Irreducibility and Emergence in Complex Systems and the Quest for Alternative Insights

The scientist does not study nature because it is useful; he studies it because he delights in it, and he delights in it because it is beautiful.

Henri Poincaré

In this essay, we briefly survey the contemporary scientific and philosophical debates on emergence and conclude that this notion has become a dilemma. We argue that the reason for this dilemma is metaphysical. Subsequently, we investigate some fundamental philosophical methods in science, such as Cartesian reduction and objectivism, as the main sources of scientific drawbacks. Eventually, we suggest some refinements in philosophical methods for improvement of scientific insight and propose the method of transcendentionism as a metaphysical panacea to encounter the dilemma of emergence. © 2011 Wiley Periodicals, Inc. Complexity 0: 0–0, 2011

Key Words: emergentism; Cartesian reduction; objectivism; unity in diversity; transcendentionism

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INTRODUCTION

The complexity of a system is not necessarily the result of our lack of information. Even the case would become worse if we integrate more information, for we would have a bigger pile of data! The authors of this essay believe that our weak comprehension of complex systems—despite the powerful instruments we use—turns back to our methodic shortcomings. It seems that we have to fundamentally reform our basic insights in experimental science as well as mathematics. It is time to search for new horizons to innervate our insights. As the late professor Paul Lieber said: "Can we use for this purpose all our faculties instead of certain narrowly cognitive ones which are limited by the use of a particular language such as mathematics? Can science be further elevated as an art?" (p. 8) [1]. We need to seek for more profound metaphysical insights and construct an alternative "philosophical structure" to become capable of explaining the events of the universe thoroughly. For such a basic reform, we need to recline on more profound philosophical foundations.

Our aim in this essay is to depict some major methodic flaws undermining scientific insights and conclude that these flaws are results of particular "metascientific" or philosophic insights, which have been chosen to construct the scientific paradigms. Of the most fundamental discussions in philosophy of science is the debate of emergentism and reductionism. The paradoxical nature of the notion of

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emergence reveals some of the most essential drawbacks of scientific thought. We will briefly survey a few selected works on this subject, while avoid the precise and jargoned philosophical discussions, for this is not the tackle of this essay. Subsequently, we summarize some philosophical concepts, which we think may be crucial to understand the most drastic drawbacks of scientific thought. We will then outline briefly some philosophical concepts that deem to be of crucial importance for constructing a more profound philosophical structure for science.

ARGUMENTS ON EMERGENCE: EVIDENCE FOR FLAWS UNDERMINING SCIENTIFIC INSIGHT

Emergence is a crucial notion in contemporary science. Kim [2] stated that the "reign" of emergentism has taken over science since the early 1970s. Briefly speaking, we may define the emergence of a property in terms of violation of aggregativity [3], which is usually attributed to William Wimsatt. Simply, color and melody are examples of emergent properties, while weight is not [4]. The extreme cases of emergence are life and mind, which are the crowded center of debates in this field. The notion of emergence is a vague and nebulous concept in science. Mitchell remarked that there has been a disagreement between most of the philosophers and scientists on emergence. Philosophers defend the idea of dismissal of causal and scientific potential of emergent properties, whereas there is a revival interest in emergence between scientists [5].

Layered or hierarchical structure of nature is under ultimate attention in contemporary sciences. As McLaughlin and Bennett [6] remarked, most of the scientists believe these layers to be epistemic, i.e., they are consequences of scientific theories and the "scope" of sciences and not inherent property of the nature. Controversially, there are scientists who advocate these layers to be ontic that hierarchy is innate for the nature, and inevitably, the concept of emergence must presuppose the notion of levels [7]; however, there is an ambiguity in hierarchical classification of systems [8]. Nevertheless, most philosophers and scientists are common in that the "substance" of all these natural levels is nothing but the physical substance [5]; and it is commonly agreed that all emergent phenomena, if any exist, have a physical base [8]. Consequently, emergentism is a form of what is now standardly accepted as "nonreductive materialism" or "constitutive reductionism." This doctrine tries to position itself between two extreme ontologies: the monist materialism or "physicalist reductionism," and the pure "dualism" of mind and matter, or life and nonliving matter [2, 9].

