COMPLEXITY REVOLUTION AND THE NEW AGE OF SCIENTIFIC DISCOVERIES

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Abstract

This summary of the original paradigm of the universal science of complexity starts with the discovered exact origin of the stagnating "end" of conventional, unitary science paradigm and development traditionally presented by its own estimates as the only and the best possible kind of scientific knowledge. Using a transparent generalisation of the exact mathematical formalism of arbitrary interaction process, we show that unitary science approach and description, including its imitations of complexity and chaoticity, correspond to artificial and ultimately strong reduction of the natural plurality of unreduced interaction results called realisations to a single, "average" or "exact", realisation. This severe reduction of the natural world dynamics in unitary science underlies all its unsolvable "mysteries" and "paradoxes", persisting "difficult problems", and finally the modern "end" of the progress of just that, actually very special kind of knowledge, whose irreducible limits lead to the modern deep crisis of the global civilisation development.

We show then how the rigorously substantiated restoration of the full richness of real-world dynamics within the intrinsically unified knowledge of the universal science of complexity provides not only the causally complete solution to the old and new problems of unitary science but opens practically unlimited possibilities for the new progress of science and civilisation as a result of this crucial extension, which we call complexity revolution. The unreduced analysis of the universal complexity science shows that at the current critical bifurcation point of development, we have only two incompatible possibilities and emerging tendencies, either the dangerously growing degradation within the dominating unitary science and thinking limits (irrespective of purely empirical technology power becoming even dangerous here) or the new golden age of scientific discoveries and civilisation progress with the qualitatively extended approach and results of unreduced complexity science and the new thinking it implies.

The exact meaning of today's "end of science" and why it is also the end of progress

Ultimate simplification of reality and ambiguous empiricism of Ptolemaic knowledge development. While the growing stagnation, impasses and degradation of the mainstream, officially supported knowledge development become the more and more evident and widely recognised even within the scholar science community (see e.g. [1-14] and references therein), the genuine, *rigorously defined and universal reason* for such "unexpected" decline of traditionally prosperous science development in the age of its technological application triumph cannot be revealed within the limits of that conventional science paradigm (themselves remaining vague and ill-defined). No wonder that the fundamental reason for the conventional science impasse emerges within the *qualitatively extended* knowledge paradigm providing its *causally complete* version of the *universal science of complexity* [10-19].

This provably complete extension of the traditional science framework is based on the *unreduced interaction problem solution* revealing the *new quality* of such non-simplified solution as compared to usual, "perturbative" or "model", approximations of *any* real system, object, or process behaviour. While the conventional science approach, including its most "rigorous" expressions, presumes the *dynamically single-valued*, or linear, kind of interaction problem result and solution, the unreduced, causally complete problem solution provides the *dynamically multivalued* result of any real interaction process, containing many *incompatible* (and physically complete) system configurations, or *realisations*, which are forced, by the driving interaction itself, to *permanently replace* one another in *causally or dynamically random order* thus defined.

And since any real, necessarily *emerging* entity, object, system, or process is both a well-specified result and a source of interaction process development, we thus obtain the qualitatively extended and now causally complete description of the unreduced world dynamics and structure, implying the *naturally and universally defined dynamic complexity* of *any* real entity

and their dynamically fractal interaction results, from elementary particles, with their intrinsically unified and causally explained properties and dynamics, to living, conscious, and social systems at superior levels of this naturally emerging and dynamically unified hierarchy of world complexity [10-45].

Dynamic complexity C of any real entity, system, or process (directly related to its inherent chaoticity) is *universally defined* as any (convenient) growing function of the number $N_\Re$ of system realisations (or the rate of their change), equal to zero for the unreal case of only one system realisation (while usually $N_\Re \gg 1$):

$$C = C\left(N_\Re\right), \; dC/dN_\Re > 0, \; C\left(1\right) = 0 \; . \tag{1}$$

Whereas the majority of common (and now essentially extended) physical quantities, like action $\mathcal{A}$, energy E, mass m, or momentum p, reappear as forms of this unified dynamic complexity [12-19], various regimes of realisation emergence and change determine the *entire diversity of world structure and dynamics* varying between two limiting dynamic regimes.

Structures formed by relatively rapid change of sufficiently similar realisations constitute the ensemble of externally compact and regular entities with a well-defined shape, like rigid macroscopic bodies or classical Newtonian trajectories. This is the unified limiting regime of *self-organisation* or, in general, *self-organised criticality* (multilevel and fractally structured self-organisation). The opposite limiting regime of sufficiently different and relatively slowly (visibly) changing realisations gives cases of *global, or uniform (strong), chaos* underlying all types of explicitly random behaviour (including the origin of randomness itself).

Note, however, that even the externally regular behaviour of self-organised structures contains the intense internal chaoticity because realisations always replace one another in *causally random* order (thus giving rise to the unified origin and definition of *unstoppable and intrinsically irreversible time flow*). This is the essential difference from the conventional science paradigm (including its *imitation* of complexity) which postulates the existence of basically regular objects and trajectories that can suffer random deviations as a result of *external* influences.

The dynamically single-valued, or *unitary*, result of any conventional science approach or solution is clearly understood now as the *maximum possible, unrealistic simplification* of any real, dynamically multivalued

interaction result down to *only one*, inevitably eternally fixed (timeless) realisation, which gives rise to all the postulated "mysteries", "paradoxes", "unsolvable" problems (including the origin of unstoppable irreversible time flow), and missing or "dark" entities of this *artificially* simplified description (including all its imitations of complexity) [10-45].

This oversimplified, or "model", or "positivistic" knowledge of conventional, officially unique science doctrine of unitary theory is *not* really different from its predecessor of *Ptolemaic science*, despite the dominating idea about the great progress of the former relative to the latter. Although modern official science uses a much more diverse and precise ensemble of *empirically* discovered "models" and their "laws", it is still qualitatively far from the *genuine*, unreduced, and *totally coherent* reality *understanding*, relying instead on isolated (and often contradictory) points of "agreement between theory and experiment". And similar to ancient Ptolemaic science, modern unitary science theory is forced to introduce a growing variety of *artificially inserted*, typically abstract and *redundant entities* (particles, dimensions, etc.) that should replace the omitted diversity of real, multivalued interaction dynamics. Both ancient and modern Ptolemaic science (corresponding also to the *positivistic* general vision of knowledge) do not really care about multiple contradictions and ruptures they contain while emphasising instead a sort of practical utility of those isolated agreement points ("hypotheses non fingo", "shut up and calculate", etc.).

We argue in our approach of unreduced complexity science [10-46] and want to emphasize in this paper that this unitary, effectively zero-dimensional (point-like) simplification of reality in the conventional science doctrine is the *genuine, unified and rigorously defined origin* of all its "difficult" problems and current end-of-science stagnation, inevitably followed by its already quite visible catastrophic degradation and resulting in the equally evident decay of the entire planetary civilisation (otherwise attributed to simulative ecological, social, or medical problems by the decadent unitary science priests and managers).

We deal therefore with the real, unified core of all dangerously "global" problems, totally unrecognised by the dominating unitary thinking but also showing the *unique way of their efficient solution* by science and thinking extension to the unreduced, causally complete knowledge of the universal complexity science, which we call *complexity revolution* or *transition*. The "end of

science" appears therefore as the real end of *only that particular, quite special kind of knowledge* of unitary science *fundamentally and ultimately limited from the start*. It can and *must* be replaced now by the *beginning of genuine, intrinsically complete science* constituting the only possible basis for further progress of this technically advanced but intellectually blind planetary civilisation.

Previous visible (though always partial and contradictory) successes of unitary science were mainly due to the rapidly growing *empirical research power* concentrating on the above limiting case of externally quasi-regular, self-organised structure dynamics, but now it "suddenly" becomes limited and inefficient after the attained *complexity threshold* in all spheres of activity (often intuitively designated as "globalisation" in social spheres), above which the intrinsic simplification of unitary models and approaches fails totally and explicitly, becoming practically dangerous (see also below). That's why any further progress, let alone truly sustainable development, is *impossible* without the qualitative extension of knowledge paradigm, content, and practice from its effectively Ptolemaic unitary reduction in modern science and technology to the reality-based, dynamically multivalued complexity science and development [10-15].

Qualitative knowledge extension by the unreduced dynamic complexity paradigm. As mentioned above, the origin of the proposed qualitative knowledge extension is in the unreduced, non-simplified analysis of *interaction processes* underlying any real structure existence, dynamics and evolution. While mathematical details of this unreduced solution of the many-body interaction problem can be found elsewhere [12-20,25-41], we want to summarise them here in a more general form to emphasize the essential features and the difference from conventional science results.

Any particular formalism of interaction problem description (including the provably universal Hamiltonian formalism of our main analysis [12-20]) can be summarised in the form of a general relation between the interacting entities or degrees of freedom:

$$\mathbb{C}\big[Q,\Psi(Q)\big]=C, \tag{2}$$

where $Q=\{q_0,q_1,...,q_N\}$ is a set of interacting degrees of freedom $\{q_i\}$, $i=0,1,…,N$, of respective interacting entities or system components, $\Psi(Q)$ is the system *state-function* describing completely its configuration,

$\mathbb{C}[Q, \Psi(Q)]$ is a suitable functional (like the Hamiltonian) describing the initial system composition, and C is a numerical value of this functional. Although we deliberately do not specify here the functional $\mathbb{C}$ to maintain the generality of our outlook, it is implied to be a form of the *universal dynamic complexity C* determined eventually according to eq. (1). Equation (2) expresses then the equally universal law of the *symmetry, or conservation and transformation, of complexity* [12-19]. It is rigorously derived in our unreduced analysis from the fact that the real system complexity is determined by the number of all combinations of its interacting degrees of freedom, which does not change during the system evolution. However, keeping in mind this unified framework of the unreduced complexity science, we concentrate now on the analysis of *arbitrary* existence equation (2) expressing the fact and starting configuration of a real, unreduced interaction process.

