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WHITEHEAD'S COSMOLOGY –

PROCESS RELATIONAL PERSPECTIVE TO RELATIVITY AND QUANTUM MECHANICS[1]

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ABSTRACT: Whitehead believed that science and philosophy mutually criticize each other to provide imaginative material for their shaping the history of thought. In the early twentieth century, as a mathematician turned philosopher, he took up the task of challenging the emerging scientific theories of the time, such as relativity and quantum mechanics, and provided a radically novel cosmological scheme. He challenged the incoherence of the mechanistic materialistic scientific world with his visionary process-relational model, based on the ontology of organisms. Almost a century later, his challenges to science are as, or even more, valid. This paper explores Whitehead's struggle with relativity, reflects on his response to quantum mechanics, and reviews his tribute to God, based on his philosophical model, as an attempt to understand divergent perspectives on the nature of universe.

KEYWORDS: Alfred North Whitehead; Process relational thinking; Quantum theory; Relativity theory

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INTRODUCTION

He stared at the Pacific – and all his men
Looked at each other with a wild surmise-
Silent upon a peak in Darien
John Keats, *On First Looking into Chapman's Homer*

By capturing the awe of people staring at Pacific for the first time, Keats beautifully rendered the emotions attached with the unexpected expansion of personal and cultural horizons. Similar emotions would have been felt when Galileo discovered a new universe by turning his telescopes to the sky, when Newton linked falling apples to Earth keeping its orbit, when Einstein imagined a falling man who would feel weightless, and when Niels Bohr visualized the nucleus of the atom with electrons spinning around it much as planets spin around their sun, each changing the course of the universe.

On January 7, 1610, by pointing his telescope to sky, Galileo (1564-1642) literally changed the direction of our planet. Earth was no more at the center of the Universe, but just one of the planets, among many, revolving around the Sun. Within a year of Galileo's death, Newton (1643-1727) was born. Whitehead (1861-1947) commented: "Galileo also prepared the way for Newton's final enunciation of the Laws of Motion…he swept away the old classification of natural and violent motions as founded on trivial unessential differences, and left the way entirely open for Newton's final generalizations."[2] These generalizations laid the foundation for classical mechanics, and gave the world the notion of absolute time and space, where space is distinct from material bodies, time passes uniformly without regard to whether anything experientially happens in the world, and the true motion of a body is its movement through absolute space. He referred to the attraction between two masses of bodies, for lack of a proper term, as gravity, and claimed that the same force which causes apples to fall on the ground, is also responsible for keeping Earth in orbit around the Sun. Newton's generalizations became so universally accepted for another two centuries, that they were termed *Laws of Motion.*

However, in Michaelson's experiment with the aid of an interferometer in 1887, it appeared that the speed of light in a vacuum is independent of the speed of the observer, and cannot be increased or decreased relative to it. In 1905, Einstein (1879-1955) with his theory of special relativity and later, in 1915, after eight years of sorting his thoughts, with his theory of general relativity, challenged Newton's Laws with

[2] Alfred North Whitehead, *Science and Philosophy* (New York, NY: The Philosophical Library, 1948), 246.

alternative theories. The genius of Einstein dethroned the notion of gravity as an attractive force, and the existence of absolute space and absolute time. He claimed that a mass can warp, bend, push, and pull space to maintain the constancy of the speed of light, and that gravity is a natural outcome of the existence of it in a four-dimensional space, whose fourth dimension is time. Einstein was confronted by Neil Bohr's (1885-1962) model of atoms, which surmises energy levels of electrons are discrete, principle of complementarity where items could be separately analyzed in terms of contradictory properties like behaving as a wave or a stream of particles. Quantum mechanics pointed towards a more probabilistic universe than the causal cosmos of Einstein and Newton.

Whitehead's cosmos, on the other hand, was process-relational, and based on an ontology of organisms. His ontology challenged standard materialist interpretations of both relativity and quantum mechanics while incorporating their key features, and presented a novel metaphysical scheme. Though the concepts of relativity and quantum mechanics had advanced the scientific world and have been used in practical applications from GPS to super-powered computers, they have hardly passed the philosophers test. While philosophers have criticized physicists for their simplistic understanding of the nature of the universe, physicists have rejected their argument for not being based on empirical knowledge. Whitehead, a renowned mathematician turned philosopher of the early twentieth century, provided a new cosmological story, the philosophy of organism, based on his understanding of science, mathematics, religion, philosophy, and arts. This paper explores Whitehead's philosophical struggle with relativity, reflects on his response to quantum mechanisms, and provides an overview of his cosmos where God plays a major role.

