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The Philosophy of Space-Time: Whence Cometh "Matter" and "Motion"?

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ABSTRACT

From the macrocosm to the microcosm, natural science has so far confirmed the most fundamental assertion of materialist dialectics that there can be no matter without motion and no motion without matter. This view of the objective reality is in sharp conflict with the one proposed by Albert Einstein in his theory of General Relativity (GR). According to Einstein, "Since the theory of general relativity (GR) implies the representation of physical reality by a continuous field, the concept of particles and material points cannot play a fundamental part and neither can the concept of motion. The particle can only appear as a limited region in space in which the field strength or energy density is particularly high"(1).

This article offers a dialectical perspective of the internal dynamics of Space-Time-Matter-Motion of the infinite universe, mediated by the virtual particles of the quantum vacuum. It is at the same time a refutation of the finite, non-material and abstract four dimensional spacetime geometric manifold as the ontological basis of objective reality, proposed by Minkowski and Einstein.

Indexing terms/Keywords

Space-Time, Matter, Motion, Finite, Infinite, Dialectical, General Relativity

Academic Discipline And Sub-Disciplines

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Physics, Cosmology, Philosophy

TYPE (METHOD/APPROACH)

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INTRODUCTION

Two exactly opposite views of the universe represented by space, time, matter and motion are discussed. Historically, the ruling and dominant view based on causality insists on a finite universe that came into being at a single instant and as a single act of creation in the finite past. The universe (and life) manifests itself in a more or less deterministic way according to the parameters set at the beginning of creation.

The opposite view based on chance and necessity of dialectics and quantum dynamics, posits an universe infinite in space and eternal in time, where matter and motion comes into being and passes out of existence as an unceasing quantum process and evolve through dialectical negation of the negation.

Starting from Parmenides, Zeno et al., to Albert Einstein and modern physics; motion remains an illusion or at best a mystery for causality based philosophy and natural science. A super-natural force no matter of what kind and of what description ("first cause", "first impulse", "first breath of life", "spontaneous symmetry breaking, etc.) were always invoked to explain motion (- change, evolution, development etc.). The nature and the origin of "matter" still remain obscure for modern physics even in its transition from the classical to the quantum formalism. (2,3)

The developments in physics, cosmology, and metaphysics so far have led to the enrichment of the content of the debate and few reversals of the notion of space-time-matter- motion; but a clear understanding of the inner dynamics and the real nature of these four elements remain as elusive as ever. The discovery of the quantum phenomena has only made the situation more complex and far more confusing.

Looking through the subjective idealism of Immanuel Kant; space and time are illusory - mere projections of the human mind; within which unknowable things-in-themselves and the subjective mind thrive.

Looking through the mathematical idealism of Albert Einstein; an integrated four-dimensional spacetime manifold is the objective reality and the new ether in a finite universe created in the finite past; through which the force of gravity and light propagate and where matter and motion are only secondary and incidental.

Looking through the dialectics of Hegel, the infinity of space and time only as a sublated moment is in eternal dynamic transition to each other represented by the virtual particles – as "being-nothing" of the quantum vacuum, that pop in and

out of existence; and forms the basis of the "becoming" of tangible matter and motion of the infinite and the eternal universe. Matter in motion is the truth of abstracted space-time.

In the theory of General Relativity (GR) proposed in 1915, Albert Einstein revived the idealist notion of space and time of ancient-Greek mathematical idealism and made a radical reformulation of that notion to an integrated and finite four-dimensional spacetime manifold with tangible physical attributes that is supposed to form the basis of the objective reality of the universe. This notion is in sharp conflict not only with the view of classical physics represented by Isaac Newton, who considered space and time as infinite and absolute, filled with some medium of ether; but also with the notion of space and time of early-modern philosophies, particularly with the subjective idealism of Immanuel Kant; which consider space and time as abstract mathematical constructs without any physical or empirical significance. The recent claim of a definitive and "unequivocal proof" of (GR) through the purported twin discovery of "gravitational waves" and "black holes"(4) raised the stake in this debate.

