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Joseph A. Bracken

Xavier University - Cincinnati

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WHITEHEADIAN ACTUAL ENTITIES AND STRING THEORY

By Joseph A. Bracken, S.J.

bracken@xavier.edu

Emeritus Professor of Theology /Xavier University /3800 Victory Parkway /Cincinnati, OH 45207

ABSTRACT

In the philosophy of Alfred North Whitehead, the ultimate units of reality are actual entities, momentary self-constituting subjects of experience which are too small to be sensibly perceived. Their combination into “societies” with a “common element of form” produces the organisms and inanimate things of ordinary sense experience. According to the proponents of string theory, tiny vibrating strings are the ultimate constituents of physical reality which in harmonious combination yield perceptible entities at the macroscopic level of physical reality. Given that the number of Whiteheadian actual entities and of individual strings within string theory are beyond reckoning at any given moment, could they be two ways to describe the same non-verifiable foundational reality? For example, if one could establish that the “superject” or objective pattern of self-constitution of an actual entity vibrates at a specific frequency, its affinity with the individual strings of string theory would be striking. Likewise, if one were to claim that the size and complexity of Whiteheadian “societies” require different space-time parameters for the dynamic interrelationship of constituent actual entities, would that at least partially account for the assumption of 10 or even 26 instead of just 3 dimensions within string theory? The overall conclusion of this article is that, if a suitably revised understanding of Whiteheadian metaphysics were seen as compatible with the philosophical implications of string theory, their combination into a single world view would strengthen the plausibility of both schemes taken separately.

Key words: actual entities, subject/superjects, vibrating strings, structured fields of activity, multi-dimensional physical reality.

WHITEHEADIAN ACTUAL ENTITIES AND STRING THEORY

Certainly one of the major reasons why the metaphysics of Alfred North Whitehead has not been better received by contemporary philosophers of science and scholars in the field of theology and science has been the objection that the notion of actual entities as momentary self-constituting subjects of experience, equivalently “spiritual atoms,” is empirically non-verifiable. As Philip Clayton comments in *Mind and Emergence*, “the evidence for spontaneity in atoms is rather more spotty than it is in the case of animal behavior studies” (Clayton, 2004, p.201). Elsewhere in the same book, he argues that there is only one kind of physical stuff in the world and that mind is emergent out of matter, given a sufficient degree of self-organization and downward causation (Clayton, 2004, pp. 60-61). But is mind here synonymous with spontaneity or spirit? Could spirit in the form of a primitive responsiveness to the environment be present in some minimal way even in atoms? Such a question, as already noted, cannot be answered empirically but only, if at all, as a logical inference from some other source (e.g., the alleged philosophical implications of string theory). For example, according to superstring theory proponents like Michio Kaku individual strings vibrate at different frequencies and they combine with one another to compose physical entities beginning with atoms in virtue of a harmonization of their mutual frequencies (Kaku, 1994, pp. 153-54). Does this hypothesis take for granted some measure of spontaneity among the individual strings in their dynamic interrelation or is it from start to finish purely mechanical? In this article I offer a philosophical argument based on a revision of Whitehead’s metaphysical scheme for a link between vibrating strings and Whitehead’s understanding of actual entities as subject-superjects, For, if this link be at least plausible, then one could further conclude that spontaneity is present at the subatomic level in the form of strings vibrating at a definite frequency. Likewise, a revised understanding of Whiteheadian “societies,” namely, aggregates of actual entities with a “common element of form” (Whitehead 1978, pp. 34-35) might unexpectedly help to explain

from a philosophical perspective why the mathematics of string theory seems to require more spatial dimensions than 3 (either 10 or 26) to work properly.

I begin by summarizing Whitehead's understanding of actual entities as subject-superjects. In *Process and Reality*, Whitehead claims: "in each concrescence [becoming of an actual entity] whatever is determinable is determined, but . . . there is always a remainder for the decision of the subject-superject of that concrescence. . . . This final decision is the reaction of the unity of the whole to its own internal determination" (Whitehead, 1978, pp. 28-29). But, if the actual entity *qua* subject is necessarily indeterminate, needing further determination, then the actual entity *qua* superject is necessarily determinate as a result of its eventual self-constituting decision. But what is that final determination that makes the actual entity an object of "prehension" for subsequent generations of actual entities (Whitehead, 1978, p. 19)? Here Whitehead is vague. Since an actual entity is a unitary reality, both subject and superject at the same time (Whitehead, 1978, p. 29), then one can only conclude that a Whiteheadian superject is an objectified subject of experience. But is this an implicit contradiction? What does it mean to be an objectified subject of experience since by definition subjects of experience are indeterminate. They cannot be objectified without ceasing to be subjects of experience.

