

Theological Insights into the Notion of Order in Physics and the Natural Sciences

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Abstract: An exploration of the metaphysics of process-ordering in Quantum Theory and Relativity Theory that is guided by Bohm, Peirce, Levinas, and Torrance.

Why Order?

The notion of order extends beyond the confines of a particular theory; permeates the whole infrastructure of concepts, ideas, and values; and enters the very framework in which human thought is understood and action carried out. To understand the full meaning of creativity, and what impedes it, it is necessary to go into the whole nature and significance of order.

[Bohm and Peat, 104-5]

Questioning the notion of Order opens us to the possibility of contemplating the unity in relatedness of theology and science, not by way of determinate content, but rather by way of likeness or meta-form. Metaphysics, which concerns the order underlying reality, can mediate this relatedness by relating the reality of the physical world to the reality of God while also maintaining the essential difference in the two realities. The mediation involves the trope of metaphor which simultaneously asserts *the identity and the difference* of the vehicle and the tenor. The reality of the physical world is the reality of God; the reality of the physical world is not the reality of God. By contemplating this paradox we might hope to be led to the insight that the reality of the physical world *in some sense* is *like* the reality of God even though the two are unlike and indeed incommensurate. That is to say, the reality of the physical world indicates or points to or *signifies* the Reality of God that is wholly Other.

As discussed by Winslow, the theological grounding for this mediation of relation is *analogia entis* whereby analogies embedded in the world are taken to be ontologically real (and not arbitrary human constructions) such that the Divine can be grasped in the created world through analogy. Viewed theologically, Winslow contends, scientific findings and discoveries “are the revelations of God’s Self to humans *through analogy* since it cannot be otherwise” [Winslow].

Natural science, and more specifically physics, deals directly with physical reality at its most fundamental level. Torrance points out that the theological notion of the creation of the world

out of nothing (*ex nihilo*) “implies that if we are to understand the world of contingent reality we must investigate the world itself, and learn of it out of its own natural processes and interior relations. By doing that, on the other hand, we have to attend to the world in its own created independence, in its own given reasonableness detached from its Author, that is by considering it in its utter otherness from God and without taking God into account” [Torrance 1985, 33]. The physical *world-in-itself* is thus the subject of physics and, in its complete Otherness, says nothing about God. The physicist looks down, as it were, upon the world as the object of interest. The independence of this gaze from the subject of God is theologically significant insofar as physics, and more broadly natural science, recognize the ontological Otherness of the Divine. However, from this can come the impression that physics stands on its own and has nothing to do with God because there is no direct route from the object of interest to its Creator—the two realities of the physical and the Divine, *each in-itself*, are wholly incommensurate and unrelatable. What is lost in this gaze is the *meaning* of the world.

When we concentrate our attention upon the universe itself, then, it gets shut up in itself, so far as our understanding of it is concerned, and thereby loses the range of depth in which its meaning as a whole is to be found. Even as a harmonious intelligible whole the universe can provide no explanation of its own inherent rationality. If we are to recover the meaning of the universe, and meaning of the universe as a whole, we must learn to look beyond the universe, or look through the universe, to its transcendent ground in the uncreated Rationality of God.

[Torrance 1985, 34]

There is a subversive presumption in this solitary gaze. It is the presumption that the unity of the universe can rest in itself. If this presumption be true, then all is physical because nothing can stand in relation to One. Consciousness, mind, humanity must be taken as illusions of “epiphenomena”. Whatever the reality of such a universe be, it cannot be our experienced reality. Where are we to stand in relation to this universe?

So, on the one hand, physics and natural science must attend to the world-in-itself to avoid confusing creation with the Creator. On the other hand, the world-in-itself, created *ex nihilo*, cannot contain unity or indeed humanity. The world-in-itself is meaningless and irrational yet natural science requires the world be rational and meaningful. What are we to do with this paradox?

One way forward is to recognize that when we attend to the world-in-itself it is not necessarily true that we are attending to the world as One. The world-in-itself is not One at the very least because we are also there, attending to it as something external to us. Even when we are attending to the world-in-itself, it must be the case that the world-in-itself is related to something beyond itself. And this relation cannot be purely *physical*. There is a necessary orientation of our participation in the world in relation to what lies beyond the world-in-itself. This orientation is an *Ordering*. Ordering occurs beyond the particulars of the physical world and brings them into general patterns or forms through relations by way of rules or natural law. Ordering is *meta-physical*.

In this light, we might say that physics is a way of Ordering in which our attention is fixed on the world-in-itself *in relation to something beyond itself that is not directly conceived*. And from this we might ask, what is the Order of ordering in physics? Perhaps the Order of ordering in physics, by way of analogy, might tell us something about our own relation to God.

All science is the search for unity hidden in likenesses ... The scientist looks for order in the appearance of nature by exploring such likenesses. For order does not display itself of itself; if it can be said to be there at all it is not there for the mere looking. There is no way of pointing a finger or a camera at it; order must be discovered and, in a deep sense, it must be created. What we see, as we see it, is mere disorder ... We re-make nature by the act of discovery, in the poem or in the theorem.

[Bronowski, 23;24;32]

What is the Ordering of Classical Physics¹?

Ordering, in the way we have been using the term, is concerned with or signifies the way in which the many are (or are not) united as one. If physics seeks to abstract the general patterns of things and their rules or natural laws from among the particulars of the physical world, then we might think of the notion of Ordering in physics as a reflection on the “pattern” of abstracting patterns.

Ordering in classical or Newtonian physics is dominated by the notion of Space and classical physics seeks Orders that are formally spatial. Newton proposed the concept of Absolute space as an unmovable “container” in which the physical universe is embedded. This concept or likeness, *for Newton*, was a metaphor for God’s omni-presence to all creatures.

Space is a disposition of being qua being. No being exists or can exist which is not related to space in some way. God is everywhere, created minds are somewhere, and body is in the space that it occupies; and whatever is neither everywhere nor anywhere does not exist. And hence it follows that space is an effect arising from the first existence of being, because when any being is postulated, space is postulated.

