity that *preserves* its total *quantity*. Namely, the potential, or “hidden” (latent) form of complexity, called *dynamic information* (and generalising “potential energy”), is transformed into the explicit, “unfolded” form of *dynamic entropy* (extending entropy concept to any process), so that their sum, the total system complexity remains unchanged, which gives rise to all emerging entities, their properties and behaviour (reflected in particular “laws” and “principles”) [4, 5]. The basic origin of that complexity transformation is revealed by the same, unreduced interaction description, containing the *explicit emergence of always internally chaotic* entities and their interactions (given by higher, fine levels of the fractal hierarchy of unreduced interaction development).

The length element, Δx , of a complexity level is obtained from solution of the unreduced “effective” equation (4)–(5) as the distance between the centres of the neighbouring realisation eigenvalues, $\Delta x = \Delta \eta_i^r$, while the time flow rate emerges as intensity (specified as *frequency*, ν) of *realisation change*. Since the emerging space and time represent the two basic, universal forms of complexity, its universal, natural measure should be independently proportional to measures of space and time. It is easy to see that such complexity measure is provided by *action* quantity acquiring thus its extended, *essentially nonlinear*, meaning: $\Delta \mathcal{A} = -E\Delta t + p\Delta x$, where Δx , and $\Delta t = 1/\nu$ are the above dynamic space and time increments, $\Delta \mathcal{A}$ is the corresponding complexity-action increment, while the coefficients, E and p , are identified as energy and momentum. The action value always decreases ($\Delta \mathcal{A} < 0$) and represents the dynamic information, whereas complexity-entropy change is the quantity opposite in sign, $\Delta S = -\Delta \mathcal{A} > 0$, leaving their sum, the total complexity, unchanged, $C = \mathcal{A} + S = \text{const}$. Dividing the differential expression of conservation (symmetry) of complexity by $\Delta t|_{x=\text{const}}$, we get the generalised Hamilton–Jacobi equation [4, 5]:

$$\frac{\Delta \mathcal{A}}{\Delta t} \Big|_{x=\text{const}} + H \left(x, \frac{\Delta \mathcal{A}}{\Delta x} \Big|_{t=\text{const}}, t \right) = 0, \quad (10)$$

where the *Hamiltonian*, $H = H(x, p, t)$, considered as a function of emerging space-structure coordinate x , momentum $p = (\Delta \mathcal{A}/\Delta x)|_{t=\text{const}}$, and time t , expresses the implemented, entropy-like form of differential complexity, $H = (\Delta S/\Delta t)|_{x=\text{const}}$. Because of a dynamically random order of emerging system realisations, the total time derivative of action, or *Lagrangian*, $L = \Delta \mathcal{A}/\Delta t = pv - H$, should be negative (where $v = \Delta x/\Delta t$ is the global-motion velocity), which provides the rigorously derived, *dynamic* expression of the “arrow of time” orientation to growing entropy:

$$L < 0 \quad \Rightarrow \quad E, H \left(x, \frac{\Delta \mathcal{A}}{\Delta x} \Big|_{t=\text{const}}, t \right) > pv > 0.$$

Realisation change process can be considered also as two adjacent complexity sublevels whose conserved total complexity C equals to the product of complexity-entropy of localised (regular) realisations and “potential” wavefunction complexity, $C = S\Psi = \text{const}$, meaning that $\mathcal{A}\Psi = -S\Psi = \text{const}$, where Ψ is the wavefunction. The total complexity change between two transitional states equals to zero, $\Delta(\mathcal{A}\Psi) = 0$, which expresses the physically evident permanence of the *unique* state of wavefunction, and gives the generalised *causal quantization rule*:

$$\Delta\mathcal{A} = -\mathcal{A}_0 \frac{\Delta\Psi}{\Psi}, \quad (11)$$

where \mathcal{A}_0 is a characteristic action value (\mathcal{A}_0 may contain also a numerical constant reflecting specific features of a given complexity level). Using equation (11) in equation (10) we obtain the *generalised Schrödinger equation* for Ψ in the form [4, 5]:

$$\mathcal{A}_0 \frac{\partial\Psi}{\partial t} = \hat{H} \left(x, \frac{\partial}{\partial x}, t \right) \Psi, \quad (12)$$

where the Hamiltonian operator, \hat{H} , is obtained from the Hamiltonian function $H = H(x, p, t)$ of equation (10) with the help of the causal quantization relation of equation (11).