WHITEHEAD'S STRUGGLE WITH RELATIVITY

> *How would the ascent of a mountain be possible, if the use of hands, legs, and tools had to be sanctioned step by step on the basis of mechanics.*
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> \- Einstein, *Foreword to Max Jammer, Concepts of Space*

In 1953, with these words, Einstein not only propagated science's practicality, but also acknowledged the philosopher's quest for the truth. The situation was not the same in the early 1920s when he vigorously defended his theory of relativity from philosopher's wrath. Philosophers like Bergson and Whitehead, while recognizing Einstein as a genius, resisted the encroachment of mechanistic science on the space shared with artists, poets, and philosophers, and battled against giving him the last word on the cosmos.

In 1905, Einstein's his theory of special relativity determined that the laws of physics are the same for all non-accelerating observers, and he showed that the speed of light within a vacuum is the same, irrespective of the speed at which an observer travels. As a result, he interwove space and time in a single continuum and called it space-time. Events that occur at the same time for one observer could occur at different times for another, if measured by a mechanical clock. In 1915, Einstein included the component of acceleration in the theory, and realized that massive objects caused a distortion in space-time, which is felt as gravity. The theory of relativity broke away from classical physics in many ways by showing that the concepts of time and space are not universal, but relative concepts. Whitehead celebrated the moment of relativity dethroning Newtonian classical physics stating, "[i]nfact, relativity actually removes a difficulty from the way of the realist. On the absolute theory, bare space and bare time are such very odd existences half something and half nothing. They always remind me of Milton's account of the Creation, with the forepaws of Lions already created and their hinder qualities still unfinished – *The Tawny Lion, pawing to get free. His hinder parts*."[3] However, both Bergson and Whitehead challenged Einstein's conception of time.

Einstein's physics, rationality, and objective universe was in stark contrast with Bergson's metaphysics, anti-rationalism and vitalism.[4] Einstein and Bergson, during their meeting at the Philosophical Society of Paris in 1922, clashed vehemently on the nature of time. While Einstein believed that that there are only two types of time, one physical which is measured by clocks, and the other psychological which is subjective, Bergson argued for the philosophical nature of it. When Einstein was in Paris, he argued, "the time of the philosophers does not exist, there remains only a psychological time that differs from the physicist's." [5] Bergson criticized Einstein for mixing two things which are not the same: the abstract and the concrete.[6] For Bergson, time was not something out there, separate from those who perceived it. It did not exist independently from us, it involved us at every level.[7] Bergson did not agree with Einstein's conception of time measured by the clock, and he was against the idea of determining the simultaneity of an event, such as the arrival of a trains with clocks. He

[3] Alfred North Whitehead, *The Interpretation of Science* (New York: Liberal Arts Press, 1961), 146.
[4] Jimena Canales, *The Physicist and the Philosopher (*New Jersey: Princeton University Press, 2015), 7.

[5] Ibid., 47.
[6] Ibid., 246.
[7] Ibid., 42.

insisted on a more basic definition of simultaneity which would explain why clocks were used in first place.[8] Bergson argued that Einstein's theory of time was particularly dangerous because of how it treated "duration as a deficiency." It prevented us from realizing that "the future is in reality open, unpredictable, and indeterminate." It eliminated real time; that is, "what is most positive in the world."[9] Continuous multiplicities belong to the sphere of duration, which was not simply the indivisible, nor was it immeasurable. Rather, it was that which divided only by changing in kind, that which was susceptible to measurement only by varying its metrical principle at each stage of division.[10] Einstein, as a sharp contrast, believed, "[f]or us believing physicists, the distinction between past, present, and future is only an illusion, even if a stubborn one."[11]