A way out of this alleged dilemma might be available in Whitehead's remark elsewhere in *Process and Reality*: "In the philosophy of organism, it is not 'substance' which is permanent, but 'form.' Forms suffer changing relations; actual entities 'perpetually perish' subjectively, but are immortal objectively" (Whitehead, 1978, p. 29). So, if an actual entity becomes a determinate superject through its own decision, then its determination would seem to be the form or pattern of its self-constitution. This pattern of its own self-constitution here and now is what endures objectively while the actual entity as a subject of experience "perishes." It is this objective pattern derived from its own process of self-constitution which "suffer[s] changing relations." It is

“prehended” [on a feeling-level experienced] in different ways by subsequent actual entities (Whitehead, 1978, p. 19).

As I will indicate shortly, in my judgment this prehension by subsequent actual entities is more indirect than direct. That is, subsequent actual entities principally prehend the pattern of self-constitution of a predecessor actual entity in and through the way this mini-pattern of individual self-constitution has affected the overall structure of the field of activity to which all these actual entities belong as members of a given “society” (Bracken, 2001, pp. 146-51; Bracken, 2009, pp. 129-35). But for the moment my point is to make clear that in a Whiteheadian universe, what endures from moment to moment are forms or patterns, not things. Whitehead, to be sure, refers to actual entities as “the final real things of which the world is made up” (Whitehead, 1978, p. 18). But this is to use the word “things” in a generic sense. Only objectified subjects of experience in and through their individualized patterns of self-constitution are “the final real things of which the world is made up.”

But, even so, what has all this to do with the vibrating strings of superstring theory? Here too, of course, one has to ask whether “string” should be understood literally or as a metaphor for some other less obvious physical reality. Where, for example, is the energy-source for the vibration of the strings to be found except in some form of subjectivity which uses the vibration of the strings as its specific mode of operation or form of self-expression? In *Process and Reality*, to be sure, Whitehead does not explicitly say that actual entities (subject-superjects) vibrate in virtue of their process of self-constitution. But in an earlier work *Science and the Modern World* in the chapter on Quantum Theory, Whitehead refers to “primates,” primary organisms which are not decomposable into subordinate organisms (Whitehead, 1967, p. 132). These primates are vibratory entities with a definite frequency: “A proton, and perhaps an electron, would be an association of such primates, superposed on each other, with their frequencies and spatial dimensions so arranged as to promote

the stability of the complex organism, when jolted into acceleration of locomotion” (Whitehead, 1967a, pp. 133-134).

Are primates in *Science and the Modern World* and actual entities in *Process and Reality* then two words for the same subatomic reality in Whitehead’s mind? Both actual entities and primates are by definition “the final real things of which the world is made up.” As such, they are the ultimate components of all other entities. Likewise, in the first chapter of *Process and Reality*, Whitehead refers to his speculative scheme as “the philosophy of organism” (Whitehead, 1978, p. 7). So it seems likely that in *Process and Reality* Whitehead continued his earlier analysis of primates now in terms of actual entities, momentary subjects of experience whose “concrecence” or process of self-constitution involves a series of vibrations. But what kind of vibration would be intended? Perhaps the easiest way to find out is to look more closely at how primates vibrate in *Science and the Modern World*.

