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What Is the Physical Nature of a Surface?—Implications for Production of Contingent Entities from Fundamental Entities

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Abstract

Surfaces have been much studied, but no consensus has been reached about the actual physical nature of the surface of a three-dimensional, mind-independent physical object. I analyze, from a common sense or "folk" perspective, the surface of a physically-extended simple in a space containing no other objects. From this, I propose the novel idea that a surface is not a part of an object or its outside but instead is made of two components: 1) the object *as a unit whole, or a unity*, which acts as a barrier to 2) the outside space next to the object. I further propose that if there is no pre-existing outside space, the process of grouping zero or more things together into a new unit whole and physical object creates one with the grouping/unit-wholeness acting as a barrier to that newly created outside. A second test case containing 3 components and an observer is used to defend the hypothesis that a new outside space is created by the grouping process. When combined with a previously published example of an extended simple containing nothing inside, the two-part surface hypothesis suggests a process by which this simple can undergo self-replication leading to a Big Bang-like expansion of space. This offers a possible solution to an important question in philosophy: How do you start with one or a few fundamental existent entities and end up with the many contingent entities we see in the universe around us?

Keywords

Surface, Boundary, Object, Simple, Big Bang

1. Introduction

Surfaces have been much discussed in the philosophical literature (Stroll, 1988; Smith & Varzi, 2000; Tahko, 2012; Varzi, 2024), and although there has been some

progress, the true physical nature of the surface of a physical object is still uncertain. That nature is the topic of this paper, and, as a non-academic, I will approach it from what I call a common sense, or "folk", viewpoint. Given this "folk" perspective, and although surfaces technically differ from boundaries (Varzi, 1997; Nunez Erices, 2019), I will use these terms interchangeably throughout. To narrow down the type of surface to be studied, I'll first use the method of Smith (1996), who classified boundaries as either bona fide or fiat. Bona fide boundaries are those physical demarcations inherent to an object, such as an apple or a ball, that distinguish it from the rest of the universe. On the other hand, fiat boundaries, such as city limits or the borders of countries, are no less real but are the result of outside mental or social action. In this paper, I only consider the bona fide boundaries of mind-independent physical objects. Even given this restriction, though, there are still several undecided issues regarding the physical nature of surfaces, and I briefly summarize some of these below.

First, where exactly is the boundary located? Is it the outermost point of that which is inside an object, the innermost point of that which is outside, between the inside and outside, shared jointly by both the inside and outside, or perhaps both the inside and outside have their own boundaries? For example, if there are black and white areas on a wall, what color is the boundary between black and white (Suarez, 1964; Peirce, 1893)? Is it the last speck of black, the first speck of white, or something in between? Aristotle (1933) seemed to think a boundary was the outermost point of the inside of an entity when he wrote:

> " 'Limit' means: (a) The furthest part of each thing, and the first point outside which no part of a thing can be found, and the first point within which all parts are contained."

Alternatively, Leonardo da Vinci (1956) chose the in-between and shared options when he famously wrote:

> "What is it therefore that divides the atmosphere from the water? It is necessary that there should be a common boundary which is neither air nor water but is without substance…"

One may get around this issue of "ownership" by defining up front that a surface belongs to the object it is the surface of and not the neighboring area, but this is a human-imposed definition (Varzi, 2011) and may not reflect physical reality.

A second issue concerns objects, like clouds, whose surfaces seem fuzzy or vague. Where is the border? Even for an object with sharp-looking borders like a ball, the surface is made of constantly jiggling ball molecules with plenty of empty space between them. Given this, where do you draw the line between ball and not ball? This is called the "problem of the many" (Unger, 1980). To my mind, fuzzy boundaries and transitions are purely matters of community and linguistic definition. The concerned community just needs to define what is contained within and what is outside (Granet, 2024). Varzi (2011) would call this a *de dicto* boundary.

Third, and related to the vagueness issue, is whether or not bona fide boundaries even exist outside the mind or are instead just abstractions. For instance, Varzi (2011) writes:

> "On closer look, material objects are just swarms of subatomic particles frantically dancing in an otherwise empty space (the 'material' volume of an apple is really only one billionth of what we commonly measure)… On closer look, therefore, it makes little sense to speak of continuous objects separated by a common *de re* boundary."

