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CAUSALLY COMPLETE SCIENCE FOR THE REASON-BASED SOCIETY

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Abstract

Modern fundamental science tends to avoid the principle of physical causality and realism, replacing it with heuristically postulated and separated mathematical constructions that impose their own rules before being adjusted to measurement results. While it is officially accepted as the single possible kind of rigorous knowledge, we argue that another, explicitly extended kind of science can provide the causally complete picture of reality avoiding the glaring gaps, growing problems and persisting stagnation of the artificially reduced knowledge paradigm. The logic of science development and especially its current state call for the urgently needed transition to the extended, causally complete kind of knowledge and related sustainable progress at superior creativity levels of self-aware, reason-based society.

Historical clash: Positivism/formalism vs causality/realism

While critically growing problems of fundamental science development evoke questions about another possible kind of science, one can recall some characteristic features of modern knowledge emergence.

It is naturally based on generalization of empirically acquired facts towards better understanding of reality. Each essential knowledge advance starts with a relatively causal and realistic vision of empirical observations. Later, however, the desire to obtain ever more convenient expression of real phenomena leads to the growing separation of technical (mathematical) formalism and its artificial constructions from real structures and phenomena it should describe.

Although Newton is considered to be among the founders of the now dominating positivist science doctrine, his vision of the gravity-driven planetary system was still a relatively causal one, where the missing exact origin of gravitational forces did not violate the intuitively realistic picture of moving bodies somehow attached to each other by invisible “ropes” (or other, quite visible links for various systems of interacting objects). We can also mention the previous approach of René Descartes that did not attain the level of suitably formulated science but was clearly oriented to strictly causal and unified understanding of reality.

The created mathematical formalism of calculus was just the powerful and unified instrument of exact real-system description. However, the key fissure between that formal description and the underlying physical reality was already introduced by the famous “hypotheses non fingo”: Once it provides a confirmed quantitative expression of major measurement results, the mathematical description itself is considered to be the unique scientifically valid kind of reality picture.

Later on, various abstract pictures, or “models”, emerge for each separate kind of phenomena and live their own life, determining scientific knowledge development. They replace the more and more definitely the underlying physical world with a growing set of totally invented and intrinsically separated constructions that form now their own, quite special kind of “mathematical reality” (see e.g. [1,2]) absolutely prevailing over its tangible physical prototype (similar to imaginary constructions of the millennia-old Ptolemaic system, also “confirmed by observations”).

This reigning “mathematical physics” describes and studies only its own structure, laws and limits assumed to be those of nature and the only reasonable science content, while the accumulating contradictions with real-world observations are rather problems “beyond science” to be endlessly and fruitlessly discussed in the humanities, finally as a kind of intellectual entertainment.

The empirical causality of the initial Newtonian approach follows progressive degradation towards purely mathematical links within a given “model” showing little or no connection to its structure origin or to other, equally “experimentally confirmed” abstract models. Such a global system of causal connections is clearly beyond the possibilities, and thus the interest, of this *artificially simplified* positivist approach. As we shall see later, the problem is *not* in mathematical description of reality as such, it is in the over-simplified and absolutely dominating version of mathematical formalism, in direct relation to the preferred separation from reality.

The last major advance of fundamental science, the “new physics” of the 20th century, reproduces and greatly amplifies that characteristic science evolution from the initial reality-based

and therefore at least empirically causal discoveries to the “physics” of postulated mathematical structures that don’t need any causal explanation, origin or external connections: Postulated “quantum mysteries” should remain mysterious forever, and “relativistic paradoxes” may be “explained” only by the postulated abstract “principles” or purely mathematical “laws of Nature” but not by a clear physical origin. A “physical theory” is now but an abstract mathematical construction hopefully adjusted to its preferred observation scope.

In the case of new-physics revolution one can clearly see that characteristic transition from the initial causal realism to abstract positivist models, as demonstrated by two respective scientific generations of physical realists (like Max Planck, Louis de Broglie and Erwin Schrödinger in quantum mechanics or Hendrik Lorentz and Henri Poincaré in relativity) and mathematical formalists (Niels Bohr, Werner Heisenberg or Paul Dirac in quantum theory and Albert Einstein in relativity). While particular researchers may have a more complicated involvement with both tendencies, the transition itself from the initial causal realism to the eventually winning mathematical formalism in this modern physics emergence is an objective tendency determining further science development and its current “contradictory” state.