Emergent properties cannot be deduced from their bases, which means that they could not be predicted [10]. As Kim [2] pointed out, we have to distinguish between inductive predictability and theoretical predictability. Most of emergent properties are inductively predictable [2]. In most cases, we can predict an emergent property when it has happened enough times to gather adequate information about it. But we cannot deduce and predict its occurrence out of our theories [11]. Kim [2] emphasizes that "this unpredictability may be the result of our not even having the concept of [what would probably emerge]" (p. 8). This approach espouses the notion of ontic or strong emergence. Collier and Muller [8] say: "[E]mergent phenomena are novel because they create new capacities" (p. 12). The emergent properties are new or novel in the sense that they have genuine causal powers, which are not found in the constituents taking separately [6, 11].

Strong emergent properties are supposed to have physical bases but cannot be derived from their bases [8]. This notion "raises the specter of anti – scientific dualism" (p. 503) [12]. Although most scientists believe that almost all physical phenomena have necessarily physical substance, some authors take mind and consciousness as exceptions, to be probably the only ontic emergent phenomena [13, 14]. Bickhard and Campbell [7] assert that the source of difficulties in making sense of ontic emergence is the metaphysics of particles and properties, or "substance metaphysics," which they believe to be an inappropriate metaphysics for understanding the nature. They propose an alternative "process metaphysics" to make the ontic emergence much more natural [7].

Kauffman and Clayton [12] endorse the idea of ontic emergence according to some remarkable biological evidences. They emphasize freedom of choice, teleology, and natural selection as obvious evidences for ontic emergence. They remark special thermodynamic work cycles of cells in which, work out of the cycle builds a further constraint on release of energy and consequently a self-ordering intelligent chain process forms in the cell [12]. This "self-propagating organization," they believe to have the "manipulation of constraints" behavior, is totally a living property and is by all means out of the scope of physics [12]. They emphasize that this special organization does not merely involve matter or energy or entropy, it involves all of these and "something more" as well. They advocate this to be a new form of "energy–matter organization," which they name "living matter" [12].

Despite these cases of ontic emergence, most of the emergent phenomena encountered by science are considered to be epistemic. Epistemic emergence is more popular in contemporary science, even known as the only meaningful version of emergentism [6, 9]. Chalmers [14] believes that the epistemic or weak emergence has its roots in the "difficulty of explanation" of a phenomenon according to "its explaining theory." In this sense, emergent phenomena arise because they are not "explicitly definable" [6]. Harré [4] adopted different sciences to be distinguished

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"discourses" and construed emergent property to arise when we try to describe a phenomenon with two incompatible scientific discourses. Bitbol [9] points out that the appearance of novel properties are the results of our scientific theory becoming "coarse-grained." For example, when we model the traffic jam, if the number of cars is enormously high, it is easier for us to use hydrodynamic and chaos theory instead of considering each car separately [13]. Here, emergence has its roots in the mutual irreducibility of the models representing traffic jam by these different theories [13].

Kim [15] proved that the notion of supervenience is a necessary condition for emergence. Nevertheless, he pointed that supervenience is an essentially negative condition, and it cannot amount to a positive account of the reality of emergent property [15]. He asserted that the nature of emergent property makes its necessary supervenience condition unexplainable, because emergence has brute nature and consequently, we cannot identify what kind of dependence governs the supervenience relation [15]. Supervenience does not explain why the higher level patterns form and what is the exact nature of dependency of higher patterns on their constituents [16]; therefore, supervenience is not sufficient for the proof of epiphenomenality of emergent properties on their lower level constituents [17]. O'Connor asserted that supervenience will fail by a dynamical account for the configuration and formation of emergent properties [16].

