

# Logical Causality in Whitehead's Theory of Extension

Relating the fundamental mereological order and the relativistic spatiotemporal order in modern physics

Michael Epperson

Center for Philosophy and the Natural Sciences

[www.csus.edu/cpns](http://www.csus.edu/cpns)

California State University Sacramento

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In much of *Process and Reality*, Alfred North Whitehead describes concrescence—the actualization of potentiality—in terms of spatiotemporal extensiveness and its relativistic restrictions. However, Whitehead's Theory of Extension in Part IV explicitly states that spatiotemporal extensiveness is not to be understood as fundamental extensiveness in his cosmology and metaphysics. As such, particular relativistic spatiotemporal restrictions, though relevant to the physical aspects of causal efficacy, are likewise not fundamental or metaphysically restrictive of *all* aspects of objectification—for example, the conceptual aspects. Whitehead explicitly describes spatiotemporal extension as a second-order extensiveness that presupposes a first-order mereological-logical extensiveness (PR 66). Whitehead's Theory of Extension as given in Part IV represents a clear and careful evolution of his previous theorizing on fundamental extension and extensive abstraction, seen in CN and PNK. In *Process and Reality*, Part IV recommunicates these theories in their most systematic form.

Since spatiotemporal extension is not the fundamental order of extensiveness in Whiteheadian metaphysics and cosmology, it is, I suggest, not at all problematic that as a 'more special' form of extensiveness (to use Whitehead's characterization), relativistic spatiotemporal extensiveness is not capable of exhibiting *all* the features of the fundamental logical-mereological extensive order. Among these would be the serial-inclusive ordering of all occasions and their regions—a necessary implication of Whitehead's theory of prehension and objectification, where any becoming occasion is internally related to "the whole of history." (PR 228)

One could attempt to impose a second-order relativistic restriction upon this cornerstone of Whiteheadian philosophy, such that any becoming occasion is internally related only to "the whole of *its relativistically restricted* history, and wholly unrelated and unconnected to any spacelike separated data and their historical relations"; but this would clearly be by choice, not by necessity. For in Whitehead's Theory of Extension, it is not the logical-mereological, serial-inclusive ordered extensiveness that presupposes the 'more special' relativistic spatiotemporal 'disordered' extensiveness; rather, it is the latter that necessarily presupposes the former.

In his excellent paper, "[Whitehead's Interpretation of Einstein's General Theory of Relativity](#)," Ronny Desmet describes the separation of geometry and physics fundamental to Whitehead's Theory of Extension. That separation, I suggest, can be further analyzed such that 'spacetime geometry' begins with 1) a logical-mereological order, yielding 2) a geometrical extensive order, yielding 3) a spatiotemporal extensive geometrical order. All of these are revealed (and presupposed) by the relations of concrescing occasions to their objectified data, since Whitehead characterizes these relations such that the former are internally related to the latter. 'Concrescing

occasions internally related to their objectified data' presupposes a fundamental asymmetrical logical modality, in other words, and the framework for this is given in Part IV.

Henry Stapp asks a question that is fundamental to any coherent attempt to metaphysically accommodate quantum mechanics by Whiteheadian philosophy: "Is there some passage in Whitehead where he explicitly states that there is an objective temporal ordering of actual occasions?"

Jorge Nobo offered the following reply, with which I agree:

I doubt you can find a passage in Whitehead in which he explicitly and unequivocally endorses the idea of an absolute order for the becoming and being of occasions. But no such passage is needed, since the idea can be easily deduced from things Whitehead does say unequivocally about an occasion's dative phase, about causal objectification, about intra-occasional supersession, about the superjective phase, and about the fact that every occasion must have at least one immediate successor.

The dative phase, whatever else it may be, *is* a region of the metaphysical extensive continuum, a region bounded and structured...

But the question of an "objective temporal ordering of actual occasions" itself begs the question of whether an objective serial order of occasions is necessarily 'temporal' or spatiotemporal. It is not. Temporality is a higher-order reflection of inter-occasional supersession in Whiteheadian metaphysics. Whitehead's Theory of Extension given in Part IV of *Process and Reality* is his attempt to correlate the concept of 'supersession of occasions' with a mereological, serial-inclusive 'supersession' of the occasions' regions. In this way,

- a) the serial internal relatedness underlying the creative advance, where each occasion is internally related to its data  
  
can be correlated with
- b) the serial-inclusive mereological relatedness defining the fundamental extensiveness of the creative advance, where each concrescent integration of the 'whole' is internally related to prior integrations—the regions bijectively related to the objectified data.

Beyond being a necessary implication of Whitehead's Theory of Prehension, Henry Stapp is exploring potential modifications of Whitehead's metaphysics that would make this implication explicit, and thus properly 'account for' the required objective ordering. Such a modification, however, might not be necessary. First, there is Jorge's point above—that the ordering is a necessary implication of Whitehead's Theory of Prehensions and objectification; if so, then an objective (but non-spatiotemporal) ordering of occasions could be seen as well accounted for by Whitehead's metaphysical scheme as a whole, as given in PR. Indeed, taken as a whole, this

scheme makes it clear that the objective ordering is not temporal or spatiotemporal, but rather mereological.

Indeed, one could argue that this ordering is well described and adequately accounted for logically and mereologically (or better, mereotopologically) in Whitehead's Theory of Extension in Part IV. There are indeed presupposed Axioms, Definitions, and Assumptions in the latter, and Whitehead could definitely have offered more explicit bridgings of his Theory of Extension in Part IV to his Theory of Prehension in Part III—as well as bridgings to his discussions of the extensive continuum in II.II. In a recent conversation, George Shields has put it this way:

It is one thing to ask whether Whitehead's system of ideas logically entails commitment to an absolute order, and another to ask whether his system is merely logically compatible with such an order... For example, I don't see that Whitehead provides enough hermeneutical ammunition for understanding all the implications of his doctrine of 'part/whole' relations that are an important feature of his doctrine of the extensive continuum; indeed, I am not sure I see clearly where the exact line of demarcation is between the highly general extensive continuum doctrine and all of his statements about extensive connections.

I agree with George that *much* work needs to be done in exploring the particular implications of Whitehead's Theory of Extension in relation to his Theory of Prehension—specifically, how the conception of the extensive continuum in the later relates to its conception (and foundation) in the former. But, as George points out, such an exploration must begin with this question: Is it the case that,

1. Whitehead's system of ideas logically entails commitment to an absolute mereological order;

or

2. Whitehead's system is only logically compatible with such an order, and therefore would require significant modification and expansion so that it is explicitly committed to and founded upon an absolute order.

I lean heavily toward the first option, and by the following reasoning: Whitehead's conception of speculative philosophy at once demands a) induction from experience, and b) strict deduction in the speculative schematization of experience so that the scheme is coherent and internally consistent. I believe both of these provide sufficient grounds for Option 1.

With respect to a), induction from scientific experience: There has been, to my knowledge, no empirically validated and incontrovertible violation of the logical order of physical causality. Notwithstanding theoretical expressions of the reversal of this order, where cause and effect are theoretically transposable, such transpositions are simply never experienced in the order of nature. Even relativity theory proscribes such transpositions; its inability to specify cause-effect relations among spacelike separated data need not be interpreted to mean that such relations do not exist *within* those spacelike separated regions. And relativity theory itself need not

necessarily be interpreted metaphysically—i.e., as fundamentally descriptive of a ‘block universe.’ Similarly, we have no empirically confirmed violations of the Principle of Non-Contradiction (PNC). A fact and its negation are never actually true at the same time—only potentially true prior to actualization. There are no actual Schrödinger Cats. One must posit the existence of multiple parallel universes, such as those implied by Everett’s Relative State / ‘Many Worlds’ interpretation of quantum mechanics, to accommodate such a violation of PNC. Even the supposedly ‘macroscopic superpositions’ recently described in experiments with superconducting quantum interference devices (SQUIDS) do not entail violations of PNC, nor do the EPR experiments (discussed below).

With respect to b), since Whitehead is quite clear in Part IV that the logical-mereological order is the *fundamental* order of the extensive continuum, any deduction from that fundamental order to a more specific or special order, such as relativistic spatiotemporal extensiveness, must maintain commitment to the fundamental order. If not, the connection to the overall scheme is no longer deductive, and the scheme loses coherence. “The metaphysical first principles can never fail of exemplification. We can never catch the actual world taking a holiday from their sway.” (PR 4). “The one genus of facts which constitutes the field of some special science requires some common metaphysical presupposition respecting the universe.” (PR 11).

That said, it is, I think, important to note that as a speculative philosophical adventure, the various axioms, definitions, and assumptions forming the foundation of Whitehead’s Theory of Extension are not *necessarily* metaphysically significant. They are, he says, only *probably* metaphysically significant. They are, in other words, features of a speculative philosophical scheme.

Whitehead’s conception of first principles/categories in the Theory of Prehensions and their correlate topological axioms in the Theory of Extension do not carry with them the traditional philosophical baggage of philosophical first principles of the sort employed by, for example, Aristotle, or Kant, in that they do not allow for sheerly reductive deduction or schematization. That is one of the great advantages of speculative philosophy as evinced by *Process and Reality*. At the same time, Whitehead’s first principles, categories and topological axioms are as close to traditional philosophical first principles as one can get in speculative philosophy. They fulfill, I think, the same purpose. With respect to the Theory of Extension and its fundamental mereological order, and the relation of this order to actual occasions:

Some general character of coordinate divisibility is probably an ultimate metaphysical character, persistent in every cosmic epoch of physical occasions. *Thus some of the simpler characteristics of extensive connection, [the mereological features] as here stated, are probably such ultimate metaphysical necessities...*

To be an actual occasion in the physical world means that the entity in question is *a relatum in this scheme of extensive connection*. In this epoch, *the scheme defines what is physically actual*.