The discovery of the quantum phenomena at the turn of the 20th century revealed a feature of objective reality that was unimaginable before. Through the use of imaginary numbers to accommodate the fractional "spin" of quantum particles; Paul Dirac unveiled not only the existence of hitherto unknown antimatter particles but also a parallel virtual dimension of space – the quantum vacuum, where the ghostly, virtual and very short-lived matter-antimatter particle pairs come into being and pass out of existence as an interminable process. The quantum rules also allow for some of these virtual matter particles to become real particles and hence make a link with the real world. This is an aspect of reality that no thinkers of history could even imagine before. In retrospect it now seems that only G.W.F. Hegel's dialectics anticipated such a possibility. His dialectical method, especially in its materialist form promises to be a versatile tool for an understanding of all evolutionary processes of Nature and Life (5) and also the Infinite (6). The dialectical perspective may offer a possible synthesis and the resolution of the conflicting notions of space, time, matter and motion and also the possible better understanding of the hitherto "weird" quantum phenomena. (7)

The Historical Background:

The roots as well as the contradictions of the notion on space, time, matter and motion originated with early Greek thinkers. In principle, the controversies and contradictions involved the philosophical question: what is primary in the world - mind or matter, spirit or nature, stasis or dynamis, the ideal or the material? This also involved the question how the world came to being, was it created by a God or has it been in existence eternally, is it finite or infinite?

The Greek idealists particularly Pythagoras, Parmenides and his student Zeno and later Plato posited that the objective reality of the world is an absolute unity, motionless, continuous, eternal and an infinite "being", which is beyond sense perception; but describable in terms of continuous space and time. Their monism also denied the possibility of any "becoming". This idealist realm of reality does not "exist" for senses, but can only be perceived through the intuition of the mind and thought and can be represented only through idealized mathematical/geometrical models. What "exists" for senses - matter, motion etc. is perishable, temporary and hence unreal and is mere illusion. Zeno through his paradoxes arising from the infinite divisibility of space and time showed that motion is impossible and is an illusion.

The contemporary dialectical thinker Heraclitus and later Epicurus on the contrary, posited that "change" (motion) is the fundamental characteristic of the world – *everything is in flux*. The materialists represented by Leucippus, Democritus and others like Aristotle asserted that only matter, that can be perceived by the senses is primary. Democritus famously said, *"Nothing exists except atoms and empty space; everything else is mere opinion".* Later Materialists, particularly dialectical materialists since Epicurus following Democritus denied the infinite divisibility of matter; but only of space and time, which were considered as infinite. The materialist trend led to the modern atomic theory of physics and chemistry; while the idealist trend finds its revival in Einstein's theories of relativity and the "spacetime" ether.

By the Middle Ages, an all-pervading omniscient God of theology came to be associated with infinite space and time and the universals of Parmenides/Platonic idealism. But after Spinoza's concept of "limit" to differentiate between the finite and the infinite; problems arose how the infiniteness of God could be reconciled with finite man. How infinite God can have any contact with finite and perishable man, which would limit His infiniteness? The contradiction of the finite and the infinite with regards to space and time was resolved later only by Hegelian dialectics, for which the finite IS the infinite and vice-versa - a dialectical contradiction of the "unity of the opposites"; which is resolved continuously by the never-ending extension of the universe both in space and time (6). But this debate still rages on in theology, mathematics, physics and in all anti-dialectical philosophies. In theology, the ecclesiastical authority of the Inquisition burnt Giordano Bruno alive on the Stake for claiming that the universe is infinite. In Physics, GR assumes a finite universe and in mathematics, Georg Cantor (1845 – 1914 A.D.) was the last to try to prove the existence of the infinite, but faced intractable contradictions and no one else followed his footpath.

The Early Modern and Modern View

The development of natural sciences and materialism, including the theory of evolution and the quantum theory since the Copernican revolution in 1543; set the primacy of matter and motion and the dominance of materialism in natural science. The debate about the ontological and epistemological status of space and time became more spirited, when Isaac Newton extended his terrestrial mechanics to the celestial sphere of the solar system and after he proposed his theory of gravitation. Newtonians conceived of space as a kind of quasi-object identified with some mystical ether media through which light {and gravitational force?) propagates. In this view, space and time are independent of all objects and relations, and lack causal relations. These are also imperceptible, and certainly in the case of space, infinite.