[Newton, *De Gravitatione*, cited by Huggett, 112]

Newton's Absolute space is a Euclidean structure in which the spatial points are possible locations for material bodies. No body can exist without space. Spatial points, on the other hand, exist whether or not they are occupied by bodies. Eternal in duration, immutable in nature, Newton's Absolute space situates an ontological structure for the universe.

¹ This interpretation of Newtonian metaphysics is more fully developed in [The Proximity of Light: A deconstruction of space](#). Some segments of the paper are repurposed here.

Using the concept of Absolute space (taken as the tenor of a metaphor for which Euclidean geometry is the vehicle), Newton crafted what we might now call *thought experiments*. Thought experiments are not based on real encounters with the physical world which might test a theory against reality. Rather, a thought experiment is a speculation about a hypothetical situation that is constructed entirely in the imagination for the purpose of thinking through its consequences *according to the theory*. In this sense, thought experiments implicitly explore the ordering principles of a theory by way of inference.

Newton's thought experiments typically begin with empirical, embodied observers interacting with a physical system, like a rotating bucket or two rotating globes, all within the physical universe of observers, observed system, earth, stars and everything else. He then imaginatively transports the observed physical system outside of the physical universe into a vacuum that is Absolute space. The physical system is assumed to maintain its identity of internal relations (as a total or whole) but it no longer has external relations to the rest of the universe, apart from imagined observers. In his thought experiments, it is unclear where the observers stand in this vacuum, but it seems as if they are imagined to be "outside" of the finite universe which is now the observed system, yet connected spatially to it, and able to interact with it. In some sense, the empirical, embodied observers are continuously transported, *without rupture*, into an ideal observer who take in the whole universe at once and as separate from one's self. This is the metaphorical trope of Newton's objectivity. It can be seen as an *effacing* of the physical embodiment of the observer. In this trope, there is the presumption that embodied experience is identical with an ideal observer who can, in some sense, be outside of the universe, grasping its totality at once. Newton's Absolute space is the medium that enables this identity by connecting the ideal observer to the metaphorically finite (whole, total) universe at an Instant. Newton postulates that an ideal observer grasping the totality of the universe would be embodied in the same substantive space as empirical observers, such as ourselves, who are bound in the physical universe. Or, put another way, Newton's Absolute space is the transcendent continuum that connects embodied empirical existence with ideal observation of totality. Absolute space can play this role because of its indifference to the physical universe. Because, as Newton wrote in *Principia Mathematica*, "Absolute space, in its own nature, without relation to anything external, remains always similar and unmovable." [as cited by Huggett, p118].

In Newtonian physics, Absolute space becomes the primordial structure ordering creation and it is assumed to have substantive existence even in the absence of observers. The form of this primordial structure is determined and fixed by the rules or laws of Euclidean geometry. Objects placed within this structure must also be taken as determined and fixed by these laws. The laws fix the internal relations of parts to one another and to any whole. They also fix external relations of any whole object to what lies beyond its spatial limits, including any observer interacting with that object. Lawful relations are governed by the principle of equality which comes from Newton's third law: *For every action, there is an equal and opposite reaction*. Thus, Absolute space might be said to mediate sameness or *equality* by way of determinate *Law*.

The primordial structure of Absolute space—when taken as a grounding container within which all of reality is embedded—necessarily leads to reductional meta-physics because relations in Euclidean space are analytical. Embedded whole objects can always be reduced to component parts if they are formally spatial which they must be if they are embedded in Absolute space. But if a whole object can be reduced to its parts, then it has no independent identity. All of creation is reduced, by Absolute space, to finite “elementary particles” which are eternal in-themselves and metaphorically *like* Euclidean points. These elementary particles obey fixed and immutable laws of determination. This is the Ordering of objectivity in classical physics.

But can this be the case for our world?

Leibniz objected to Newton’s notion of Absolute space because of its failure to accommodate the distinction between the particular and the general. Euclidean space is formal and general—it is a structure that manifests physically through likeness of multiple instances. Reality, on the other hand, is particular—it is *this* world or universe and not some other. What would be the reason, Leibniz argued, for God to place the universe *here* in Absolute space and not somewhere else—two meters to the left, for example? Both instances would be indistinguishable according to Absolute space. What this question surfaces, for our modern understanding, is the fact that general structures, like Euclidean space, possess symmetries that must be *broken* in order for the structure to manifest in a physical instance. These symmetries are necessarily present because a general form unites multiple particulars as indistinguishable instances or tokens of that form. Leibniz further maintained that space is purely relative and therefore not Absolute. The relativity of space is consistent with the recognition that the Euclidean point actually does not exist in-itself. In isolation, a point is reduced to nothing. Euclidean points are limits within a relational ordering that is structured by Euclidean geometry and this relational ordering is the basis for the calculus of infinitesimals invented by Leibniz and Newton and mathematically formalized in modern analysis. Calculus is formally grounded in the notion of limits. The limit can be approached but never exceeded by the structural order. Yet something about the limit-boundary always remains external to the (spatialized) structure and this Otherness is related to particularity through broken symmetry.

Kant, on the other hand, argued that physical space cannot be purely relative. When physical objects are uniformly translated or rotated in space, they do not change their internal spatial relations. A car, once rotated about an axis, is indistinguishable from the unrotated car with respect to its spatial form. Therefore, the internal spatial relations that characterize objects can be said to be relative. However, Kant noted that physical objects in the three-dimensional world we live in can possess an internally distinct orientation of “handedness”. A right-handed object (for example your right hand or a right-handed screw) can be distinguished from a left-handed object (for example, your left hand or a left-handed screw) even though the internal relations are the same—one is a *reflection* of the other in respect of its spatial form and is distinguishable with respect to an external orientation. The property of orientation might be said to be *internal* to the object as an entity-in-itself and it manifests by way of relation to an *external* Other for which the opposite property holds. However, Euclidean space does not support internal properties because the Euclidean point has no interiority. Physical space, as

represented by Euclidean geometry, involves an arbitrary breaking of the symmetry of orientation that is absolute in the sense that it is external to the geometry of the space. This broken symmetry—an *interiority*—comes from beyond Absolute space which is purely *external*.