The unreduced formulation of the many-body interaction problem in eq. (2) includes all inseparably entangled interaction links between the system components, degrees of freedom and corresponding state-function components. Therefore, this arbitrary, real interaction problem *cannot* be solved in the explicit, closed form implied by the unitary approach: it is respectively qualified as a *nonseparable* and *nonintegrable* one. But as some unitary problem solution is still needed, conventional theory performs a "convenient", ad hoc (and rough) problem simplification by cutting multiple interaction links to artificially separate the entangled degrees of freedom and obtain a closed-form expression, $\Psi = \tilde{\Psi}_0(Q)$, for the system state-function:

$$\tilde{\mathbb{C}}_0\big[Q, \tilde{\Psi}_0(Q)\big] = C , \tag{3}$$

with a simplified complexity functional $\tilde{\mathbb{C}}_0[Q, \Psi(Q)]$. Such *"perturbative"*, or *"exact"*, or *"model"*, solutions $\tilde{\Psi}_0(Q)$ are then considered as acceptable imitations of reality that can be properly adjusted to experimental data by various parameter and model variations (or simulation details in numerical solution versions). The remaining quantitative and qualitative discrepancies (like "quantum mysteries" or "dark matter") are taken as inevitable deviations to be further reduced by new models and especially their redundant new entities beyond detection by existing experimental facilities (parallel worlds, "hidden dimensions", imperceptible dark-matter particles, etc.).

Such introduction of artificial and abstract entities is often justified by a typical unitary-science trick of "(spontaneously) broken symmetry", where

a *postulated* fundamental (!) symmetry is both there and not there as if because of "spontaneous" and "unexpected" appearance of a "necessary" new entity that violates the "initially" perfect symmetry and thus provides the otherwise missing explanation. Those "broken symmetries" of conventional theory resemble thus the famous "Schrödinger cat" being both dead and alive, together with the whole resulting unitary world picture being both true and false. There should be no surprise that finally such kind of "rigorous" Ptolemaic science arrives at its end when the scope of "unsolvable" contradictions and postulated mysteries dominates so much that it makes further knowledge progress senseless in principle, irrespective of details.

To avoid those "unavoidable" impasses of unitary science, it is sufficient to remain logically honest from the beginning and consider the real interaction process description (2) in its unreduced, non-simplified version whose nonseparable formulation, with all its *unbroken* interaction links may just contain the correct, *qualitatively extended* and therefore *noncontradictory solution* devoid of broken symmetries and other obvious tricks of simplified unitary picture of reality. This approach can be specified within the *generalised effective potential method* [10-20,46], where the nonseparable interaction link network is not reduced but mathematically "transferred" from multiple interaction participants to the modified, effective interaction potential in equations for fewer interaction entities, until we obtain a formally (though not really) integrable equation for one entity with a complicated and dynamically rich form of the effective potential. This equivalent formulation of the unreduced interaction problem is more suitable for revealing the essential, qualitatively extended features of its non-simplified solution.

Transition to the effective potential formalism in eq. (2) is performed by the generalised substitution of variables (state-function components). The state-function can be conveniently presented as a combination of components describing the interacting degrees of freedom, $\Psi(Q) = \{\Psi_i(Q)\}$, $i = 0,1,\ldots,N$, transforming eq. (2) into an equivalent system of equations for $\{\Psi_i(Q)\}$:

$$\mathbb{C}_i\left[Q,\{\Psi_i(Q)\}\right] = C_i \ , \ \ i = 0,1,\ldots,N \ . \tag{4}$$

Using these equations, we then express each state-function component $\Psi_i(Q)$ with $1 \le i \le N$ through $\Psi_0(Q)$ with the help of the Green's function technique [12-20]:

$$\Psi_i(Q) = \mathcal{F}_i[\Psi_0(Q)] \ , \quad i = 1, 2, \ldots, N \, . \tag{5}$$

Substituting these expressions into the equation for $\Psi_0(Q)$ in the system of equations (4), we obtain the *effective (existence) equation* for $\Psi_0(Q)$ alone, which does not explicitly contain other state-function components transferred to the expression for the effective interaction potential (containing also other important dynamic parameters):

$$\mathbb{C}_0^{\text{eff}} \big[Q, \Psi_0(Q), \{ \mathcal{F}_i[\Psi_0(Q)] \} \big] = C_0 \ , \quad i = 1, 2, \ldots, N \, . \tag{6}$$

Solutions for $\Psi_0(Q)$ of the effective interaction equation (6) are to be used then in eqs. (5) to obtain the total system state-function $\Psi(Q) = \{ \Psi_i(Q) \}$:

$$\Psi(Q) = \big\{ \Psi_0(Q), \mathcal{F}_i \big[\Psi_0(Q) \big] \big\} \ , \quad i = 1, 2, \ldots, N \, . \tag{7}$$

It is important to emphasize that the effective problem formulation (5)-(7) is strictly equivalent to the unreduced interaction problem (2), (4), without any simplification of the latter.

However, the effective problem formulation is suitable for revealing the *new quality* of the unreduced problem solution, inevitably lost in any unitary reduction of eq. (3). The effective existence equation (7) explicitly emphasizes a key feature of the unreduced interaction process, which is only implicitly present in a usual problem formulation of eqs. (2) or (4): it is a hierarchy of *feedback loops* introducing fundamental instability in any system configuration and thus forcing the system to *permanently change* in search of its new possible configurations. This feature appears mathematically in eq. (7) as the essentially increased power of the "characteristic equation" for the system eigenvalue (usually its energy-complexity) leading to the respectively increased number of the problem eigensolutions relative to their expected number $N_0 = N^2$ as mechanically extended from the reduced problem formulation of eq. (3) [12-20]. The latter "standard" eigensolution number N_0 is obtained as N eigenstates of interacting degrees of freedom combined with N system components, which finally form the *single* (or "unique") general solution $\Psi = \tilde{\Psi}_0(Q)$ of the reduced problem (3) *incorrectly* extended in standard, unitary theory to a possible, or approximate, solution of the unreduced interaction problem of eqs. (2), (4), and (5)-(7).

The real number of unreduced interaction problem eigensolutions becoming apparent in its effective formulation (5)-(7) is $N_{\text{eff}} = N_0 N_{\mathfrak{R}} + N$, with the *number of system realisations* $N_{\mathfrak{R}} = N$ also determined by the number N

of interacting modes or, in general, their combinations (we consider here a common case example, avoiding inessential details in these expressions). We obtain therefore the *dynamically redundant* number $N_\Re$ of *equally possible* but mutually *incompatible* system configurations, each of them containing the *physically complete* "standard" eigensolution number N_0, so that the system is forced, by its driving (internal) interaction alone, to *permanently change* its realisations in *dynamically, or causally, random order* thus defined (as all elementary realisations have equal chances to appear). This causally complete, *dynamically multivalued* solution of unreduced interaction problem leads therefore to the purely dynamic, *a priori definition of probabilities* of realisation emergence (and thus of *any* real event probability) [12-20]:

$$\alpha_r = \frac{N_r}{N_\Re} \ , \quad \sum_r \alpha_r = 1 \ , \tag{8}$$

where α_r is the *r*-th realisation probability and N_r is the number of the above elementary realisations within the actually observed, in general compound, *r*-th realisation.

We also obtain, in the above complete set of $N_{\text{eff}} = N_0 N_\Re + N$ eigensolutions, an additional incomplete set of N solutions, which cannot form a usual system realisation (configuration) with $N_0 = N^2$ eigensolutions but represents the necessary intermediate, or *main*, system realisation during its unceasing transitions between those regular, strong-interaction realisations. The interacting degrees of freedom become transiently disentangled in this intermediate realisation returning the system to its initial state with effectively vanishing interaction magnitude (which explains its anomalously small eigensolution number *N*), before being again strongly entangled in the next emerging regular realisation. This special intermediate realisation is the *causally derived* and *physically real* unified extension of the quantum mechanical wavefunction and all other "distribution functions" at higher complexity levels, also called *generalised wavefunction (or distribution function)*. The generalised wavefunction $\psi(x)$ reproduces, now in a causally specified form, all the features of wavefunction and distribution functions, including the *generalised Born rule* for realisation probabilities (now causally derived):

$$\alpha_r = \left| \psi(x_r) \right|^2 \ , \quad \sum_r \left| \psi(x_r) \right|^2 = 1 \ , \tag{9}$$

where x_r is the emerging space coordinate, or dynamically emerging "centre", of the r-th realisation structure (for "corpuscular" complexity levels, the modulus squared of the generalised wavefunction for "undular" levels shown here should be replaced by its plain value) [12-18,22-28].

Returning to the unreduced, effective problem solution (5)-(7), we can summarise the revealed new qualities of its *causally complete, dynamically multivalued* version by expressing the measured system density $\rho(Q)$ as a *dynamically probabilistic* sum over system realisations (numbered by r):

$$\rho(Q) \equiv |\Psi(Q)|^2 = \sum_{r=1}^{N_{\Re}} {}^{\oplus} \rho_r(Q) = \sum_{r=1}^{N_{\Re}} {}^{\oplus} |\Psi_r(Q)|^2, \tag{10}$$

$$\Psi_r(Q) = \left\{ \Psi_0^r(Q), \mathcal{F}_i^r \left[\Psi_0^r(Q) \right] \right\}, \quad i = 1, 2, \dots, N, \tag{11}$$

where modulus squared should be replaced by the state-function value itself for corpuscular (non-undular) complexity levels, $\{\Psi_0^r(Q)\}$ is the complete set of eigensolutions of the effective existence equation (6), and the probabilistic sum sign $\oplus$ implies that individual realisation densities $\rho_r(Q)$ permanently emerge and disappear probabilistically, with the causally derived probabilities (8), irrespective of the number of events observed.