In opposition to the absolutist concept of Newtonian physics, G.W. Leibniz posited a relational concept of space and time pivoted on material bodies and insisted that space cannot exist independent of objects (7). Leibniz thus insisted that there is a relational dimension between matter and space and one cannot exist without the other.

Immanuel Kant took a subjective idealist view of space and time in opposition to both the Newtonian and the Leibnizian view and proposed that these are subjective projections of the human mind and absolutely have no objective existence, In his view, "*Space is not something objective and real, nor a substance, nor an accident, nor a relation; instead, it is subjective and ideal, and originates from the mind's nature in accord with a stable law as a scheme, as it were, for coordinating everything sensed externally."* (8)

G.W.F. Hegel following Leibniz and in opposition to both Newtonian and the Kantian view of space and time posited a revolutionary dynamical relation of space, time matter and motion. For Hegel space and time are potentials as "possibility" becoming "reality" [*Wirklichkeit*] rather than anything yet concrete. For Hegel, *"…the correct determination remains that space is a mere form, i.e., an abstraction, that of immediate externality. - To speak of points of space, as if they constituted the positive element of space, is inadmissible, since space, on account of its lack of differentiation, is only the possibility and not the positing of that which is negative and therefore absolutely continuous. The point is therefore rather the negation of space. This also settles the question of the infinitude of space. Space is in general pure quantity, though no longer as a logical determination, but rather as existing immediately and externally. Nature, consequently, does not begin with quality but with quantity, because its determination is not, like logical being, the absolute first and immediate, but essentially a mediated being, a being external to and other than itself "* (9). More on Hegel's view of space and time, discussed below.

James C. Maxwell (10) in his book "Matter and Motion" offered a profound view of space and time in opposition to the view of Descartes, who sought a unity of matter and space. Maxwell took a relational view of space and time similar to that of Leibniz. For Maxwell human knowledge is relative, but needs definite space and time as a frame for its coherent expression.

Hermann Weyl (11) in his book "RAUM—ZEIT—MATERIE" discloses a philosophical position of the dynamical relation of space, time matter and motion, which is very close to that of Hegel. He began the book with some reflections of a philosophical nature: "*Space and time are commonly regarded as the forms of existence of the real world, matter as its substance. A definite portion of matter occupies a definite part of space at a definite moment of time. It is in the composite idea of motion that these three fundamental conceptions enter into intimate relationship."*

Almost all modern works on the philosophy of space-time-matter-motion take inspiration from the four-dimensional spacetime formulation of Hermann Minkowski and Albert Einstein (discussed below). Most physicists universally accept this concept. From cosmology to quantum physics, most modern physicists take an inconsistent, vague and poorly defined approach of "quasi-realism" on this question of space and time; as everything is couched in idealized mathematical formalism. Any modern official philosophical works therefore, are mere justification of the spacetime formalism (12, 13) of the theories of relativity..

The Spacetime Manifold, the Theories of Relativity And Mathematical Idealism

In physics until Albert Einstein, a vague Newtonian materialist notion of matter and motion existing in the infinite void of absolute space and time prevailed. But things changed radically after Albert Einstein proposed his theory of Special Relativity (SR); that made the velocity of light an inviolable universal constant; with profound implications for the notion of space, time, matter and motion. Following SR, Einstein's teacher, Hermann Minkowski proposed a hitherto unthought of and un-intuited concept of an integrated spacetime as a four-dimensional manifold. This is a radical reformulation, in which space and time loose their independent conventional meaning. According to Minkowski (14) , *"The views of space and time which I wish to lay before you have sprung from the soil of experimental physics, and therein lies their strength. They are radical. Henceforth space by itself, and time by itself, are doomed to fade away into mere shadows, and only a kind of union of the two will preserve an independent reality"*.