The challenge from Leibniz and Kant is that there appears to be something about physical space that deconstructs the Absolute Euclidean geometry grounding Newtonian meta-physics. The challenge comes from the nature of relationality. Newton began by taking space as a metaphor for the transcendental relation between creatures as physical bodies-in-the-world and the Infinite (Creator). But Euclidean space, if reduced to Euclidean points and their lawful relationships of equality², only supports relations of equality. So while space might mediate relations that are *like* the mediation of Infinite presence, spatial relations are also unlike Infinite presence in that the spatially mediated relation involves an equality between two or more bodies that are reciprocally related through co-presence. Spatial relations exclude the formal *Otherness* of the transcendental.

Because *we* are embodied in physical space, *we* experience physical co-presence with other creatures in the world that is mediated by space. Newton claimed that the mediation of this physical co-presence is *like* the mediation of God's omni-presence to his creatures. Leibniz argued that the mediation cannot be like God's presence to his creatures because space is not Absolute. Kant argued that the mediation cannot be purely relative in-itself either because objects in physical space can possess an orientation that exceeds the internal relations of Euclidean geometry. Orientation is a directed (one-way) relation that points from the interior to something beyond the interior. Orientation is a *sign* of the Absolute.

If we take physics to be a way of Ordering in which our attention is fixed on the world-in-itself *in relation to something beyond itself that is not directly conceived*, then classical physics suggests that the nature of this Ordering to the Beyond is like the intentionality of *signs*. There is a bifurcation of *ourselves* involved inasmuch as the subject of physics is the world-in-itself while, at the same time, the meaning of physics is found in the way in which it is a sign of the Infinite. This bifurcation distinguishes the physical body from the mind as Descartes had observed, *but it does not disconnect or absolutely divide them*. The duality is contained within the three-fold relationality of the sign which unites particular exterior physical bodies to communal and formal interior re-presentations. However, if we ignore the Orientation to the Beyond and take physics to be merely a way of ordering the world-in-itself we may lose touch with the proper connection between an external physical body and its interiority. Moreover, we may confuse the tenor and the vehicle of our deep metaphor of space, and wrongly assume that the mental formalism (a model of reality) is identical *in every way* with experienced physical reality.

² Euclidean space actually does not reduce to points because points-in-themselves do not exist—they are relational objects. The problem is that I have gone from Euclidean space to objects embedded in Euclidean space and then *back* to Euclidean space again and this has created a confusion between metaphor and substance. You may object to this form of reasoning. But my point is that this is the type of reasoning that characterizes the meta-physics of modern interpretations of Newtonian physics.

In *Space, Time and Incarnation*, Torrance makes explicit the theological limitations, from within the Christian tradition, of using spatial metaphors to speak of God. He points out that the relation between God and space is not itself a spatial relation. God stands in a creative, not a spatial (or temporal), relation to space. When we speak of the Incarnation in terms of Jesus “coming down” from Heaven, this should not be taken as a spatial metaphor. It is an act of kenosis, or self-emptying, through which God “humbled himself to be one with us and to take our finite nature upon Him, all for our sake” [Torrance 1969, 3]. Christ is *in* us through sharing in our bodily existence here on earth, yet he is also *in* the Father through his Oneness with Him. The Divine and human are united in Christ even while they remain separate and distinct. From this comes *paradeigma*, according to patristics, which is the act of *pointing*.

Paradeigma is essentially an operational term in which some image, idea or relation is taken from this worldly experience to point beyond itself to what is quite new and so to help us get some kind of grasp upon it ...

... It is in Christ that the objective reality of God is intelligibly linked with creaturely and physical forms of thought, so that the latter may be adapted and given orientation enabling them to direct our minds to what God really makes known of Himself, although in view of His infinite nature they will not be able to seize hold of Him as He is in Himself.

[Torrance 1969, 16]

Unlike the transcendental movement of *paradeigma*, in modern physics space is taken as a reciprocal and lawful coordination between two or more bodies that are themselves taken to be mutually co-present in their totality. In *Otherwise than Being or Beyond Essence*, Levinas makes explicit, from within the Jewish tradition, the ethical imperative to overcome the limitations of space as a deep metaphor. Not only is the relation between God and creation *Otherwise than spatial*, so too is the relation between persons. The condition of a human person, according to Levinas, is to be in a relationship of responsibility to the Other which takes the form of giving of oneself wholly *for* another person. Without this prior ethical imperative, the human person becomes bound within systems of reciprocal relations which take the other person to be the same and deny the particularity of Otherness which is the source of freedom. Such systems *in-themselves* are systems of power that are constitutionally oppressive.

Neither is the relation between God and creation spatial, nor is the relation between human persons purely spatial. This suggests that the deep metaphor of space may be inherently misleading for physics too. Hegel has argued that the determination of space subverts our capacity to conceptualize any form of creativity or self-realization to physical bodies.

Space is the existence in which the Concept inscribes its differences as in an empty lifeless element, in which they are just as inert and lifeless. The actual is not something spatial ... In a non-actual element like [space] there is only a truth of the same sort, i.e. rigid dead propositions. We can stop at any one of them; the next one starts afresh on its own account, without the first having moved itself on to the next, and without any necessary connection arising through the nature of the thing itself ... [this kind of]

knowing moves forward along the line of equality. For what is lifeless since it does not move of itself, does not get as far as the distinctions of essence, as far as essential opposition or inequality and therefore does not make the transition of one opposite into its opposite, does not attain to qualitative, immanent motion or self-movement.

[Hegel, §45]

If space is not Absolute, then taking space to be the grounding for theories of the physical world—either explicitly or metaphorically—may result in what Smith calls an inscription error.

An inscription error [is] a tendency for a theorist . . . to read [ontological] assumptions or their consequences back off the system, as if that constituted an independent empirical discovery or theoretical result.

[Smith, 50]

An inscription error happens when a re-presentation of reality is taken to be the same as reality itself.