The more ultimate side of this scheme, perhaps that side which is *metaphysically necessary*, is at once evident by the consideration of the mutual implication of

extensive whole and extensive part. If you abolish the whole, you abolish its parts; and if you abolish any part, then that whole is abolished. (PR 289)

The only difference is that as ‘speculative’ metaphysical principles, the course they set towards ‘truth’ in Whiteheadian speculative philosophy is asymptotic; whereas their traditional counterpart conceptions in, say, Kantian or Aristotelian philosophy, were typically taken as providing a direct route.

For example, Whitehead’s categories and first principles are *a priori* as employed; but also, and at the same time, *a posteriori* as created imaginative generalizations. This defies the traditional dichotomy employed by Hume, Kant, and the other early moderns. The first principle, categories, and axioms are grounded in experience—like an airplane on the ground prior to takeoff, to use Whitehead’s simile from Chapter 1 of *Process and Reality* (PR 5); they begin with experience. But the *enterprise* of speculative generalization begins with the takeoff. Once the speculative principles are formed in flight, one lands again for ‘renewed observation rendered acute by rational interpretation’—and at *this* point, the first principles are treated as *a priori*. They are re-evaluated against new experiences; and if the principles fail, all the better. For ‘the negative judgment is the peak of mentality’ (PR 5). But, as Whitehead continues:

In this description of philosophic method, the term ‘philosophic generalization’ has meant ‘the utilization of specific notions, applying to a restricted group of facts, for the divination of *the generic notions which apply to all facts.*’ (PR 5)

So in this sense, the role of the first principles, categories, and axioms in *Process and Reality* are clearly intended to be speculative attempts to characterize the generic notions which apply to all facts. That’s not too far off from the way Leibniz characterized logic, or the way the Pythagoreans characterized mathematics. The only real difference is the manner of ‘divination.’ For Whitehead, the method is ‘imaginative rationalization’ or ‘philosophic generalization.’ Furthermore, he offers a definition of ‘coherent’ principles as those that presuppose each other and cannot be sensibly abstracted from one another. In Whitehead’s dipolar scheme, the physical and conceptual poles of actual occasions are mutually implicative in this way, as are ‘potentiality’ and ‘actuality.’

The second condition for the success of imaginative construction is unflinching pursuit of the two rationalistic ideals, *coherence* and *logical perfection*. Logical perfection does not here require any detailed explanation. An example of its importance is afforded by the role of mathematics in the restricted field of natural science. The history of mathematics exhibits the generalization of special notions observed in particular instances. In any branches of mathematics, *the notions presuppose each other.* (PR 6)

Since the approach to first principles is always asymptotic for Whitehead, there is always opportunity for refinement, modification, reversion, etc. But with respect to the matter of relativistic spatiotemporal extensiveness and its coherent accommodation by the fundamental mereological order of extensiveness in Part IV, I see no necessary violation of the latter by the former. I agree that the relationship between the two in the context of Whitehead’s Theory of

Prehensions could have been further explored in *Process and Reality*—at least in terms of how a) the relativistically restricted causal order dominant in the physical pole of concrescence, and b) the relativistically unrestricted logical-mereological order dominant in the conceptual pole mutually condition one another in the dipolar actual occasion. But the general relation is, I believe, given clearly in Parts III and IV *when taken together*, as Whitehead recommends in the preface to PR. One ought not, in other words, *base* one's understanding of 'extensive continuum' by reference primarily to any isolated discussion of extension in PR—even in Part II.II, which is temptingly entitled 'The Extensive Continuum.' This is because, as Whitehead explains in the Preface to PR:

In the third and fourth parts, the cosmological scheme is developed *in terms of its own categoreal notions*, and without much regard to other systems of thought. For example, in Part II there is a chapter on the 'Extensive Continuum,' which is largely concerned with the notions of Descartes and Newton, compared with the way in which the organic philosophy must interpret this feature of the world. But in Part IV, this question is treated from the point of view of *developing the detailed method in which the philosophy of organism establishes the theory of this problem*. (PR xii).

Returning to Henry's original question as to the existence of some specific, self-contained passage in Whitehead where he explicitly states that there is an objective ordering of actual occasions fundamental to the relativistic proscription of such ordering... I agree that such a brief statement would have been handy. But at the same time, Whitehead at least gives a hint why there isn't one: because no simple statement could possibly capture the essential complexity of the issue, and therefore would be more likely to mislead than clarify.

It must be thoroughly understood that the theme of these lectures is not a detached consideration of various traditional philosophical problems which acquire urgency in certain traditional systems of thought...

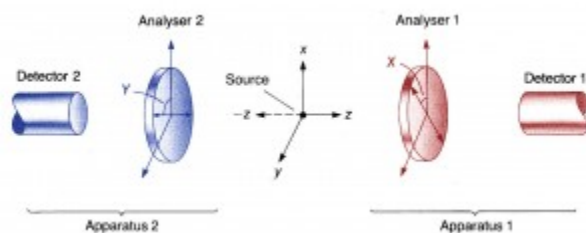
The unity of treatment is to be looked for in the *gradual development of the scheme*, in meaning and in relevance, and *not in the successive treatment of particular topics*. For example, the doctrines of time, of space, of perception, and of causality are recurred to again and again, as the cosmology develops. *In each recurrence, these topics throw some new light on the scheme, or receive some new elucidation*. At the end, in so far as the enterprise has been successful, there should be no problem of space-time, or of epistemology, or of causality, left over for discussion. The scheme should have developed all those generic notions adequate for the expression of any possible interconnection of things. (PR xii)

Obviously, a more work needs to be done to achieve this goal in a way that readers can clearly understand what Whitehead took to be a satisfactory treatment of these issues. But for Whitehead, a satisfactory treatment is not one that ends the exploration, but one that gives it a solid first step. This is important to emphasize, particularly when bringing Whiteheadian metaphysics and modern physics together in conversation. For it is often the case that in physics,

‘solving a problem’ is treated as ‘ending the exploration’ of a particular topic—especially if the problem solved is considered to be cosmologically fundamental.

So, while my preference is for Option 1 above—that Whitehead’s system of ideas logically entails commitment to an absolute mereological order—the question which interests me the most is: Do the presupposed axioms, definitions, and assumptions given in Part IV give sufficient justification for the order they yield? They are first principles of extension that correlate with the first principles of prehension. The ‘Categorical Notions’ are, says Whitehead, reflected in both. One could argue that it simply isn’t enough—that there must be some additional specified dynamical process that would yield the sought after order in the language of physics. But to my thinking, this is akin to Plato’s exploration of the question, “Why is the universe reasonable? Why is it logically ordered?” His own cosmology in the *Timaeus*, like Whitehead’s, contains similarly presupposed first principles—along with an admonition in the *Theaetetus* that attempting to apply a reductionist argument to account for those first principles will lead nowhere, to nothing.

Similarly, physicist Murray Gell-Mann has no problem appealing to the necessary logical order when explaining why, in Aspect’s famous EPR experiment, spacelike separated detection events A at Detector 1 and B at Detector 2 yield the correlation coefficients predicted by the quantum theory—even though they are not spatiotemporally well-ordered by the theory.



The entangled state with spacelike separated detectors prevents their relativistic spatiotemporal ordering; one cannot specify one detection event as ‘cause’ and the other as ‘effect.’ The language of the *physics* limits the description of the relationship between A and B as one of “reciprocal influence,” in the words of Abner Shimony,

without singling out one event as the cause and one as the effect. This kind of causal connectedness between two events with space-like separation has no classical analogue, and no classical analogue should be expected, since quantum mechanical potentiality has essentially broadened the concept of an event. (“Conceptual Foundations of Quantum Mechanics”)

Yet even if the physics, with its relativistic spatiotemporal scheme of ‘fundamental’ extensiveness, fails to give us an ‘absolute order’ of actualizations A-B or B-A, many physicists, including Roland Omnès and Murray Gell-Mann, simply appeal to a pre-spatiotemporal (metaphysical) ‘logical-historical order’ to contextualize the correlations. That is, for these physicists, as for Whitehead, the relativistic spatiotemporal order is not *the* fundamental order, in that it explicitly presupposes a more fundamental logical-historical order. Murray Gell-Mann, for example, has written:

Measurement does not cause any physical effect to propagate from one photon to the other. Then what does happen? If, on a particular [potential] branch of history, the plane polarization of one photon is measured and thereby specified with certainty, then on the same branch of history the plane polarization of the other photon is also specified with certainty... No action at a distance takes place. (*The Quark and the Jaguar*, 172)

Of course, there is a lot implied by the casual use of the word ‘history’ here—an implied serial-asymmetrical order of events, for one thing. Also, histories as sets of events contain other histories, and such inclusive sets must be consistent within any broader set internally related to them. Whitehead’s Theory of Extension is a description of these same mereological, logically governed relations. In his Theory of Prehension, each concreting occasion is internally related to the world-as-history, “*each creature including in itself the whole of history*” (PR 228). In his Theory of Extension, Whitehead precisely describes the meaning of the words “including in itself” in that quote: It is defined as a logically governed, serial-inclusive, mereological order of ‘whole to part.’ This order is intended to give *extensive meaning* to the *intensive notion* of a concreting occasion being internally related to the history of the world. (I will return to this in more detail below.)

Further, I believe as Henry does that Whitehead’s metaphysics and cosmology as systematized in *Process and Reality* do describe a relativistic notion of ‘coming into beingness’ in terms of the *spatiotemporal* extensive standpoints of actual occasions and their *spatiotemporally* coordinated data. But I disagree that the latter, ‘more special’ (to use Whitehead’s words) relativistic spatiotemporal extensive order therefore necessarily trumps the former more fundamental logical-mereological extensive order—and that because of this undermining, a serious modification of Whiteheadian philosophy is required to relieve the incoherence.