Minkowski's concept gained further importance when Einstein used a spacetime "continuous field" in his theory of General Relativity (GR), as the primary objective reality of the universe and not matter and motion -, thus overturning the materialist basis of Newtonian physics. Einstein proposed the theory of General Relativity (GR) in 1915; purportedly as a better description of gravity to replace Newton's theory of gravity, which had to depend on a mysterious attractive force and "action at a distance". GR describes gravity not as a force but as a geometrical consequence, attributable to the curvature of the spacetime "quasi-physical" manifold due to the presence of matter. Contrary to the contemporary philosophical notions of space and time; this view renders spacetime with tangible physical attributes describable by idealized mathematics and geometry, supposedly without the need of any empirical input. In Einstein's (15) words, *"Our experience hitherto justifies us in believing that nature is the realization of the simplest conceivable mathematical ideas. I am convinced that we can discover by means of purely mathematical constructions the concepts and the laws connecting them with each other, which furnish the key to the understanding of natural phenomena. … In a certain sense, therefore, I hold it true that pure thought can grasp reality, as the ancients dreamed".*

Based on these premises and a "continuous field of space-time" as the basis of objective reality of a finite world; GR forms the geometric theory of gravitation in modern physics, mathematically self-consistently and describable by Einstein's field equations – which are a system of partial differential equations. GR is a very a successful, aesthetically superior and a self-consistent mathematical theory that has retained dedicated support and prestige and captivated generations of physicists. "Proving" GR and its various predictions at the very limit of modern technological ability, is the major

preoccupation of modern physics as well as the source of many controversies; starting from Arthur Eddington' s 1919 attempts to prove GR.

In the latest such attempt on February 11, 2016, the LIGO team (4) announced the "unequivocal" discovery of gravitational wave (GW), one of the major predictions of GR. This "discovery" if further validated, is not only the incontrovertible proof of the "spacetime" manifold of the physical reality of the objective universe as proposed by GR; but by extension is the proof of "black holes" (another prediction of GR) that supposedly generated the observed gravitational wave. History of the gravitational waves itself is murky and at best confusing. Albert Einstein himself as well as others inconsistently expressed doubt about gravitational waves at various times. In 1936 his paper denouncing gravitational waves was rejected by the very journal that just now published proof of their existence (16). But this claim of the "discovery" of GW is not only in contradiction with Einstein himself and others; it also violates the notion of space and time of contemporary philosophical intuition and also quantum dynamics.

GR was proposed at a time when the discovery of quantum uncertainty in the microcosm of natural science, in addition to the theory of biological evolution, promised to threaten the age-old and revered notion of certainty, continuity, causality, determinism etc. of rationalism, idealism and theology. GR also represents a radical departure from the materialism and empiricism of Newtonian physics, as the role of matter and motion is relegated to secondary importance. With all its hype, GR unfortunately represents a point of departure for physics to mathematical idealism and away from materialism that was once its profound strength. For all their mathematical consistency, Einstein's field equations have some perfectly good solutions; such as the infamous Gödel (17) solutions; that have no physical meaning at all. For Einstein's frenzied followers in theoretical physics, mathematics is no longer a mere tool of scientific enquiry, but rather it is an "a priori" determinant of the universe. In his book "Our Mathematical Universe" Max Tegmark (18), one of the leading theoretical physicists sets out to show how space, time, matter and motion might emerge from numbers and mathematical codes as the early Greek idealists thought.

GR also brought back the highly controversial concept of the ether - the hypothetical medium of spacetime with purported physical attributes. Einstein is an address on 5 May 1920 at the University of Leiden :"*Ether and the Theory of Relativity",* elaborated his view of "New Ether"(19):*"But on the other hand there is a weighty argument to be adduced in favour of the ether hypothesis. To deny the ether is ultimately to assign that empty space has no physical qualities whatever. The fundamental facts of mechanics do not harmonize with this view. For the mechanical behaviour of a corporeal system hovering freely in empty space depends not only on relative positions* (*distances*) *and relative velocities, but also on its state of rotation, which physically may be taken as a characteristic not appertaining to the system in itself*." Einstein goes on to distinguish the ether in relation to the gravitational and electromagnetic fields (20), "*If we consider the gravitational field and the electromagnetic field from the standpoint of the ether hypothesis, we find a remarkable difference between the two. There can be no space nor any part of space without gravitational potentials; for these confer upon space its metrical qualities, without which it cannot be imagined at all. The existence of the gravitational field is inseparably bound up with the existence of space. On the other hand a part of space may very well be imagined without an electromagnetic field; thus in contrast with the gravitational field, the electromagnetic field seems to be only secondarily linked to the ether, the formal nature of the electromagnetic field being as yet in no way determined by that of gravitational ether*".