Modern physics no longer takes space to be Absolute. In fact, through Relativity Theory, the deep metaphor of space is replaced with the deep metaphor of Light. God's omni-presence to creatures is not like determinate space, it is like creative *Light*. Yet, the physics community still tends to cling to the deep metaphor of space in the way that theories are constructed and interpreted and thereby it may be vulnerable to entrapment in inscription error [Unger and Smolin].

Where is the Subject³?

In a nutshell, the reductional Ordering of classical physics takes physical bodies to be determined material objects interacting through universal laws of reciprocal equality. The material objects reduce to collections of disjointed and metaphorically finite elementary “particles” which exist eternally in them-selves. Within this reductional Ordering, there is no place for *interiority*, no place for individual identity, or agency, or creativity or personhood. The deep metaphor of Euclidean space rules whereby material objects are formally *like* Euclidean points and creation is taken to be embedded in an empty, inert container of nothingness. From this comes the notion that elementary physical objects exist eternally in-themselves; they are not created *ex nihilo*.

This spatial metaphor, however, cannot be Absolute. Euclidean points are not discrete objects-in-themselves. Euclidean points are relational objects that exist by way of the formal laws of Euclidean geometry which bind Euclidean points into formal relations that create a *whole* structure. Euclidean points only exist by way of being part of the whole structure in which they

³ This interpretation of subjectivity is more fully developed in [On the Embodiment of Space and Time: Triadic logic, quantum indeterminacy and the metaphysics of relativity](#).

are embedded. The calculus of differences, which underwrites classical physics, reduces Euclidean points to discrete objects forged from reciprocal relations of equality. What is excluded in the limiting processes of differential calculus is the way in which Euclidean points, within a *Real* continuum, are related to their neighbour in a likeness or image of self-emptying *for the Other*. There is a form of proximity and substitution through which one point constitutionally implicates and merges with its neighbour. It is an asymmetric, directed relation of orientation, like the arrow of time. It is the act of *pointing*. In this sense Euclidean points can be said to possess an interiority which is pure reference to Other. And this interiority is an image of the exteriority of the whole structure of space which also possesses a broken symmetry of reference to Other.

Within the calculus of differences, the limiting processes exclude the implicate order of interiority. Reference to what lies outside of the whole structure or *Explicative Order* is cut off at the same time as reference to what lies within the interior of the elements or *Implicate Order* is cut off. There is nothing outside the whole structure in the same way as there is nothing inside the elementary units constituting the whole structure. What is cut off in this limiting process is the asymmetric act of pointing, the act of being-in-relation-for-another, the act of Love.

Paradeigma.

Paradeigma is time. It is interior reference to exterior presence. It is intentionality. Without paradeigma, the spatial metaphor of Euclidean geometry, taken as Absolute identity, leads to an infinite regress of fragmentation such that no physical body can be said to have *individuality*. Geometrical space is a general formalism that creates indistinguishable, relational tokens of multiplicity that lack *particularity*.

Newton's trope of objectivity is the culprit here. Namely, the trope of *effacing* the physical embodiment of the observer. Newton takes objectivity to be a vantage that is accessible to a *single* human mind, as an observer, by way of its embodiment in physical space. Yet what we take to be objective is that which is general and common to multiple persons. Objectivity involves communion of persons and in communion there is relationship. The many participate in One by way of their relations. In Newtonian physics, relations are governed by universal Law and result in equality or justice, but they lack *Paradeigma* or Love which relates to particularity.

Perhaps the way in which the individuality of human personhood involves communion tells us something about the nature of individuality itself. Specifically, individuality involves particular interiority that re-presents the general, whole forms of exteriority as communally enacted relational signs. The individual is a particular *subject* in communion with others by way of signs that represent objectivity as generalized, external forms—an outward and visible sign of an inward and invisible grace.

Individuals are relationally created in Love.

"Here I am ... for you."

Does Quantum Theory Signify a Different Ordering?

The strangeness of Quantum Theory, from the vantage of classical Ordering, manifests in the double-slit experiments which are described in introductory textbooks on quantum mechanics. In classical terms, the experimental set up involves directing a beam of electrons at a screen that can have either *one* single narrow slit or *two* narrow and closely spaced parallel slits. The screen is placed perpendicular to the trajectory or path of the electrons and the slits are aligned directly in the path of the electrons. Some of the electrons will pass through the slits and travel onward to a second screen that is parallel to the first. The second screen has a coating that emits a tiny flash of light whenever an electron strikes it.

If the first screen only has one slit, then a strong electron beam, containing a large number of electrons per unit volume, forms a single band of light on the second screen, mirroring the slit but slightly spread out because of diffraction of electrons from the edges of the slit. If the beam is made very weak, such that only one electron passes through the slit at a time, then the second screen emits individual flashes of light. By keeping track of these flashes, it is found that after a large number of electrons have hit the second screen, the same pattern appears. This finding is consistent with what one would expect with classical Ordering assuming the electrons are *discrete particles*.

If the first screen has two slits closely spaced together, then a strong electron beam will form, on the second screen, multiple bands of light separated by dark bands. This is also consistent with classical Ordering if the electron beam is considered to be a *continuous wave* that passes through both slits and forms an interference pattern on the second screen. The characteristic interference pattern occurs because the part of the wave passing through one slit interacts with the part of the wave passing through the second slit.

However, if the beam is made very weak, such that only one electron passes through the first screen at a time, then something quite strange happens. Each electron passing through the double-slitted screen will emit a small flash of light on the second screen. By keeping track of these flashes it is found that, after a large number of electrons have hit the second screen, the same interference pattern is formed as with the strong beam. Because classical Ordering leads us to believe that a single electron will pass through either one slit or the other—*but not both*—it is difficult to understand how an interference pattern can form since such a pattern results from the interaction between the part that passes through one slit with the part that passes through the other slit. Moreover, if the experiment is set up in a way that allows us to observe which slit each electron passes through, then the interference pattern will not form. Instead, it will be the like the pattern that forms with just one slit in the screen. Somehow, the act of observing the electrons disrupts the interference.