The claim of requirement here is undermined by the fact that, for Whitehead, the logical-mereological order is the fundamental extensive order—not the ‘more special’ relativistic spatiotemporal extensive order. (See the quotes from PR below). It is the former, most general order that deductively accommodates the latter, more special order; therefore, there is no need to modify the whole scheme because the latter cannot wholly accommodate the former.

One could, however, argue that the fundamental mereological extensive order as given in Part IV is *not*, in fact, capable of coherently accommodating relativistic spatiotemporal extension. But it would be difficult to argue this on philosophical grounds, and harder still to argue it on physical grounds since as Whitehead points out, physics presupposes and requires the very logical-mereological order it would attempt to obviate with such an argument. The above discussion of quantum mechanics and the EPR experiment, and the approaches of Gell-Mann, Omnès, et al, might be taken as evidence of this. A related presupposition is the *a priori* congruence definition presupposed by relativistic depictions of spatiotemporal extension. (cf. PR 331-332). Whitehead writes:

The transformations into an indefinite variety of coordinates to which the ‘tensor theory’ refers, *all presuppose one congruence definition*. The invariance of the Einsteinian ‘ds’ expresses this fact. (PR 98)

In a recent [New York Times editorial](#) (11/24/07), Paul Davies wrote:

***The very essence of a scientific explanation is that the world is ordered logically.***

He goes on to say,

When physicists probe to a deeper level of subatomic structure, or astronomers extend the reach of their instruments, they expect to encounter additional elegant mathematical order. And so far this faith has been justified.

The most refined expression of the rational intelligibility of the cosmos is found in the laws of physics, the fundamental rules on which nature runs. The laws of gravitation and electromagnetism, the laws that regulate the world within the atom, the laws of motion — all are expressed as tidy mathematical relationships. But where do these laws come from? And why do they have the form that they do?

When I was a student, the laws of physics were regarded as completely off limits. The job of the scientist, we were told, is to discover the laws and apply them, not inquire into their provenance. The laws were treated as “given” — imprinted on the universe like a maker’s mark at the moment of cosmic birth — and fixed forevermore. Therefore, to be a scientist, you had to have faith that the universe is governed by dependable, immutable, absolute, universal, mathematical laws of an unspecified origin. You’ve got to believe that these laws won’t fail, that we won’t wake up tomorrow to find heat flowing from cold to hot, or the speed of light changing by the hour.

Over the years I have often asked my physicist colleagues why the laws of physics are what they are. The answers vary from “that’s not a scientific question” to “nobody knows.” The favorite reply is, “There is no reason they are what they are — they just are. The idea that the laws exist reasonlessly is deeply anti-rational. After all, the very essence of a scientific explanation of some phenomenon is that the world is ordered logically and that there are reasons things are as they are. If one traces these reasons all the way down to the bedrock of reality — the laws of physics — only to find that reason then deserts us, it makes a mockery of science.

Thus we hear a resounding echo of Whitehead’s conception of speculative metaphysics, and the function of presupposed first principles and desiderata. One cannot appeal to physics to account for the logical order of the universe since physics necessarily presupposes that order in all of its operations and expressions, in all of its descriptions of nature. Nor can one appeal to philosophy or metaphysics to account for the logical order of the universe—for the very same reason. Any reasoned principle or process, physical or metaphysical, one could possibly come up with to *account for* (i.e., explain the source of and reason for) the logical order of the universe would, itself, presuppose the very order it purportedly accounts for. Socrates’ dream in the *Theaetetus* always ends the same way.

With respect to the endeavor of Whiteheadian speculative philosophy, *beginning* with a logically ordered and governed universe is fine, so long as the first principles describing this order and governance are mutually implicative, and empirically applicable and adequate. These are Whitehead's desiderata for speculative philosophy. With respect to empirically validated relativistic spatiotemporal extensiveness, then, the task is to demonstrate its compatibility with the underlying, presupposed logical order—specifically, compatibility with the latter's expression as a logical-mereological 'first-order' extensiveness. This Whitehead attempts to achieve in Part IV. So long as the logical first principles are mutually implicative and empirically applicable and adequate, *and* can be shown to underlie any mathematical expression of relativistic spatiotemporal expression, then I believe that's the best philosophy can do—that is, to *describe* this logical order and its implications as deeply as possible. But no matter how deep the description, it will never become an explanation—an 'accounting for.' Any 'deepest scheme' purporting to 'account for' these logical first principles cannot be anything but theological, it seems to me, or a theological feature of metaphysics. And of course theology has its own presupposed first principles.

In conclusion of these introductory remarks, I suggest that these two levels of extensive ordering—the first order logical-mereological order and the second-order relativistic spatiotemporal order—are *not inherently incompatible* in Whiteheadian metaphysics and cosmology. I believe Part IV provides an adequate demonstration of compatibility. Nor do I believe that Whitehead's philosophy is incomplete or fundamentally incoherent because it either presupposes or implies a fundamental logical order—that the metaphysics and cosmology given in *Process and Reality* could be improved with the addition of some physical or philosophical 'accounting for' the logical order. I do not believe such an accounting is possible—although I do think additional exemplifications of this order, seen at deeper and deeper levels with the advance of science, can and should be explored. Such explorations can contribute significantly to the philosophy—either by reinforcing the speculative scheme, or inspiring some novel augmentation or reversion.

Returning to the issue of the compatibility of the first-order logical-mereological extensiveness described in Part IV, and the second-order relativistic spatiotemporal extensiveness, well validated empirically: The modifications Whitehead made to his earlier theory of extensive abstraction, per the criticisms of de Laguna, etc, were intended to make that fundamental mereological order compatible with the more specialized relativistic features of spatiotemporal extensiveness—which Whitehead did, indeed, accept in *Process and Reality*. Whitehead's theory of extension as given in his two earlier works, CN and PNK, were also compatible with relativity theory, but only when viewed through the lens of the latter. It was incompatible, however, from the standpoint of the metaphysics, which is why Whitehead was inclined to alter the theory.

In Part IV of PR, Whitehead argues that the congruence relations provided by the fundamental mereological order are what make the relativistic theory of spacetime extension (or any form of measurement at all) possible. (cf. PR 331-332). Making this conventionally tacit presupposition more explicit, for Whitehead, is the *proper* way of integrating Einsteinian relativity with the philosophy of organism. And it is this way that de Laguna's criticisms were crucial to that particular, proper integration, for it allowed Whitehead to define 'point' without reference to

‘duration’ (cf. PR 287). In other words, it allowed Whitehead to define an extensive region without reference to a spatiotemporal region as defined and restricted by relativity theory.

According to the classical pre-relativistic notions of time, there would be only one duration including M, and it would contain all M's contemporaries. According to modern relativistic views, we must admit that there are many durations including M—in fact, an infinite number, so that no one of them contains all M's contemporaries. (PR 320)

But the compatibility is not to be interpreted as “relativistic spatiotemporal extensiveness *trumps* and *wholly displaces* logical-mereological extensiveness. Whitehead, beaten, concedes all to special relativity.” This, I would argue, is simply inaccurate. Where relativistic spatiotemporal extensiveness defines spacelike separations as mutually non-efficacious and causally irrelevant, it is a *major* leap to impose that specialized restriction upon the more fundamental features of his Theory of Extension—namely, the logical and mereological features.

The entirety of the following presentation should be related to these excerpts from *Process and Reality* which pertain immediately to the subject at hand:

The real potentialities relative to all standpoints are coordinated as diverse determinations of one extensive continuum. This extensive continuum is *one relational complex* in which all potential objectifications find their niche. It underlies *the whole world*, past, present, and future. Considered in its *full generality*, apart from the additional [relativistic] conditions proper only to the cosmic epoch of electrons, protons, molecules, and star-systems, *the properties of this continuum are very few and do not include the relationships of metrical geometry*. An extensive continuum is a complex of entities united by the various [mereological] *allied relationships of whole to part, and of overlapping so as to possess common parts, and of contact, and of other relationships derived from these primary relationships*. This extensive continuum expresses *the solidarity of all possible standpoints throughout the whole process of the world*. [i.e., the solidarity that provides for the objective immortality of all settled facts and their mereological relations of whole/part.] It is not a fact prior to the world; *it is the first determination of order* [i.e., logical order]—that is, of real potentiality [cf. 'real potentiality' in the quote above]—*arising out of the general character of the world... All actual entities are related according to the determinations of this continuum; and all possible actual entities in the future must exemplify these determinations in their relations within an already actual world*. (PR 66)

Extension, *apart from its spatialization and temporalization*, is that general scheme of relationships providing the capacity that many objects can be welded into the real unity of one experience. Thus, an act of experience has an objective scheme of extensive order by reason of the double fact that its own perspective standpoint has extensive content, and that the other actual entities are objectified with the retention of their extensive relationships. *These extensive relationships are more fundamental than their more special spatial and temporal relationships*.

Extension is the *most general scheme* of real potentiality, providing the background for all other organic relations. (PR 67)

In [\*Quantum Mechanics and the Philosophy of Alfred North Whitehead\*](#), I proposed a distinction between:

1. causal influence of actualization by temporally prior actuality
2. causal affection of potentia by logically prior actuality

By ‘logically prior’ I mean ‘internal to’ in Whitehead’s Theory of Extension—i.e., within the route of internally related abstractive-extensive regions. “*All actual entities are related according to the determinations of this [pre-spatiotemporal, fundamentally mereological-logical] continuum; and all possible actual entities in the future must exemplify these determinations in their relations within an already actual world.*” (PR 66) That deeper, mereological-logical level of ordering is not *wholly* describable in the more specialized framework of relativistic spatiotemporal extension.