Irrespective of personalities, once again the scientific thought tries at first to look deeper into the physically real and causally complete origin of the observed phenomena and structures but then stops before the emerging difficulties and descends to a causally incomplete yet technically “effective” and practically convenient world view. The real payment for this characteristic “weakness for simplicity” comes later, right now, after the glorious completion of the “unreasonable effectiveness” of the mainstream mathematical positivism, where the accumulated “less important” problems lead to unreasonably growing contradictions and impasses, while the true origin of the crisis may be not evident.

What we want to defend in this essay is that the “genuine”, *provably causally complete* and *mathematically much more rigorous* kind of science does exist, in the form of explicit extension of the traditional paradigm, and not only it provides natural, intrinsically unified solutions to those accumulated “difficult” problems of conventional positivist knowledge but also shows the way to further, now *unlimited knowledge progress*, with its essentially extended content, respective new organization and superior, guiding role in further civilization development.

While examples of rigorous expression of this extended science can be found elsewhere (e.g. [3]), we concentrate here on the logical necessity of such knowledge extension today, without which the already visible degradation of science and society becomes irreversible and catastrophic (with the opposite tendency of unlimited progress within the extended knowledge paradigm).

In terms of both internal development of science and its technological applications, how can one rely on the allegedly objective and logically rigorous kind of knowledge that contains postulated inexplicable mysteries, physical paradoxes and multiple contradictions in its very basis and ends up in the dominating “dark” matters, “hidden dimensions” or the infinity of entire “parallel” worlds permanently breeding all around us? In such scandalously real situation, even former confirmed (but largely empirically driven) successes of this mainstream science become seriously compromised, not to mention its further development possibilities that need clear understanding where one finds only blind and now unreasonably ineffective empiricism.

And while the standard paradigm desperately tries to hide its specific deficiency behind some obviously irrelevant constructions like notorious Gödel's theorems from the arithmetic number theory, its true limits have a quite different, specific and self-imposed (artificial) origin further clarified below. By contrast, the natural, always temporary and moving "limits" to the causally complete and reality-based knowledge development are only due to empirically inaccessible parts of reality (e.g. in space and time). But when empirical observations and measurements can be basically (technically) complete, there should be no "mysteries", "paradoxes", or stagnating fundamental problems within the truly rigorous kind of science.

We see thus that the essential history of science (and technology) development has naturally brought us to the urgent necessity of serious upgrade of its traditional content and role, and we can consider now major details of this imminent knowledge extension towards the new, fundamentally unlimited kind of progress. The described historical clash between the causally complete but technically difficult realism and superficially more "effective" but strongly incomplete positivism should now be resolved within their constructive upgrade in the ultimate (and the last in history) scientific revolution towards the intrinsically consistent, creative and therefore sustainable knowledge progress.

Causality revolution and the extended criterion of truth

Looking for the origin of scholar science incompleteness, we note the absence of causal derivation of an entity or process from its physically real components, replaced by the straightforward postulation of a ready-made simplified and abstract structure, or "model", whose quantitative features should be adjusted to selected measurement data. The real, unreduced interaction dynamics leading to explicit causal *emergence* of new structures and properties is beyond the scope of the standard science paradigm.

As the unreduced many-body interaction dynamics can be too complicated, we should not even try to understand its exact picture and stay satisfied with its best possible "transparent" (linear, averaged, fixed, "geometrically" well-defined) mathematical imitations. Even the considered "solutions" to major "dynamic" equations (themselves being only postulated, i.e. actually guessed, constructions) are always but rough "perturbative" (or "integrable") imitations of the unreduced solutions remaining unknown, while those imitations just reformulate the already known system configuration inserted, directly or indirectly, in the equation to be solved.

In this way, the real interaction *dynamics* and especially its explicit, creative, structure-forming *evolution* are replaced in conventional science by the empirically suggested or semi-empirically guessed abstract *structures*. And while this dominating positivist method may still seem to be "effective" for exceptional, configurationally simple cases reduced to one-dimensional motion ("separable" problems), every real, many-body system behavior immediately reduces this superficial effectiveness to values below zero. Statistical models or computer simulations used in such "difficult" (but increasingly dominating) cases provide only other versions of the same method of rough mathematical imitation and adjustment, with its inevitably ill-defined criterion of truth.