This wide separation of the atoms that compose a surface prompted Simons (1991) to write:

> "a connected boundary would need to bridge the gaps between the [particles] and thus would be both an 'imaginary' rather than real entity (like saying a fakir bed of nails has a flat top) and to some extent arbitrary (like the curves scientists draw through the scattered and inexact data to give a smooth graph)."

This view, however, doesn't take into account that electromagnetic forces bridge the empty spaces and gaps and tie together the atoms (and their gaps) of an object to make them part of a unit whole. While a fakir's bed of nails isn't held together by electromagnetic forces, whether or not a bed of nails even exists as an outside-the-mind existent object is debatable.

A fourth area of debate on surfaces is about their dimensionality and ontological status. Many think that a surface has one less dimension than, and is ontologically dependent (Chisholm, 1983; Varzi, 1997) on, the object it is the surface of. That is, the surface of a three-dimensional ball is a two-dimensional entity that cannot exist without the ball also existing. The latter point seems clear, but how a two-dimensional entity with literally zero height can actually physically exist in the outside-the-mind world is not obvious, at least to me. Others think a surface is just a thin layer of the entity that interfaces with the outside, for instance, the outermost layer of atoms of a rock. But, one could then ask what is the outermost thin layer of the atoms? And, then of the protons, neutrons and electrons that make up the atom? It seems like the thin layer idea can only go so far.

Given these open questions, there seems to be no clear consensus on what a bona fide surface/boundary of a mind-independent physical object actually is in physical terms. In this paper, I try to answer that question. I suggest that a surface is not a specific structure that's part of an object or its outside, but instead contains two parts: 1) the object *as a unit whole*, *or a unity*, which acts as a barrier to 2) the outside space next to the object. I also argue that if there is no extant outside, the grouping together of components to create a new unit whole creates one. I then use this hypothesis to propose a solution to the seemingly unrelated question of how one can start with one or a few fundamental entities and end up with the many contingent entities we currently see in the universe. To build the case for the two-component solution, I use a very simple model system, that of a mind-

independent, physically-extended, metaphysically-indivisible (Markosian, 1998) simple in a space containing no other objects. The simplicity of this system avoids extraneous issues and sharpens the focus just on the surface. Whether or not physically-extended simples are possible is controversial, and I will briefly discuss that in section 2, but that is not the point here. Whether abstract or real, an extended simple, like every entity, has a surface, and use of this uncomplicated but spatially-extended model system means that 1) We don't need to worry about whether or not the simple is even really there as might be true with an infinitesimally small point-like simple. 2) There are no questions about whether the surface is a part of the simple because simples have no parts. 3) Likewise, we don't need to worry about vague boundaries because, again, simples have no parts and no gaps between parts. 4) There are no questions about whether or not the surface is part of or a neighboring entity or whether it's an interface between the two because there are no neighboring entities. 5) The surface is not a fiat boundary imposed by humans (there are no humans), so we don't need to worry about fiat-related issues.

In Section 2, I discuss whether or not physically-extended simples are possible. Section 3 will very briefly cover whether extended simples even have surfaces. In Section 4, I analyze the surfaces of extended simples made of either some continuous "stuff" or nothing at all and derive from this the two-component nature of a surface. Section 5 extends this conclusion from simples to a simple composite object containing only 3 objects and an observer. Section 6 briefly considers the surfaces of vague objects and illustrates that the two-component nature of surfaces applies to them as well. In Section 7, I combine the two-part surface hypothesis with the example of an extended simple containing nothing inside and use it to suggest a method for a self-perpetuating expansion of a space similar to the Big Bang. This method offers a possible solution to the question, "How do you start with one or a few fundamental existent entities and end up with the many entities we see in the universe around us?" Finally, a brief conclusion is given in Section 8.