...An act of experience has an objective scheme of extensive order by reason of the double fact that its own perspective standpoint has extensive content, and that the other actual entities are objectified *with the retention of their extensive relationships*. (PR 67)

For example, this sentence expresses the universal internal relatedness given in the Principle of Relativity, but now expressed in terms of an “objective scheme of extensive order” that is a “general scheme of relationships...*apart from* spatialization and temporalization”; neither this order, nor its relationship to the Principle of Relativity has a direct, complete analog in terms of 4d relativistic spatiotemporal extensiveness.

An actual entity, in its character of being a physical occasion, is an act of blind perceptivity of the other physical occasions of the actual world. When we consider such an occasion morphologically, as a given entity, **its perceptive bonds are divisible by reason of the extensive divisibility of its own standpoints, and by reason of the extensive divisibility of the other actual occasions.** Thus we reach perceptive bonds involving one sub-region of the basic region of the perceiver, and one subdivision of the basic region of the perceived. **The relationship between these sub-regions involves the status of intermediate regions functioning as agents in the process of transmission. In other words, the perspective of one sub-region from the other is dependent on the fact that the extensive relations express the conditions laid on the actual world in its function of a medium.**

(This is further discussed later in this paper as it relates to Whitehead’s scheme of serial-inclusive extensive regions.)

These extensive relations do not make determinate *what* is transmitted; **but they do determine conditions to which all transmission *must conform*.** They represent the *systematic scheme* which is involved in the real potentiality

from which every actual occasion *arises*. **This scheme is also involved in the attained fact which every actual occasion is.** The 'extensive' scheme is nothing else than the generic morphology of the internal relations which bind the actual occasions into a nexus, and which bind the prehensions of anyone actual occasion into a unity, coordinately divisible.

For Descartes the primary *attribute* of physical bodies is *extension*; **for the philosophy of organism the primary *relationship* of physical occasions is *extensive connection*.** This ultimate relationship is *sui generis*, and cannot be defined or explained. **But its formal properties can be stated. Also, in view of these formal properties, there are definable derivative notions which are of importance in expressing the morphological structure. *Some general character of coordinate divisibility is probably an ultimate metaphysical character, persistent in every cosmic epoch of physical occasions. Thus some of the simpler characteristics of extensive connection, as here stated, are probably such ultimate metaphysical necessities...***

But, for our epoch, extensive connection with its various characteristics is the fundamental organic relationship whereby the physical world is properly described as a community. There are no important physical relationships outside the extensive scheme. **To be an actual occasion in the physical world means that the entity in question is a relatum in this scheme of extensive connection. In this epoch, the scheme defines what is physically actual. (PR 288)**

**The more ultimate side of this scheme, perhaps that side which is metaphysically necessary, is at once evident by the consideration of the mutual implication of extensive whole and extensive part. If you abolish the whole, you abolish its parts; and if you abolish any part, then *that* whole is abolished.**

In this general description of the states of extension, **nothing has been said about physical time or physical space, or of the more general notion of creative advance. *These are notions which presuppose the more general relationship of extension.*** They express additional facts about the actual occasions. The extensiveness of space is really the spatialization of extension; and the extensiveness of time is really the temporalization of extension. (PR 289)

That said, the “objective scheme of extensive order” is clearly operative and present for Whitehead, to the extent that the relativistic theories are logico-mathematical constructions that do partially describe the logical-causal order of physical interactions in nature. Further, the logical-mereological order is more than merely reflected (incompletely and imperfectly) in the relativistic spatiotemporal order; Whitehead asserts that it is indeed wholly presupposed by the latter.

With respect to the phrase “causal affection of potentia by logically prior actuality”: My term ‘logically prior’ in the context of Whitehead’s theory of objectification simply means objectified ‘and therefore immortal’ facts. If these ‘facts’ are spacelike separated from the concreting occasion, they are nevertheless objectified—though *not physico-causally* as they would be if they

were time-like separated. They are objectified in the sense of the logical-mereological internal relatedness discussed above. (This is discussed in greater detail below in terms of the serial-inclusive mereological order in Whitehead's theory of extensive abstraction.) As Jorge Nobo wrote in a recent communication: "There is nothing in Whitehead's metaphysics to restrict the causal objectification of completed occasions... The definite set of completed occasions is defined relative to that definite occasion's initiation and vice-versa. Space-like separation is completely irrelevant."

I agree with this assessment. One sees it also in the following quote from Part IV:

This extensiveness is the pervading generic form to which the morphological structures of the organisms of the world conform... If we confine our attention to the subdivision of an actual entity into coordinate parts, we shall conceive of extensiveness as purely derived from the notion of 'whole and part,' that is to say, 'extensive whole and extensive part.' This was the view taken by me in my two earlier investigations of the subject. This defect of starting-point revenged itself in the fact that the 'method of extensive abstraction' developed in those works was unable to define a 'point' without the intervention of the theory of 'duration.' Thus what should have been a property of 'durations' became the definition of a point. ***By this mode of approach the extensive relations of actual entities mutually external to each other were pushed into the background; though they are equally fundamental.***

Since that date Professor T. de Laguna has shown that the somewhat more general notion of 'extensive connection' *can be adopted as the starting-point for the investigation of extension; and...my difficulty in the definition of a point, without recourse to other considerations, can be overcome.* (PR 287)

A logical-mereological conception of 'point' is fundamental to the conception of 'duration' and its relativistic restrictions (which Whitehead discusses at length in PR 125-126). It is this redefinition in liberation of such restrictions that allows for spacelike separated occasions "mutually external to each other" to nevertheless enjoy "equally fundamental" extensive relations by a prehending subject. Even though by the more special order of relativistic spatiotemporal extensiveness, spacelike separated occasions ('mutually external' - 'contemporary' occasions) are physically-causally unrelatable, *there are nevertheless relations* among such mutually external occasions by the more fundamental order of mereological-logical extensiveness. And in the process of objectification, these logical relations are "equally fundamental" to the relativistically restricted physical-causal relations in Whitehead's scheme.

The contemporary world is in fact divided and atomic, being a multiplicity of definite actual entities. These contemporary actual entities are divided from each other, and are not themselves divisible into other contemporary actual entities. This antithesis will have to be discussed later (d. Part IV). But it is necessary to adumbrate it here.

This limitation of the way in which the contemporary actual entities are

relevant to the 'formal' existence of the subject in question is the first example of the general principle, that objectification relegates into irrelevance, or into a subordinate relevance, the full constitution of the objectified entity. Some real component in the objectified entity assumes the role of being how that particular entity is a datum in the experience of the subject. In this case, the objectified contemporaries are only directly relevant to the subject in their character of arising from a datum which is an extensive continuum. They do, in fact, atomize this continuum; *but the aboriginal potentiality, which they include and realize, is what they contribute as the relevant factor in their objectifications. They thus exhibit the community of contemporary actualities as a common world with mathematical relations-where the term 'mathematical' is used in the sense in which it would have been understood by Plato, Euclid, and Descartes, before the modern discovery of the true definition of pure mathematics.*

The bare mathematical potentialities of the extensive continuum require an additional content in order to assume the role of real objects for the subject. This content is supplied by the eternal objects termed sense data. These objects are 'given' for the experience of the subject. Their givenness does not arise from the 'decision' of the contemporary entities which are thus objectified. *It arises from the functioning of the antecedent physical body of the subject; and this functioning can in its turn be analysed as representing the influence of the more remote past, a past common alike to the subject and to its contemporary actual entities. [See the graphic on p. 23 of this paper]* Thus these sense-data are eternal objects playing a complex relational role; *they connect the actual entities of the past with the actual entities of the contemporary world, and thereby effect objectifications of the contemporary things and of the past things. (PR 62)*

The objectified space-like separated fact, then, *is objectified* in the same significant sense that a time-like separated fact is objectified; the spacelike separated fact is nevertheless a *fact of the world* even though it cannot be extensively coordinated as a 'temporally prior actuality.' I will repeat here passages from PR 288-289 previously quoted:

**To be an actual occasion in the physical world means that the entity in question is a relatum in this scheme of extensive connection. In this epoch, the scheme defines what is physically actual. (PR 288)**

**The more ultimate side of this scheme, perhaps that side which is metaphysically necessary, is at once evident by the consideration of the mutual implication of extensive whole and extensive part. If you abolish the whole, you abolish its parts; and if you abolish any part, then that whole is abolished. (PR 288)**

These extensive relations do not make determinate *what* is transmitted; **but they do determine conditions to which all transmission must conform.** They represent the *systematic scheme* which is involved in the real potentiality from which every actual occasion *arises. This scheme is also involved*

*in the attained fact which every actual occasion is. The 'extensive' scheme is nothing else than the generic morphology of the internal relations which bind the actual occasions into a nexus, and which bind the prehensions of anyone actual occasion into a unity, coordinately divisible. (PR 288)*

*...for the philosophy of organism the primary relationship of physical occasions is extensive connection. This ultimate relationship is sui generis, and cannot be defined or explained. But its formal properties can be stated. Also, in view of these formal properties, there are definable derivative notions which are of importance in expressing the morphological structure. Some general character of coordinate divisibility is probably an ultimate metaphysical character, persistent in every cosmic epoch of physical occasions. Thus some of the simpler characteristics of extensive connection, as here stated, are probably such ultimate metaphysical necessities...*

But, for our epoch, extensive connection with its various characteristics is the fundamental organic relationship whereby the physical world is properly described as a community. (PR 288)

In this general description of the states of extension, **nothing has been said about physical time or physical space, or of the more general notion of creative advance. These are notions which presuppose the more general relationship of extension.** They express additional facts about the actual occasions. The extensiveness of space is really the spatialization of extension; and the extensiveness of time is really the temporalization of extension. (PR 289)

In terms of this fundamental mereological order, then, an objectified spacelike separated datum (fact of the world), though not 'temporally' prior as disallowed by relativity theory, is nevertheless 'prior' somehow. It is prior logically (i.e. asymmetrically internal to the objectifying occasion) and mereologically (i.e., an inclusive 'part' to the objectifying occasion as a 'whole') in the extensive continuum. It is this fundamental logical-mereological ordering that prevents the universe from collapsing into a loose, sheerly indeterminate patchwork of relativistically unrelatable extensive regions that simply cannot be unified within a concreting occasion:

The atomic actual entities individually express the genetic unity of the universe. The world expands through recurrent unifications of itself, each by the addition of itself, automatically recreating the multiplicity anew. [i.e., The many become one and are increased by one. Also, cf. the above passage from PR 67, depicting fundamental mereological order of extension as "extension apart from its spatialization and temporalization, and is that general scheme of relationships providing the capacity that many objects can be welded into the unity of one experience." Again, "The many become one and are increased by one."]