Whitehead refers to two different but nevertheless interrelated kinds of vibration for primates in that earlier book: vibratory organic deformation and vibratory locomotion. In both cases he has in mind primates as components of subatomic entities such as electrons and protons. With respect to vibratory organic deformation, he says: “A primate must be associated with a definite frequency of vibratory organic deformation so that when it goes to pieces it dissolves into light waves of the same frequency, which then carry off all its average energy” (Whitehead, 1967a, p. 134). He then adds: “It is quite easy (as a particular hypothesis) to imagine stationary vibrations of the electromagnetic field of definite frequency, and directed radially to and from a centre, which, in accordance with the accepted electromagnetic laws, would consist of a vibratory spherical nucleus satisfying one set of conditions and a vibratory external field satisfying another set of conditions” (Whitehead, 1967a, 134). Vibratory organic locomotion of the primate comes about as a result of this organic deformation. That is, the vibratory organic deformation of a primate takes

time to occur; the realization of its specific pattern only happens within a given time-span or duration. “Thus the primate is realized atomically in a succession of durations, each duration to be measured from one maximum [realization of the pattern as a whole] to another. . . .If it is considered as one thing, the orbit is to be diagrammatically exhibited by a series of detached dots. Thus the locomotion of the primate is discontinuous in space and time” (Whitehead, 1967a, p. 136).

At the time of writing *Science and the Modern World*, Whitehead was evidently convinced that his theory of vibratory primates satisfied the mathematics of quantum physics available to him at the time, and in addition opened up new possibilities for understanding the otherwise baffling behavior of subatomic particles. Yet in his masterwork *Process and Reality* some years later, he dropped reference to the term primate, presumably substituted for it the term actual entity, and defined the latter as a momentary self-constituting subject of experience or subject-superject. The notion of the gradual modification of a pre-existing pattern within a given time-span or duration, however, is part of his understanding of actual entities as atomic realities. Is this process of first modifying an existing pattern and then transmitting that altered pattern to a successor actual entity within the same “society” or field of activity in line with Whitehead’s notion of primates as involving vibratory “change of pattern” and then “vibratory locomotion of a given pattern as one whole”? (Whitehead, 1967a, p. 131). I would argue yes for the following reasons. Vibratory change of pattern is implied in the first two stages in the self-constitution of an actual entity: first, the “prehension” of empirical data both physical and conceptual; then, the integration, however brief or prolonged, of these contrasting prehensions into a final state of “satisfaction” (Whitehead, 1978, p. 40). “Vibratory locomotion of a given pattern as one whole” is then implied in the final stage of the self-constitution of an actual entity when it releases or, in Whitehead’s language, “superjects” its specific energy-content and form into the already structured field of activity or “society” in which it originated (Whitehead, 1978, pp. 28, 47). This particular energy-content and form are in turn prehended by the next actual entity in the “society” or series of actual entities so as

to begin its own process of self-constitution. This involves locomotion, at least in the sense of something new replacing something old within the given field of activity. But in many if not most cases it also involves actual change of place. As noted above, Whitehead claims that the “orbit of an electron is to be diagrammatically exhibited by a series of detached dots” (Whitehead 1967a, p. 136).

This is, of course, in no sense of the word a proof for the identification of a tiny vibratory string within superstring theory with a Whiteheadian actual entity as a self-constituting subject of experience with a specific impact both in terms of energy-content and form on successor actual entities in their own self-constitution as constituents of the same society or field of activity. But what Whitehead claims for these actual entities is basically what Kaku in *Hyperspace* claims for individual strings within superstring theory. In both cases, one is dealing with “the final real things of which the world is made up” and in both cases the number of these final real things at any given moment is virtually infinite. Likewise, the “things” in question are in both cases too tiny to be sensibly perceived in human experience. They are therefore in the strict sense metaphysical realities; their existence can only be postulated as the necessary components of what can be sensibly perceived. “Metaphysical,” accordingly, is not immaterial, namely, what exists apart from space and time, but what exists physically or materially in space and time but at a level of existence and activity inaccessible to human perception and thus to direct empirical verification.

I turn now to my exposition of how a revised understanding of Whiteheadian societies might help to explain why superstring theory only works in 10 or even 26 dimensions and thus makes little or no sense in our customary 3-dimensional world of human experience. Once again, of course, I have to begin by summarizing what I have laid out in more detail elsewhere, in this case, my hypothesis that Whiteheadian societies are to be understood as enduring structured fields of activity for successive generations of constituent actual entities (Bracken, 2001, pp. 146-51;