2. Are Extended Simples Possible?

Whether or not simples can have spatial extension is controversial (Gilmore et al., 2024), but substantial evidence has been provided that spatially extended simples are possible (Markosian, 1998; Braddon-Mitchell & Miller, 2006; Simons, 2004; McDaniel, 2007). While the purpose of this paper is not whether or not simples can have spatial extension, I will very briefly consider it to defend the use of extended simples as a test case for analyzing surfaces. First, this debate seems odd to me. It is difficult to imagine a simple that does not have spatial dimension or is infinitesimally small and point-like. An existent entity, real or abstract, in which any one of its three physical dimensions is literally zero would seem to no longer be there. Even in the mind's eye, can one truly "see" an object with a size dimension of zero? One might see an object that's very flat or very small but not actually of zero size. For the same reasons, while it seems possible that there could be a

world *containing* a system of zero size, or nothing (see Lee, 2016), it seems impossible that the world itself (i.e., the "container") that one physically sees or imagines could be of zero size or infinitesimally small and point-like. The empty set of mathematics is an example of an imaginable world containing nothing. It contains nothing, but one can still imagine the concept, or curly braces, denoting such a set. Even if a simple is not actually zero size in dimension but is instead infinitesimally small, or approaching zero, such as a point-like simple, can one ever actually grasp it and visualize it? No, because it's always slipping away by being ever smaller. Because it's always a little smaller, it's never actually there for it to exist or to visualize. Other philosophers have discussed, if not supported, similar qualms (Markosian, 1998). Thus, to my mind, if simples exist, especially outside the mind, they must be physically extended.

Second, while Simons (2004) argues for extended simples, he discusses an argument against them which is that if they occupy volume, then they have "parts that correspond to the parts of the region that it occupies". But this presupposes a background spacetime that is either continuous or has smaller divisions than the sizes of extended simples. This is an unfounded assumption. Modern physics is seriously investigating the possibility that spacetime is not continuous but comes in quantum units (Clavin, 2021; Minic, 2020). Braddon-Mitchell and Miller (2006) make this point in talking about a world made of Planck-length square units. They write:

> "Planck squares, however, have no such sub-volumes (subregions, in this case) and hence have no proper parts."

Extended simples with the appropriate properties would seem to be ideal candidates for these quantum spacetime units or Planck squares. If so, it's not that extended simples would occupy a pre-existing region of space-time. Instead, the extended simple would itself be a fundamental region, or unit, of space-time, location and volume. If this were the case, however, it seems possible that these extended simples might also undergo motion and thereby allow a space filled by no simples to be between them. So, perhaps spacetime is a combination composed of extended simples and the spaces between them?

Third, Zimmerman (1996) discusses but does not support, a classic argument for a world made of points and against a world made of extended simples: that of a perfect sphere touching a flat plane. He describes the argument this way:

> And when they touch, a part of the one [the sphere] must be in direct contact with a part of the other [the plane]. But for any extended part of the sphere you pick, the whole of that part cannot be in direct contact with any part of the plane. Only a point-sized part of the sphere and of the surface could be such that all of the one is in contact with all of the other.

This argument is flawed, however, in that if the sphere is composed of extended simples, the whole of the extended simple can be in direct contact with the plane.

An extended simple is, by definition, a single unit whole containing no smaller point-like parts, so that when the sphere touches the plane, the point of contact is the extended simple, *as a whole*, and not a part of the simple. The extended simple has no smaller, point-like parts, by definition, despite the mind's desire to imagine their presence. The mind desires this because we live in a world of composite things where everything we see has smaller components. But, extended simples do not live in that world, and we need to get used to that.

In sum, I argue that physically extended simples exist. But, as mentioned above, even if they only exist as abstract objects, they still have surfaces that can be visualized, and they can serve as a useful system to examine the nature of a surface.

3. Do Extended Simples Have Surfaces?

Does an extended simple have a surface? I argue that the answer is yes for several reasons. First, the assumption that objects in general have boundaries seems to be uncontroversial (Nunez Erices, 2019; Varzi, 2024). As Varzi writes:

> "But whether sharp or blurry, natural or artificial, for every object there appears to be a boundary that marks it off from the rest of the world."

This is also supported by an argument recently made by Granet (2024) that:

> "a thing exists if it is a grouping which ties zero or more things together into a new unit whole and existent entity" and that this "grouping is visually manifested as the surface, or boundary, of the thing."

Second, try to imagine how any physically existent thing could exist without an outermost edge or surface. Even if your eyesight is so good you can see anything that exists no matter how small, what you're seeing is the surface of the thing. Is a thing really there, or even visualizable, if it has no surface? I don't think so. Third is just the common sense "folk" view that every physically existent object that exists has a surface.

