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OBJECTIVE FUNDAMENTAL REALITY STRUCTURE BY THE UNREDUCED COMPLEXITY DEVELOPMENT

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Abstract

We explain why exactly the simplified abstract scheme of reality within the standard science paradigm cannot provide the consistent picture of "truly fundamental" reality and how the unreduced, causally complete description of the latter is regained within the extended, provably complete solution to arbitrary interaction problem and the ensuing concept of universal dynamic complexity. We emphasize the practical importance of this extension for both particular problem solution and further, now basically unlimited fundamental science development (otherwise dangerously stagnating within its traditional paradigm).

Objective fundamental reality cannot rely on postulated "principles", "mathematical reality", or "observation results"

Despite the growing verbal popularity of "emergent" reality and concepts, the standard, positivistic science and knowledge structure is deeply and rigorously fixed, devoid of any intrinsic emergence dynamics and thus, basically, evolution, which is only formally simulated by artificial insertion of the notorious time-parameter (cf. e. g. [1]). That is exactly why "more is different" [2] in *that*, actually *quite special* (see below) and now desperately "ending" kind of science, where no structure or behaviour is directly, explicitly obtained from simpler components and should therefore be considered as given, by inevitable invention of ad hoc postulates, technical "principles", and equally abstract new entities.

This is the true reason behind all the difficulties and ambiguities around the "what is fundamental?" question, again only within that kind of positivistic, or "unitary", science and its simplification of reality, which can be *rigorously* specified within the extended and intrinsically complete knowledge basis (see below). Characteristic examples include the relation between quantum and classical behaviour (both of persistently ambiguous origin), relativity, gravity, and cosmology issues. And although the observed structure and dynamics for each case and level of reality can be technically postulated as an empirically based "model", with various (but always limited) degree of success, the *dynamic emergence links* between the *truly fundamental entities* of unreduced reality (and therefore their genuine origin) remain poorly specified, thus compromising the objectivity of the resulting *order of the world*.

The fact that these are not only "philosophical" problems of little practical or scientific importance is strongly supported by the accumulating new and persistent old "unsolvable problems" and "mysteries" of modern scholar science, which even falls in a strangely *critical* state, in the middle of its technical omnipotence, where the yet quite recent situation of science ending because of its quasi-total completeness is "suddenly" replaced by those growing numbers of "difficult problems" without solution in various fields, in striking similarity to the situation of imminent scientific revolution a hundred years ago. This quite practical importance of accumulated "general" problems of the official knowledge paradigm becomes even more evident and *globally* vital at higher levels of "truly complex" systems, in biology, medicine, ecology, and the *entire civilisation development*, critically depending on the growing unitary science impasse (in ever more striking contrast to the spectacular technological progress, strongly influencing also the fundamental science development).

And while the empirically based intuition underlies the attempts of positivistic science to put the broken unity of nature together again by arbitrary guesses and respective artificial adjustment of separated world components in terms of abstract postulated "principles", redundant entities and their ambiguous "observation results", the obtained "Frankensteinian" construction of mechanically fixed "mathematical reality" [3] does not and cannot show the intrinsic, interaction-driven coherence and life-supporting efficiency of unreduced world dynamics and evolution, thus confirming ever more the importance of genuine, *dynamically emerging* fundamental levels of reality. The latter can be unambiguously derived only within the intrinsically unified and causally complete image of reality, obtained with the help of essential, *qualitative extension* of simplified unitary science projection to the unreduced hierarchy of *dynamically multivalued interaction results*, or *universal dynamic complexity* [4-16], providing consistent solutions to old and new problems, within the *rigorously specified objective structure of fundamental reality* emerging as the multilevel hierarchy of unreduced dynamic complexity.

Dynamically emerging reality of unreduced interaction complexity

In accord with the above programme of *emergent* and *therefore* objective fundamental reality, one should start its causally complete description with the *unreduced solution* of the underlying (arbitrary) interaction problem, beginning at its *simplest* possible configuration of the *most fundamental* level of reality that forms its material origin as such and then *directly producing* all its higher-level fundamental entities, in full agreement with their *natural emergence*, with all their intrinsic properties, dynamical laws and "fundamental principles", now unambiguously *derived* in their natural *unity* [4,8-10] (instead of being only mathematically and separately "postulated" in usual theory description).