It seems to be a type of selection upon the properties of parts during constructing the whole. This property selection occurs only by some form of interaction with whole [10]. An organism is alive in virtue of "certain" features of its constituents and these constituents could not maintain those features if they were not participate in that living organism [11]. Paul Humphreys has invented the concept of "fusion" to justify the irreducibility of emergent properties [6]. In his opinion, the properties of constituents of a system fuse together in a way that they lose some of their causal powers and "cease to exist as separate entities" [6]. Humphreys' concept of fusion is supposed to be a necessary but not sufficient condition for emergence.

Collier and Muller [8] remark that the causal interactions between different levels of a system constitute the organic unity of system. They say: "[C]ohesion represents those factors that causally bind the components of something through space and time, so it acts coherently and resists internal and external fluctuations" (p. 6) [8]. It happens there to be a sort of information guides the system to evolve or develop in proper ways [18]. Francescotti argues that the whole has causal influence on its parts so the properties of parts differ in virtue of the whole. Therefore, parts build the whole and the whole guides them how to do this! He names this "intervention" [11]. He emphasizes: "[The emergent property] supervenes only with the help of properties the parts would lack were they are not parts of the whole with [the emergent property], the base on which [the emergent property] supervenes is dependent on the presence of [the emergent property] itself" (p. 62) [11]. Emmeche et al. [19] state that there is a sort of "dialectic" between higher level and lower level, similar to the notion of Sperry's "interactionism." Kauffman and Clayton [12] discuss the extinction of species and remarks that when the last member of a species dies, it dies as a whole organism and its death influences the molecular construction of the biosphere.

In most of the natural systems, there are several negative and positive feedback loops that stabilize the emergent properties of higher level while act as constraints for constituents of lower level by directing and controlling them [5]. This is called downward causation. In some natural systems, higher levels exert downward causes on lower levels by generating boundary conditions on the behavior of lower levels [8]. By these boundary conditions, the whole selects its proper configuration from different possible combinations of constituents [10]. Kim says: "Some activity or event involving a whole ... is a cause of, or has a cause influence on, the events involving its own micro constituents." (p. 26) [2]. He calls this "reflexive downward causation" [2].

Kim [2, 15] argues that downward causality is the central component of emergentism which accounts for novelty of emergent properties; Kim [2] investigated logical aspects of upward causality and pointed out that this notion seems "paradoxical." He argued that downward causation entails the same level causation; but at the same time, the same level causation presupposes downward causation [2]. He concluded the "diachronic reflexive downward causation" to be the least problematic solution to the conflict of downward causation. He urged that the problem still remains, for that it is unremarkable as a type of causation [2]. Kim [15] urged that downward causation is ambiguous and the relation between emergent property and its constituents cannot be viewed as causal. Welshon [17] discussed some deductive aspects of the notion of downward causation and emphasized that "[t]he emergent property just looks like a free rider"! (p. 42); however, he stated that although the concept of supervenience of emergent properties on, and their realization by their bases are ambiguous, we cannot prove the epiphenomenality of emergent properties either; and therefore, the logical space for emergent properties to be causally efficacious on their bases remain available [17].

Bertrand Russell claimed that emergent qualities were merely epiphenomena and of no scientific significance, saying that analysis "enables us to arrive at a structure such that the properties of the complex can be inferred from those of the parts" (p. 3) [5]. This insight is what has been

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named as reductionism. Anderson [20] unveiled a corollary of this approach: "[I]f everything obeys the same fundamental laws, then the only scientists who are studying anything really fundamental are those who are working on those laws" (p. 393). Wójcicki remarked that reduction is noteworthy only if it declares implicit definability of higher properties by the lower constituents [21]. Bersini and colleagues say that reductionism is correct if is restricted to the structure, as we certainly know that every living body constituted by molecules. But if we insist on explaining the properties of living bodies just by its molecular structure, it turns to be problematic and even impossible [22]. Kistler [23] claims that many of scientific reductions are approximation, placed between full description of nature and radical elimination of its properties.