Einstein himself fed to further confusion to the spacetime "ether" when he said (21), *"Spacetime does not claim existence on its own but only as a structural quality of the [gravitational] field".* Einstein also reportedly said (22*) "...time and space are modes by which we think and not conditions in which we live".* All these make the theories of relativity as somewhat esoteric and alien to human cognition. It seems that Einstein's spacetime in effect is the same as the subjectively projected abstract space of Kant; where Einstein replaces Kant's subjective logical categories and their structure with his abstract geometrical and mathematical structures and their relations supposedly rendering it somewhat quasi-physical attributes.

Additionally, Einstein not only expressed doubt publicly about the existence of GW, he expressed his doubt about GR itself, in a letter to his friend Besso, towards the end of his life: *"I consider it quite possible that physics cannot be based on the field concept, i.e., continuous structure. In that case, nothing remains of my entire castle in the air, gravitation theory included, (and of) the rest of modern physics".* (23)

Most physical theories of the past provided intuition of the objective reality that conformed to social experience, practice and technological developments etc., - some of the most important criteria for positive knowledge of the world and the validity of the theories. GR with its axiomatic basis and the radical reformulation of the concept of space and time on the other hand has provided very little practical benefit compared with the other major theories and on the contrary has led to increasingly more and more abstract speculation and mystification of the objective reality based on the unlimited extension of idealized mathematics and its logical consistency alone. GR's major merit seems to be its capacity to restore confidence on the old notions of certainty, continuity, causality, and determinism etc. of rationalism, idealism and theology; rather than a guide to a tangible understating of the physical world. The continuing attempts for more than a century that are being made to "prove" GR with ever more tenuous and subjective experiments at the very limit of modern technological abilities is a testament to the fact that GR has yet to provide substantive positive knowledge about space, time, matter and motion that corresponds to social and historical practice like most other major theories of physics; most importantly quantum dynamics. GR so far has provided little convincing and tangible intuition about the space-time manifold even though its proponents claim high success in ALL the tests that this theory was subjected to. The problem with GR may lie with its purely mathematical nature and lack of sufficient empirical content. GR like the propositions of geometry and the Epicycles of the early Greeks have been turned into tautologies, where the conclusion is already contained in the premise and hence leads to no new positive knowledge.

Einstein himself seems to have alluded to the axiomatic nature of geometry and the limitations of the theories of relativity. In his book "Relativity: The Special and General Theory (20), Einstein says, *"Geometry sets out from certain conceptions such as "plane," "point," and "straight line," with which we are able to associate more or less definite ideas, and from certain simple propositions (axioms) which, in virtue of these ideas, we are inclined to accept as "true." Then, on the basis of a logical process, the justification of which we feel ourselves compelled to admit, all remaining propositions are shown to follow from those axioms, i.e. they are proven. A proposition is then correct ("true") when it has been derived in the recognized manner from the axioms. The question of "truth" of the individual geometrical propositions is thus reduced to one of the "truth" of the axioms. Now it has long been known that the last question is not only unanswerable by the methods of geometry, but that it is in itself entirely without meaning … The concept "true" does not tally with the assertions of pure geometry, because by the word "true" we are eventually in the habit of designating always the correspondence with a "real" object; geometry, however, is not concerned with the relation of the ideas involved in it to objects of experience, but only with the logical connection of these ideas among themselves"*.