The mentioned simplest (and thus most fundamental) configuration of the global interaction process is obviously provided by two initially homogeneous continuous media, or "protofields", uniformly attracted to each other (and eventually giving rise to the electromagnetic and gravitational interaction forces respectively). If we analyse this interaction process rigorously and without any "model" or "perturbative" simplification (thus without any assumption of interaction weakness or special configuration), as permitted by the *generalised effective potential method* [4-10], then we obtain the *explicit dynamic emergence* of

elementary world structures, recognised as (massive) elementary particles, in the form of *quantum beat processes*. The latter are obtained as *localised*, highly nonlinear and *internally chaotic* self-oscillation processes of the *homogeneously* attracting protofields, which perform nonstop cycles of their local interaction-driven squeeze (or "reduction") and extension due to the *intrinsic dynamic instability* of the *unreduced* interaction process. It is important that each dynamic reduction of the particle's quantum beat process is centred on a new physical "point" of thus *emerging space*, chosen in a *dynamically random* fashion among many other, *equally probable and incompatible*, or "redundant", reduction centres.

We thus discover here, already at this lowest, most fundamental level of reality, the origin of the *universal dynamic complexity* within *every real world structure*, in the form of those *dynamically multivalued, or redundant*, results of *any real, unreduced interaction process* (which should, of course, be strong enough for noticeable structure formation, beyond insignificant fluctuations) [4-14]. Those explicitly emerging and mutually incompatible configurations of a system or interaction process, called *realisations*, are forced, by the driving interaction itself, to permanently replace one another *in truly and causally random* order thus *dynamically* obtained and rigorously defined. *Dynamic complexity* C (intrinsically coupled to *chaoticity*) is universally specified then as a growing function of the number of system realisations $N_{\Re}$ (for integral complexity measures) or rate of their change (for differential complexity measures) equal to zero for the unrealistic case of only one system realisation, $C = C(N_{\Re})$, $dC/dN_{\Re} > 0$, $C(1) = 0$ (e. g. $C = C_0 \ln N_{\Re}$ or $C = C_0(N_{\Re} - 1)$).

In fact, it is only the latter unrealistic case of effectively zero-dimensional (point-like) projection of dynamically multivalued reality that is exclusively considered in usual, *dynamically single-valued*, or *unitary*, theory and science paradigm (including its complexity *imitations*), thus underlying all its specific features, with relative successes, unsolvable mysteries, and ambiguities of abstract postulated "fundamental" entities and properties (which *cannot* be consistently defined within this severely limited approximation).

While the detailed mathematical formalism of the universal complexity science can be found elsewhere [4-14], leading to the *new mathematics of complexity*, we can summarise it here by a *symbolic* relation, expressing the emerging complex-dynamical (multivalued) structure of any real interaction process $V(q_0, q_1, ..., q_n)$:

$$V(q_0, q_1, ..., q_n) \Rightarrow \mathfrak{D}\left[\{\Re_r\}, \{\alpha_r\}, \{\rho_r(q_0, q_1, ..., q_n)\}\right], \tag{1}$$

where $q_0, q_1, ..., q_n$ are the degrees of freedom of interacting system components forming the causally complete, multivalued, or complex, system dynamics $\mathfrak{D}$, which includes a well-defined set of system realisations $\{\Re_r\}$, with their respective, dynamically determined emergence probabilities $\{\alpha_r\}$, measured system density distributions $\{\rho_r(q_0, q_1, ..., q_n)\}$, and other relevant features. The *dynamically entangled* degrees of freedom of the resulting system structure on the right-hand side of eq. (1) (within every realisation) form the *physically real space* of the emerging complexity/structure level, $x = \{x_r(q_0, q_1, ..., q_n)\}$.