It is this, unreduced interaction problem solution (10), specified as the *dynamically multivalued* solution for *any* real system and object state/dynamics, that gives rise to the *universal complexity/chaoticity definition* of eq. (1), while any *unitary, dynamically single-valued* solution and system state/dynamics of usual theory (including all its *imitations* of complexity and chaoticity) have strictly zero value of unreduced dynamic complexity (and chaoticity) of eq. (1).

To emphasize the fundamental difference of the unreduced, dynamically multivalued solution and world description (5)-(10) from its reduced unitary version of eq. (3), we can symbolically summarise the unreduced problem solution in the following way:

$$\mathbb{C}\left[Q, \Psi(Q)\right] = C \Rightarrow \{\rho_r(Q)\}, \{\alpha_r\}, \ r = 1, 2, \dots, N_{\Re}, \tag{12}$$

with r-th realisation emergence probability α_r and system density $\rho_r(Q)$ determined by the above equations (8)-(11). At the same time, the conventional, unitary problem solution is obtained as:

$$\mathbb{C}\left[Q, \Psi(Q)\right] = C \Rightarrow \tilde{\mathbb{C}}_0 \left[Q, \tilde{\Psi}_0(Q)\right] = C \Rightarrow \rho_0(Q) = |\tilde{\Psi}_0(Q)|^2, \ N_{\Re} = 1, \tag{13}$$

with the zero value of the unreduced dynamic complexity (1), $C(1) = 0$. Note that often the single system realisation remaining in its ultimately simplified unitary description, $\Psi = \tilde{\Psi}_0(Q)$, originates in the intermediate realisation (or generalised distribution function) $\psi(x)$ of the causally complete, dynamically multivalued problem solution: $\rho_0(Q) = |\tilde{\Psi}_0(Q)|^2 \sim |\psi(x)|^2$. But instead of being just a transient system state during its probabilistic transitions between multiple regular realisations in the real system dynamics, the intermediate realisation is "upgraded" to the entire system dynamics in the unitary approximation, thus reducing the considered eigensolution number from its complete set of $N_{\text{eff}} = N_0 N_{\Re} + N$ solutions to only the last special group of N eigensolutions.

This huge qualitative difference between the multivalued, real system dynamics (12) and its oversimplified unitary scheme (13) becomes even more impressive, if we take into account that system splitting into incompatible but equally possible realisations occurs in general in many hierarchical steps, where each of the first-level realisations produces its own internal set of permanently changing realisations and so on, so that the final system structure and dynamics can be described as the multilevel *dynamically probabilistic fractal* containing a huge number and variety of probabilistically changing realisations. While the rigorous derivation of this dynamical fractal structure is obtained by the recursive application of the same effective potential method [13-16,30-41], we can provide here a simple estimate of its *exponentially huge dynamical power* as being due to the total number of all possible combinations of interacting system modes. If N is the number of interacting system modes (such as genome bases or neuron connections), then the total number of their possible combinations determining the system realization number $N_{\Re}$, its unreduced complexity C of eq. (1), and operation power P is of the order of $P \propto N_{\Re} \simeq N! \simeq \sqrt{2\pi N}(N/e)^N \sim N^N$. If N is already a great number (like $N \sim 10^{12} - 10^{14}$ in the above examples), we obtain a practically infinite, exponentially huge value of the unreduced system dynamical power P explaining e.g. the "magic" properties of life and consciousness [11-16,19,30-42]. And this huge power is totally lost in unitary science, which still insists on its impossible imitations of "complexity", "chaos", "life", and "consciousness", including sensitive applications in medicine or economy!

The qualitatively extended, dynamically multivalued character of any real entity origin and dynamics involves the natural and universal solution

of the "problem of time" desperately stagnating in the official science frame-work (and now we can see why it cannot be otherwise) [10-17,19,22-42,45]. It is not difficult to understand that *real physical time* makes a leap with each event of *unstoppable* realisation change, and it flows *irreversibly* due to the *dynamically random* choice of each next system realisation. Since the world structure emerges as a hierarchy of unreduced complexity levels, we obtain the respective *hierarchy of time flows*, where the most fundamental and "fine-grained" (high-frequency) levels of elementary particles give rise to the unified time flow of the Universe, while each emerging new level and entity contains its own, intrinsic time flows at the rate of its internal (also, in general, multi-level) realisation change processes. The related notions of *event*, *emergence*, *motion*, and *evolution* also acquire now their mathematically rigorous and universally applicable meaning (instead of purely empirical definitions in the usual science framework). In particular, time is obtained in its naturally *relativistic* version (at all levels of the unified time hierarchy), now *causally derived* from the underlying multivalued dynamics as a *physical* effect, instead of a postulated principle for the empirically postulated time flow.

Physically tangible *space* is also obtained as a *universally emerging form of complexity* determined by the uneven structure of emerging system realisations. Specifically, the *size r_0 of an emerging space point* is determined by the eigenvalue separation of the effective existence equation (6) within one realisation, $r_0 = \Delta x_i = \Delta_i \eta_i^r$, while the *elementary length* $\Delta x = \lambda$ (the minimum distance between points) is determined by the eigenvalue separation between different (neighbouring) realisations, $\Delta x = \lambda = \Delta x_r = \Delta_r \eta_i^r$. The *elementary time interval* Δt is dynamically determined by the *spatially chaotic realisation change frequency ν*, actually expressing its *intensity*, $\Delta t = 1/\nu$. The Δt value can be conveniently obtained from the elementary length λ and the velocity υ_0 of perturbation propagation in the interacting component material, $\Delta t = \lambda/\upsilon_0$. We emphasize once again that these truly *emerging* time and space definitions are obtained from the unreduced interaction description alone whose initial expressions (2), (4) do not contain any time and space variables.

The *unified law of dynamics and evolution* is obtained then from the universal symmetry of complexity (equally rigorously derived) as the time change of the integral *potential complexity* form of *generalised action $\mathcal{A}$* [12-17,26-28,31-42] (see also below). We show that each known (correct) law or

principle of usual science (empirically postulated in its standard framework) is obtained as a particular case of this universal dynamical law of the unreduced complexity evolution, which demonstrates once again the unrestricted universality and wholeness of the proposed complexity science.

We finally emphasize the essential extension of the *mathematical basis* of science underlying the obtained crucial knowledge quality progress. The intrinsically incomplete and therefore inevitably broken, abstract and contradictory framework of unitary, dynamically single-valued mathematics is replaced by the causally and technically complete description of dynamically multivalued interaction problem solutions, leading to the holistic *mathematics of complexity*, which shows the genuine, unrestricted efficiency of the truly exact "language of nature" [10-16,19]. It naturally explains the origin of several relative successes of unitary mathematics for limiting cases of externally ordered or ultimately chaotic systems (both already formed as such), with the majority of generic real system dynamics and evolution falling outside of those extreme (and further simplified) situations. While the unitary mathematics inherits ruptures, incompleteness, ultimate mechanistic simplification, and arbitrary accumulation of irrelevant abstract constructions from the general unitary science approach, the new mathematics of complexity is based on the *single universal law* of the (never broken!) *symmetry of complexity* describing the *equally unified real-world dynamical structure* as it is, in the form of *dynamically probabilistic fractal* including its own permanent, causally random change and evolution.

Unitary science is incompatible with further progress. The summary of the above presentation is the *urgent necessity of transition* to the unreduced complexity science in our understanding of all levels of reality, which we call *complexity revolution* because of the dramatic and deep changes involved. In the next section, we present a brief description of essential, problem-solving results already obtained due to the extended framework efficiency and outline perspectives of further progress possibilities, with the only alternative of dramatic degradation of the planetary civilisation and life quality appearing already in too evident forms everywhere, including the most "developed" countries and societies.

Unreduced complexity revolution in science and thinking as the unique basis for the new, unlimited progress

Unified causally complete reality instead of its fundamentally separated and superficially adjusted imitations. Any causally *complete system* of knowledge should explicitly and consistently *derive* all the observed entities and laws of their behaviour from the provably minimal, simplest, and reality-based initial interaction configuration, without any ad hoc, artificially imposed abstract "postulates" and "principles". While this completeness criterion is permanently and strongly violated in the standard, unitary science framework (actually using the *opposite* approach of maximum inconsistency and flagrant manipulation), the *universal science of complexity* [10-45] starts indeed its *explicitly emerging* world construction from the simplest interaction configuration, which progressively produces the observed, physically real world structures and entities, together with their intrinsic properties and *naturally unified* laws of their dynamics and evolution.

This simplest starting world interaction configuration includes two effectively homogeneous, structureless and timeless physical entities, or "protofields", homogeneously attracted to each other. One of them, eventually giving rise to the gravitational interaction between the emerging particles, is called *gravitational protofield* and can finally be identified as a dense enough condensate of emerging quark excitations [12-14,22-29]. The second one, transmitting the emerging electromagnetic (e/m) interactions, is the *e/m protofield* composed of a much lighter material. The origin and composition of protofields can be discussed but cannot be consistently and critically studied within this world, which *starts* from their fundamental (and the simplest possible) interaction *results*.

We show then, within our universal, dynamically multivalued interaction process description (see the previous section), how this simplest interaction development gives rise to emerging space and time, elementary particles, their intrinsic properties, naturally unified fundamental interactions, quantum, classical, and relativistic dynamical laws (without any "mysteries",

paradoxes and "spontaneously broken symmetries"), and further, more complex structure emergence and evolution [12-14,19,22-29]. While the detailed and mathematically rigorous theory is presented in the cited papers, we provide here a summary of the most fundamentally and practically important features explaining the origin of stagnating unsolved problems and postulated "paradoxes" of usual theory, which lead to wrong technological decisions and development impasses (see also [25,28]).