The narrative of the question of space-time-matter-motion in physics and philosophy since Albert Einstein is dominated by the incorporation of the mathematical idealism of the early Greeks, the imposition of a geometrical model on the notion of space and time; the adoption of a spacetime manifold with tangible physical characteristics (along with the negation of matter and motion) as the basis of objective reality of the world. As it is evident from the various deliberations of Einstein himself; GR does not provide a coherent philosophical and rational understanding of the "real" nature of space-time-matter-motion and the relation among themselves. The theories of relativity also leads to speculation like time-travel, supraliminal expansion of spacetime, strange cosmic objects, Zeno type paradoxes etc., that defy human intuition. Moreover the intractable difficulties to reconcile GR with the quantum phenomena continue to be the most important deficit in modern theoretical physics. Even the dedicated supporters of Einstein and his theories of relativity now feel obliged to contemplate a reversion of the spacetime notion back to the independent status of "Space" and "Time" in modern theoretical physics (24), violating the spacetime formalism.

A Dialectical Perspective:

Historically, the dialectical materialist view on the questions of space, time, matter and motion remained in the periphery of this debate in physics in class-dominated societies; but it consistently insisted on the primacy of "matter in eternal motion" in an infinite universe. This was also in conformity with Democritus's view that the world consists of atoms and empty space. This view was essential in resolving the contradiction between idealism/theology on one side and materialism on the other. The development of natural science and technology settled this question in favour of the primacy of matter and motion and also a dialectical perspective of the world in the form of the theory of evolution in biology by the 19th century. The discovery of the quantum phenomena that soon followed; has greatly widened the scope of the dialectical view of the universe. It may be argued that the dialectical philosophy of G.W.F. Hegel (770-1831 A.D.) may have foreshadowed these new revolutionary developments in natural science.

Hegel readopted the dynamical view of the objective reality of Heraclitus and formulated a revolutionary world outlook - the "view of reason" or dialectics as opposed to the "view of understanding" of idealism rationalism and classical materialism. Using the encyclopedic knowledge of Nature, human society, history and thought and his dialectical method, Hegel reflected the subject matter of his philosophy with such thoroughness as if it was an a-priori construction. Hegel used his dialectical method as a tool to resolve not only the old disputes of philosophy in general, but also the questions of space, time, matter and motion in particular. In spite of his idealist orientation and his "Absolute Idea", Hegel brought an end of all philosophy in the conventional sense of the term and set it in the course along the direction of positive knowledge of natural science. Thus justifying his own famous assertion, *"Truth in philosophy means that concepts and external reality correspond".* Hegel showed that like everything else in the world; positive knowledge is in a flux and necessarily is a historical and iterative process; progressing through successive generations of mankind without ever terminating in one final or absolute truth; a futile quest, which was the aim of all pre-Hegelian philosophy – idealist, materialist, mathematical, scientific or theological. A progressively better understanding of the infinite universe can only come about by studying the finite around us guided by the general laws of dialectics.

For Hegel, space, time, matter and motion are in a dynamical and dialectical relationship among themselves giving rise to the observable phenomenology of the universe: Like Leibniz, Hegel's space and time have only virtual existence without any tangible quality, but only have potential quantitative nature - the spurious or "bad infinity". Space and time become meaningful only in the context of matter and motion. Space and time are the dialectical unity of the opposites that resolves itself into matter and motion.: *"Motion is the process, the transition from time into space and vice versa: matter on the other hand, the relation of space and time, as latent identity. Matter is the primary reality, the existing Being-in-itself; it is not only abstract being, but positive persistence of space, as excluding, however, other space*."(9)

Hegel elaborated the dialectics of space-time-matter-motion in the following ways:

"*Its essence [of motion, AM] is to be the immediate unity of space and time; it is time really persisting through space, of space which is only made truly distinct through time. Thus we know that space and time belong to motion; the velocity, the quantum of motion is space in relation to a definite time that has elapsed. One says also, motion is the relation of space and time; the deeper manner of this relation, however, remained to be grasped [Hegel did not elaborate the "deeper meaning" of this relation, AM]. Only in motion have space and time reality* . G.W.F. Hegel, Naturphilosophie, E., p.65. *(25)*

"Space and time are filled with matter. Space is not conformable to its notion; hence it is the concept of space itself that creates its existence in matter [Modern quantum mechanical conclusion that there can never be absolute vacuum A.M.*]. Often a beginning has been made with matter, then space and time regarded as forms of matter. What is correct is that*

matter is real in regard to space and time. But the latter, on account of their abstraction, have to appear to us here as primary; and then it must be shown that matter is their truth. Just as there is no motion without matter, so also there is no matter without motion." Naturphilosophie, E., p.67. *(ibid)*

Quantum Vacuum and the Being-Nothing-Becoming Triad of Dialectics

Before the advent of quantum dynamics, space was considered as "real" Hilbert space, which was constituted of "real" numbers or so called scalars and their inner products as also real numbers. Thus all classical physics including electromagnetism and GR dealt only with "real" Hilbert space.