Bracken, 2009, pp. 129-35). My argument is that with his own notion of society Whitehead was clearly thinking of something more than a coincidental or purely accidental aggregate of actual entities. For such a configuration he had the word *nexus* (Whitehead, 1978, p. 22). A society is a nexus with “social order,” that is, an aggregate of actual entities which are genetically related to one another in virtue of their individual prehension of a “common element of form” in their predecessor actual entities of the same society (Whitehead, 1978, p. 34). Yet, while a society thus bears some resemblance to the classical understanding of substance as that which endures over time (Whitehead, 1967b, p. 204). Whitehead was presumably reluctant to call it a substance. For, the word substance is integral to the classical philosophy of being espoused by Aristotle and the medieval scholastics which Whitehead wanted to replace with his own metaphysics of becoming where the being of an entity is its process of becoming (Whitehead 1978, p. 23). So he did not further specify what he meant by society over and above a set of genetically related actual entities in virtue of a common element of form.

My counter-proposal is that, if a Whiteheadian society be understood as a field of activity or system which is structured by successive generations of actual entities in their dynamic interrelation, one would clearly have at hand a metaphysical concept other than substance which endures over time but which unlike a substance gradually evolves in terms of its governing structure or common element of form. The field or system, in other words, exercises a formal or informational causality from the top-down on its current set of actual entities. They are constrained in their individual processes of self-constitution by the existing structure in the field or system to which they belong. But since minor changes in the individual self-constitution of constituent actual entities can over time have an impact on the structure or field of activity in which they are active, the actual entities exercise a type of bottom-up causality which is foreign to “accidents” in the Aristotelian-Thomistic understanding of substance. The only way for accidents to affect the substantial form of an entity is to force a complete change in that substantial form or essence, as in

the birth or death of an organism. There is then in the classical understanding of the relation between substance and accident no evolution of the substantial form but rather, as a result of dramatically different circumstances the generation of a new substantial form (Aristotle, 1979, 192-193 [1067b]). Hence, to preserve the notion of relatively enduring structure or form within an evolutionary context, I use the terms field or system which are already in common usage within the natural and social sciences in the twentieth century (Bracken, 2012, pp. 31-45, 75-89) Moreover, Whitehead himself in *Science and the Modern World* and other philosophical works antecedent to the publication of *Process and Reality* made regular use of the term field as a foundational concept. But, in *Process and Reality*, he uses field-imagery only with respect to the “extensive continuum” as the “one relational complex in which all potential objectifications find their niche. It underlies the whole world, past, present and future” (Whitehead, 1978, p. 66). But his focus here is on how individual actual entities occupy different positions within this underlying continuum, not on how societies of actual entities exist as interrelated subfields of activity within the overall extensive continuum.

Yet, granted the plausibility of this reinterpretation of Whiteheadian societies, what difference does it make for understanding superstring theory, above all, the presupposition of 10 or even 26 dimensions for the mathematics of superstring theory to work satisfactorily? In *Hyperspace*, Kaku claims that “the beauty and symmetry found in nature can ultimately be traced back to higher-dimensional space” (Kaku, 1994, p. 159). Higher-dimensional space exists in 26 dimensions; presumably individual strings exist in 26-dimensional space. Kaku continues: “The symmetries of the subatomic realm are but remnants of the symmetry of higher-dimensional space” (Kaku, 1994, p. 159). That is, while individual strings exist in 26-dimensional space, subatomic elements like protons and electrons exist in 10-dimensional space. Finally, “the symmetries that we see around us, from rainbows to blossoming flowers to crystals, may ultimately be viewed as manifestations of fragments of the original ten-dimensional theory” (Kaku, 1994, p. 159). The

entities of normal human experience exist in only 3 dimensions. Is there a parallel for this progressive shrinkage of spatial dimensions to be found in my revised understanding of Whitehead's category of society? My proposal is that actual entities as the elementary constituents of a given society could conceivably exist in 26 dimensions much like individual strings. These same actual entities, however, when combined with actual entities from other temporally ordered societies within a Whiteheadian "structured society" (Whitehead, 1978, p. 103) would exist in far fewer than 26 dimensions. For, the number of spatial dimensions for actual entities presumably depends upon the complexity of the "structured societies" within which they find themselves. Thus the structured society representing a subatomic particle with different kinds of quarks and leptons as its components would conceivably exist in only 10 dimensions and the structured society representing a macroscopic thing or organism with multiple subsocieties of actual entities would exist in just 3 spatial dimensions. The more complex the structured society, the more the constituent actual entities will experience constraints on their freedom of movement and range of activity within that same structured society.