Reductionism has been criticized to be at least inadequate and even misleading at worst [18]. Anderson [20] stated: "[T]he ability to reduce everything to simple fundamental laws does not imply the ability to start from those laws and reconstruct the universe" (p. 393). Wójcicki [21] mentioned the Goedel's incompleteness of formal systems of logic and mathematics and remarked that this theorem may thread other scientific disciplines as well. McLaughlin and Bennett asserted that supervenience of higher levels on physical substance is not sufficient for logical acceptance of reduction [6]. Kim [2] remarks that the positivistic reductionism is almost totally collapsed and the idea of unified science has become suspicious recently.

Reductionists claim that we would eventually deduce all natural laws out of the physical laws. This idea is known as physicalism. Despite some acceptances, there are strong arguments against physicalism. Any attempt to grip with this concept becomes controversial and is not metaphysically clear [5, 24]. Mitchell [5] asserted that physics works with descriptions and all descriptions are abstractions or idealizations. Furthermore, descriptions are always partial. Essentially, physics, in its analytical and modern form, has been founded and flourished based on reduction since its early days. Descartes had reduced the entire physical universe to matter and motion [18]. Kauffman and Clayton state that for a physicist, work has a reduced meaning. For him, work is merely force acting on a distance and is represented by a scalar. In biology, this definition is not adequate for work, and more systematic approaches are required. For example, Atkins has defined work as "constrained release of energy" [12]. More strict realms are mind and life, which are not by all means reducible to physics [21]. Philosophy of mind declares the most plausible and compelling arguments against physicalism [24]. Nevertheless, as Stoljan emphasized, we live in an overwhelmingly physicalist intellectual culture [24]. The prevailing "causal closure of physical" law, which insists that every event which has a cause must have a physical cause, dominates the contemporary science [24].

Quantum mechanics is the most underlying realm of physics. Inevitably, reductionists have to adopt this slogan that every phenomenon in the world must be eventually explained by quantum mechanics. This is what already reductionists proclaim. Despite this fact, there are many statements to appease the hankering of this query. Bitbol [9] affirms that if the message of quantum mechanics is taken seriously, the reification of not only high level phenomena and emergent properties but also the low level and so-called basic constituents becomes rigorously under suspicion. Furthermore, the best candidate for emergence is known to be in the quantum mechanics itself! This is due to the nonseparability of quantum states, the characteristic which Chalmers has urged to be the only example of downward causality that he knows [14]. Bohm, an indispensably outstanding quantum mechanist, emphasized that quantum mechanics "is not a theory at all." It is just an algorithm for calculating certain results. It does not offer any way of explaining or conceiving these results. To assign a meaning to quantum mechanics, we may just say that it gives the probability of something which can be observed by means of an apparatus [25].

Quantum field theory has been invented by quantum mechanists as a unifying framework for constructing quantum mechanical models of systems. According to this theory, what appears to be particle is the consequence of quantization of the field excitatory activity. Quantum field theory eliminates the localization and atomization of substance into particles. Quantum fields are processes and only exist in patterns [7]; therefore, instead of substantial individuals, quantum field theory deals with types of patterns [9]. Bitbol [9] emphasizes that according to quantum field theory, physics cannot be the substantial ground for other sciences. Every level of organization which is in the purview of physics is relational. No level can be considered as ultimate one [9]. Beside these arguments, quantum mechanics cannot predict the higher level phenomena without acquisition of information from those levels. Given the vast number of states that are accessible at the quantum level, we have to read downward from, say, H_2O to make the right choice, and subject the Schrödinger equation to the appropriate boundary conditions. [10].