Quantum theory demands "complex" Hilbert space, which satisfies all the rules of formal mathematics. It is only that the underlying concept of numbers has been enlarged from the "real" to the complex field, as this kind of algebraic structure is called. Mathematical analysis thereby attains its perfection as it extends to the complex domain of objective reality. The complex number is represented by the expression x+iy, where "i" satisfy the relation $i^2 = -1$. These numbers constitute a "complex" (virtual) two dimensional field. Inasmuch as every real number x is also a complex number (one for which y = 0), it is obvious that the "complex" field extends the field of "real" numbers.

One can see from the discussion above that complex (virtual) reality extends the scope of the objective reality through quantum dynamics. To describe the spin ½ quantum particles, Dirac found it necessary to incorporate imaginary and complex quantities in his equations that gave rise to the complex-conjugate field φ* of the real field φ, where the complex-conjugate fields φ* can accommodate the hitherto unknown antimatter particles –an exotic form of matter. This is a new aspect of reality brought forth by the developments in quantum dynamics that also conforms to materialistic dialectics. Physics previously was one-sided and limited; dealing only with integral spins of 0, 1 and 2 in its equations namely, the Klein–Gordon, Maxwell (electromagnetism) and Einstein (general relativity) equations, respectively; which readily accommodate real fields, as these equations are formulated using real numbers only.

The existence of an antimatter particle as such is not a big problem for anti-dialectical physics. Because neutral and integer spin particles (like bosons) can be viewed as their own antiparticles, as they must be created by fields φ that obey the relation φ = φ* — that is, real fields, like electromagnetism and gravity discussed above. Through the incorporation of complex fields; Dirac could demonstrate that this field – the quantum vacuum, exists as virtual space in parallel to "real" space; where virtual matter/antimatter particle pairs exists as transient species in eternal motion of coming into being and passing out of existence. The rules of quantum dynamics allow for the transition of virtual matter/antimatter particles to become "real" (existing) particles and the "real" ones becoming "virtual" ones also, as an eternal process.

We can now see how Hegel's concept of "being-nothing-becoming" corresponds to the virtual matter/antimatter particle pairs of the quantum vacuum and the tangible "becoming" (also of going out of existence) of matter/antimatter particles and motion as the outcome of the resolution of the contradiction between space and time. Hegel only anticipated it as the logical extension of dialectics, a conclusion he drew because of his confidence on the merit of his dialectical laws. In the absence of any factual basis Hegel restricted himself to saying: *"One says also, motion is the relation of space and time; the deeper manner of this relation, however, remained to be grasped*".

"Being-Nothing" forms the logical first and also the last contradiction is relation to any material existence resolving to a "Becoming" which in turn forms another rung of contradiction and so on, the dialectical "negation of the negation" through which any tangible process begins and ends in an iterative form of evolution, development, change etc. The "Being-Nothing-Becoming" triad seemed esoteric at Hegel's time. The subsequent dialectical materialist thinkers like Marx, Engels and Lenin, downplayed this logical but idealist extrapolation by Hegel, because of the absence of any tangible materialist or empirical basis for this notion. The quantum phenomena and the existence of antimatter and virtual particles are new and revolutionary aspects of ontology, which were unknown or unanticipated; at least at the time of Marx and Engels and only preliminary ideas of the quantum phenomena were known to Lenin. But in the light of subsequent development of quantum dynamics, it now seems that Hegel was far ahead of his time. Hegel's logical extrapolation to the possible origin of any material beings from a contradiction and fluctuation of space- time as "Being – Nothing", anticipated the virtual particles of the quantum vacuum.