While celebrating the dethronement of classical Newtonian physics and recognizing Einstein as a genius, Whitehead, with his organic view of nature not only criticized Einstein's concept of time, but also his concept of space-time, stating the fallacy of bifurcation of nature for the former, and fallacy of misplaced concreteness for the latter. Time for Whitehead, like Bergson, cannot be simply bifurcated. He stated, "[i]t follows from my refusal to bifurcate nature into individual experience and external cause that we must reject the distinction between psychological time which is personal and impersonal time as it is in nature."[12] Mechanical clocks used to measure physical time by distributing it in discrete units are, like everything else in the Universe, aging, and to be aging is to be caught up in irreversible organic process, and hence they cannot step out to provide an objective measure.[13] According to Whitehead's fallacy of misplaced concreteness, we often mistake the abstract for the concrete, and the four-dimensional space-time fabric, which was concrete for Einstein, was an abstraction for Whitehead, it doesn't mean that it is not real, only that it is not actual. In other words, "space-time" for Whitehead is continuum of potential or possible relations. His space-time is a definite patterning of eternal objects that ingresses through the prehensive unification of actual occasions.[14] In Whitehead's process ontology, "actual occasions of experience are not determined by the structure of space-time, rather than structure of space-time is an emergent product of the experience of actual occasions."[15] Einstein's

[8] Ibid., 42.
[9] Ibid., 45.
[10] Gilles Deleuze, *Bergsonism* (Canada: Zone Books, 1990), 40.
[11] Matthew D. Segall, *Physics of the World-Soul* (San Francisco, CA, 2016), 73.
[12] Ibid., 70.
[13] Ibid., 72.
[14] Ibid., 76.
[15] Ibid., 75.

four-dimensional ready-made space-time fabric was an emerging abstraction for Whitehead, whose geometry emerges from the character taken collectively, of individual drops of experience, which are the final real things of which reality is composed.[16] The four-dimensional space-time was not a fully woven fabric whose spatial curvature is modified by bodies situated in it, as Einstein perceived, but is historically contingent and could change as the creative advance of Universe continues to unfolds.[17] In Whitehead's words "this planet, or this nebula in which sun is placed, may be gradually advancing towards a change in the general character of spatial kind."[18] In this way, he translates many of the properties that Einstein's general relativity defines *a priori* into empirical, or *a posteriori* facts.[19]

In 1922 Einstein debated with Bergson. A year earlier, in a 1921 meeting between Einstein and Whitehead, Einstein admitted that he had difficulty grasping Whitehead's radically novel metaphysical scheme,[20] also highlighting the difference between the physicist and philosophers' understanding of the cosmos. Bergson was often criticized for his lack of mathematical background in order to understand relativity, but such criticisms were not applicable for Whitehead, a renowned mathematician turned philosopher. The physicist theory of relativity gained traction, and it was strongly challenged by another physicist.

WHITEHEAD'S RESPONSE TO QUANTUM MECHANICS

For the field of quantum mechanics, a lot happened in between the period of 1925-27; however, the Fifth Solvay Congress debate between Einstein and Niels Bohr in 1927 in Brussels, epitomizes the dispute over the nature of the cosmos. While Einstein's cosmos was causal, Niels Bohr's argued for a probabilistic one.

In 1900, Max Planck, contracted by the German government to create a more efficient light bulb, hypothesized an idea that would lay the groundwork for an altogether new scientific paradigm.[21] He assumed that the energy carried by electromagnetic waves is emitted, not continuously, but rather in discrete packets called

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[16] Ibid., 75.

[17] Ibid., 77, In Whitehead's terms, space-time is a definite patterning of eternal objects that ingresses through the prehensive unification of actual occasions, and these eternal objects having a relational function provides actual occasions with adverbial "how?" characterizing their prehensions of other occasions, shaping both private experience and public fact.

[18] Alfred North Whitehead, *Modes of Thought* (New York, NY: The Free Press, 1968), 57.

[19] Isabelle Stengers, *Thinking with Whitehead* (Harvard: Harvard University Press, 2014), 168.

[20] Segall, *Physics of the World-Soul*, 65.