Massive *elementary particles* emerge in the protofield interaction process in the form of complex-dynamical, unstoppable, and spatially chaotic *quantum beat processes*, together with the first level of fundamental physical space and time. The initially homogeneous system of two coupled protofields shows instability with respect to local density pulsation, where an initial density increase tends to grow and then, after the maximum compression phase, disappears in favour of the next squeeze around another *reduction* centre. Those randomly chosen reduction (peaking-concentration) centres constitute plural and incompatible system realisations for this case (see the previous section), while the internally chaotic quantum beat process thus emerging in the initially homogeneous system is the physical essence of the simplest *elementary particle*, such as the electron. Different elementary particles correspond to different effective protofield interaction magnitudes, which are naturally quantised into two cases of relatively weak protofield interaction (and local deformation) magnitudes for the electron and other leptons and much stronger interaction magnitudes for the proton and other hadrons.

Since the naturally emerging and physically real elementary *field-particle* thus obtained permanently changes its state from the corpuscular one at the moment of maximum protofield concentration to the extended, undular state between consecutive protofield reductions, we avoid the canonical "mystery" of *wave-particle duality* from the beginning: what remains fundamentally "inexplicable" in the reduced dynamically single-valued "model" of standard unitary theory becomes the *inevitable* and *unstoppable* change of qualitatively different system states for the unreduced, dynamically multi-valued interaction process (taking the form of quantum beat for this simplest system of the first complexity level). It is not difficult to see that the common intermediate realisation introduced in the general interaction analysis of the previous section constitutes the well-specified, physically real version of extended, undular state of the *wavefunction* transiently taken by the system

between consecutive reductions towards its localised, corpuscular states of a "particle" as such. Respective rigorous analysis and quantum dynamics description in terms of the *emerging* Schrödinger equation and Born rule reflect the multivalued interaction dynamics [12-14,22-29] (see e.g. eq. (9)).

It is important that already this lowest level of emerging world structure is characterised by *positive* (and big enough) *dynamic complexity* and chaoticity as determined by the number of *explicitly obtained* system realisations according to the universal definition of eq. (1). Thus, the realisation number of the isolated electron $N_{\mathfrak{R}}^{e}$ is of the order of inverse fine-structure constant $\alpha \simeq 1/137$, $N_{\mathfrak{R}}^{e} \sim 1/\alpha = 137$ (up to a numerical constant of the order of π) [12-14,25-29], while larger structures generally possess much higher realisation numbers and complexity values.

The unreduced dynamic complexity of each emerging elementary particle is causally related to the origin of mass and fundamental physical time. Indeed, the property of *inertia* and *mass* is due to the irreducible *chaoticity* of the internal realisation change process within each matter particle (the process of quantum beat for the elementary particles) because the existence of this internal particle dynamics with random deviations necessitates finite efforts for its modification towards a regular motion tendency. The same chaotic realisation change process determines the *unstoppable irreversible flow* of the most fundamental level of *real physical time* and the emergence of *space* elements (see the previous section for respective general description). Mathematically, the value of mass-energy-complexity is universally determined by the *temporal rate (frequency)* of realisation change:

$$E = mc^2 = -\frac{\Delta \mathcal{A}}{\Delta t}\Big|_{x=\text{const}} = \frac{h}{\tau} = h\nu \,, \tag{14}$$

where E is the total energy and *differential complexity measure* proportional to the system mass m (the rigorous derivation of this natural complex-dynamic relation, with c being the speed of light, can be found in the cited papers), the extended *action-complexity* $\mathcal{A}$ is a universal integral measure of unreduced interaction complexity (here of the quantum beat process), the quantum beat period $\tau = \Delta t\big|_{x=\text{const}}$ and frequency $\nu = 1/\tau$ express the *physically real wave-particle duality*, and the *Planck constant* $h = \Delta \mathcal{A} = \mathcal{A}_0$ naturally and rigorously emerges as the characteristic change and value of *action-complexity* remaining *discrete* due to realisation discreteness but also *fixed* and *universal* at this *lowest* complexity level [12-14,22-29].

Similarly, space emerges in connection with the extended universal definition of *momentum* as another differential complexity measure characterising the *spatial rate* of system realisation change:

$$p = \frac{\Delta \mathcal{A}}{\Delta x}\bigg|_{t=\text{const}} = \frac{h}{\lambda} \ , \tag{15}$$

where $\lambda = \Delta x|_{t=\text{const}}$ is the size of emerging spatial inhomogeneity of the average, global part of the moving system (here field-particle) structure at a fixed time moment. The same field-particle system performs many *spatially random* jumps (corpuscular realisation changes) around this average structure-forming tendency, which contribute to the property of inertial mass defined in eq. (14). It is not difficult to see that eq. (15) is equivalent to the *de Broglie wavelength definition*, $\lambda_{\text{B}} = h/p$, where we can see its *physically real origin* in the quantum-beat pulsation of a globally moving field-particle interaction process.

Equations (14) and (15) can also be interpreted as expressions of the famous quantum *uncertainty relations*, which remain mysterious in standard quantum theory but actually express an aspect of the *physically real* wave-particle duality of the multivalued quantum beat process, where localised field-particle states are naturally transformed to the extended wavefunction structure and back:

$$p\Delta x = h \ , \quad E\Delta t = h \ , \tag{16}$$

where for small values of p and E, $p = \Delta p$ and $E = \Delta E$ (and these "quantum uncertainties" cannot vanish for the *dynamically discrete* quantum beat process with the finite value h of action-complexity change).

Due to the *universality* of inertial mass definition in eq. (14) as a differential complexity measure characterising the temporal rate of *spatially chaotic* realisation change (starting from the quantum beat pulsation), one *does not need* a special particle species, the Higgs boson, artificially introduced in unitary theory as the missing "source of mass" and now becoming redundant (with multiple contradictions of non-universality, absence of the gravitational aspect of mass, etc.) [12-14,22-29]. What is measured as the Higgs mass-energy resonance in accelerator experiments can be much more consistently interpreted now as the energetic magnitude of protofield attraction and mechanical strength [29]. This conclusion alone, together with other ones (see below), implies a necessary change of the entire research strategy

of extremely resource-consuming high-energy physics experiments (huge accelerators, space and underground research). Indeed, the intrinsic causality of the universal complexity science fundamentally excluded from ultimately reduced abstract models of unitary science implies the *essential transition* from the technically powerful but intellectually blind, empirically based search of the latter to the logically consistent and therefore *exponentially more efficient progress* of the causally complete science of explicitly emerging and physically real entities (see also below). This is the fundamental-physics part of the *complexity revolution* further developing at higher complexity levels, with the same result of exponentially higher efficiency.

This universal complex-dynamic origin of mass in the quantum beat dynamics naturally leads to *dynamically derived* (rather than postulated) *relativity intrinsically unified now with quantum behaviour* of the same field-particle process [12-14,22-29]. It can be briefly demonstrated starting from the usual expression for the total derivative of action-complexity $\mathcal{A} = \mathcal{A}(x,t)$:

$$\frac{\Delta\mathcal{A}}{\Delta t} = \frac{\Delta\mathcal{A}}{\Delta t}\Big|_{x=\text{const}} + \frac{\Delta\mathcal{A}}{\Delta x}\Big|_{t=\text{const}} \frac{\Delta x}{\Delta t} = p\upsilon - E ,$$

or

$$E = -\frac{\Delta\mathcal{A}}{\Delta t} + p\upsilon = \frac{h}{T} + \frac{h}{\lambda}\upsilon = hN + p\upsilon , \tag{17}$$

where the total energy E and momentum p are defined according to eqs. (15), (16) (with their extended complex-dynamical meaning), υ is the global motion velocity,

$$\upsilon = \frac{\Delta x}{\Delta t} , \tag{18}$$

and $\Delta t = T$ is the "total" value of the quantum beat period ($N = 1/T$ is the corresponding frequency) describing the chaotic field-particle jumps around its global motion tendency of the second summand of eq. (17). As that internal system dynamics within its global motion tendency determines the internal system time flow (in its "rest frame"), we can see already the real *physical origin* of relativistic time dilation with growing global motion velocity as being due to the growing proportion of that global motion energy (the second summand in eq. (17)). The key point here is the physically real *complex-dynamic origin of time* described above: it is the total energy of the *same* chaotic quantum beat dynamics which is unevenly distributed between the global motion and the "time production" part of the internal system dynamics.

Using in eq. (17) additional, dynamically derived relations for the multivalued quantum beat process, $p = E\upsilon/c^2 = m\upsilon$ and $T\tau = (\tau_0)^2$ (with τ defined in eq. (14) and quantum beat period in the rest frame $\tau_0 = 1/\nu_0 = h/E_0$), we can represent the complex-dynamic energy partition of eq. (17) and related dynamic relativity basis in its final form [12-14,22-29]:

$$E = h\nu_0 \sqrt{1 - \frac{\upsilon^2}{c^2}} + \frac{h}{\lambda_{\mathrm{B}}}\upsilon = m_0 c^2 \sqrt{1 - \frac{\upsilon^2}{c^2}} + \frac{m_0 \upsilon^2}{\sqrt{1 - \frac{\upsilon^2}{c^2}}} , \qquad (19)$$

$$T = \frac{\tau_0}{\sqrt{1 - \frac{\upsilon^2}{c^2}}} , \quad N = \nu_0 \sqrt{1 - \frac{\upsilon^2}{c^2}} , \qquad (20)$$

$$m = \frac{E}{c^2} = \frac{m_0}{\sqrt{1 - \frac{\upsilon^2}{c^2}}} , \qquad (21)$$

where the causal time dilation of eq. (20) is easily complemented by equally universal relativistic mass transformation, eq. (21), and other related effects of special relativity (now in their causally complete, physically real version, without any reference to abstract ad hoc postulates of usual theory). We see that there is no contradiction now between quantum and relativistic effects, which are *intrinsically unified* instead by their common origin, the multivalued quantum beat dynamics. It is important to note that this unified quantum and relativistic behaviour includes not only fundamental physical entities from the lowest complexity levels but can be extended to all higher levels of complexity, time and space [12,13,27,31,45].