The other type of indefinite multiplicity, introduced by the indefinite coordinate divisibility of each atomic actuality [here Whitehead is speaking of relativistic 4d spacetime and its inability to render determinate relations among *all* occasions], seems to show that, at least for certain purposes, the actual world is to be conceived as a mere indefinite multiplicity.

**But this conclusion is to be limited by the principle of ‘extensive order’ which steps in. [cf. the fundamental mereological discussed in PR 66-67.] The atomic unity of the world, expressed by a multiplicity of atoms, is now replaced by the solidarity of the extensive continuum. This solidarity embraces not only the coordinate divisions within each atomic actuality, *but also exhibits the coordinate divisions of all atomic actualities from each other in one scheme of relationship.* (PR 286)**

Placing the above in the context of the earlier passages further clarifies Whitehead’s conception of the fundamental order of the extensive continuum and its unifying role within his cosmological scheme:

The extensive continuum is a complex of entities united by the various [mereological] *allied relationships of whole to part, and of overlapping so as to possess common parts, and of contact, and of other relationships derived from these primary relationships... It is the first determination of order... The properties of this continuum are very few and do not include the relationships of metrical geometry.*” (PR 66)... *These extensive relationships are more fundamental than their more special spatial and temporal relationships... Extension, apart from its spatialization and temporalization, is that general scheme of relationships providing the capacity that many objects can be welded into the real unity of one experience.*” (PR 67)

In the context of the above, I believe it crucial to emphasize that in Whitehead’s theory of prehensions, the objectified datum is *contained within the prehending occasion via internal relation*. That is a logically asymmetrical modality. This internal relation and its asymmetrical logical modality is represented in Whitehead’s Theory of Extension as a fundamental scheme of serially ordered, *inclusively related* regions. In other words:

### **Internally related data <-> Inclusively related regions**

This inclusion relation is carefully defined in Part IV, and it is worthwhile to attempt to carefully correlate it with the concept of ‘internal relations’ in Part III (and elsewhere). I believe this is wholly justifiable, since in the introduction to PR, Whitehead says that Part III and IV *together* constitute the heart of his cosmological scheme and *together* reflect its categorical notions. Part IV is, in other words, no mere afterthought, nor is it a digression where Whitehead is simply defining a straight line. It is more than just an epistemic exercise to ground relativistic spacetime in an abstract logical basis. It is, rather, the ontological basis for all internally consistent and explicitly logical scientific conceptions of physical extensiveness. If the logical-mereological order describes fundamental extensiveness, then so does its particular structure, which entails serial-inclusive abstractive sets. This serial-*inclusive* order correlates precisely with the *internal* relatedness of an occasion to the past world. If it is this order that allows "equally fundamental" relations among spacelike separated occasions, then I argue that this serial-inclusive extensive order of regions/standpoints must correlate with a serial-internal relatedness among the occasions bijectively related to their regions. Part IV, then, represents an important evolution of thought

from Whitehead's previous conceptions of extension given in CN and PNK. His modifications inspired by de Laguna are, I think, non-trivial.

What follows is a summary presentation of my understanding of this correlation in Part IV. (No doubt much of this needs refinement at the very least.)

Returning to the idea that we might explore the following correlation:

Internally related data  $\leftrightarrow$  Inclusively related regions

These regions, as described in Part IV, are bijectively correlated with their respective data—i.e., as a concurring occasion includes its datum, so its region includes the extensive relations of its data. As the abstractive regions are serially-inclusively ordered, so then are their bijectively correlated actual data. The concurring occasion is, in other words, internally related to its data. These data are not serially ordered 'in time,' however. They are serially ordered in terms of their relations of inclusion, which is an asymmetrical logical order that is *reflected* (incompletely) in the temporal order yielded by derivative relativistic spatiotemporal extension.

When we consider such an occasion morphologically, as a given entity, its perceptive bonds are divisible by reason of the extensive divisibility of its own standpoints, **and by reason of the extensive divisibility of the other actual occasions.** Thus we reach perceptive bonds involving one sub-region of the basic region of the perceiver, and one subdivision of the basic region of the perceived. **The relationship between these sub-regions involves the status of intermediate regions functioning as agents in the process of transmission. In other words, the perspective of one sub-region from the other is dependent on the fact that the extensive relations express the conditions laid on the actual world in its function of a medium.** (PR 288)

A more fundamental ordering such as the mereological scheme of extensive abstraction proposed by Whitehead in Part IV may not be *wholly revealed* in some more specialized ordering, such as spatiotemporal ordering. It must be emphasized that the mereological extensive order of actual occasions and their regions is fundamentally denumerable. Any more specialized super-denumerable extensiveness, such as relativistic space-time extensiveness, must be shown to derive from that more fundamental denumerable mereological order.

This could be seen as counterintuitive—especially if one interprets relativistic spacetime according to a non-Whiteheadian 'block universe' metaphysics: In the same way that a finite ruler contains infinite actual subdivisions, for example, one might consider the set  $\mathbb{Q}$  of rational numbers (denumerable) to be a subset of the set  $\mathbb{R}$  of all real numbers, which is super-denumerable. Thus the *actual* infinitude of the ruler is essentially fundamental to its finite spacetime representation.

But Whitehead's argument in Part IV posits the opposite, and reflects his belief in Aristotle's "*infinitum actu non datur*": There is no 'actual' super-denumerable infinite—only infinite *potentia* for division. And all potentia for division derive from some denumerable actual relationship among denumerable actual occasions. For Whitehead, the set  $\mathbb{Q}$  is *not* a subset of  $\mathbb{R}$ , because the

fundamental order must be denumerable. Regions must be denumerable because they are defined by actual occasions; they are indeed potentially sub divisible super-denumerably, but only by actual occasions, which presuppose their basic denumerable regions.

At a 2001 Whitehead colloquium at the University of Bielefeld, C.M. Ringel made an excellent point in his paper, “Whitehead’s Theory of Extension”: Whitehead’s argument depicting  $\mathbb{R}$  as an abstraction from  $\mathbb{Q}$  is strictly a mereological one:  $\mathbb{R}$  can be ‘covered’ (see Definition 11 below) by a denumerable number of bounded intervals— $[n, n+1]$ , etc—and it is each of these *intervals* that is super-denumerably, potentially divided. But relative to any interval spanning any two occasions—even, I would argue, those that are spacelike separated—there is no super-denumerable infinity of actualities. The *potentially* infinitely divisible and super-denumerable regions (e.g. relativistic spacetime regions) are, for Whitehead, derived from the denumerable *actual* intervals. As set  $\mathbb{R}$  is derived from and dependent upon a more fundamental set  $\mathbb{Q}$ , so is relativistic spatiotemporal extensiveness derived from and dependent upon first-order mereological extensiveness.  $\mathbb{R}$  is an abstractive potentiality for division—that is, *abstracted from* the actual, denumerable order of  $\mathbb{Q}$ . (see Whitehead’s discussion of ‘extensive abstraction’ below).

Of course, the essence of such a metaphysical schematization depends entirely on ones’ first principles—in this case, Whitehead’s categorial obligations, correlate with the axioms, definitions, and assumptions in Part IV. If one disagrees with Aristotle, Hume, and Whitehead re: “*infinitum actu non datur*” and believes that there *are* actual, super-denumerable infinities, then indeed, one can metaphysically depict a block universe where relativistic spatiotemporal extensiveness, as conceptualized by Einstein, is seen as a first order, super-denumerable extensiveness. And then the issue of ‘objective temporal’ orderings of spacelike separated occasions becomes a real problem; and a major modification of Whiteheadian philosophy would indeed be required since a fundamentally super-denumerable extensive order such as that given in relativistic spatiotemporal extension is wholly incompatible with Whitehead’s theory of prehension and objectification.

By contrast, however, I would argue that for Whitehead, the super-denumerability of relativistic space-time extension has nothing to do with either the deepest or broadest general structure of the extensive continuum; it pertains, rather, to super-denumerable potential extensive divisions relative to denumerable actual occasions and their regions.

Whitehead’s use of the term ‘region’ in Definition 11, and ‘point’ in Definition 21 have nothing whatever to do with *spatiotemporal* extension *per se*; they are purely abstractive concepts and pertain only to the mereological (whole-part) relationship between a concreting occasion and its relata.