Genuine causality and its intrinsic criterion of truth can be restored if we abandon those artificially imposed restrictions of the standard positivist approach and consider the unreduced interaction dynamics, starting from its provably simplest possible configuration that should progressively produce all more complicated structures, properties and phenomena, together with all the “laws” for their description that should be *rigorously derived* within the same unreduced, *self-consistent* and causally complete interaction analysis and never just “postulated” as “empirically confirmed” relations. In this way, we obtain not only the causally complete picture of the universe structure and dynamics but also its unreduced *cosmological evolution*, from elementary particles to consciousness, arts and spirituality. And we certainly obtain the well-specified, physically real *origin of time*, together with that of space and other fundamental entities and properties.

We must still “postulate” the starting configuration of the emergent interaction hierarchy and its self-consistently confirmed expression, but this is the natural, unique, provably minimum and reality-based assumption, with practically absent structure of the world we know, which should yet emerge from that minimal initial configuration. This is also the answer to the argument of “necessary incompleteness” mentioned above: Any system description becomes “correctly” incomplete only at the borders of system existence or measurement, generally at the system origin (initial moment, simplest structure) and its end of development. But where every reasonable measurement can be performed with confirmed results, one should have no persisting “unsolvable” (fundamental) problems, “mysteries” or any other “limits of science” because we *explicitly and rigorously derive* everything in this extended, causally complete science paradigm.

As to the role of mathematics in the intrinsically causal science, it not only preserves but now fully regains its status of the “language of nature”, since this unreduced interaction description, including explicit emergence of all structures, laws and properties, implies the superior level of genuine rigor and completeness of the upgraded mathematical image of reality.

The extended, causally complete *criterion of truth* is naturally present in the knowledge structure thus obtained: it is the *total, explicitly confirmed consistency*, far beyond point-like adjustment of particular models to certain measurements in conventional positivist science (with persisting contradictions and “mysteries” being pushed to other fields of knowledge or never-ending “future research”). As interaction processes never stop, new, yet unexplained details and phenomena will emerge, but in this case fortunately, since they will be causally explained in their turn, thus giving rise to *sustainable progress* of this extended, intrinsically complete knowledge.

We obtain thus not only the superior kind of knowledge but also the superior way of unified development of knowledge and humanity, now without any conventional, always contradictory scientific revolutions of empirically driven positivism. The described essential (and urgently needed) transition from the broken conventional science to its causally complete extension, which can be called “causality revolution” (or “complexity revolution”, for reasons specified below), will be the last qualitative change of the entire knowledge body, structure and practice towards its ultimately complete and intrinsically creative (i.e. truly sustainable) kind, after which one will always have generally uneven but permanent science (and civilization) progress in various fields and directions. We can now consider in more detail the key features of this extended science content, practical organization, operation and social role.

Explicitly extended, provably complete knowledge for the new progress of humanity

Today we live in a qualitatively new (and therefore quite unusual) epoch, where the power of technologies has made possible the quasi-complete experimental discovery and study of virtually all tangible material objects and processes in the ultimately large spatial and temporal range of their existence. Those *empirically* strong methods and instruments do not provide themselves the equally complete and scientifically necessary *understanding* of the observed structures and processes, but they may demonstrate the basically *finite* material structure of this, directly accessible level of reality, up to ultimately distant frontiers of the observable universe.

We shall hardly discover new, stable enough elementary particles and chemical elements, already because the known ones are quite sufficient for creation of all observed objects in their full diversity. Moreover, even numerous products of their interaction hierarchy constitute a very large but eventually also finite range of combinations in molecules, substances and bodies, especially if we consider qualitatively new and “interesting” (in any sense) structures. Since the mentioned empirically sufficient power of modern technologies covers all this accessible diversity of tangible structures, the method of traditional scientific research attains the inevitable *fundamental saturation* (unique in history), where we know empirically almost every directly observable entity, even without its suitable understanding, and our knowledge (and with it civilization) progress saturates there, also because we attain here the basic overproduction level, with the help of the same over-sufficient technologies. And as a universal development law, often ignored within the positivist science framework, tells us that a long enough stagnation tendency will inevitably turn into degradation, this modern epoch of the “end of science” [4,5] (due to the described *conventional* knowledge saturation) may “suddenly” change from the happy consumption to a sad destruction.