This causally complete, essentially *dynamic* and therefore *naturally unified* character of all fundamental laws and entities in our world picture continues to higher complexity sublevels of *interacting field-particles*. We obtain here the physically real origin, major features and the exact number of fundamental interaction forces (dynamically unified from the beginning), and related intrinsic particle properties, as well as the causal link between the dynamically emerging forces and space dimensions (instead of empirically postulated or arbitrarily invented entities in usual theory).

The observed *number of spatial dimensions* for our world, $N_{\mathrm{dim}} = 3$, is *causally obtained* in the universal complexity science as the global realisation

number of the world determined by the number of global interaction components, i. e. two protofields plus their uniform coupling. In general, a universe emerging from n interacting protofields coupled by m global interactions should have at least $N_{\mathrm{dim}} = n+m$ global spatial dimensions. Depending on the protofield interaction details, the number of emerging spatial dimensions may be given by another growing function $N_{\mathrm{dim}}(n,m)$ [12], but always with the *exact correspondence* between the number of interacting global fields and the emerging dimension number, since real space and its dimensions directly *emerge* as dynamically entangled states (realisations) of those global interacting entities. This *causal, dynamic origin* of *tangible* physical space and its dimensions is very different from abstract constructions and arbitrary assumptions of usual theory, where one can add any redundant numbers of various fields (such as the Higgs field) or "hidden dimensions", replacing the absent *dynamic origin* of all observed entities and properties.

Similarly, the observed fundamental forces of interaction between field-particles are explicitly obtained as a result of the underlying protofield interaction processes (in the form of quantum beat), including their intrinsic unification and known properties. In a world emerging from n protofields coupled by m global interactions, the quantum beat pulsation process gives rise to nm long-range interaction forces (through n respective protofields), while the additional n short-range interactions simply reflect the underlying structures of respective protofields (with their fundamental elements remaining weakly perceivable from the emerging world levels). For our world parameters, $n = 2$, $m = 1$, we obtain two long-range forces (electromagnetic and gravitational interactions, explaining the names of respective protofields) and two short-range forces (weak and strong interactions, within the e/m and gravitational protofields respectively), all of them being *dynamically unified* by the quantum beat process within every massive field-particle. The most complete unification is obtained for heavier, strong-interaction realisations of protofield interaction (forming hadrons), while much lighter and weaker-interaction realisations (leptons) can unify only three actually present interactions (electromagnetic, weak, and gravitational forces). We also obtain a physically transparent explanation of separate "closer" unification of forces within each protofield: the known (but now causally understood) electro-weak unification within the e/m protofield and the *gravity-strong unification* within the gravitational protofield, unknown in usual theory. The

latter conclusion means that the same interaction between the elements of the gravitational protofield that gives rise to the short-range strong interaction underlies the long-range gravitational interaction. And we also obtain here the most probable physical structure of the gravitational protofield as a "quark(-gluon) condensate" [12-14,22-29].

Since the number and physical (dynamic) origin of space dimensions, particle species and fundamental interaction forces are causally, rigorously determined in that way by the underlying global interaction process, they cannot be arbitrarily added as it is permanently done in usual theories, including the Higgs field, interaction, and particle, "dark matter" particles, and other "hidden dimensions". In particular, it is not difficult to obtain the connection between the number of dimensions $N_{\dim} = n+m$ and the number of fundamental forces $N_F = n(m+1)$: $N_F = n(N_{\dim} - n + 1) = (m+1)(N_{\dim} - m)$, which gives $N_F = 2(N_{\dim} - 1)$ for our world with $m = 1$. Therefore, one cannot arbitrarily and independently vary the quantities of N_F and $N_{\dim}$.

The observed features of particle interactions and the related *intrinsic particle properties* (electric charge, spin, and gravitational mass) are also causally derived as dynamic features instead of their empirically based postulation in usual theory. Electromagnetic interactions between field-particles emerge due to the e/m protofield deformation by their quantum beat processes. This deformation interaction can be considered as the exchange of weak e/m protofield excitations called *photons*, but now they are quite *real* excitations, rather than abstract "virtual" photons from usual theory. To obtain permanent interaction features (attraction of unlike and repulsion of like electric charges), one must have the exact temporal *phase correlation* between quantum beat processes of *all* (electrically charged) elementary particles, where all elementary charges of the same sign pulsate in phase, while all opposite-sign charges pulsate in antiphase. We obtain thus a causal and unique explanation not only for the observed features of electromagnetic interactions but also for the *continuous and unified time flow throughout the Universe* [12-14,22-29]. The property of (elementary) electric charge itself acquires its *causally complete, dynamic meaning* as the expression of those phase-ordered quantum beat self-oscillations with a well-defined (or "quantised") magnitude, in accord with the well-known relation between the elementary charge e and the Planck constant $\hbar = h/2\pi$ (also expressing the quantum beat magnitude, but irrespective of its phase): $e^2 = \alpha c \hbar$, where α is

the fine-structure constant, and c is the speed of light. The reality of quantum beat within elementary particles is thus additionally confirmed.

We also obtain the dynamic origin of the intrinsic particle property of *spin* as being due to the highly nonlinear pulsating-vortex motion of the e/m protofield around its reduction centre in the quantum-beat pulsation cycle. It is due eventually to the shear instability in the e/m protofield matter during its self-amplifying compression, similar to the dynamics of fluid passing through a narrow hole. Taking into account this two-component (oscillation and rotation) structure of quantum-beat cycles, we can rewrite the energy-frequency relation (14) for the field-particle at rest, $E_0 = h\nu_0$, as a sum of two respective contributions: $E_0 = h\nu_0 = \hbar\omega_0 = h\nu_0/2 + s\omega_0$, where $\omega_0 = 2\pi\nu_0$ is the circular frequency of quantum beat and $s = \hbar/2$ is the observed "anomalous" angular momentum of the particle spin (for the simplest fermion). We see that the oscillatory energy part, $E_0/2 = \hbar\omega_0/2$, coincides with the fundamental quantum expression for the oscillator ground-state energy.

We also obtain thus the causal origin of the magnetic field as being due to (partially) ordered vorticity of many individual spin vortices (more in the extension phase of respective quantum beat processes). This causal origin of electric charge, spin and e/m fields includes also the equally causal explanation of the (now emergent) classical electrodynamic laws [12], beyond empirical postulates and abstract entities of usual theory.

Another fundamental long-range interaction force, naturally emerging in our coupled protofield system, is due to the deformation interaction between quantum-beat processes through the gravitational protofield medium. However, as our world structure is asymmetrically displaced towards its e/m protofield side, this *gravitational* long-range interaction between particles is a much weaker and less direct one, without phase correlation and quanta-exchange mechanism (also due to a more fluidic nature of the gravitational protofield). Particle quantum-beat processes influence one another here rather by density (or internal tension) variation of the gravitational medium (probably a quark-gluon condensate) around them. That is why we have only attractive interaction between the gravitational "charges", which are particle masses automatically and naturally acquiring thus the gravitational power proportional to their inertial property (14) (for weak enough, "nonrelativistic" interaction magnitudes). We see that the famous "principle of equivalence" also naturally and causally emerges within the same unified

picture, without the necessity of any abstract postulation (and contrary to its total absence in the canonical Higgs origin of inertial mass).

The laws of *general relativity* for thus obtained emergent gravity then equally naturally follow, in their *intrinsic unity* with both emergent special relativity (17)-(21) and quantum behaviour [12-14,22-29]. The basic causal origin of time flow dependence on the gravitational field is due to the fact that both time flow and gravitational field are determined by the same quantum beat process within each massive elementary particle. Specifically, the gravitational protofield density becomes inhomogeneous in the presence of quantum beat processes, which leads to respective coordinate dependence of any test-particle mass-energy in relations (14):

$$M(x)c^2 = h\nu(x) = mc^2\sqrt{g_{00}(x)}, \qquad (22)$$

where $\nu(x)$ is the test-particle quantum beat frequency (determining the local causal rate of time flow), $M(x)$ is its total mass, m its relativistic mass in the absence of gravitational field (i.e. other bodies), and usual theory's "metric" $g_{00}(x) < 1$ actually describes the spatial distribution of the gravitational protofield density/tension. Since for weak fields $g_{00}(x) = 1 + 2\varphi_g(x)/c^2$, where $\varphi_g(x) < 0$ is the gravitational field potential [47], eq. (22) describes the *causally derived time dilation in gravitational field* (instead of formal postulates about geometric "curvature" of a formal "mixture" of abstract space and time in usual theory), where both time and gravitational field are now *intrinsically quantised from the beginning*.