THE QUEST FOR ALTERNATIVE INSIGHTS IN FOUNDATIONS OF SCIENCE

The obscure status of contemporary science encountering the concept of complexity in systems has not remained unobserved by most of scientists. According to our brief survey, it is obvious that the concept of emergence has become a dilemma. As Humphreys [26] remarked, we are now in the midst

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of a tangle of familiar issues none of which have easy solution. Kim [2] urged that contemporary emergentism is inherently unstable and it threatens to collapse into either reductionism or more serious forms of dualism. He also asserted that downward causation has "paradoxical nature" [2]. However, we may unravel this paradoxical nature by reforming our scientific theories and/or methods. The request of science to more profound explanatory and unifying theories has been commonly mentioned recently and urged by some sophisticated scientists and philosophers, of some who have already begun the discovery of such theories. Mitchell [5] remarks that what is required is a "richer conceptual framework" to explain dynamically the reciprocal causations between the emergent property and its constituent parts. Kim [15] asserts that the downward causation has to be founded on a stronger theoretical base. Wójcicki [21] emphasizes our mathematical theories to be "too weak" to adequately capture the relations between the fundamental laws and the phenomena we seek to explain. Kauffman and Clayton [12] urge that biology presently lacks a "theory for the organization of processes"; and that no adequate theory of the organization of many biological processes currently exists in scientific or philosophical literature, "even in outline" [12]. Kim asserts an adequate "theory for organization" to be missing in the current emergentism–reductionism debates [2]. Goldstein [27] believes that none of our mathematical methods and computer simulations offers much promise in detecting the emergent levels. These authors, amongst many others, have suggested some alternative approaches to obviate the paradox of emergence. Goldstein suggests considering the emergent level as a new "natural kind," i.e., a construct reflecting how nature is parsed according to its observed regularities. Novel natural kind constructs appear when science, mathematics, or philosophy introduces new ways of looking at nature leading to the recognition of regularities not perceived before. He believes that as natural kinds become more accepted they will be taken as theoretical primitives [27]. Bickhard and Campbell [7] adopt the notion of "process organization" based on quantum field theory as an explaining reason for generation of emergent properties in systems. Alberts proposes "essentialism" instead of reductionism. He advocates a method of simplification without reduction based on essentialism. He emphasizes that we must simplify without losing the essence of the system and/or behavior [28].

These proposals, how much clever they are, cannot resolve the dilemma of emergence. The authors of this essay believe that the concept of emergence is superfluous, and we are potentially capable to overcome this paradox, at least to some extent. All events and entities in the world have certain causes and are therefore epiphenomena. If we are not capable of understanding the cause of a so called emergent event, it does not mean that it does not exist! We would attain to understand and explain this causality by innervating our scientific methods with wiser theories. To achieve these theories, we need to fundamentally reform our interpretation of universe by empowering our intellect. Toward this goal, we have to recline on a more powerful and profound philosophical structure to underlie our scientific paradigms. Scientific paradigms have become mature enough to pervade their domains far to their boundaries and now they require fundamental reform, i.e., scientific revolution. This enterprise, however, requires strong insight and innovation, either in philosophy and science. Bohm many years ago emphasized that physics has become more and more dogmatic and mechanical [25]. Collier remarked the need for new innovative change in foundations of science and mentioned the important flaws in contemporary science: "This [change] requires creativity and openness that is not necessarily encouraged in current scientific training" (p. 10) [29]. He insightfully added: "If we don't open up our methodology, however, we risk being as foolish as the drunk who lost his watch in the alley, but looks for it under the street lamp because the light is brighter there" (p. 10) [29]. Lieber [1] wisely emphasized many years ago: "We need a new paradigm, that is, we must invent new modes of experimentation" (p. 9); i.e., we need a scientific revolution. He added: "[D]eep facts [in science] ... necessarily demand a universal correspondence between all modes of experimentation and that science in its present state... is essentially limited... by a particular mode of experimentation" (p. 5) [1]. The recent attention to emergence is an evidence for such a quest; as Bersini et al. [22] noticed, the reason of concern about emergence in the last 10 years is the general conversion of science towards an "integrative view" of the nature.