[21] Chad Harris, *Quantum Mechanics, Depth Psychology, and a New World View* (Unpublished, 2017), 7.

quanta. This was groundbreaking at the time, as in the nineteenth century wave theory of light was widely accepted. In 1905, Einstein extended Planck's hypothesis to explain the photoelectric effect. To make sense of the fact that light can eject electrons even if its intensity is low, Einstein proposed that light, rather than being a wave propagating through space, is composed of corpuscles or photons, the energy of which is given by Planck's relationship. With this theory, Einstein helped pioneer quantum theory, and also later received the Nobel prize. In 1913 Copenhagen, Niels Bohr incorporated quantum theory in Rutherford's model of the atom, and described the properties of atomic electrons in terms of a set of allowed (possible) values. Niels Bohr's model of an atom, as per quantum mechanics, proposed that energy levels of electrons are discrete, and that they revolve in stable orbits around the atomic nucleus but can jump from one energy level (or orbit) to another. Einstein's idea was taken to even stranger territory by de Broglie, who in his 1924 PhD thesis proposed that, if light waves could behave like particles, then perhaps particles of matter could also behave like waves.[22]

The period between 1925-27 was a period of creativity without parallel in the history of physics. On one hand, in 1925, Werner Heisenberg, Max Born, and Pascual Jordan formulated matrix mechanisms to account for quantum jumps proposed by Bohr's model of atoms, considering electrons as particles. On the other hand, in 1926, Erwin Schrödinger expressed de Broglie's hypotheses concerning the wave behavior of matter in mathematical form, assuming electrons were like a wave permeated in space-time. However, in the same year, Max Born formulated the interpretation of probability density function in Schrödinger's equation, showing that his waves are, in effect, "waves of probability" encoding the statistical likelihood that a particle will show up at a given place and time based on the behavior of many such particles in repeated experiments. When the particle is observed, the wave-function "collapses" to a single point, allowing us to see the particle at a particular position.[23] Born's probability wave also aligned with Werner Heisenberg's "uncertainty principle." In 1927, Heisenberg concluded that in the quantum world it is not possible to obtain exact information about both the position and the momentum of a particle at the same time. He imagined that shining a light on a particle to measure its position gave it a jolt that changed its momentum, so the two could never be precisely measured at once.

The nature of cosmos was at stake in 1927 Brussels when leading physicists met to discuss quantum theory. Bohr's presented his version of quantum mechanism, known as the Copenhagen interpretation, as an honor to Bohr's home city, advancing the

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[22] https://cosmosmagazine.com/physics/einstein-bohr-and-the-origins-of-entanglement

[23] Ibid.

works of Born's probability waves and Heisenberg's uncertainty principle. His cosmos was probabilistic, and this was the biggest problem for Einstein, whose cosmos was causal. Einstein clarified his position earlier to Max Born, in a letter dated December 4, 1926, "Quantum mechanics is very impressive. But an inner voice tells me it is not yet the real thing. The theory produces a good deal but hardly brings us closer to the secret of the Old One. I am at all events convinced that He does not play dice."[24] Einstein believed in a deterministic world based on cause and effect, where events are continuous and deterministic, and every cause matches up to a specific, local effect. In Bohr's quantum mechanics, events produced by the interaction of subatomic particles happen in jumps, with probabilistic. Einstein believed in object permanence, in which objects continue to exist, even if they are not observed. For Bohr, it was meaningless to assign reality to the universe in the absence of observation. Bohr's probabilistic cosmos was spooky for Einstein.

On the other hand, Whitehead's cosmos was process-relational, based on an ontology of organisms. According to Whitehead, in 1925, "the difficulty with the quantum theory is that, on this hypothesis, we have to picture the atom as providing a limited number of definite grooves which are the sole tracks along which vibration can take place… [However] [o]n the organic theory of nature there are two sorts of vibrations which radically differ from each other. … [T]here is vibratory locomotion of a given pattern as one whole, and there is vibratory change of pattern."[25]

To explain his organic theory, Whitehead used the concept of a primate. A primate for Whitehead was any organism of primary genus which is not decomposable into subordinate pieces. There could be different species of primates, and "we can imagine the atomic nucleus as composed of a large number of primates of different species, and perhaps with many primates of the same species, the whole association being such as to favour stability."[26] In keeping with the distinction between concrete events and abstract objects, Whitehead reserved the term 'reiteration' for concrete events, and uses the term 'vibratory' for abstract pattern, therefore a vibratory entity is an abstract notion for him.[27] He distinguished between two sorts of vibrations, the vibratory locomotion of a given pattern describes the particle-like aspect (i.e. their discontinuous epochal realizations, as felt from without), while the vibratory change of pattern or organic deformation describes the wave-like aspect of primate organism (i.e. their continuous