These experiments show that electrons exhibit wave-particle duality. Under certain experimental conditions they behave as if they were discrete entities-in-themselves, like particles. Under other experimental conditions they behave as a whole wave which does not reduce to discrete entities in-themselves. There is no apparent resolution of this duality within classical Ordering that excludes the asymmetrical relation of reference or orientation. Electrons, as metaphorical particles, are irreducibly entangled with one another to form a whole like a wave. Yet the whole can collapse into a discrete and localized event such as the flash of light on a screen. This is not just true of electrons. It is true of all matter and energy. Given our exploration of classical Ordering, perhaps we might conjecture that the conundrum of Quantum Theory lies in an inscription error regarding the nature of individuality. Classical Ordering pushes us to assume that individuality has the form of *being-in-itself* because the irreducible relation to Otherness—*being-for-another*—is either excluded or deeply implicit and unexpressed. If individuality in our world is relational, then we need to be careful about how we approach the notion of unity.

Maudlin has argued that there are, in fact, three categories of Quantum Theory that differ according to their orientation to the Real, namely collapse theories, pilot-wave theories, and many worlds. Each has its strengths and weaknesses and so far none has subsumed the others wholly by way of experimental verification. Given our theological desire to avoid a determinate image or re-presentation of One, suppose we take this to be the nature of theory. Namely, theories come in categories and there is no higher unifying *Category* under which all theories can be subsumed into One.

Let our current exploration be located within the category of pilot-wave theories proposed by de Broglie and Bohm. According to this form of theory, the electron can be considered as an individual particle that is guided by a quantum wave. The quantum wave presents to the particle the form of the experimental set-up such that the particle is guided through the experiment's single or double-slitted screen to the second screen where it is detected by the experiment. Each individual particle is particularly guided by the quantum wave such that, as a whole, the ensemble of particles in the experiment will form the observed pattern on the detection screen. This general pattern will be the pattern of a single band if only one slit is open and it will be the interference pattern if both slits are open. The individual electrons thereby make *explicit* the *implicit* ordering of the quantum wave. The explicit order is a real physical pattern on the detection screen. The implicit ordering comes from the quantum wave that is inferred but not physically embodied in a single instance of the experiment. In other words, each individual electron is a particular sign of the overall quantum wave that characterizes the general form of the physical set-up of the experiment.

If inscribed in Absolute space, the pilot-wave theory reduces to a theory of electrons as discrete and separable particles that are deterministically directed by trajectories that clearly distinguish where each electron precisely begins, which slit each went through and where each precisely hits the detection screen. The mystery of the interference pattern becomes inscribed into the precise articulation of the initial conditions of the electrons. However, this precise determination is not experimentally accessible *in principle*. The pilot-wave theory provides the

relational logic of inference: *if* the electron begins precisely at this point in space and time, *then* it will follow a particular trajectory and reach a particular location on the detection screen. Yet the events that are being related—the relata—are experimentally indeterminate because electrons cannot be fully localized in space and time. Their locations have an inherent indetermination that comes from Heisenberg's uncertainty principle for actualized experiments (and also from the absolute limit to the speed of light in Relativity Theory).

Perhaps there is an inscription error here.

Indeed, Bohm thought otherwise. He proposed that the quantum wave is *Active Information*.

The basic idea of active information is that a form, having very little energy, enters into and directs a much greater energy. This notion of an original energy form acting to "inform", or put form into, a much larger energy has significant implications in many areas beyond quantum theory.

[Bohm and Peat, 93]

Active information is a general form that carries a signal which can be received or interpreted by a particular electron. The information in the quantum wave is *potentially* active everywhere but only *actually* active when its form enters into and directs a particular, embodied electron. In this sense it is like a radio wave whose form carries a signal that is actualized by a specific receiving device, such as your cell phone or my grandmother's radio. The particular receiving electron, in turn, must possess an interiority that is capable of responding to and interpreting the form of the quantum wave *for itself*, for its own particular situation in the world, and then expressing that form through its particular action-in-the-world *for others*.

Within the Ordering of classical physics the differential notion of active information is redundant and superfluous because particulars are empty tokens of general form and what directs their action is determinate natural law. Any body inscribed in Absolute space will deterministically follow the form of law applicable to its location. But, as we have seen, such a body is merely a fragmented collection of disjointed null points. It is merely dust.

Or so it would seem.

Yet, if we remember the paradigmatic *pointing* that is excluded from the calculus of differences, then we might say that the fragmented bodies of classical Ordering do possess an interiority that is obscured by the Explicative Order itself. This interiority is the implicate order of time. And, for externally unformed bodies that are like Euclidean points, the implicate order generates uniform or inertial trajectories in spacetime according to Newton's first law of motion.

An opening.

Furthermore, Relativity Theory signifies *Light* as a likeness or sign of the Absolute rather than space. Light is found to mediate space and time by way of signaling processes that are absolutely limited by the finite speed of light. In Relativity Theory the instantaneous structures that are required for embodiment in space cannot obtain physically because that would require infinitely fast signaling. (A spatialized structure is an instantaneously synchronized form.) Perhaps the interior of physical bodies should be categorically differentiated from the exterior in Relativity Theory. From this we might speculate that electrons could possess an interior that cannot be subsumed by the external geometry of spacetime. This interior is in a state of responsiveness to the active information of the exterior “geometry” of the whole. The interior of a particular electron processes active information and then responds in synchronicity with the processing of active information of other electrons. That is to say, Relativity Theory concerns itself with the synchronization of processes in spacetime where processes involve particular responses to general, communally constituted forms of active information. What unites the particular to the general in these processes is the way in which a particular electron contains within itself images of the whole and these images are signs (sign-vehicles) that reference external form (sign-object) by internal form (sign-interpretant).

The arc of our trajectory leads us to speculate that non-relativistic Quantum Theory might involve an inscription error that excludes the interiority of time. And Relativity Theory might be understood as a theory of particular processes that can never reduce self-consistently to a spatialized geometry of the general because actual physical embodiment is particular and involves the act of breaking general symmetries.