How can the *qualitatively different* kind of causally complete science introduced above change this fundamental development impasse to a new progress? First of all, it provides the unique possibility to eliminate all the gaps, “unsolvable” problems and persisting mysteries from existing fundamental knowledge, transforming it into a naturally unified and coherent system, now truly *exactly* describing the real-world structure and dynamics. Already as a result of this essential knowledge extension, we obtain new progress possibilities, especially for complex many-body interaction cases, including unreduced nano and quantum technologies, qualitatively new energy sources, complex computer, control and AI systems, all life sciences, science of intelligence and consciousness, all Earth sciences, all social, economic and development sciences, all the humanities and arts (also becoming now fields of rigorous, or “exact”, knowledge). Note that the empirically driven and over-simplified approach of traditional positivist science cannot provide any such possibility in principle (hence its modern “end of science”). By contrast, the truly unlimited approach of the causally complete science should not stop there, since it can efficiently, selectively develop and study the complicated interaction hierarchy ever further, towards yet *unknown complexity levels*, always culminating in the ultimate goal of human consciousness development.

As mentioned above, this sustainable progress of the causally complete knowledge paradigm starts at the lowest level of the world interaction hierarchy by considering the provably simplest interaction configuration (like two physically real, practically structureless, homogeneously

interacting entities) but within the *unreduced* analysis of its natural development by a general, self-consistently confirmed formalism. One obtains then a *much richer* interaction product diversity and dynamics, where multiple and equally real system versions *permanently* and *randomly* replace one another, thus giving rise to the irreversible time flow, emergent space structure and physically specified elementary particles, with their *dynamically emerging* intrinsic properties (including mass-energy, electric charge and spin), unified interactions, quantum and relativistic dynamics [3].

Irrespective of rigorous derivation details, we want to emphasize here that this essential progress relative to conventional abstract, physically unspecified and separated “state vectors” is obtained only due to the causally complete, unreduced analysis of *real interaction dynamics*, so easily ignored and over-simplified in the dominating positivist approach. Another advantage of the causally complete interaction analysis is that it gives the world structure hierarchy in its naturally emerging, evolving and thus also *cosmologically complete* version, while a study of the birth and evolution of state vectors sounds grotesquely and fails inevitably. Where heavily reduced positivist models can see only abstract mathematical points and lines without physically specified tangible *quality*, the real interaction picture provides qualitatively specified and explicitly emerging, multi-valued and multiplying structures.

The *unified consistency criterion* is thus naturally maintained in the causally complete science approach, as opposed to its permanent violation in reductive positivist science, starting already from the most fundamental levels of “quantum mysteries”, “relativistic paradoxes” (never explained physically), “spontaneously broken symmetries”, “dark matter/energy”, “hidden dimensions”, etc. It finally looks even surprising (or “unreasonable”) that conventional abstract-positivist science has attained as much as it did without being able to provide the general (complete) solution to any real interaction problem (it cannot even say what “nonintegrability” of such a problem truly means, i.e. what the interaction result could be like). The power of empirically driven technologies and related research intuition is obviously not so small, but it has its well-specified limits, now exceeded by those “unreasonably” great successes themselves.

By contrast, it should not be surprising that causally complete knowledge provides the exact and consistent version of world objects and properties in a *naturally unified* way of both the *physically unified world structure* and the *universal law of its dynamics and development* (unifying the causally extended versions of known laws) [3]. Here again, this unified description is logically inevitable in the truly rigorous, causally complete knowledge system, irrespective of the language and instruments used (first of all, it should be the extended, causally complete mathematical framework, but now naturally translatable into an equally complete verbal description, due to causality).