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[24] Jim Baggott, *The Quantum Story* (New York, NY: Oxford University Press, 2011), 78.
[25] Alfred North Whitehead, *Science and the Modern World* (New York, NY: The Free Press, 1967), 131.
[26] Ibid., 132, 134.
[27] Murray Code, *Order and Organism (*Albany: State University of New York Press, 1985), 139.

transition of realized pattern, as felt from within).[28] A vibratory change of pattern requires a definite duration for its complete realization, so a definite quantum of time is associated with each primate.[29] Therefore, Whitehead, with his organic model, also acknowledged the behaviour of a primate as discontinuous in space and time, like Bohr's jump of an electron from one orbit to another. However, Whitehead's organic model had specific features for the duration of realization and happenings below the quanta of time.

In Whitehead's organic process-relational cosmos, "the continuity of the complex of events arises from the relationships of extensiveness, whereas temporality arises from the realization in a subject-event of a pattern which requires for its display that the whole duration is spatialized, as given by its aspect in the event."[30] One complete period defines the duration required for the complete pattern. The realization proceeds via a succession of epochal durations, and the primate is realized automatically in a succession of durations, where each duration is to be measured from one maximum to another.[31] Whitehead noted,[32] "If it is considered one thing, its orbit to be diagrammatically exhibited as a series of dots. In between this series, or reformulation of complete patterns, something is happening." Whitehead stated, "If we go below the quanta of time which are the succession vibratory periods of the primate, we find a succession of vibratory electromagnetic fields, each stationary in the space-time of its own duration….This vibration is not to be thought of becoming of reality, it is what the primate is in one of his discontinuous realizations."[33] In Whitehead's theory of primates, the primate moves in a manner, analogous to a wave- packet, that is by the continual dissolution and reformulation of the pattern, based on his postulation of two different types of vibrations, vibratory organic deformation and vibratory locomotion.[34]

Whitehead's organic primates, like all biological creatures on Earth, with both their ecological relations in the present, and evolutionary relations in the past, are bound together as co-creators in a multiform cosmogenetic community emergent from one original unfathomably powerful energy-event.[35] Whitehead also believed in the realm of potentiality as being linked to concrete actuality, something akin to "quantum void" from which all potency is ceaselessly born. Creativity, and the sheer potentiality of it, is

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[28] Segall, *Physics of the World Soul*, 61.
[29] Code, *Order and Organism*, 139.
[30] Ibid., 135.
[31] Ibid., 135, 136.
[32] Ibid;, 136.
[33] Ibid., 136.
[34] Code, *Order and Organism*, 234.
[35] Segall, *Physics of the World Soul*, 60.

said always to be conditioned by at least one actual creature, the primordial creature of creativity, God.[36]

WHITEHEAD'S TRIBUTE TO GOD

Whitehead's cosmos has a special role for God. God, with its presence and absence, has played a critical role in the descriptions of cosmology for the entire evolution of humankind. In modern periods, while Newton wondered what sets planets in motion, and Einstein's and Bohr's debate on whether "God plays dice," Whitehead gave God a central position in his cosmology in which "the concrescence of an actual occasion is a description of the metaphysical means by which God and the world continually co-create one another."[37]

God according to Whitehead, is very different than that of science. Probabilistic quantum mechanics, which points towards God playing dice, presupposes actuality, describes the evolution of actual facts and their associated potentials, but does not believe in the evolution of vacuous potentials into actuality and therefore cannot explain the emergence of it by reference only to potentiality.[38] However, for Whitehead, potentiality has never been untouched by reality, and is conditioned by the primordial nature of God.[39] According to Whitehead, "[v]iewed as primordial, he is the unlimited conceptual realization of absolute wealth of potentiality. In this aspect, he is not before all creation, but with all creation."[40] God is the unconditioned actuality of conceptual feeling at the base of all things, the reason that there is an order in the relevance of eternal objects to the process of creation.[41] God, for Whitehead, is not an exception to all metaphysical principals, but their chief exemplification, whose conceptual actuality at once exemplifies and establishes the categorical conditions.[42] His primordial nature is composed of conceptual feelings, with neither the fullness of them nor consciousness, whose subjective forms determine the relative relevance of eternal objects for each occasion of actuality.[43] Whitehead claimed that "[t]he primordial nature of God is the acquirement of creativity of a primordial character…He is the lure for feeling, the eternal urge for desire."[44]

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[36] Ibid., 82.
[37] Ibid., 84.
[38] Ibid., 83, Micheal Epperson's argument.
[39] Ibid., 82.
[40] Whitehead, *Process and Reality*, 343.
[41] Ibid., 344.
[42] Ibid., 343, 344.
[43] Ibid., 344.
[44] Ibid., 344.