What might be the Ordering of Orders or the Order of Ordering in Quantum Theory?

How might we go about interrogating the Ordering of Classical physics with respect to its aptness or appropriateness as a fit for Quantum Theory? The challenge is that if we are implicitly seeking a structural order that resolves the paradoxes of Quantum Theory, then we continue to seek a suitable Ordering that is metaphorically spatial. But this might lead to inscription error. Is it even possible to look for a different form of Ordering within physics?

Furthermore, Relativity Theory is based on the principle that space and time are interwoven through a deeper, implicit ordering of Light. Perhaps this ordering is also non-spatial in the same way that Quantum Theory involves non-spatial ordering. How might that work?

In *Science, Order and Creativity*, Bohm and Peat take on this challenge of reflecting on the notion of Order in relation to Quantum Theory. They introduce a threefold categorization of Ordering in which the three categories are interwoven spatiotemporally by way of processes. These three categories are: Explicative Order, Implicate Order, and Generative Order.

Explicative Order

Explicative Order involves the general patterns or invariants in time that are manifested *externally* by a system and usually have well defined locations in space. For example, the patterns that form on the detection screen in the double-slit experiments are Explicative Ordering. Explicative Order involves determinate structure and it is metaphorically spatial. The Ordering of Classical Physics discussed above belongs to the category of Explicative Order. The expectation of most physicists that all Ordering must be Explicative Order [Unger and Smolin] is what leads to problems with interpreting Quantum Theory according to the categorical approach to Ordering of Bohm and colleagues.

Implicate Order

The *Implicate Order* involves an implicit Ordering that constitutes the Explicative Order by way of an irreducibly dialectical or (metaphorically) dia-logical relationship. The quantum potential that forms a pilot-wave that guides particles, such as electrons, is an example of Implicate Ordering. The Implicate Order makes manifest or *expresses* the Explicative Order of the double-slit experiments. However, unlike the Explicative Order, the Implicate Order cannot be made explicit *as a whole*. The Implicate Order therefore opposes or deconstructs the totalizing presumptions of Classical Ordering because it always exceeds any attempt to be made fully explicit. The Implicate Order constitutionally relates that which is *interior* to that which is *exterior* where interiority and exteriority are categorically distinct.

According to Bohm and Peat, the Implicate Order can be thought of in terms of successive levels or degrees of enfoldment without end or culmination in an Ultimate Order that might be made Explicit. The Implicate Order unfolds successively into the expression of successive Explicative Orders and from a given Explicative Order, the next degree of enfoldment of the Implicate Order can be inferred.

What is essential to [the Implicate Order] is the simultaneous presence of a sequence of many degrees of enfoldment with similar differences between them ... such an order cannot be made explicit as a whole, but can be manifested only in the emergence of successive degrees of enfoldment. This may be contrasted with an explicate or unfolded order, in which the similar differences are all present together, in a manifest and extended form.

Particular kinds of entities, such as electrons and neutrons, [have their] own implicate order. But there may be a further unknown set of entities, each having its implicate order, which goes deeper and deeper without limit and is ultimately unknown.

[Bohm and Peat, 180]

The Implicate Order is *categorically different* from the Explicative Order—it does not reduce to a hidden Explicative Order that has yet to be unfolded in its final totality. Using the spatial metaphors of Classical Ordering, the Explicative Order is like the ordering of *objects* that are

seen in their totality as external and unaffected by any form of interiority of the observer or the observed. Using temporal metaphors excluded from Classical Ordering, the Implicate Order is like the ordering of *music* that is *heard* from within the experience of the whole musical composition and never manifests a fully present external object.

At any given moment, a number of [musical] notes are present in awareness in various degrees of enfoldment. The simultaneous awareness of all of these is what constitutes the sense of unbroken differences that are present simultaneously in different degrees of enfoldment of successive notes.

[Bohm and Peat, 189]

Yet it is important to recognize that, for Bohm, this does not mean that the Implicate Order is contingent on human participation or consciousness. Electrons for example, by way of their interiority, are in resonance with the Implicate Order of the Quantum Wave and such resonant interactivity guides the interior responsivity of particular electrons (which might otherwise be wholly random) to outwardly express or unfold an Explicative Order that is thereby made manifest *in the world*.

Generative Order

To overcome the tyranny of Absolute space that rules Classical Ordering, a third category of Order is also required such that the relation between the Explicative Order and the Implicate Order is not itself deemed to be explicative or spatial. From the perspective of the Explicative Order, its own relationship to the Implicate Order is paradoxical and can only be articulated through a temporal dialectic of opposition or complementarity. That is to say, the relationship is asymmetrical like time and it subverts the formation of a totalizing Explicative Order.

Yet, neither can the temporal relation of successive unfolding of the Implicate Order be taken as Absolute because such a relation *in-itself* could never generate an Explicative Order. The asymmetric relationality of time lacks *Return*, which is necessary for stasis, structure and self-identity.

If the Explicative Order be like space in its structural unfoldment, and the Implicate Order be like time in its processes of unfolding, then the third category, the *Generative Order*, is like Light.

The Generative Order *creates*. Whereas the Explicative Order is the extensional *form* of Ordering and the Implicate Order is the intentional *act* of Ordering, the Generative Order is the *source* of Ordering.

[The Generative Order] is primarily concerned not with the outward side of development, and evolution in a sequence of successions, but with a deeper and more inward order out of which the manifest form of things can emerge creatively.

[Bohm and Peat, 151]

The Generative Order creates or *generates* by way of generalization. Generalization is the process through which particulars are united in common forms. The Generative Order creates hierarchies of Ordering which unfold in space and time by *expressing* the general.

... the inclusiveness of orders, one within the other, is no longer a mere abstract subsumption in the sense that a more general category contains its particulars. Rather the general is now seen to be present concretely, as the activity of the generative principle within the generative order. This suggests a new notion of hierarchy, in which the more general principle is immanent, that is, actively pervading and indwelling, not only in the less general, but ultimately in reality as a whole. Emerging in this fashion, hierarchies are no longer fixed and rigid structures, involving domination of lower levels by the higher. Rather, they develop out of an immanent generative principle, from the more general to the less general.