We should add that the proposed new knowledge basis of the unreduced, causally complete interaction description is closely related to the notion of (*dynamic*) *complexity*: The mentioned extended (and “excessive”) richness of real interaction results just represents the real-world complexity and intrinsic (ordered) chaoticity, where “complexity”, “chaoticity” and “causal completeness” are practically synonymous characteristics of real-world dynamics, starting already from its most fundamental, lowest levels. This rigorously obtained *universality* of the extended dynamic complexity concept describing the entire range of real-world dynamics is essentially different from various reduced, purely formal and non-universal imitations of complexity (of exclusively “large”,

higher-level systems) in conventional science. Therefore, we can designate the forthcoming transition of causality revolution also as complexity revolution. It inevitably occurs not only in science content but also in its organization and now much more important social applications of the extended knowledge paradigm.

Liberal research system for the unlimited knowledge development

The traditional hierarchical, bureaucratic and rigidly fixed system of scientific research demonstrates a “strange” correlation to the positivist knowledge content split into irreducibly separated and artificially restricted abstract structures. It would be natural to expect a qualitative change of this conventional science *organization* after the proposed transition to the causally complete knowledge *content*: “New wine into new bottles”. The necessary correspondence between the two implies the *explicitly liberal* kind of science organization after the causality revolution, with the dominating role of (interactive) individual creativity and its progress-bringing results, as opposed to the formal position-dominated organization of today’s bureaucratic system, which contradicts fundamentally any genuine creativity and real knowledge progress.

The detailed realization of this new, liberal and intrinsically creative, system of knowledge development may vary, but it should be based on individual problem-solving creativity, free, easily adaptable organizational structure and the evolving diversity of (now qualitatively extended) social roles of science. One can imagine a system of various interactive and readily evolving enterprises (or start-ups) based on every single researcher’s activity, combined with the socially recognized status of researcher that should be confirmed by real-progress results. In return, the detailed science-related activity should not be limited to “academic” or “laboratory” research work in its traditional narrow meaning but can include management, promotion and any practical maintenance of research projects, popularization and wide public support of science (as the real basis of any progress), various application activities and so on, where participant scientists would often change their roles and spectrum of activities (but always in relation to progress-bringing results). We obtain thus a living, open and efficient “market for ideas”, while today’s science organization around formal, largely fixed positions, subjective authorities and restricted functions is opposite to that explicitly creative kind of research organization, which emphasizes the need for essential change.

Causally complete knowledge and the reason-based society

As the research content, dynamics and organization are interconnected within a system of science, the latter is also closely related to the englobing social system and the entire planetary civilization. Fundamental science is the only irreplaceable source of genuine, “big” progress of humanity, and if this source enters the phase of persisting stagnation (which is the case of modern official, positivist science), then nothing will be able to stop the resulting degradation of the global civilization, including most attractive applied technologies (also depending on the underlying scientific discoveries). This would already be a sufficiently important reason behind the urgent need for a qualitatively “different” (much more creative) kind of science today.

However, related to that general progress demand, there are also intrinsic social and human development factors that independently necessitate the transition to superior, truly consistent kind of knowledge. As felt by many in various ways, modern developed societies have attained an intrinsic barrier to their further progress, largely due to their recent successes of overproduction and overconsumption (fundamental massive saturation of all bio-physical needs). At the same time, those massively satisfied needs and multiplying activities create new problems on any scale. While the causally complete science confirms this critical bifurcation moment of global civilization development, the name of “complexity threshold” would be more exact than the popular term of “globalization” (or sometimes “singularity”) for designation of this specific and unprecedented limit to traditional growth, after which not only the standard knowledge system but the underlying social organization and dynamics become insufficient for adequate existence and functioning (let alone further progress) of human civilization.

It becomes obvious that now, after the complexity threshold, all usual, largely achieved social purposes of “prosperity” and “wellbeing” lose their guiding role of previous epochs, together with the related traditional forms of “political” (tribal-hierarchical) social organization, and the only real candidate for the new, truly sustainable social order of superior efficiency is the *reason-based governance of the self-aware society development* that should rely on the essential application of the causally complete knowledge of unreduced interaction dynamics described above. In other words, the traditional social organism, with its muscles, nerves and functional organs, should be completed now with a unified (distributed) conscious brain able to ensure global society progress in a provably sustainable way, where the leading role of extended, causally complete and unified knowledge is evident and cannot be simulated any more by reduced positivist thinking. This is the socially important reason why we should make science great again by passing to the superior level of causally complete, intrinsically realistic and therefore truly reliable knowledge.

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* Two complementary references were added in [3] compared to the submitted version.