SOME PHILOSOPHICAL WITHDRAWALS IN CONTEMPORARY SCIENCE

There are many phenomena in the world not reducible to a set of separate individuals. Nevertheless, we employ such a set of reduced individuals as alphabetic constituent in order to study the phenomena. We actually invent and acquire those individuals as a language for the ease of studying the system. For example, a symphony is not actually composed from combinations of music notes. A composer uses music notes as an instrument or a language for writing, documenting, and transferring music composition to others, but the music is not actually made of the notes. The composer generates the music as an intuitional big picture in mind. This big picture is an irreducible picture. Actually, a scientist

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who attains to understand a truth, holds such a big picture about that truth in her mind. She must be cautious not to misguide her insights by forging the truth to be only definable and explainable by the reduced alphabets, to be understood and acknowledged by other scientists. Every scientific definition or theory in this sense amounts a kind of reduction; which spontaneously destructs the corresponding original truth.

Physics is very expert in this type of destructive reductionism. Most of physical quantities have been defined in this way. Mass is a very familiar example. Originally, mass is a very special revelation of a global mysterious truth we conceptually name matter. We reduce this revelation to a mere quantity. Then reduce this quantity to be just a number. This sequential reduction is not withdrawal by itself. The crisis happens when we forget that the number per se is just a reduced picture of reality and is not the very truth at all! Consequently, we misunderstand the truth with its reduced picture. Many physical concepts such as mass, energy, and force are reduced pictures of a whole. We have reduced them in an appropriate way to become quantifiable. When we talk about matter, if we forget that we actually talk about a mysterious truth with inherent potential for, say, life; then we have to impel ourselves that life emerges from this crude meaningless matter. We must not forget that physical theories and concepts are not facts. Physics by itself is a reduced view of nature. If we really quest for a more sincere understanding of the universe, we have to illustrate the so-called big picture of the universe scientifically; just as what a musician does when composes music. All sciences have to work closely together to illustrate a more truthful picture of the world. Physical theories and entities would be far from reality if we isolate physics from other sciences. Of course, phenomena of other sciences would be emergent according to this isolated science!

An important philosophical method undermining scientific paradigms is the conventional notion of Cartesian reductionism. In this method of analysis, we simplify a compound to some finite (or infinite) number of understandable simple basal objects; then reconstruct the compound as nothing but an aggregation of these simple objects. This method may sound to work perfectly in some cases but not in most of the cases. Because of its easiness, we actually have defined many of entities and concepts compatible with this method of reduction. For example, we have defined physical space as nothing but an entity measured by three mutually perpendicular directions. Then we have defined all physical entities such as velocity, acceleration, and force compatible with this mutual perpendicularity. We have reduced all these entities and concepts to vector. We even have reduced the titanic concept of time to just a scalar. We have done all these definitions in amount of proper compatibility with the method of Cartesian reductionism. Expectedly, complexity would arise sooner or later, because the nature is not reducible.

Descartes declared that he has adopted this reduction method from the Euclidean geometry. Euclid has postulated five simple axioms for plane geometry. These axioms together construct a functional structure by defining a systematic relation between some undefined entities, e.g., point, line, and incidence. Euclid's axiomatic method, which is very conventional in contemporary mathematics, is completely distinguished in essence from the Descartes' reduction. Euclid's undefined entities are not simple understandable objects. Furthermore, the sentences of the axioms do not relate these undefined entities aggregately or linearly. Euclid's axioms demonstrate simple but essential and not reduced configuration of geometry. Point, line, and incidence are concepts, which Euclid has borrowed from drawing. They are not mathematical at all. The geometric origin of the axioms is not mathematical either. Nevertheless, what is mathematical is the representation of axioms by which an exact operational system is formed. Consequently, geometry becomes mathematical, i.e., analyzable. Here is an obvious case of what Alberts [28] remarked that simplification does not necessarily imply reduction.

The essential idea underlying the Cartesian reduction is objectivism. The easiest way to treat the phenomena of the world is to consider them as objects. Objective interpretation has this simplifying advantage that we can separate an object from other objects and study its properties in isolation. This method is fundamentally accepted in contemporary science. One side—effect of objectivism is the complexity of systems. Complexity and irreducibility will remain in all levels of nature, and/or all scientific discourses, even in the so called most underlying sciences such as physics and especially in quantum mechanics, as far as our scientific methods stay affine to objectivism.