[Bohm and Peat, 164]

Looked at in this way, we might say that Classical Ordering is a particular form of Ordering in which the Implicate Order is inert and the Generative Order is excluded. Quantum Theory (and Relativity Theory), on the other hand, might signify a more inclusive Ordering that is generative. Bohm and Peat use the image of a stream to portray the generative flow of Ordering at all levels of creation.

... science has, up to now, emphasized the sequential order of successive changes. In the larger scale this includes, for example, the theory of evolution. In the generative order, however, time is not put into the first place. Rather, time has to be related in a fundamental way to the generative order. The image of a stream is helpful in this respect. The stream can be studied by following an object that floats along it, in a time process. However, it is also possible to consider the entire stream all at once, to reveal the overall generative order that goes downstream from the source or origin ...

... the temporal process of evolution of the universe is constantly generated within this flow from a "source" or "origin" that is infinitely far into the implicate and generative orders. To see the universe in this way is to see "the whole stream at once" and this perception may be called timeless, in the sense that what is seen does not involve time in an essential way. However, the modes of generation and unfoldment in the stream imply that everything changes in successive moments of time. So in the flux described above, the timeless order and the time order enter into a fundamental relationship. However, because this relationship is now seen through the generative order, the time order appears very different from what it is in the traditional approach. It is not primarily a transformation within a given level of organization and explication. Rather it is, in the first place, a transformation of the entire "stream" of the implicate and generative orders that takes place from one moment to the next.

[Bohm and Peat, 197-8]

Categories and Processes⁴

A key insight Bohm and Peat draw upon in developing their notion of three Orders comes from reflecting on the way in which human thought, like human perception, works through *categorization*. Categorization, according to Bohm and Peat, is a creative process that involves the mutual interplay of differences and similarities. Categories are formed when entities are selected or abducted or abstracted from the environment by a subject through the perception of *differences* from the diffuse and undifferentiated background. These selected entities can then be collected together as *likenesses* by regarding their differences from each other as unimportant while still maintaining their differences from the background as important. For example, birds of different size and colour may be abstracted together from the general background of a tree by attending to their likenesses and ignoring their particular differences.

Categories ... emerge through the free play of the mind in which new forms are perceived through the creative action of intelligence and are then gradually fixed into systems of categories. But this system of categories always remains fluid and open to further change, provided that the mind itself is open to the creative action of intelligence.

[Bohm and Peat, 115]

The treatment of categorization, by Bohm and Peat, is formally like that of Charles Sanders Peirce although they make no explicit reference to his work. Peirce proposes three interwoven categories, called *Firstness*, *Secondness* and *Thirdness*. Like the three Orders in Bohm and Peat, Peirce's three categories are not fully differentiated nor mutually exclusive. Being constitutionally entangled, they flow in and through one another essentially. They are not further reducible (for example, to a combination of unitary and/or binary categories). However, Peirce claims that any additional categories (for example, four or five categories) are reducible to three. Because the three categories are not reducible, they cannot be individually defined *per se*. They relate as a whole such that their identities and their differences are brought into play at the same time. The more we speak about and work with the categories, the more clearly they might come into view:

- *Firstness* is “that whose being is simply in itself, not referring to anything nor lying behind anything” [Peirce, 248]. It is potential that is not yet actual—pure indeterminacy that is dynamic and self-othering. Firstness only appears in and through Secondness and Thirdness. It is fresh, spontaneous, whole. Peirce often refers to firstness as *quality*.
- *Secondness* is “that which is what it is by force of something to which it is second” [Peirce, 248]. It is event, effect, otherness, compulsion. Secondness is constituted by things and facts which inter-act. It is the domain of pure *experience* or “brute actuality”.

⁴ The following section describing Peirce's three categories is taken from [Light Signifying Form: Peirce on Creativity, Responsiveness and Emergence in Quantum, Biological and Linguistic Systems](#).

- *Thirdness* is “that which is what it is owing to things between which it mediates and which it brings into relation to each other” [Peirce, 248]. It is mediation, laws and habits, *generality*. The Third connects the First and the Second and weaves “a fabric of concrete reasonableness in and through the world” [Corrington]. The Third relates “things” to generalized “systems” from which Firstness re-emerges.

Within this metaphysical orientation, the *Generative Order* would belong to the category of *Firstness*, the *Implicate Order* to *Secondness*, and the *Explicative Order* to *Thirdness*. The three Peircean categories animate and sustain a continuous evolutionary process that takes the form of growth or progressive *learning*. The process is both hierarchical and emergent, such that higher levels of complexity are forged from lower levels. Each progressive level involves more intricate bodily forms with deeper interiority that grows in responsiveness and intentionality.

Peirce’s metaphysics of categories is based on the notion of a *sign* which also involves an irreducibly threefold relationality. The three elements of a sign are: the *sign-vehicle* (also called representamen or simply “sign”) which stands for an *object* to which a response may be made by an *interpretant*. The sign-vehicle does not signify anything in itself. Rather it is able to signify because it is affected or determined in some way by the object and, in turn, it is able to affect the interpretant. The interpretant is a change of state that allows the sign to mediate between the object and an interpreting entity. Often the interpretant will be a change in an interior state of an interpreting entity. For example, it may be an “image” or “thought” in someone’s mind (i.e. what is signified to someone by the sign). However, the interpreting entity need not be a person, it could be any physical body whose inner state may be changed in response to the sign, such as an electron or an amoeba.

It is important to note that Peircean signs and categories are not necessarily contingent on human consciousness and do not require human actors. They represent a more robust form of Ordering than is possible with the theories of Classical Physics. The notion of three categories, in Peircean metaphysics, replaces the notion of a *Grand Unified Theory* in Classical Ordering. In the context of physics and the natural sciences, the three categories are potentiality, actuality and generality. The notion of a *Sign*, in Peircean metaphysics, replaces the notion of an *Object* in Classical Ordering. In the context of physics and the natural sciences, a sign is a repeatable bodily *process* whereby particular interior action and common exterior form are functionally related. The quanta of Quantum Theory are thereby taken as embodied signs that signal communal and lawful processes.