The generalised Hamilton–Schrödinger formalism, equations (10)–(12), is a universal expression of the symmetry of complexity. Expanding the Hamiltonian in equation (10) in a power series of momentum and action, one obtains a form of the universal Hamilton–Schrödinger formalism that can be reduced to any usual, “model” equation by series truncation [4, 5],

$$\frac{\partial\Psi}{\partial t} + \sum_{\substack{m=0 \\ n=1}}^{\infty} h_{mn}(x, t) [\Psi(x, t)]^m \frac{\partial^n \Psi}{\partial x^n} + \sum_{m=0}^{\infty} h_{m0}(x, t) [\Psi(x, t)]^{m+1} = 0,$$

(here the expansion coefficients, $h_{mn}(x, t)$, can be arbitrary functions), which confirms its universality and shows the genuine, unified origin of model equations, semi-empirically guessed and postulated in the unitary theory. All fundamental laws and “principles” of the conventional science, such as relativity (special and general), principle of entropy increase, principle of least action, other “variational” principles, can now be obtained, in their *causally extended, complex-dynamical* versions, from the same unified law of conservation, or symmetry, of complexity [4, 5]. Note, in particular, that the universal complexity conservation, realised by its *unceasing transformation* from decreasing dynamic information (action) to increasing entropy, provides a remarkable unification of the universal, extended versions of least action principle (conventional mechanics) and entropy increase principle (“second law” of thermodynamics), which reveals the true meaning and origin of those “well-known” laws. In a similar way, the “quantum”, “classical”, and “relativistic” effects and types of behaviour are *causally* explained now as inevitable, and thus universally extendible, manifestations of the unified symmetry of unreduced complexity [4, 5, 11]. The underlying complex (multivalued) dynamics specifies the essential difference of the symmetry of complexity from its conventional imitations: the formal “operators” of the latter are replaced in the former by actual realisation change and complexity unfolding, just forming the real, creative world dynamics (cf. Section 1).

One should emphasize the importance of genuine, *dynamically emerging*, or “essential” *non-linearity*, defined above and closely related to the dynamic multivaluedness, for the universal symmetry of complexity, as well as its fundamental difference from the conventional, mechanistically defined (non-dynamic) “nonlinearity”. The essential nonlinearity *inevitably* emerges as a result of *unreduced* interaction development, even starting from a formally “linear” initial problem formulation (see equations (1)–(7) and the following analysis). On the other hand, formally “nonlinear” equations of the standard approach, being analysed within its reduced,

unitary projection, cannot produce any truly new structure that would not be actually postulated within the starting formulation, and therefore they remain always *basically linear*, as it is confirmed by their invariably perturbative, or *exact*, solutions. The *real* nonlinearity appears as a dynamically fractal network of self-developing interaction feedback loops, explicitly revealed just in the “effective” problem expression of the generalised EP method [4–8]. This *emerging* nonlinear structure forces the system to take, or “collapse” to, *one* of its *multiple* possible realisations, which means that those realisations, *actually* and *unceasingly* replacing one another in a *dynamically random*, or “chaotic”, order, are *dynamically symmetric* among them, while they always *differ* in their detailed, partially *irregular* structure. However, the same system in the phase of transition between its normal, “localised” realisations is forced, by the *same* driving interaction, to transiently disentangle its components up to their quasi-free state of “generalised wavefunction” (see above), and that is why the system in this state temporarily behaves as a weakly interacting, quasi-linear one. This remarkable, “intermittent” structure of unreduced interaction process, remaining totally hidden in the dynamically single-valued projection of the conventional theory, explains why and how the real system dynamics naturally unifies the opposed, complementary properties of quasi-linear and highly nonlinear behaviour and symmetry. The realistic, causal explanation of “wave-particle duality” and “complementarity” in quantum systems (and classical “distributed” systems as well) is only one particular consequence of that omnipresent structure of the unreduced symmetry of complexity [4–8].