Whitehead's God, as well as being primordial, is also consequent, its nature being dipolar. According to Whitehead, "[t]he consequent nature of God is conscious; and it is the realization of the actual world in the unity of his nature, and through the transformation of wisdom. The primordial nature is conceptual, and the consequent nature is the weaving of God's physical feelings upon his primordial concepts."[45] The consequent nature of Whitehead's God is the changing world becoming 'everlasting' by its objective immortality in God. The temporal world is perfected by its reception and its reformation, and God is completed by the individual.[46] In its consequent nature, Whitehead's God is not standing outside, but is the great companion – the fellow sufferer who understands. The consequent nature of God is composed of a multiplicity of elements with individual self-realization, so the actuality of God can be understood as multiplicity of actual components in the process of creation. "This is God in his function of the kingdom of heaven.... for the kingdom of heaven is with us today,"[47]noted Whitehead

Whitehead's dipolar God, being both primordial and consequent, is the presupposed actuality of conceptual operation, in unison of becoming every other creative act, and his conceptual nature is unchanged by reason of final completeness. God's primordial nature is free, complete, eternal, actually deficient and unconscious, while his consequent nature is determined, incomplete, 'everlasting,' fully actual, and unconscious. God is the beginning and the end.[48]

CONCLUSION

> *Science and Philosophy mutually criticize each other and provide imaginative material for each other…The history of thought is the story of the measure of failure and success in this joint venture.*
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> – Whitehead, *Adventure of Ideas*[49]

Whitehead, almost a century ago, criticized science for its outdated imaginative background of mechanistic materialism, which had become the de facto natural philosophy of Western civilization.[50] Western science with its history stretching from Thales of Miletus, around 600 BCE, had moved forward through the curiosity of the

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[45] Ibid., 355.
[46] Ibid., 347.
[47] Ibid., 350, 351.
[48] Ibid., 345.
[49] Whitehead, *Adventures of Ideas*, 146.
[50] Segall, *Physics of the World Soul*, 7, 8.

human spirit, permeated with criticisms, and divorced from superstitions, has reached a place where the universe is analyzed as a materialist machine.[51] Whitehead substitutes a scientific mechanistic materialistic universe with his process-relational philosophy based on the ontology of organisms.

Whitehead celebrated the dethronement of classical Newtonian physics which was based on the fallacy of simple location, proven by Einstein's relativity theory. However, he criticized Einstein's relativity for bifurcating time to the psychological and physical, and for treating space-time as concrete. Space-time for Whitehead was an emerging abstraction whose geometry came from the character taken collectively of individual drops of experience, which are the final real things of which reality is composed. In the debate between Einstein and Bohr over quantum mechanics, Whitehead presented an organic model and acknowledged the behavior of a primate as discontinuous in space and time, like Bohr's jump of an electron from one orbit to another. However, for Whitehead, the duration of a jump involves dissolution and reformulation of complete patterns. Quantum mechanics presupposes actuality, but for Whitehead, potentiality has never been untouched by it, and is conditioned by the primordial nature of God. Where scientists have often avoided the topic of God, Whitehead's God is dipolar, both primordial and consequent, whose primordial nature determines the relative relevance of eternal objects for each occasion of actuality, and consequent nature, makes him a fellow sufferer.

Whitehead was a visionary of his time, and many centuries ahead in his thinking. His ideas are even more relevant today, with almost complete dominion of the materialistic mechanistic scientific world. Though sometimes difficult to grasp, Whitehead's process- relational philosophy of organisms, integrates various perspectives from mathematics, science, religion, and poetry, and provides the world an alternative imagination. The radical novelty of Whitehead's mature cosmological scheme expands personal and cultural horizons. A deeper look could create an impression of new discoveries, much like Keats's men watching the Pacific for the first time.

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[51] Whitehead, *Adventures of Ideas*, 141.

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