Initial justification for my hypothesis here comes from reflection on the way that fields differ from substances in their customary mode of operation. In Aristotelian metaphysics, for example, substances are free-standing entities which have only external relations to one another. That is, a substance exists in the first place in virtue of its substantial form or innate principle of activity. One substance can absorb into itself another substance (as in the consumption of food by an animal) only by breaking down the substantial form of the other substance into its component parts which are then integrated into the ongoing existence and activity of the more complex substance. Fields, on the contrary, can be hierarchically ordered vis-à-vis one another, equivalently "stacked" on top of one another, without loss of ontological integrity for lower-level, less complex, fields of activity. The lower-level field of activity serves as necessary infra-structure for the existence and activity of the higher-level field, even as the higher-level field with its more complex

structure and mode of operation serves as a constraint on the potentialities of the lower-field taken by itself, apart from incorporation into the existence and activity of the higher-level field. This notion of hierarchically ordered fields of activity involving both bottom-up and top-down interaction seems to be the premise of “strong emergence” theory as opposed to “weak emergence” theory. That is, the structure and mode of operation of higher-level fields cannot be simply reduced to the activity of elements in the lower-level field in response to a changing environment. For the components of the higher-level field have a distinctive mode of operation which acts as a constraint on the activity of the components in the lower-level field as long as they remain part of the higher-level field of activity. In more common sense terms, a molecule is still a molecule within a living cell, but some of the potential in its normal mode of operation as a molecule been sacrificed for the sake of inclusion within the mode of operation of the cell as a higher-level field of activity (Clayton, 2004, pp. 60-62; Whitehead, 1978, pp. 99, 106).

Now, keeping in mind this generalized understanding of the way that fields can be hierarchically ordered vis-à-vis one another without loss of ontological integrity for the lower-level fields in their own subordinate mode of operation, we see how Whiteheadian subsocieties within a structured society could have a reduced number of spatial dimensions as a result of being constrained by the spatial limitations of the structured society within which they find themselves. As noted above, it makes sense to say that the greater the complexity of a Whiteheadian structured society, the stricter are the spatial parameters for its normal mode of operation. Greater order implies greater constraint on the independent self-constitution of the actual entities within subsocieties in their dynamic interplay with one another within a Whiteheadian structured society.

Whitehead in *Process and Reality* seems to say much the same thing in his description of how an individual society of actual entities relates to other societies of actual entities to which it is in one way or another necessarily related for its own operation.

[T]here is no society in isolation. Every society must be considered with its background of a wider environment of actual entities, which also contribute their objectifications to which the members of the society must conform . . . But this means that the environment, together with the society in question, must form a larger society in respect to some more general characters than those defining the society from which we started. Thus we arrive at the principle that every society requires a social background, of which it is itself a part (Whitehead, 1978, p. 90).

Whitehead uses the term “environment” rather than “field” in this citation but his point seems to be basically the same as my own. No society exists in isolation. To fit into its environment the actual entities of the society in question have to take into account the structural limitations (objectifications) imposed by the working of other societies of actual entities in the environment. Presumably these structural limitations would also include the spatial parameters needed for the ongoing dynamic interrelation of all these societies of actual entities with one another as members of a larger social reality (structured society).

My conclusion then with respect to the varying number of spatial dimensions within superstring theory is that Kaku’s “higher-dimensional space” is less ordered than the 10-dimensional space proper to subatomic particles since a single quark is not inhibited in its spatial configurations by the presence of other quarks as likewise components of a subatomic particle (a proton or electron). Likewise, a subatomic particle is less inhibited in its spatial configurations than an atom or even more so than a molecule since its individual self-constitution does not have to be adjusted to the spatial dimensions of an atom or molecule. But this implies that the extra spatial dimensions in each case are not “compactified” so as to fit into the spatial dimensions of the more complex physical reality (Kaku, 1994, pp. 158-59). Rather, since these extra spatial dimensions are no longer of value for the ongoing existence and activity of a quark within the more complex reality of a subatomic particle, or of the ongoing existence and activity of a subatomic particle within an

atom or a molecule, they cease to exist in actuality but become instead residual potentialities for use in altered circumstances, e.g., in the breakdown of social order within a given process as it approaches the stage of chaos where no discernable order among constituent parts or members can be detected. Chaos, of course, is a relative term. As Whitehead comments in *Process and Reality*, “[t]here is not just one ideal ‘order’ which all actual entities should attain and fail to attain. In each case there is an ideal peculiar to each particular actual entity, and arising from the dominant components in its phase of ‘givenness’ [acceptance of and conformity to the limitations of the encompassing environment] (Whitehead, 1978, p. 84).