In this general description of the states of extension, nothing has been said about physical time or physical space, or of the more general notion of creative advance. *These are notions which presuppose the more general relationship of extension.* They express additional facts about the actual occasions. The extensiveness of space is really the spatialization of extension; and the extensiveness of time is really the temporalization of extension. (PR 289)

Key to our discussion, I believe, is Definition 11—the covering relation / inclusion relation:

An abstractive set  $\alpha$  is said to ‘cover’ an abstractive set  $\beta$ , when every member of the set  $\alpha$  includes some members of the set  $\beta$ .

**It is to be noticed that *each abstractive set is to be conceived with its members in serial order, determined by the relation of inclusion.* [i.e., “The many become one and are increased by one.” PR 21]**

The series starts with a region of any size, and converges indefinitely towards smaller and smaller regions, without any limiting region. When the set  $\alpha$  covers the set  $\beta$ , each member of  $\alpha$  includes all the members of the convergent tail of  $\beta$ , provided that we start far enough down in the serial arrangement of the set  $\beta$ . (PR 298)

I suggest that in Definition 11, the covering/inclusion relation depicts how ‘internal relatedness’ in the Theory of Prehension/Objectification is described in terms of abstract extensiveness (or ‘first-order’ extensiveness referred to in the PR 65,67 excerpt above). In a shorthand correlation of Internally related objectification in Part III and Inclusively related extension in Part IV, given in Def. 11:

Set  $\beta$  is subsequent to set  $\alpha$  in the serial order. Set  $\beta$  consists of all the prehended data (relata) of Occasion B’s actual world. Set  $\alpha$  consists of all the prehended data of Occasion A’s actual world. As Occasion B is internally related to Occasion A, so is set  $\alpha$  included in set  $\beta$ .

By the restriction given in Definition 10, this inclusion is both infinite and ‘*non-tangential.*’

A set of regions is called an ‘abstractive set,’ when (i) any two members of the set are such that one of them includes the other *non-tangentially*, and (ii) there is no region included in every member of the set.

This definition practically limits abstractive sets to those sets which were termed ‘simple abstractive sets’ in my ‘Principles of Natural Knowledge’ (paragraph 37.6). Since every region includes other regions, and since the relation of inclusion is transitive, it is evident that every abstractive set must be composed of an infinite number of members. (PR 297-8)

Definition 10, then, clearly contains non-trivial *a priori* desiderata. Point (ii) in the definition prevents abstractive sets from converging to a limit. Thus “every abstractive set must be composed of an infinite number of members.” Extensive abstraction therefore depicts *how*:

The oneness of the universe, and the oneness of each element in the universe, *repeat themselves to the crack of doom in the creative advance from creature to creature, each creature including in itself the whole of history and exemplifying the self-identity of things and their mutual diversities.*” (PR 228)

The many become one, and are increased by one. In their natures, entities are disjunctively ‘many’ in process of passage into conjunctive unity. (PR 21)

Equally important, point (i) in Definition 10 restricts inclusion to *non-tangential* inclusion. This prevents abstractive sets from converging to boundary points, which would allow for exemptions from the inclusion relation. With such an exemption, a point could no longer be said to belong *either in* region  $\alpha$  *or outside* it. PNC could, therefore, be violated. By contrast, a Whiteheadian abstractive set always converges to a set of inner points that are relevant to every region that includes that convergence.

In terms of relativistic spatiotemporal extension, it means a datum either is in the actual world of a prehending subject, or it is not. (In Epperson 2004, I attempt to relate this satisfaction of PNC to the orthogonality of eigenvectors in quantum mechanics). Spacelike separated data pose a problem in this regard, but it is only a problem in terms of ordering these occasions *spatiotemporally*. Since the underlying fundamental order is mereological, and always non-tangentially inclusive, Whiteheadian metaphysics gives serial, mereological-logical order even to occasions whose ‘more special’ spatiotemporal extensive relations do not evince that order. To quote the passages from PR again:

**Extension, apart from its spatialization and temporalization, is that general scheme of relationships providing the capacity that many objects can be welded into the real unity of one experience... These extensive relationships are more fundamental than their more special spatial and temporal relationships. Extension is the most general scheme of real potentiality, providing the background for all other organic relations.** (PR 67) Considered in its *full generality*, apart from the additional [relativistic] conditions proper only to the cosmic epoch of electrons, protons, molecules, and star-systems, the properties of this continuum are very few and *do not include the relationships of metrical geometry*. An extensive continuum is a complex of entities united by the various [mereological] *allied relationships of whole to part, and of overlapping so as to possess common parts, and of contact, and of other relationships derived from these primary relationships*. (PR 66)

Tangential inclusion at the fundamental mereological level would undermine the objective immortality of facts and their relations; and it would also allow violations of PNC, since boundary data are neither included in one set or another, and thus cannot be serially ordered.

Whitehead’s proscription of tangential inclusion in Definition 10 is an a priori restriction—a mereological-logical first principle. It is a first principle in the same sense as the Ontological Principle and Principle of Relativity, and indeed, it is central to both of these. Consider, for example,

**The Principle of Relativity:** “That the potentiality for being an element in a real concrescence of many entities into one actuality is the one general metaphysical character attaching to all entities, actual and non-actual; and that *every item in its*

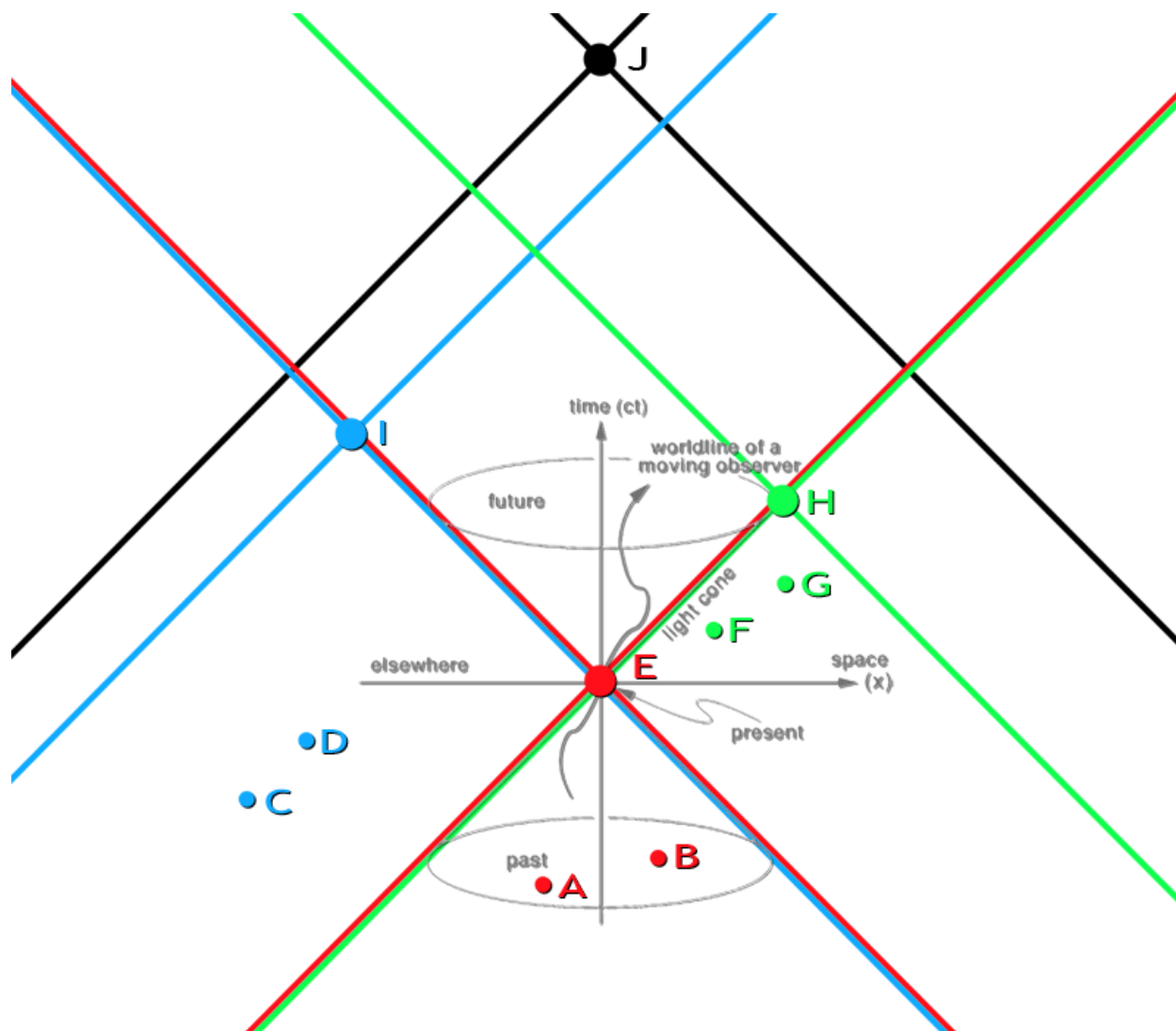
*universe is involved in each concrescence.* In other words, it belongs to the nature of a ‘being’ that it is a potential for *every* ‘becoming.’” (PR 22)

*How* it is that, in terms of extensiveness, all entities can be elements in the concrescence of one actuality, is given in Whitehead’s theory of extensive abstraction—particularly in Definitions 10 and 11 concerning abstractive sets and their inclusion relations. These describe *how*, in terms of extensiveness, “*every* item in [a concrescing occasion's] universe is involved in *each* concrescence.”

Moreover, and more important for this discussion, Whitehead’s theory of extensive abstraction adds a crucial mereological-logical order to the Ontological Principle and the Principle of Relativity: Namely, 1) serial-inclusive ordering; and 2) non-tangential inclusion preventing violations of PNC (and the Principle of the Excluded Middle [PEM], since every datum not only can be but *will be* either in a particular region, *or* outside it.) Its situation in the serial order of nested abstractive sets is unique and objective.