This unified and physically sound complex-dynamical origin of particle properties and interaction forces includes a natural solution to the stagnating problem of the hierarchy of particle mass spectrum related to conventional Planck units [12-14,22-29]. The latter are obtained in usual theory as purely formal combinations of the Planck constant $\hbar$, the speed of light c, and the gravitational constant γ with the dimensions of mass, space, and time, supposed to correlate with the observed particle properties, but showing instead too extreme values, which imply, in particular, inexplicable huge gaps in the particle mass spectrum. In our theory Planck units would reflect the extreme values of the *physically real* quantum beat processes within the observed elementary particles, where the *effective value* of the relevant, *short-range* gravitational constant $\gamma_0 \gg \gamma$ (close to strong-interaction parameters, in accord with the above unified interaction picture) should rather be

derived from the observed extreme values of particle mass (or size):

$$M_{\mathrm{P}} = \sqrt{\frac{\hbar c}{\gamma_0}} \simeq 10^{-22} - 10^{-21} \text{ g } \left(10^2 - 10^3 \text{ GeV}\right) = m_{\mathrm{exp}} \ , \tag{23a}$$

$$L_{\mathrm{P}} = \sqrt{\frac{\gamma_0 \hbar}{c^3}} \simeq 10^{-17} - 10^{-16} \text{ cm} = l_{\mathrm{exp}} \ , \tag{23b}$$

$$T_{\mathrm{P}} = \sqrt{\frac{\gamma_0 \hbar}{c^5}} \simeq 10^{-27} - 10^{-26} \text{ s} = t_{\mathrm{exp}} \ , \tag{23c}$$

$$\gamma_0 = \left(\frac{m_{\mathrm{P}}}{m_{\mathrm{exp}}}\right)^2 \gamma \simeq (10^{33} - 10^{34})\gamma \ , \tag{24}$$

where m_{exp}, l_{exp}, and t_{exp} are the measured extreme values of particle mass, characteristic length (size), and time, coinciding with the corresponding modified Planck units M_{P}, L_{P}, and T_{P}, while the effective gravity-strong interaction constant γ_0 can be obtained from the ratio of usual, formal Planck mass m_{P} to the observed extreme mass m_{exp}. We thus resolve the conventional "hierarchy problem" and demonstrate once again the physically real origin of particle mass spectrum looking now quite naturally (see also above for the lepton and hadron mass origin), together with the relative weakness of usual, long-range gravitational constant γ.

Moreover, the wholeness of thus obtained picture of the protofield interaction result includes the explanation for the approximate coincidence of the *highest mass of stable atomic nuclei* with the modified Planck (and extreme particle) mass $M_{\mathrm{P}} \simeq m_{\mathrm{exp}} \simeq 100 \text{ GeV}/c^2$ as being due to the nuclei's dense, strong-interaction structure behaving like a big elementary particle in terms of extreme mass values. Indeed, higher mass values of any strongly interacting *single* object would simply destroy the underlying protofield material exceeding its internal interaction strength, which also explains why it is impossible to separate a single quark from the quark condensate of the gravitational protofield. Similarly, the same scale of energy, $E \simeq M_{\mathrm{P}}c^2 \simeq 100 \text{ GeV}$, gives the electro-weak interaction scale and the observed resonance of the "Higgs mass" as being due to the highest magnitude of the protofield interaction close to the physical strength of the protofield material and system.

This ultimate unification of many isolated facts and features, now causally explained, shows the power of our causally complete interaction analysis and leads to *essential changes* in many directions of conventional science,

from the *strategy of high-energy physics* (where new, ever more powerful accelerators are of no need anymore) to various fields of applied conventional theory (such as *cosmology*) essentially based on the usual, unreal values of Planck units. Instead of blindly searching in vain in these purely abstract dimensions of usual theory, the new, causally complete physical research should concentrate on the unreduced, complex dynamics of already known particle species within the attained energy scales. This is also the way to the *new sources of energy* necessarily based on the *unreduced complex dynamics* of interacting particles, fields, and nuclei.

Referring to a more detailed analysis elsewhere [12-14,22-29], we can also emphasize here our causal explanation of the *physical, dynamic origin of all fundamental constants* and intrinsic particle properties as a part of the obtained *holistic* picture of the emergent, interaction-based universe. Thus, even the simplest constant, the *speed of light c* is the speed of the e/m protofield excitation propagation in its material coupled to the gravitational protofield (which is the *physically real content* of the abstract conventional "vacuum"), instead of the postulated maximum speed of any signal propagation in standard relativity. The dynamic origin and manifestations of the *gravitational (or gravity-strong) constant* γ, γ_0 are described above, as well as those of the *elementary charge e*. The complex-dynamic analysis of the standard relation $e^2 = \alpha c \hbar$ reveals both the dynamical meaning of the *fine-structure constant* α (already mentioned above) and the *fundamental physical origin of the Planck constant* $\hbar$ and its *universality* for *any* small-scale entity or process. The fine-structure constant is determined by the number of realisations of the electron as a complex-dynamical process and coincides (eventually up to a numerical factor) with its realisation probability, $\alpha \sim 1/N_{\mathfrak{R}}^e = \alpha_r$, where α_r is given by our unified definition of the latter, eq. (8). The Planck constant determines the universal value of the effective potential well volume for the protofield interaction in terms of action-complexity, which depends only on the protofield material and interaction magnitude remaining unchanged for both strong-interaction species and processes with a deep and narrow effective-potential well (hadrons, nuclear interactions) and weak-interaction species and processes with a shallow and wide effective-potential well (leptons, atomic interactions). We can again evoke here the universal symmetry (conservation) of complexity.

The *next complexity level* is naturally obtained as unreduced field-particle interaction dynamics and results in the form of *quantum measurement* for slightly dissipative interactions, (genuine) *quantum chaos* for non-dissipative dynamics, and *classical behaviour emergence* in elementary bound (and closed) systems like atoms [12-14,20-29].

The *causal, physically transparent* versions of the canonical *Dirac quantisation rules* and *related Schrödinger and Dirac equations* for interacting field-particle dynamics are rigorously derived as manifestations of the universal symmetry of complexity for interacting quantum beat processes [12-14,23-29]. They include the nontrivial involvement of universal mass-energy-complexity defined above (eq. (14)) and describe the interaction-driven patterns produced by the underlying unstoppable quantum beat processes (providing a physically real version of mystified "quantum jumps" from standard quantum theory).

Causal quantum measurement picture is obtained as the unreduced complex-dynamic interaction of *quantum* field-particles in the situation of moderate energy leaks towards a properly structured (macroscopic) measurement device or system configuration [12,13,21]. It is important that due to the underlying dynamically chaotic jumps of quantum beat processes, the measured quantum system *really* takes all the possible "eigenstates" in *dynamically random order* (even without the actual measurement), with the dynamic probabilities of eqs. (8) and (9) (the Born rule) often corresponding to the self-organised critical states around measured values and dissipative leaks. This kind of behaviour necessarily looks confusing within the dynamically single-valued vision of standard theory limited to only one system trajectory, where many equally possible but incompatible system states *cannot permanently exist and chaotically change for one another*. Hence its separately introduced and highly mystified "quantum measurement postulates" completing the *illusively* smooth unitary quantum evolution and vaguely explained by *external* influences of measurement with "decoherence" and "quantum state reduction" (absent in our description).

In this connection it is important to mention a similar complex-dynamic solution within our causally complete picture of another canonical "quantum mystery", that of *quantum entanglement* and related "spooky action at a distance". Here too, the initial close interaction between particles or quantum systems in general implies, in its causally complete complex-

dynamic version, certain *correlations* between temporal and spatial degrees of freedom of internal quantum beat processes, which *persist* after their separation over any large distance (in the absence of other strong interactions), so that any correct measurement on those separated and externally "independent" objects will *inevitably* reveal the persisting correlations between their internal dynamic quantities looking mysterious in the absence of internal degrees of freedom in unitary theory.

The case of *quantum chaos* concerns the nondissipative, Hamiltonian quantum system dynamics, where usual theory encounters a *fundamental problem* of *absence of genuine dynamic randomness* in quantum Hamiltonian systems because of quantum dynamics discreteness and related stability with respect to small perturbation amplification constituting the canonical chaos origin in classical systems. The basic *unitarity* of standard quantum dynamics excludes any random deviations (until they "mysteriously" appear in the quantum measurement process through a special ad hoc postulate), thus *violating the fundamental correspondence principle*, according to which quantum dynamics should pass to its classical version in the classical limit $\hbar \to 0$ (e.g. with growing masses of system components). Needless to say, this problem does not even appear in the dynamically multivalued interaction description, which is applicable, due to its universality, to both classical and quantum systems, where it reveals the same plurality of system realisations and their change in random order (eqs. (6)-(12)) providing *natural and genuine quantum chaos* that passes to its classical analogue (now also extended) upon usual quasi-classical transition [12-15,20,27,28,30-32,46].

This intrinsic and genuine dynamic randomness in any real, multivalued quantum system dynamics has fundamental implications for the *feasibility of unitary quantum computers* and various *nanobiotechnological applications*. Since truly quantum systems are situated close to the bottom of the world interaction hierarchy, characteristic interaction parameters (like intra- and inter-element frequencies or level spacings) are necessarily of the same order implying a *strong, or global, chaos regime* with explicit genuine randomness that *cannot* be suppressed by any "chaos-control" schemes, at these lowest, quantum complexity sublevels. And this means that even in an ideal, noiseless system, without any external influences, real interactions within such an ideal quantum machine will themselves produce a lot of truly random and essential deviations violating unitary dynamics. The unitary

theory approach cannot reveal this major problem because it cannot find the origin of genuine quantum chaoticity and tries to concentrate therefore on "decoherence suppression" techniques and "fault-tolerant" schemes of quantum computation. The unreduced interaction analysis shows, however, that they are useless in principle, because of much larger and irreducible randomness inherent in Hamiltonian system dynamics.

The same estimate of high intrinsic chaoticity is valid for the real *nanoscale machines* falling within that group of lowest interaction sublevels. While it limits any unitary (e.g. quantum) machine feasibility, it opens quite different, *complex-dynamic* perspectives of high efficiency realised, in particular, in living systems and explaining their "magic" properties [13-16,30-32]. If we liberate our approach to include the unreduced, dynamically multivalued interaction possibilities, we can profit from the effect of *exponentially huge efficiency* of such unreduced chaotic dynamics (see the end of the first section for a detailed estimate) and move towards a new kind of "living machines" or "active condensed matter" [15] realising the full power of living structures in artificially designed systems. This approach leads also to the real possibility of *artificial but genuine intelligence* and *machine consciousness*, as well as complex-dynamical, truly intelligent (autonomous) computer, control, and communication systems [36-40].