What I am implicitly presupposing here is that mathematics in general, and the mathematics of superstring theory in particular, deals with logical potentialities (what would be the case if . . .), not with empirical actualities as such (what is here and now the case). The value of mathematics for those working in the empirical sciences, in other words, is that it enables these scientists to abstract from the de facto situation at hand and work out the logical implications of alternative scenarios for why the empirical reality is the way that it is. Ideally, there is only one set of mathematical equations which fully explains the workings of Nature. But, as Kaku notes in *Hyperspace*, “physicists still do not know the physical principle which underlies string theory” (Kaku, 1994, p. 161). As a result, superstring theory, despite its ability to harmonize the equations for general relativity and quantum mechanics (Kaku, 1994, p. 159), remains controversial as a comprehensive explanation of physical reality at the quantum level. Kaku quotes Edward Witten, who was closely involved in the development of superstring theory, as follows: “By rights, string theory shouldn’t have been invented until our knowledge of some of the ideas that are prerequisite for string theory had developed to the point that it was possible for us to have the right concept of what it was all about” (Kaku, 1994, p. 161).

The point of this article has been to suggest that the metaphysics of Whitehead, especially his categories of actual entities as momentary self-constituting subjects of experience and the societies of various kinds into which they aggregate, might be one of the prerequisites for the understanding of superstring theory that were suggested by Witten. For Whitehead's metaphysical scheme as a comprehensive world view could possibly resolve some of the current problems associated with the acceptance of string theory, given its foreignness to common sense experience. The aim of Whitehead's early book *Science and the Modern World* which laid the groundwork for his later philosophical synthesis *Process and Reality* was to challenge common sense experience insofar as it has been shaped by the implicit presuppositions of early modern science: "The thesis which these lectures will illustrate is that this quiet growth of science has practically recoloured our mentality so that modes of thought which in former times were exceptional are now broadly spread through the educated world" (Whitehead, 1967a, p. 2) In particular, Whitehead had in mind in the earlier book what he called "the fallacy of simple location" :

To say that a bit of matter has *simple location* means that, in expressing its spatio-temporal relations, it is adequate to state that it is where it is, in a definite finite region of space, and throughout a definite finite duration of time, apart from any essential reference of the relations of that bit of matter to other regions of space and to other durations of time (Whitehead, 1967a, p. 58).

Did Whitehead have in mind entities existing in more than three spatial dimensions? Probably not; but his statement, taken at face value, could allow for that possibility. What he really had in mind was presumably to challenge materialistic determinism as the philosophical world view most compatible with early modern science. He himself felt much more sympathy for the ancient and medieval world view with its emphasis on the world as somehow "alive," namely, as an ontological totality with intrinsically interconnected parts or members much like a cosmic organism. In rejecting the implicit materialism of early modern science and accepting the pre-modern understanding of the world as an organic reality, Whitehead made the further claim that "the final

real things of which the world is made up” are momentary self-constituting subjects of experience with internal rather than purely external relations to one another. Even more than Aristotle and the medieval scholastics, he thus emphasized the intrinsic interdependence of everything on everything else within the cosmic process.

Such a metaphysical scheme is, of course, empirically non-verifiable. It cannot be proven but at best hypothetically inferred from the data of scientific observation. In that sense, Whitehead’s metaphysical scheme is just as foreign to common sense experience as superstring theory. But in a curious way the two world views might bolster one another’s claims to authenticity in the interpretation of reality. For, insofar as Whitehead’s metaphysics and the philosophical implications of superstring theory are thought to be compatible, even complementary in adding further ramifications not provided by either one of them separately, then together they might compose the new “conceptual framework” that Witten sees as needed for genuine progress in our understanding of what the world is all about.

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