Occasion A’s world is thus included (and reproduced) in Occasion B’s world via internal relation. Set  $\alpha$  is thus said to ‘cover’ a portion of set  $\beta$  such that all the members of  $\alpha$  and that portion of  $\beta$  are the same. Thus occasion B is said to genuinely ‘contain’ those aspects of occasion A; the facts of A’s world remain facts for B’s world.

Later in Part IV, Whitehead discusses this fundamental, ‘first-order’ purely mereological conception of extensiveness in terms of the more specialized form of spatiotemporal extensiveness. The following graphic is intended to depict how the above discussion might be mapped on to spatiotemporal extension. (For ease of translation, you might replace A and B in the above discussion with E and H, or H and J, etc):



It is to be noted that this regions-as-lightcones depiction represents both spatiotemporal extensiveness with its relativistic limitations *and* the serial-inclusive mereological ordering (represented by the alphabetical ordering of occasions.) But this latter ordering is, for Whitehead, grounded solely on axiomatic presuppositions and definitions—‘first principles’ that reflect the categorial obligations. Thus, there are aspects of the fundamental mereological extensive ordering that *might not be revealed* in the relativistic spatiotemporal extensive order defined by the lightcones. Specifically, there are Lorentz transformations that would show CDE and ECD as equivalent. E, in terms of the above discussion, is tangentially included in both H’s and I’s regions.

Nevertheless, Whitehead’s scheme provides for a metaphysically grounded and schematized CDE objective ordering by virtue of the fact that the first-order mereological extensive relations discussed above are fundamental to any more specialized spatiotemporal ordering. By Definitions 10 and 11, only non-tangential inclusions are allowed; the ordering must be either CDE or ECD. In this case, the fundamental extensive ordering is reflected in the diagram’s objective ordering of CDE.

In recent correspondence, Jorge Nobo wrote:

There is nothing in Whitehead's metaphysics to restrict the causal objectification of completed occasions in the becoming of any occasion whose initiation of becoming finds those occasions already in existence.

The definite set of completed occasions is defined relative to that definite occasion's initiation and vice-versa. Space-like separation is completely irrelevant. Whitehead does say or imply otherwise, but that is an inconsistent and unnecessary accommodation to relativity.

Since Whitehead does, indeed, say that "extensive relations of actual entities mutually external to each other...are equally fundamental" as discussed above (PR Part IV, p.287), I agree with Jorge in all but the last sentence. One could characterize the above sketch of Whitehead's Theory of Extension as a mediation of a fallaciously concrete dualism between, 1. full relativistic restriction of objectification, vs. 2. no restriction at all; every actuality is perfectly objectively time-ordered. I do not believe, in other words, that in our attempt to accommodate modern physics within a Whiteheadian metaphysical and cosmological scheme, our choices are either 1. relativistic spacetime extension trumps prehension and objectification, such that there is *no* prehension of data outside a conerescing occasions backward lightcone; or 2. relativistic spacetime extension is totally irrelevant to prehension and objectification.

I find nothing in Whitehead's writings that indicate a sharp vacillation between each of these positions, wherein one chapter he indicates the former, and in another chapter he indicates the latter. I know he is accused of this, but I find his writing to be more careful—definitely knotty at times, but never, I think, blatantly self-contradictory. What I find, instead, is an attempt to relate the relativistic and absolute features of objectification in dipolar fashion—in the same way he attempts to bring together physicality and conceptuality—such that each presupposes the other within the unity of the conerescence. Part IV likewise demonstrates Whitehead was attempting to show a similar dipolar relationship between a) the relativistically restricted physico-causal order and b) the absolute, unrestricted mereological-logical order in objectification.

My interpretation of Whitehead's mediation, discussed at length in Epperson 2004, is that the relativistic restrictions are dominant in the physical pole, and the critical velocity 'c' is the reflection of this; and the features of objectification that are *not* restricted by relativity (the logical-conceptual features described above) are dominant in the conceptual/mental pole. Whitehead states, for example, that the 'critical velocity *c*' operative in the physical aspect of objectification, restrictive of the spatiotemporal order of extensiveness, is a physical reflection of the logical congruence conditions operative in the conceptual aspect of objectification; and in Part IV he posits that these congruence conditions derive from the fundamental logical-mereological order of extension discussed above.

Two segments are congruent when there is a certain analogy between their functions in a systematic pattern of straight lines, which includes both of them. **The definition of this analogy is the definition of congruence in terms of non-metrical geometry.** It is possible to discover diverse analogies which give definitions of congruence which are inconsistent with each other.

That definition which enters importantly into the internal constitutions of the dominating social entities is the important definition for the cosmic epoch in question.

Measurement is now possible throughout the extensive continuum. This measurement is a systematic procedure dependent on the dominant societies of the cosmic epoch. When one form of measurement has been given, alternative forms with assigned mathematical relations to the initial form can be defined. One such system is as good as any other, so far as mathematical procedure is concerned. **The only point to be remembered is that each system of 'coordinates' must have its definable relation to the analogy which constitutes congruence.**

Physical measurement is now possible. The modern procedure, introduced by Einstein, is a generalization of the method of 'least action.' It consists in considering any continuous line between any two points in the spatio-temporal continuum and seeking to express the physical properties of the field as an integral along it. The measurements which are presupposed are the geometrical measurements constituting the coordinates of the various points involved. **Various physical quantities enter as the 'constants' involved in the algebraic functions are concerned. These constants depend on the actual occasions which atomize the extensive continuum.** The physical properties of the medium are expressed by various conditions satisfied by this integral. (PR 331-332)

The transformations into an indefinite variety of coordinates, to which the 'tensor theory' refers, all presuppose one congruence-definition. t The invariance of the Einsteinian 'ds' expresses this fact. (PR 98)

In the concreting occasion, the logical-mereological order in this sense 'governs' the overall integration of potentia in terms of the coordinate division of the satisfaction of the concreting occasion. In Epperson 2004 I link this 'logically affective' governance of integration to the integrations of potentia in quantum mechanics, where nonsensical (off-diagonal) potential integrations (subjective forms) are eliminated, in state reduction, from the process of actualization. Potential integrations (some logical and some illogical) are reduced to probable integrations which are mutually exclusive and exhaustive—i.e., logically coherent, satisfying PNC and PEM, respectively.

In dealing with this dualism of restricted relativistic objectification vs. absolute, unrestricted objectification, one ought not be too quick to dismiss the positive implications relativistic spacetime has for Whitehead's cosmology; though the latter is often seen by Whitehead scholars as being somehow tarnished by the former, it is not at all clear that Whitehead felt that way, despite his arguments against conventional philosophical interpretations of Einsteinian relativity. The argument was against hastily inflating relativistic *physical* cosmology into a vaguely constructed *philosophical* cosmology; it was not against relativity theory *per se*. Indeed, relativistic restrictions of physical causality reflect a number of important features of Whitehead's metaphysics and cosmology (I deal with these somewhat in Chapter 5 of Epperson 2004, in terms of 'publicity' and 'privacy').

Given the above, I advocate an analysis of the process of ‘objectification’ in terms of two dipolar-related modes which can be directly correlated with the physical and mental poles of concrescence, as well as coordinate and genetic analysis, respectively:

1. The physical-causal ‘influence’ upon objectification in the primary phase / physical pole; this reflects Whitehead’s accommodations of relativity theory (which I believe to be sensible); it is analyzable via coordinate division of actualization (i.e., of Whiteheadian ‘satisfaction.’)
2. The logical-causal ‘affection’ of potentia and their logically governed subjective formal integrations in the supplementary phase / mental pole of concrescence; this reflects the fundamental logical-mereological ordering in his Theory of Extension; it is analyzable via genetic division of actualization/satisfaction.

Thus, the relativistic veiling of spacelike separated data is not *completely* opaque to Whiteheadian objectification; the veil is transparent to the process of logical-causal affection, despite its heavy cloaking in the process of physical-causal influence. In this way, one can easily interpret Whitehead’s statements on these issues so that they maintain consistency and compatibility with his overall metaphysical and cosmological scheme. The dipolarity of the occasion is reflected in these dipolar modes of objectification.

In a recent communication, Jorge Nobo wrote:

The accommodation can be more consistently made in terms of the doctrine of conformation of subjective forms provided we give up the notion that every occasion must conform, in the specified sense, to every occasion that is causally objectified for it.

My understanding is that physical conformation and conceptual conformation are distinct. I am not aware that Whitehead ever imposed the physical restrictions of objectification (relativistic spacetime restrictions, etc.) upon the conceptual aspects of objectification. Hybrid physical prehensions, for example, are not subject to total relativistic restriction; the physical features are so restricted, but not the conceptual features. With regard to fundamental extensiveness as discussed above (the non-tangential inclusion relations, etc), there is obviously a mereological-logical conformity. And indeed, without that conformity, there could be no objectively immortal facts in Whitehead’s scheme; nor could there be immortalized objective relations of facts that are necessarily free from violations of PNC. Both of these are presupposed desiderata in Whitehead’s scheme given in the Categorical Obligation of Objective Identity and Objective Diversity, and also the Category of Subjective Unity.

A coherent doctrine of the internal relatedness of a concrescence to “the whole of history” is simply not possible if *all* causal conditioning in prehension (i.e, *all* conformal aspects in the primary phase) is restricted to the lightcone. The relativistic restrictions of the *physical* aspects of efficient causality (pure physical prehensions and the *physical* aspects of hybrid physical prehensions) are clearly given in and compatible with Whitehead’s metaphysical and

cosmological scheme. There is no tension between the fundamental mereological order of the extensive continuum and the more special spatiotemporal physico-causal extensive order pertinent to our particular cosmic epoch.