Close to the method of Cartesian reduction in philosophy, is the notion of linearity in mathematics. According to Descartes' reduction, a linear system (or behavior) is a system which is reducible to simple irrelevant and independent objects (or behaviors). When the amounts of these simple behaviors change, the whole behavior does not change. This means the local and the global scopes of a linear behavior are identical. Collier and Muller remarked that we use idealizations of the nature to make our models more tractable and one of the most important idealizations is linearity. But the evidence for linearity even in simple realistic physical systems is quite weak [8]. Nonlinearity is a loose term, by which we centralize linearity as our affine behavior and subsume all other behaviors under a broad spectrum of nonlinearity. Nonlinearity and emergence are twins. Bickhard and Campbell [7],

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among others, advocated this essential point that nonlinearity is crucial to causal emergence. Nonlinear systems involve relations among their parts that cannot be localized [8].

Fusion of constituents, much similar to what Humphreys has defined, exists and strongly dominates the nonlinear dynamical equations. This seems to be the core reason of incomprehensibility of nonlinearity. For a function $y = f(x)$ such as $y = x^2$, if we add a term like bx we can comprehend the consequent change. This is because in our sense, this equation is compatible, and therefore, all the arithmetic operators accompanying it are the ones we know and comprehend separately. By contrast, in the case of a nonlinear dynamical equation such as $\dot{x} = f(x)$, we do not have a general insight of the consequent changes in $x(t)$ if $f(x)$ is changed. This is due to the inconsistency of the nonlinear dynamical equation, given that the derivative is a linear and local operator. Because of this affinity to linearity, the comprehension of the behavior is dominantly possible if the right hand side of the dynamical equation is linear either. However, if we place a nonlinear function at the right side, this means that we are trying to model and percept a nonlocal behavior by an inherently local device, i.e., derivative. This leads to a conflict. Therefore, nonlinear dynamical equation possesses an essential conflict, for this equation is a reduced picture of a behavior which is inherently irreducible!

When the mathematical operators participate in a nonlinear equation, which is inherently incoherent, they fuse together and each of them reveals an effect which does not possess separately. We call this in vivo operation. In contrast, we call a mathematical operation in isolation or in a linear system in vitro operation. Mathematical operators turn from in vitro to in vivo, when they participate in nonlinear dynamical equations. This change of behavior, as we believe, is due to essential incoherency of nonlinear equations and reveals our wrong assumption about the essence of mathematical operators, i.e., reducing them to isolated and linear operators. This is what we usually do in mathematics and other sciences, because it is easier. Instead of this Cartesian reduction, we have to invent a mathematical theory in which an entity or operator always be defined according to its obligation in the system it participates.

SUGGESTIONS FOR SOME METAPHYSICAL REFINEMENTS

Attempting to resolve a dilemma like emergence, we have to surpass the conventional metaphysics and try to grasp a more profound insight of the universe. This is tantamount to a partial fulfillment of man's search and sustained quest for the identification of the essential elements of nature, which of course derives from his faith and conviction that they indeed exist. Such underlying essential elements can in no sense be incidental, either phenomenologically or in the laws that condition the phenomena incurred in various realm of scientific experience. An essential feature is thrust toward unity in diversity, which is of the utmost prominence and is intricately mingled with almost every property of the nature. Trying to logically deduce this postulate leads to a paradox. As Hegel has emphasized, this essential becomes understandable only in the realm of intellect, which begins at the utmost ability of reason. Every profound metaphysical structure that attempts to unravel the scientific paradoxes like emergence has to encounter the essential concept of unity in diversity in its predicates, and considers it in its axiomatic agenda.

All scientific laws from different disciplines have a few common obligations, which implicitly accompany them. These obligations encompass scientific laws and rule them as their souls. Two of these obligations are symmetry and optimality. Most of the scientific laws implicitly obey these rules. Although in different disciplines and for different laws, the interpretation of symmetry and optimality are not alike, the simple essence of each of them seems to be identical. Even in a more profound metaphysics, they seem to unify under a more fundamental principle. Our metaphysical system must deal with these two essential rules and intelligently discover their efficacious status in the universe.