How might the Process-Ordering of Quanta be considered both Individual *and* Relational⁵?

Quantum Theory, complemented by Relativity Theory, might lead us to conceive a different Ordering of physics such that physics is concerned with *the physically embodied processes of individuation*.

⁵ This interpretation of relational ontology is more fully developed in [Spacetime as a Formal Semiotic Process](#)

Within this way of conceiving Order, an individual is a particular body that enacts physical processes, which are iterative in time, formally replicable in space, and synchronously related to other individuals. An individual possesses an interior which responds to the whole by way of general forms. The general forms, enacted by a community of like individuals, interpret the world for the individual through relational signs. An individual, in its particularity, possesses degrees of indetermination, randomness or freedom commensurate with the communal forms and its interior possesses images of the whole that reference external form and sustain the individual as temporally enduring and spatially structured *being-in-itself-for-another*.

An individual, in its particularity, is a *Subject*. Subjectivity belongs to the category of *Firstness*. A Subject is a unique locus for agency in the world. A Subject possesses an interior that is in a mediated relation with the external world. The individuality of the Subject is sustained relationally in its spatiotemporal inter-actions with other individuals by way of general patterns, rules and laws. The *being-in-itself* of the Subject is given to the Subject by the community of individuals who are mutually entangled and inter-acting in the world. Yet, *in-itself*, the being of the Subject is not Real because it has no *significance*.

The general patterns, rules and laws belong to the category of *Thirdness* and are sustained by common or general signs that are collectively processed by a community of individuals. Each individual Subject is in a mediated relationship with Others by way of the formal system of patterns, rules and laws which constitute a creative grammar for the community. Thirdness mediates the relationship between the interior of an individual and its exterior world. Because a Subject is particular and unique, the interior of an individual possesses some degree of indetermination (or randomness) which also grants the individual limited agency in the world. For example, the interior of an electron possesses quantum spin which is indeterminate *in-itself*.

The individual Subject stands in a relationship of objectivity to the external world, such that other individuals manifest to the Subject as individuals through the mediation of general forms. This mediated relationship occurs through communal sign-processes. There is a categorical difference between a Subject and an *Object*. A Subject is an agent that is particular, responsive and possesses an interiority that is immediately inaccessible to other individuals. An Object is an image that is external, formal and interpreted by a community of individuals. Through *inter-action* with other individuals, the individual Subject puts forward an externalized image-of-itself that is available for an Other individual to respond to. This is a referential *being-for-another* that brings the Subject into relation with another individual as a potential sign. For example, an electron puts forward an image of physical extension in space and time that has the form of spatially constrained and temporally repeated resonance or vibration, which can be responded to by another individual electron to form a synchronous couplet. Yet *in-itself*, the couplet is still not Real because there is no external relation to what lies beyond the couplet. The internal vibration of the Subject is a potential sign of the vibration of another electron with which it is entangled. What is required to obtain Reality is that the Subject and each Other to which it is synchronously coupled communally form a *system or manifold*. This systemic manifold forms

the image of each constituent electron as a general, shared form from the common standpoint of every individual electron in the system. This shared general form—the image—is the externalized image-of-itself that is given to the Subject to express through its synchronous inter-action with all Others in the system.

This is a circular process that is created and sustained through Return.

The vibrational mode of the Subject is an internal image that comes from the entangled system or manifold of electrons as a whole. In acting out this internal image the Subject makes the image available to Other Subjects in the system or manifold. The internal image references the external image as a sign. As long as all the electrons continue to reference or interpret one another in the system through the generalized image of constrained vibration, they communally enact the Real which becomes a vibrating manifold of extensional objects.

In more complex systems, such as those formed by the double-slitted experiments, the internal subjectivity of an individual is a microcosm that stands in relation to the whole as an inexhaustible source of signs [Bohm, 196]. The individual, as Subject, receives *Active Information* from the whole in the form of generalized images which it then processes internally. Through the internal processing of Active Information, the Subject thereby *acts* in the world *for* Others by expressing its own internal images. This action-in-the-world for Others presents to Other individuals the Explicative forms of Active Information which are the general forms of communal interpretation.

Wherefore Order?

The Ordering of classical physics takes *Space* to be the highest universal category. The privileging of Absolute space can be traced back to Newton. When space is taken to be the highest category, the universe becomes parsed into timeless, finite “monads” whose being exists *in-themselves*. The result is a formal system of monadic relations in which relation is derivative to self-sufficient monads that have eternal existence and are not created *ex nihilo*.

Within classical Ordering, God’s immediate relation to creation becomes wholly transcendent and the notion of relation becomes derivative. The core problem with such monadic relationality is that it can lead to false images of One. In Christian theology, this metaphysical problem can be linked to Arian-like views regarding God’s Oneness that mis-represent the relational mystery of Trinity. Perhaps not coincidentally, Newton—for whom physics and theology were deeply connected—held such views and apparently did not believe in the Christian formulation of the Trinity [Westfall, Torrance 1969].

Quantum Theory and Relativity Theory are perhaps more coherently understood through a different orientation to Ordering whereby quanta become manifestations of relational processes. Such a relational ontology [Zizioulas] provides an alternative paradigm for interpreting modern physics. Within this metaphysical approach to Ordering, a system and its

constituents are formally connected through semiotic processes of signaling or communication [Deely]. Whereas the fundamental constituents of monadic relationality are objects, the fundamental constituents of relational ontology are signs. An object exists *in-itself* and terminates in a timeless, spatialized *Self-image*. A sign, by contrast, exists *in-itself-for-another* and always remains relational, pointing towards something *Other*.

Relational ontology is consistent with Trinitarian theology [Zizioulas]. Therefore, starting from God's revelation of His Trinity we might begin to trace "vestiges" or *hints* of Trinity in modern physics [Augustine]. Theologically speaking, this is proper to metaphysics; whereas the path that involves using Self-images from creation to determine or delimit God's loving essence is improper [Augustine].

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