It would be worthwhile to note finally that the described conceptual transition from the conventional, dynamically single-valued (unitary) to the proposed dynamically multivalued (unreduced) description of system dynamics and the related upgrade of the separated and broken unitary symmetries to the intrinsically unified and exact symmetry of complexity involves important progress in mathematical description of reality, standing as the main, universal tool of science. We have seen that the proposed advance in that description, which practically totally eliminates the existing gap between real phenomena and their unitary “models”, is realised simply due to the unreduced, or *really exact* mathematical analysis using quite ordinary particular tools. This is certainly good news for mathematics, which can thus preserve and develop its status as a universal method and basis of *objective* knowledge about reality, the image that has considerably faded in the last period of growing “uncertainty” [10], separations, and untractable technical sophistication. On the other hand, the price that is clearly to be paid for that essential and intrinsically sustainable progress consists in the corresponding considerable, fundamentally rooted upgrade of the scholar framework, which tends traditionally to hide its real difficulties behind the externally “solid” façade of the formally fixed “existence and uniqueness” theorems and other *postulated* constructions. This report presents a brief account of the means and results of elementary realisation of that qualitative transition demonstrating, in our opinion, both its feasibility and inevitability in the future progress of science.

3 Particular manifestations of the unified symmetry of complexity

We can only briefly outline here other manifestations of the universal symmetry of complexity obtained for particular or arbitrary levels of complexity and systems. One of them is universal classification of all possible types of real system behaviour which can vary continuously between the limiting cases of *uniform, or global, chaos* (quasi-homogeneous distribution of probability for sufficiently different realisations) and *multivalued self-organisation, or self-organised criticality* (inhomogeneous realisation probability distribution, close elementary realisations) [4, 5]. It is this latter case that can be more successfully approximated by conventional, dynamically single-valued (intrinsically regular) models, though with irreducible fundamental losses (such as absence

of irreversible time flow). The universal criterion of transition from self-organised (generally ordered) dynamics to the global chaos, in both quantum and classical systems, is obtained in the form of frequency resonance between interacting modes (such as intra- and inter-component dynamics), which extends considerably the concepts of both chaoticity and resonance [4–8]. The observed alternation of globally chaotic and self-organised levels in the hierarchy of complexity is another manifestation of the universal symmetry of complexity.

Application of the unreduced existence equation solution to the simplest system of two attracting, initially homogeneous protofields gives explicitly emerging field-particles, in the form of spatially chaotic quantum beat processes, endowed with the rigorously derived, realistic and unified versions of all “mysterious” quantum features, “relativistic” effects and intrinsic properties (mass, electric charge, spin), obtained as standard, inevitable manifestations of unreduced complexity [4, 5, 11]. The number (four), dynamic origin, properties and intrinsic unification of fundamental interaction forces between particles are obtained within the same picture. The true quantum chaos, passing to classical chaos by the usual semiclassical transition, intrinsically indeterminate quantum measurement, and dynamic emergence of classical, permanently localised behaviour within a closed, bound system (like atom) are obtained as naturally emerging complexity levels, with important practical conclusions for such popular applications as quantum computers, nanotechnology, and quantum many-body systems with irreducibly “strong” interaction [4–6, 11]. The obtained “emergent” and causal world picture includes also natural solution of the problems of cosmology. Finally, symmetry of complexity manifestations for biological and intelligent systems reveal the causal essence of life, intelligence, and consciousness as high enough levels of unreduced complexity, which leads to practically important conclusions [4, 5, 7] and proves once more the universal applicability of the unreduced symmetry of complexity.

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