The metaphysical features we discussed above must be complied and synchronized in a metaphysical system. Here, we illustrate briefly an outline of our suggestive method. Imagine this puzzle: build four triangles by six equal match sticks. As we know, this problem is not solvable in the plane, or in other words, it is impossible to solve it if we bound ourselves to planar purview. The solution is a tetrahedron, which is a spatial configuration. Many paradoxes of science are similar to this puzzle. We would successfully solve them if we transcend our perspective. The correct way to insightfully understand and analyze the nature is not reduction but transcendence. Metaphysically, a substantial whole and its constitutional parts are almost of no metaphysical distinction, and holism in physical sense is equilevelar to reduction but in different direction. Holism and reduction deal with different scopes and functional scales of a system. The metaphysical method we state here is perpendicular to both reductionism and holism. We name this method transcendentionism. Detailed discussion about this method requires further elaborative essays. However, briefly speaking, transcendentionism deals with a completely different type of cause, which we call transcendental or existential cause. This cause is a metaphysical concept and is not objective, rather it is deductive and its necessity would be proved by logical inference. Based on this transcendental causality, we will be able to illustrate an imaginary big picture of the universe (and for every natural system) which is

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metaphorically like a cone. At the higher and hidden levels of this cone, existential causes complementarily combine, which is the source of symmetry and optimality of laws of the nature. The combinations of existential causes are their projections on the lower level. These projections are existential causes for further lower levels. Consequently, there would be a hierarchy for each and every system, in which there exists a single cause at its vertex and potentially infinitely many projections at its base. This structure justifies the postulate of unity in diversity. Such metaphysical approach is applicable in mathematics and is conjectured to be capable to substitute a fundamental theory in place of the set theory.

By this transcendental causality, we may become able to merge and unify entities and the laws governing their relations. In the conical hierarchy of system, depicted by transcendentionism, all diverse objects are different aspects of a single transcendental cause, and consequently, they become unified. We have to keep in mind that this hierarchy is not objective but imaginary and deductive; and various conventional levels of nature are considered to be different projections of this transcendental hierarchy.

One of the characteristics of the method of transcendentionism is the aspectual view. Every entity in this metaphysics becomes a particular aspect of a transcendental cause. Any transcendental cause is global for its epiphenomena, and its epiphenomena are particular aspects for that cause. The cause is the existential reason of its aspects and its aspects are particular projections of their transcendental cause. In this metaphysics, whole/individual is a horizontal classification and global/particular accounts for a vertical hierarchy. Another feature of this metaphysics is that object is replaced by action. Every entity is an action; because every entity is a particular aspect/projection of a transcendental cause and, therefore, will be defined by its particular duty.

This transcendental metaphysics, if sophistically developed and tenaciously founded on philosophical inferences, seems to be successfully capable of solving paradoxes like emergence. The coherency of different natural laws and the unification of laws and entities, which result in the virtue of aspectual hierarchy of actions, seem to be powerful enough to obviate the notion of emergence as well as many other problems in the contemporary science. However, this is just an outline and needs philosophical developments as well as scientific exemplifications.

SUMMARY AND CONCLUSION

In this essay, we briefly reviewed contemporary debates on emergence and showed the dilemmatic nature of this notion in science. This dilemma is not because of our lack of information or lagging computers. The reason for this paradoxical status is our metaphysical insights underlying our scientific paradigms. The Cartesian reductionism and its inevitable counterpart, i.e., objectivism were construed to be an essential source of drawback in our scientific insights. Eventually, we suggested some metaphysical concepts such as unity in diversity and symmetry to be among the most important essentials for composing a profound metaphysical structure. We also suggested a metaphysical method, which we named transcendentionism, as a methodic framework for the alternative metaphysics for science.

To overcome the dilemma of emergence, we need an enterprise, an endeavor to be carried out by scientists who delight in beauty of nature.

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