Finally, the highest interaction sublevel in this lowest group of emerging complexity levels is that of elementary classical behaviour obtained in a closed Hamiltonian nano-system, without any "decoherence" from the environment and macroscopic limits of unitary theory [12-14,25-28,31]. It appears that this first classical complexity level is obtained in the *simplest bound systems*, such as atoms, due to the nontrivial role of *internal chaotic dynamics* (quantum beat) of each of the bound system components that limits the compound system ability to perform larger quantum jumps and walks as a whole. It is easy to show that the probability of bound system wandering falls exponentially with distance exceeding a characteristic length of the order of Bohr radius (for the simplest case of the hydrogen atom). Therefore, any such bound system of *essentially quantum* components will "suddenly" show a quite different, permanently localised kind of behaviour known as "classical" and representing here the lowest level of self-organised criticality, or "confined chaoticity", without any artificially inserted external "decoherence" of unitary theory. This origin of classicality as a *higher complexity level*

is confirmed by the (partial) *recurrence of quantum behaviour* for large enough but *properly interacting* systems (such as large molecules), where quantum wondering is recovered due to those additional interactions with measuring device or larger system elements (while the decoherence theory fails in such cases). We see that *no macroscopic system size or influence* is essential for classical behaviour emergence (as postulated in the standard theory), which originates instead in the *dynamically multivalued, truly random* internal state of each real object, starting from elementary particles (giving *microscopic elementary classical systems*, in the form of *isolated atoms*).

The obtained *intrinsically emerging*, interaction-driven and *naturally unified* character of our *complex-dynamical world* picture is particularly important for *cosmology*, which is a theory of world emergence and evolution as a whole. Correspondingly, the standard, unitary cosmology only tries to guess empirically some stages of universe dynamics but necessarily encounters multiple "insoluble" problems, all of them being due to the artificially limited, dynamically single-valued origin of any unitary theory of the official science paradigm. All the known and always growing problems of the standard mechanistic Big Bang scenario, including the "fine-tuning problem", dominating dark matter and energy, numerous contradictions of the proposed redshift interpretation and the too-small age of the universe, do not even appear in our provably minimal interacting protofield configuration if only one applies the *unreduced*, dynamically multivalued interaction analysis to follow the *naturally emerging* world structure [12-14,26-28].

Thus, the *fine-tuning problem* and the closely related "anthropic principle" do not even appear in the complex-dynamical world evolution because, as we briefly described above (see also the cited references), all the observed entities, including particles (matter), their interactions, and even "fundamental constants", have an intrinsically coherent dynamic origin containing mutual adaptation in its very basis (being the global self-organised criticality case). The quantity of matter in the universe is saturated just where it should for a generic (not anomaly small or great) protofield interaction magnitude, with the dynamically emerging secondary interactions (being the "fundamental" interactions between particles) that follow the same dynamic adaptability mechanism. However, due to a much greater "quantity of motion" (and thus of energy and mass) in the unreduced, dynamically multivalued interaction result as compared to its artificially limited projection in

the unitary description, the real universe contains much more energy and mass in its natural, essentially chaotic structure, which explains the (false) problems of dark mass and energy, as well as various other contradictions of the effectively zero-dimensional unitary model. We also obtain the *unstoppable, irreversible and unified (continuous) time flow* for the *entire universe*, which is far beyond the limits of unitary cosmology unable even to provide any reasonable origin of time and space, its basic entities.

It is important also that our unreduced complex-dynamic cosmology, contrary to its unitary imitation, does not stop at the physical structure emergence and includes, as it should, the *entire hierarchy of complex-dynamical world structures*, from the elementary particles and fundamental physical laws (now *rigorously derived* and *causally specified*) to the most complex world entities and phenomena, such as life, intelligence, consciousness, and the key notions from the conventional humanities and arts (now also rigorously and causally specified), not excluding even spiritual and other "ultimate" notions [12-16,19,33-45]. The anthropic-principle ideas are thus transcended again, now in the ultimately complete way. Here we can only briefly refer to the origin and *unreduced dynamics of life* and *causally complete genomics* totally changing the entire set of respective unitary imitations and dangerous experimental practices [12-16,33-35] as illustrated by the underlying phenomenon of the exponentially huge power of unreduced complex dynamics (see the first section). The *causal complex-dynamic origin of intelligence and consciousness* [12,13,36-40] also opens a wide scope of applications of superior efficiency, especially as compared to the glaring deficiency of respective unitary theories. Finally, the perspective of *edge research* program [13] emerges as superior complexity levels beyond those of directly observed material structures, but now equally causally obtained and explored. One should neither forget the "intermediate" or global-consciousness sublevels of interacting conscious subjects, usually studied in social sciences but now acquiring critical practical importance far beyond their usual scope, due to the emerging global *complexity revolution* (see the first section) [10-16,41-44], which leads, in the *now emerging* future, either to the superior-level civilisation or to the fatal degradation, without any "moderate" possibility between them.

One should emphasize the *intrinsically unified* character of the obtained causal world structure and dynamics, in both their physical, real-

world emergence and causally complete mathematical description [10-19] (see also the first section here), in sharp contrast to the irreducibly separated abstract models of unitary science. The *dynamical structure of the world*, including all its manifestations at all complexity levels, is obtained as the permanently changing structure of the *dynamically probabilistic fractal*, while the *single unified law* of this world structure dynamics and evolution is provided by the *universal symmetry, or conservation and transformation, of complexity* including the causally extended versions of all correct principles, laws, and dynamic equations. Among them, we can mention *all major conservation laws* now naturally unified with the *universal law of change* from the *dynamic action-complexity* to the *dynamic entropy-complexity* (the generalized second law of thermodynamics, or energy degradation principle, now including the extended least action principle) and the *unified Hamilton-Schrödinger formalism* as the universal description of any system dynamics within a given complexity level.

The dynamically probabilistic fractal of the world structure can be further specified as an irregular alternation of *two major types of dynamic regimes*, the *global, or uniform, chaos* and *self-organised criticality*, so that all the observed system states and processes vary between those two limiting cases of strong chaoticity and external regularity, with the rigorously specified *criterion* of transition between them in terms of the value of the *chaoticity parameter* κ [12-16,18-20,26-28,30-40]. Contrary to the fundamentally inconsistent ideas of unitary science, the intrinsic dynamic randomness and unreduced complexity are present within *any* real structure and dynamics, though often in a self-organised or confined-chaos regime, while the notion of (now genuine) dynamic randomness itself is totally different from the wrong canonical idea of "exponentially diverging trajectories" and originates in the plurality of any system realisations absent in conventional interaction description (including all the imitations of unitary "complexity science").

The number and scale of the obtained practical, problem-solving and "life-changing" applications, from fundamental physics and cosmology to life sciences and further civilisation development is but a natural manifestation of the huge extension from the essentially Ptolemaic level of abstract and separated unitary guesses in conventional science to the causally complete picture of the now intrinsically unified reality in the universal science of complexity. The practical transition to the objectively correct description of the

latter called here the *complexity revolution* becomes *critically important and urgently needed* now, as the universal law of evolution mentioned above and applied to the global civilisation development shows the objective signs of deep degradation tendency *inevitably* replacing the absent progress that cannot be maintained any more at the outdated level of unitary, Ptolemaic world vision. The epoch of deliberate reduction and therefore inevitable destruction of genuine real-world complexity in the unitary thinking approach is definitely finished now, and the *only* positive possibility and *sense* of the forthcoming future is the causally complete understanding and related progressive development of the *unreduced dynamic complexity* of the world.

The unprecedented turning point in civilisation development

The urgency of change. In this section, we would like to emphasize once again the urgent necessity of complexity revolution in all spheres of human activity, including the new age of scientific discoveries it will bring, before the quickly advancing degradation becomes irreversible forever, within the current aeon of world development. Far from arbitrary, subjectively motivated empirical guesses typical of unitary science, this *already occurring* fundamental change and the urgency of complexity revolution it implies are rigorously substantiated by the universal evolution law of the symmetry of complexity, where the unstoppable transformation of action-complexity, the hidden form of interaction complexity, into the explicit form of entropy-complexity of real world structures has entered the objectively inevitable phase of *transition to the superior level of unreduced complexity* (in this case of the entire planetary civilisation), with the *only alternative* of self-destructive "death branch" of the entropy-complexity growth curve [10-16,41-43]. Needless to say, this transition to the superior complexity level and the unfolding dynamics of the latter can only be driven by essential development of higher complexity sublevels of *creative knowledge* and *evolving human consciousness* opposite to the blind ideological restrictions of unitary paradigm.

The necessary huge upgrade of the entire world complexity includes numerous entangled interactions at various complexity levels and different aspects of human life, now unified within the process of progressive global change. The associated inevitable difficulties and dramatic perturbations of a previous "normal life" should not be underestimated, but the alternative, equally inevitable and severe changes are much harder as they lead to catastrophic degradation, contrary to the essential progress towards permanent prosperity in the case of positive complexity evolution. The rigorous development curve analysis shows that the previous period of gradual progress has *ended at the current development stage* (basically towards the end of the 20th century), so that the illusion of a generally good life slowly becoming ever better stops here and becomes fatal under attempts of its artificial

extension. We are therefore in a nothing-to-lose kind of situation for the imminent complexity revolution, whatever may be its difficulties and related fears of change.