The actual occasion, however, is *dipolar*, with mutually implicative physical *and* conceptual features both of which are ontologically significant. The conceptual features are not merely epistemic abstractions deriving from a more fundamental physical reality. The actual occasion is not fundamentally ‘physical’ and neither is the extensive continuum fundamentally physical (spatiotemporal). Causal efficacy in Whiteheadian philosophy is likewise not fundamentally physical. If the physical relativistic restrictions of the physical features of efficient causality are inflated into a metaphysical restriction of the non-physical aspects of efficient causality (conceptual prehensions and the conceptual aspects of hybrid physical prehensions), then the following passage, which encapsulates the essence of Whiteheadian philosophy, becomes untenable:

The oneness of the universe, and the oneness of each element in the universe, repeat themselves to the crack of doom in the creative advance from creature to creature, each creature including in itself the whole of history and exemplifying the self-identity of things and their mutual diversities. (PR 228)

The objective immortality of facts—their identities and relative diversities—would be utterly lost, recast as subjective immortality. But Whitehead makes it clear that the relativistic restrictions pertaining to spatiotemporal coordinate division, those that limit physical prehension to the lightcone, are restrictive only of the physical aspects of prehension. Conceptual prehensions are not restricted to these subregions. Actual occasions and their genetic (and therefore ‘serial’) inclusive relations with the world are analyzable as ‘genetic division’ of a concrescence; they pertain to the serial-inclusive mereological integration of the past world *within* that concrescence; it is a division of the concrescence and the integrated world to which it is internally related. Whitehead characterizes genetic division as distinct from the spatiotemporal ‘coordinate division’ of a satisfaction, which relates the concrescence to its concrete dative world. The latter, despite its tacit characterization and explicit use by modern physics as a quasi-metaphysical ‘ultimate background’ contextualizing any and all possible relations, is for Whitehead merely a restricted mode of coordinate analysis of an actual occasion, pertinent only to the physical aspects of prehension; it does not define the actual occasion or the totality of its possible relations:

In so far as the objectification of the actual world from this restricted standpoint is concerned, there is nothing to distinguish this coordinate division from an actual entity. *But it is only the physical pole of the actual entity which is thus divisible. The mental pole is incurably one.* Thus the subjective form of this coordinate division is derived from the origination of conceptual feelings which have regard to the *complete* region, and are not restricted to the sub-region in question. (PR 284-285)

The recreation of past facts is always conformal with respect to their existence; actual occasions never cease to be actual, and never cease to be efficacious upon subsequent occasions in *some way*—even if not *physically* efficacious. If physical causal efficacy is to be limited to the lightcone, which was indeed Whitehead's position, there must remain some non-physical / metaphysical efficacy operative in the conformal aspects of prehension which will allow for the objective immortality of the past and the satisfaction of the Categories of Objective Identity and Objective Diversity. The physical efficacy of the former is analyzed via coordinate division; and the non-physical efficacy of the latter is analyzed via genetic division.

The novelty of *how* facts are felt in their perpetual recreations, say via conceptual reproduction and reversion, must first presuppose their objective and immortal existence as 'real' dative (historical) entities. It is in this sense that "an actual entity, in its character of being a physical occasion, is an act of *blind perceptivity* of the other physical occasions of the actual world." (PR 288) There are physical relativistic restrictions governing (and sometimes 'blinding') *how* occasions are physically related (and spatiotemporally coordinated); but these restrictions do not in any way pertain to the fact *that* occasions exist in the world, even if they are 'blinded' by spacelike separation; and if they are actual, they are, in Whitehead's philosophy, necessarily related in some way. If not physically, then in some more fundamental metaphysical way. The fact that occasions exist guarantees their perception and integration into a concrescence, even if this perception is 'blind' in terms of spatiotemporal coordination.

The scheme by which actual occasions are fundamentally related metaphysically, in terms of their bare existence (i.e., the scheme reflecting *that* they exist in genetic and therefore 'serial' relation, not *how* they are *physically* coordinately related) is the mereological scheme of extensive connection--

--the *systematic scheme* which is involved in the real potentiality from which every actual occasion *arises*. **This scheme is also involved in the attained fact which every actual occasion is. The 'extensive' scheme is nothing else than the generic morphology of the internal relations which bind the actual occasions into a nexus, and which bind the prehensions of anyone actual occasion into a unity, coordinately divisible.**

**To be an actual occasion in the physical world means that the entity in question is a relatum in this scheme of extensive connection. In this epoch, the scheme defines what is physically actual.**

**...for the philosophy of organism the primary *relationship* of physical occasions is *extensive connection*. This ultimate relationship is *sui generis*, and cannot be defined or explained. [That is, 'accounted for' by some physical theory] **But its formal properties can be stated. Also, in view of these formal properties, there are definable derivative notions which are of importance in expressing the morphological structure. *Some general character of coordinate divisibility is probably an ultimate metaphysical character, persistent in every cosmic epoch of physical occasions. Thus some of the simpler characteristics of*****

*extensive connection, as here stated, are probably such ultimate metaphysical necessities...*

**The more ultimate side of this scheme, perhaps that side which is metaphysically necessary, is at once evident by the consideration of the mutual implication of extensive whole and extensive part. If you abolish the whole, you abolish its parts; and if you abolish any part, then that whole is abolished. (PR 288)**

In this general description of the states of extension, **nothing has been said about physical time or physical space, or of the more general notion of creative advance. These are notions which presuppose the more general relationship of extension.** They express additional facts about the actual occasions. The extensiveness of space is really the spatialization of extension; and the extensiveness of time is really the temporalization of extension. (PR 289)

Even if certain of these bare, blindly perceived facts are integrated as negative prehensions, the concreting occasion must nevertheless first conform itself to the existence of these facts before eliminating them from further integration. If *all* conformal existence is relativized, and not just the physical-causal efficacy of the extant data, and spacelike separated data are wholly opaque to *all* the conformal features of prehension in the primary phase, then the existence of spacelike separated data becomes *wholly* irrelevant to the concreting occasion—not just physically-causally irrelevant. While this poses no difficulty in a causally closed ‘block universe,’ it is extremely problematic in a cosmological scheme like Whitehead’s where the objective immortality of each occasion entails “the concreting unity of that universe” (PR 228)—both of which (the occasion and the universe mereologically relative to it—i.e., ‘internal to it’) are carried forward and recreated as real internal constituents of some subsequent occasion.

This is no mere epistemic-representational internalization, but rather an ontological one. It’s problematic because the antecedent objectified worlds of previously spacelike separated data must, at some point in the future, be integrated within some actual occasion. It is difficult to see how the objective immortality of every actual occasion is possible within this scheme of perpetually recreated unified universes if these universes, themselves integrated by unification in some subsequent occasion, disagree about the existence of their constituent actual data.

Disagreements with respect to *how* these data are physically prehended and objectified are not a problem, and are a necessary feature of Whiteheadian metaphysics. But the engine of internal relations that drives Whiteheadian metaphysics permits no disagreements with respect to the objective *existence* of these data and their objective *relations*—that they are related via “blind perception” even though *how* they are related physically, and coordinated spatiotemporally, remains unspecified.

If one were to impose the relativistic spatiotemporal restrictions of physical causal relations upon the *entirety* of relations in Whitehead’s scheme, then the Categories of

Subjective Unity, Objective Identity, and Objective Diversity would be entirely undermined. These categoreal obligations permit diverse subjective forms (forms of facts) and predicative patterns; but they do not permit ‘subjective’ facts. The bare ‘its’ are always *given* to an occasion via “blind perception” for feeling and predication. Predication and feeling do not yield the bare ‘it’; they presuppose the bare ‘it.’ The creative advance yields unified, objective universes of facts, each of which makes its way genetically (and therefore serially) into subsequent concrescences; each concrescence is internally related to its universe, and each datum in its universe similarly ‘contains’ within it its antecedent universe. For all these universes to be unified over and over again ‘to the crack of doom’ such that every fact enjoys its objective immortality, it is clear that the concept of prehension cannot be reduced to or assimilated to mere physical prehension, and wholly confined within the relativistic restrictions of the latter.

The need for the Category of Objective Identity becomes quite clear in this context.

Thus the process of integration, which lies at the very heart of the concrescence, is the urge imposed on the concrescent unity of that universe by the three Categories of Subjective Unity, of Objective Identity, and of Objective Diversity. The oneness of the universe, and the oneness of each element in the universe, repeat themselves to the crack of doom in the creative advance from creature to creature, each creature including in itself the whole of history and exemplifying the self-identity of things and their mutual diversities. (PR 228)

The Category of Objective Identity states that...

...there can be no duplication of any element in the objective datum of the ‘satisfaction’ of an actual entity, so far as concerns the function of that element in the ‘satisfaction.’ Here, as always the term ‘satisfaction’ means the one complex fully determinate feeling which is the completed phase in the process. This category expresses that *each element has one self-consistent function*, however complex. Logic is the general analysis of self-consistency. (PR 26)

If objectification is dipolar, in the sense of having mutually implicative physical and conceptual aspects, then it follows that *certain aspects* of objectification—those pertinent to causal efficacy in the physical pole—are physical and therefore restricted by the ‘more special’ relativistic spatiotemporal framework; and other aspects of objectification (the conceptual features) are governed by the more fundamental logical-mereological extensive order described in Whitehead’s Theory of Extension. Since Part III (The Theory of Prehensions) and IV (The Theory of Extension) together constitute the heart of Whitehead’s cosmological scheme and *together* reflect its categoreal notions, the proper contextualization of the theory of objectification requires careful and consistent reference to both.