As realisations are permanently changing (appearing and disappearing) in dynamically random order, the observed system density $\rho(x)$ is obtained as the *dynamically probabilistic sum* of individual realisation densities $\rho_r(x)$:

$$\rho(x) = \sum_{r=1}^{N_{\Re}} \oplus \rho_r(x) \ , \tag{2}$$

where the sign $\oplus$ marks the special, dynamically probabilistic meaning of the sum, implying the unstoppable probabilistic emergence and disappearance of individual realisation contributions $\rho_r(x)$, with *dynamic* probabilities α_r causally determined as

$$\alpha_r = \frac{N_r}{N_{\Re}} \quad \left(N_r = 1, \ldots, N_{\Re}; \ \sum_r N_r = N_{\Re} \right), \quad \sum_r \alpha_r = 1 \ , \tag{3}$$

where $N_{\Re}$ is the total *number of elementary realisations* (determined by the number of interacting system mode combinations) and N_r the number of elementary realisations grouped within the *r*-th actually observed, compound realisation (which is the unified self-organisation mechanism, see below).

The eventual multilevel, *probabilistically fractal* structure of the general interaction problem solution is implied in (1)-(3), so that any real system structure (including the world as a whole) emerges as permanently probabilistically evolving, multilevel branches of the *dynamically probabilistic fractal* [4-14], whose integral dynamic complexity C is always defined by a growing function of realisation number $N_{\Re}$, $C = C(N_{\Re})$, $dC/dN_{\Re} > 0$, $C(1) = 0$.

Returning to the first level of world structure emergence in the form of quantum beat processes within every elementary particle (to be compared with abstract "state vectors" in usual theory), we note that already this *lowest* level of fundamental world structure is made by *complex-dynamical*, multivalued processes with complexity values $C(N_{\Re}) > 0$ (and e. g. $N_{\Re} \sim 100$ for the electron). This leads, in particular, to the *intrinsic* and *universally defined* property of *inertial mass*, emerging without any additional entity (like the Higgs field and boson in the Standard Model), but simply due to the *dynamic (spatial) randomness, or chaoticity*, of the quantum beat process [4,8-10]. Other intrinsic particle properties (electric charge, spin, interactions) are also explicitly obtained as *dynamically emerging* features of the protofield interaction result. The related dynamical, e. g. quantum and relativistic, laws are equally consistently derived as results of interaction complexity development, without any abstract postulates or formally imposed "principles". All those properties and laws emerge in their *natural unity*, simply by their clearly specified dynamic origin, thus solving the "unsolvable" problems of usual theory.

The fundamental entities of *physically real space and time* are obtained as *emergent forms of unreduced dynamic complexity*, reproducing the multilevel hierarchy of the latter [4-10]. The naturally discrete space emerges as the material tissue of dynamically entangled interaction components (the two protofields at the most fundamental level), in the form of physical space "points" given by the size of localised realisation structure (its eigenvalue separation in the unreduced interaction problem solution) and elementary length given by the separation of neighbouring realisations (i. e. their eigenvalues). The *unstoppably and irreversibly flowing time* emerges as the non-material *realisation change* process, specified by its *intensity*, i. e. *frequency* of realisation change *events*, where both the flow and irreversibility of this physically real time are due to the *dynamic multivaluedness* of unreduced interaction results. It becomes clear why these physically real entities of time and space cannot be consistently specified within the unitary science description and paradigm.

Fundamental particle interactions that naturally emerge, with their observed properties, in this interaction-driven structure formation process [4,8-10] give rise to emergence of higher complexity levels, with their own, specific in detail, but universally described multi-valued structures and processes, in the long general sequence of *dynamic complexity development, or unfolding*, determined eventually by the initial protofield interaction.

The entire world structure hierarchy, including its highest known levels of life and consciousness, is thus explicitly obtained as *emergent*, interaction-driven, *physically real* and *dynamically unified* fractal of realisation sets (1)-(3), containing the *clearly specified variety of dynamic regimes* and obeying the *single law* of the *universal symmetry, or conservation and transformation*, *of complexity*, which includes the extended, causally complete versions of all (correct) particular laws and principles [4-16]. The mentioned diversity of complex dynamic regimes includes the entire range of observed *internally chaotic* structures, from the externally quasi-regular *multivalued self-organisation* case (with multiple and constantly changing, but very similar realisations, thus solving the entropy-growth problem) to the ultimately irregular regime of *global, or uniform, chaos* (with strongly differing and "entangled" realisations), with the rigorously specified criterion of transition between them.