The mentioned "reasonable progress" illusions of the ending unitary thinking epoch include, in particular, popular imitations of "progressive thinking" (now becoming aggressive and malicious as the necessity of change becomes ever more evident), which appear typically in the form of various attempts to "save humanity" from various advancing "global risks" by imposing artificial *restrictions* on progress (and thus actually decreasing its already reduced chances). This superficially calculative and inevitably regressive imitations of "higher consciousness" within the dominating unitary thinking approach fundamentally limited by its ultimate simplification of reality, include various ideologically and politically motivated versions of restrictive ecology, unreliable climate science, manipulative medicine, destructive genetics, misleading biology and senseless "conservation" efforts, which lead only to ever more advancing degradation of development towards its ultimately destructive death branch of the irreversible civilisation fall. The respective unitary and therefore totally misleading "computer models" of the provably noncomputable reality provide a clear illustration of the latter tendency for modern technically powerful but intellectually blind societies.

With this fundamental turning point of civilisation development showing the necessity of complexity revolution by the clearly seen general signs and critical tendencies [12,13,41-44], one can easily specify its manifestations in various particular development aspects, being sufficiently important already by themselves, but also indicating the same kind of "unsolvable" problems and the direction of the necessary change.

Thus, in both the *global economy* and its local manifestations we can see the *critically growing signs of fundamental instability*, of a scale that cannot be either causally understood or practically managed by the best efforts of unitary science leaders and practical development governors. This modern *irreversible* instability is directly related to the completely saturated level of complexity development that cannot be explained and cured as standard development crises of the preceding phase of naturally progressive complexity growth. Today's unlimited and unjustified financial profits, made practically out of thin air by subjective manipulations with abstract entities, are accompanied by massive production and consumption problems of general

stagnation (slow degradation), within a technically over-productive and technologically omnipotent industrial world. The emerging clumsy efforts of subjective mechanical redistribution of the access to material wealth (basically within the impoverished middle class) lead only to ever more degrading production (additionally killed by protective ecology imitations) and growing social ruptures. It becomes obvious, within the *unreduced analysis of the universal complexity science* [12-16,41-44], that this modern development impasse is qualitatively different from all conventional "economic crises" and can be surpassed *only at the superior complexity level* of qualitatively extended scientific analysis, new kind of production processes, essentially modified social organisation, infrastructure, and development management (see the cited references for more details). Because of many closely related and strong system interactions involved, this *complexity transition* cannot occur gradually (similar to the previous development stage) but can only take the form of a rapid and well-directed revolutionary change.

The underlying *scientific basis* for this new level of complexity development necessarily includes its own fundamental upgrade, the *last scientific revolution*, leading from the quasi-Ptolemaic empirical guesses of conventional unitary science to the *causally complete knowledge* of the universal science of complexity naturally free from officially postulated mysteries and accumulating unsolvable problems of the official science paradigm [10-16,19, 41,42]. The related deep *internal crisis* in modern science development is noted by many professionals involved (see e.g. [1-10] and references therein), the more and more including now former strong supporters of unitary science paradigm. Therefore, the internal complexity revolution in science is urgently needed, both for the fundamental science development itself and for further civilisation progress it should initiate. If we limit ourselves only to results *already* obtained and rigorously substantiated within the causally complete science paradigm [10-46] (see also the previous section), we can mention the key, problem-solving advances and applications of the new, irreducibly complex-dynamic (multivalued) and causally complete fundamental physics without mysteries, complex-dynamic (intrinsically chaotic) nanobiotechnology paradigm with active condensed matter, creative, causally complete genomics and biology, integral medicine, genuine artificial intelligence and machine consciousness related to complex computer, control, and communication systems, new settlement and related unlimited

human development towards superior levels of individual and collective consciousness inaccessible within the dominating unitary thinking paradigm (including the famous positivistic slogan "shut up and calculate" as the basis of its "great successes" and "unreasonable effectiveness"). And without this essential knowledge upgrade, the current degradation in science and society will only grow, including the misleading and resource-consuming *mega-projects of unitary science* with essentially false results, which should be abandoned in favour of the provable superior efficiency of the causally complete knowledge extension substantiated here [10-16]. Note that all the popular and highly praised *imitations* of "complexity science" within the standard unitary paradigm (cf. [1-3]) are among those misleading efforts to be replaced by the unreduced complexity paradigm as they try to study the *exponentially huge power* of complex system behaviour (see the first section) within its artificially reduced, single-valued projections, thus killing the very essence of complex real-world dynamics.

The essentially new *role, organisation and dynamics of further knowledge development* within the causally complete science paradigm naturally reflect its extended content and underlie the quite different kind of *reason-based Harmonic society* after the complexity transition, as opposed to *profit-based Unitary society and science* within the dominating unitary level of knowledge and effective consciousness.

Universal complexity science after the end of unitary science: Extended results, new organisation and creative dynamics

In all the discussions about the increasingly catastrophic state of modern official science [1-10], one wouldn't even need to operate with quantified facts and disturbing tendencies while trying instead to look at an average sample of today's scientific journal content, especially in so-called "exact" sciences. In that way, one would invariably discover a sad sequence of meaningless technical tricks within a practical infinity of irreducibly separated, ad hoc abstract "models" that solve nothing at all and do not bring any real knowledge development but occupy nevertheless tons of never-read volumes and consuming all the huge and particularly precious financial and human resources uselessly injected into the futile system.

From the perspective of the causally complete science of unreduced complexity [10-46] presented above in this paper, the fundamental reason for the strange persistence of such dangerously corrupt structure of modern unitary science is its artificial ultimate reduction of the exponentially huge number of dynamically unified real-system realisations (see the first section) to just one, arbitrarily distorted point-like projection of reality. Simulative adjustment of any such infinitely wrong unitary "model" (including computer calculations and unitary imitations of complexity) to any given set of "observation results" is always possible with the help of the respective number of free parameters (as it was possible for the previous, original version of Ptolemaic science), but without any irreducible truth or real knowledge progress being obtained on that way of artificially structured misunderstanding. This useless structure of redundant unitary imitations is then naturally reproduced in bureaucratic science organisation.

In the meanwhile, the technical power of purely empirical manipulation with natural and artificial systems and processes has grown exponentially and does ask for the equally essential knowledge progress measured, in particular, by real problem solutions. The accumulating absence of the latter cannot be permanently replaced by abstract model "solutions" to unitary

imitations of reality and being superimposed onto the critically hot social context of the increasingly globalised world, finally leads to massively destructive political manipulations as the last means to hide the deadly impasse of real development and the scandalous failure of its single accepted driver of standard unitary science. This is the *true origin* of today's extraordinary changes in human system management and evolution that can bring only further catastrophic degradation without the necessary essential upgrade of the underlying knowledge basis, role and organisation.

While the ultimately centralised and informally totalitarian system of the official science organisation and dynamics inevitably reproduces the inherent limitations of its unitary content, the necessary structure of truly sustainable knowledge and social development must correspond to the *unreduced complex dynamics of real-world systems*, which takes the form, as we have seen above, of the *dynamically multivalued probabilistic fractal* of permanently changing realisations. This unlimited, causally complete system development implies the *key principles* of *free-interaction*, *complex-dynamical control*, and *complexity correspondence*, where a higher-complexity level or structure naturally guides and creatively controls lower-complexity element dynamics [10-19].

In terms of practical science organisation system, it means that the dominating "traditional" system of the centralised bureaucratic structure must be replaced by a qualitatively different system of permanently internally evolving independent scientific enterprises of all scales, including individual scientists, their suitable groups, projects, collaborations, and special promotional and social-relation units [10-13]. In other words, one must obtain a freely developing *market of ideas* based on and driven by *real problem solutions*, including its own evolution and social role, guided by the *naturally unified* dynamical structure of *unreduced complexity* (as expressed by the *universal symmetry of complexity*). This superior kind of knowledge system must necessarily *dominate* in the sustainable-development society that should be directly and publicly governed by its *unstoppable knowledge progress* (instead of selfish subjective interests in the "traditional" but now quickly degrading *Unitary System* of social organisation) [10-16,41-44].

The necessary change in science organisation and content should inevitably involve thus the qualitative change of governance towards the *superior complexity level* (we call it the *Harmonical System*) as a major practical part

of the underlying *complexity revolution* introduced above. The latter unifies all the related changes in knowledge content, organisation, practice, and social role, which are now *causally understood* in their intrinsic unity emerging as the necessary *superior level of global consciousness*. This urgently needed change cannot occur "gradually" and "traditionally", as "it always happened before" (the favourite objection of interested unitary science priests), but can emerge only in the form of this *ultimate* scientific revolution, after which those traditional, Kuhnian "scientific revolutions" of unitary knowledge become unnecessary and disappear in a permanently, naturally developing system of unreduced, *causally complete* knowledge, far beyond the limits of artificially reduced unitary abstractions constituting now the entire content of stagnating official science.

Despite the huge scale of the necessary change, this stepwise progress can be realised because many structural elements and tools are ready for it and the only alternative is the already dangerously growing catastrophic degradation. And while the entire society and global civilisation should be directly involved in this forthcoming change par excellence, it can be conveniently and naturally initiated and guided by the mentioned *complexity revolution in science organisation and practice* towards a new system of independent, freely interacting and evolving units of *real* knowledge creation distinguished from today's endless and fruitless "research" of unitary science enterprise by their problem-solving dynamics, in direct interaction with respectively upgraded civilisation structure (eventually *totally and directly based* on this sustainable knowledge development, instead of today's "practical" purposes of profits and survival, which are not efficient any more).

The false mysteries and artificial ruptures of conventional unitary science can and will disappear in favour of causally complete and intrinsically unified knowledge of unreduced complexity only at a new, superior and naturally unified level of content, organisation, dynamics, and evolution of *both* extended knowledge creation system and the world intellectual, social and management structure.

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