To reinterpret Hegel; the real world exists as the dialectical "unity of the opposites" of its virtual counterpart of space and time; which in turn are the dialectical opposite of each other. The virtual reality is manifested by the virtual particles of the quantum vacuum as particle/antiparticle pairs, which continuously pop in and out of existence as "Being-Nothing" of the logical first as well as the last dialectical contradiction. The "becoming" of real particle/antiparticle pairs (as low mass stable species like proton/anti-proton) as atomic particles occur through quantum fluctuation, quantum tunnelling and some other yet unknown processes. The dynamics of virtual to real and vice versa conversion is accelerated in regions of concentrated mass/energy; preferably at the core of the galaxies, where the necessary mass/energy equivalent of the elementary particles is available (6, 7, 26). The dynamics of space-time-matter-motion, therefore, is a dialectical process mediated by the virtual particles of the quantum vacuum. Herein also lies the secret of the origin of the material world. Hegelian dialectics thus abolishes all creation theories, particularly the modern Big Bang theory of one-time creation of all existing space-time-matter-motion. As Frederick Engels said, (for dialectics) "*There is no leap in Nature, precisely because Nature is made entirely of leaps!"*

In the light of Hegelian dialectics, then, the Finite and the Infinite no longer seemed to be "unknowable things-in-themselves" but the "unity of the opposites"; the finite IS the infinite and vice versa. The properties of matter and its structure under the various conditions in terrestrial nature must be the same that exists under similar conditions billions of

light years away. In fact, one sun with its planets and its life supporting earth and one Milky Way galaxy with its surrounding family group form the essential basis for an understanding of the universe. Beyond 15 billion light years there is no wonderland or lurking monsters to be seen. What we will see there is more or less the same we now see within a few million light years around us!

The infinite universe is not a mere abstract, quality less, boring, endless extension of uniformity (spurious or *bad infinity*), it includes a variety of qualitative contents with different forms of movements passing one into the other and developing historically. The infinite space is adorned with the drama of things "coming into being" and "passing out of existence" in each of the innumerable island universes; each island universe with innumerable galaxies and each galaxy in turn with innumerable stars and planets. Under favourable conditions, galaxies propagate (26); the stars produce the higher elements; the planets give rise to the evolution of molecules, to organic life and finally to the thinking brain through which infinite Nature (for a brief period of time) *becomes conscious of itself*! Self-consciousness is therefore, the property of the highest developed form of matter, which like everything else comes into being and passes out of existence as temporary bubbles in the eternal and infinite universe. Perceptible time is an intrinsic and a relative characteristic parameter for a particular particle or a unit of assembly. It begins when the unit comes into being and ends with its passing away out of existence or with the dissolution of the unit. Like space; time is therefore infinite and eternal. This dialectical view of the universe was passionately expressed by Frederick Engels (27), even before the quantum phenomena was known, *"… however many millions of suns and earths may arise and pass away, however long it may last before the conditions for organic life develop, however innumerable the organic beings that have to arise and pass away before animals with a brain capable of thought are developed from their midst, and for a short span of time find conditions suitable for life, only to be exterminated later without mercy, we have the certainty that matter remains eternally the same in all its transformations, that none of its attributes can ever be lost, and therefore also, that with the same iron necessity that it will exterminate on the earth its highest creation, the thinking mind, it must somewhere else and at another time again produce it."*

Conclusion

According to Hegel's dialectical (and quantum dynamical) philosophy, space-time as a sublated moment, forms the virtual source/sink of matter and motion; eternally coming into being and passing out of existence and evolving through "the negation of the negation", quantity changing into quality and vice versa. This philosophy also abolishes the "first cause", the "unmoved mover', the "first impulse", the "first breath of life", the "Big Bang origin" etc., causality based notions of the universe.

One can therefore conclude that Minkowsky's compounded spacetime formulation of space and time renders them static and sterile. Spacetime obscures or removes the potential of their inner dynamics and makes the appearance of matter and motion at best mystical or an act of Providence. For Hegel as for Weyl; space, time, matter and motion are truly integrated and find reality through a dynamic exchange process of the virtual particles of the quantum vacuum. A dialectical and quantum dynamical perspective therefore, offers better possibilities for acquiring positive knowledge of the dynamics of space-time-matter-motion in particular and that of the universe in general.

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