While the unified mathematical expression of this emergent world structure formation, dynamics and evolution can be found elsewhere [4-16], what we want to emphasize here is the related natural, physically and mathematically complete solution to all "fundamentality problems", simply because *all* world's *explicitly emerging* structures, features and laws, obtained in the unreduced completeness of their observed properties, are both *fundamental* by their *clearly specified* dynamic origin and equally causally *ordered* in this fundamentality, according to respective values of *rigorously* and *universally* defined unreduced *dynamic complexity* (as outlined above).

As a particular example, we obtain the classical, permanently localised kind of system and behaviour as a higher level of unreduced dynamic complexity emerging from interaction of essentially quantum components (usually elementary particles) in the form of elementary bound systems, such as atoms [4,6,8,9], without any ambiguous "decoherence" of usual theory, just arbitrarily breaking the fundamental natural order of emergent world structures. It is confirmed by many other examples from "physical" and higher complexity levels, including genuine quantum chaos in nanosystems and the complex-dynamic origin of life, intelligence and consciousness, remaining "mysteries" in unitary science [4-13].

Beyond the horizon: The breakthrough research agenda

There is much more than mere "philosophical" consistency to the described naturally emergent hierarchy of unfolding (unreduced) complexity of the world: in addition to causally complete solution of all "difficult", old and new, problems of unitary science (e. g. in cosmology [8-10]), it provides the *fundamentally unlimited prospects* for such *intrinsically complete knowledge development*, which are just badly missing in modern official science state that shows the growing and already dominating signs of its inevitable "end", either in the form of ontological saturation towards the independently progressing technologies or as a strangely increasing number of internal contradictions and "unsolvable" problems.

Indeed, the described way of progressive development of the unreduced interaction complexity doesn't need to stop at any its known level and can have various probable links and issues towards larger and deeper reality of other complexity levels and structures. While they can be separated from the explicitly known world structures by natural complexity gaps (actually omnipresent in the observed complexity hierarchy and contributing to its reasonable efficiency), nothing prevents us from their progressive discovery and understanding, similar to previous, although often spontaneous and fundamentally blind search for deeper levels of now "well-known" material reality. Even the latter is very far from being perfectly understood within the dominating unitary science projection, as we show in detail in various applications of the qualitatively extended and provably complete framework of the universal science of complexity, from elementary particles to consciousness and modern development problems [4-16].

It becomes evident therefore that still much greater and fundamentally unlimited novelties can be waiting for us in the infinitely larger, dynamically multivalued space of unreduced complexity dimensions, and there are clear and rigorously specified indications in favour of their reality [8], far beyond the most advanced dreams of unitary science paradigm.

It is important that now this fascinating search for genuine, qualitative novelties, both within and beyond the "ordinary" material reality, doesn't need to remain empirically intuitive and conceptually blind (which is the inevitable way of traditional unitary, or positivistic, science), since the unified hierarchy of naturally developing world complexity outlined above and constituting the *objectively specified and causally complete fundamental reality* provides both the consistent, well-defined "order of the world" and the guiding line for its further exploration.

In summary, we show how and why the unreduced, now truly rigorous mathematical solution to the arbitrary interaction problem (illustrated by eqs. (1)-(3)), with its *qualitatively extended* (dynamically multivalued) structure as compared to the artificially restricted, dynamically single-valued projection of standard positivistic "models", not only provides intrinsically consistent solutions to various stagnating problems of the latter, but leads to the objectively determined and causally complete picture of multilevel fundamental reality, where all "impossible miracles" of unitary science become possible and natural, including the *total, physically real unification of all, now causally complete knowledge* and its *basically unlimited development* towards new levels and dimensions of unreduced, universally defined dynamic complexity [4-16].

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