4. The Surface of an Extended Simple

In this section, I examine the surface of a mind-independent, physically-extended, indivisible simple present in an empty space containing no other objects, and use it to put forward a two-component model of a surface. The argument applies whether or not the simple is made of some continuous substance, nothing at all or something else.

First, does an extended simple have a vague boundary? No, for the straightforward reason that it has no component parts for there to be gaps between or doubts about.

Next, where is the surface located? In the simple, in the outside space, or someplace else? To begin, is the surface part of the simple? That is, does a simple have a part, structure or layer called the surface? By definition, a simple has no parts and, thus, has no separate part, structure or layer called "the surface". The simple

is one thing, a unit whole. So, if the surface is in the simple, there's only one choice for what it can be: the simple as a unit whole. This is true no matter what a simple is composed of. You might argue, though, that a two-dimensional surface is part of the simple, but not really a physical part. But this argument doesn't apply for the following reasons. First, simples don't have parts, physical or abstract. Second, the model system being studied is a *mind-independent*, physically-extended simple. Abstract, two-dimensional surfaces need not apply. Third, the reasons presented in Section 2 that a simple must have a non-zero spatial extension and can't be infinitesimally small and point-like also apply to surfaces. A two-dimensional layer that has literally zero height or is infinitesimal in size and therefore always approaching zero height would seem to not exist and not be capable of being visualized, no matter if the surface is physical or abstract. In sum, if the surface is located in the simple, it must be the simple as a single unit whole.

Next, is the surface a structure in the outside space? In this model system, the outside space is empty and contains no structures, so it contains no structure called a surface. Also, for the reasons listed above, the surface can't be a two-dimensional or infinitesimally small structure in the outside space. Despite this though, the "outside" space still seems to be an integral part of the idea of a surface. The very nature of the surface of an object is that it's an interface with an outside space or what is often called the complement of that object (Varzi, 1997). This also complies with our intuitions because, for instance, when we think about standing on the surface of a floor or touching the surface of a baseball, our minds are in the outside space next to the floor or baseball. The surface is acting as a barrier to entry to that outside space. Have you ever been in a surface? No. We're always in the outside space looking at the surface as a barrier to our entry. The surface, as a barrier, is why we, in the outside space, don't fall through the floor or why our bat doesn't go right through the baseball. Therefore, given that the outside space is apparently critical to the nature of a surface, but in this model system, there is no sub-structure called a surface in the outside space, it must be that the outside space, in general, is what's important to the surface of the simple.

Finally, is the surface between or shared by the simple and the outside space, perhaps as some two-dimensional or infinitesimally small structure? No, because, again, there are no parts or structures called "the surface" in this model system besides the simple and the empty outside space. And, as discussed, the surface can't be a two-dimensional or infinitesimally small structure shared by the simple and the outside space.

So, what is the surface of the simple? We've ruled out any part, structure or layer in the simple, in the outside space, or shared by/between the simple and the outside space for the plain reason that, in this model system, there are no parts, structures or layers other than the component-less simple, the component-less outside space and nothing else. Therefore, the only two things that are left that the surface could be are:

1) The simple *taken as a unit whole*. That is, the surface isn't a specific part or

layer of the simple. It's the simple as a unit whole. Because an extended simple has no parts (despite the mind's inclination to imagine their presence, as mentioned in Section 2), this is the only thing it could be. That a surface isn't a specific part of an object but is instead the object as a unit whole also makes sense because there wouldn't even be a surface were not some amount of stuff grouped together to form a new unit whole called the object. For example, a ball wouldn't have a surface if the individual atoms of the ball weren't first grouped together to form a unit whole called the ball. If the ball atoms were all just spread around on the ground and not grouped together, there would be no ball and, therefore, no surface. If one removes a big chunk of the atoms from the ball, there wouldn't be a surface of the new chunk-removed ball were not the remaining atoms still grouped together to form a unit whole called the chunk-removed ball. So, the very existence of a surface depends on the grouping of things together to form a unit whole.

2) The *outside space in general*. As discussed above, an inherent part of the nature of a surface is that it's an interface with an outside space. Yet, there are no sub-structures in the outside space in this model system that can serve as a surface, so it must be the outside space, in general, that is important to a surface.

Combining these two, I suggest that the surface of an entity is not a single thing or a part of anything but instead has two components: 1) the entity as a grouping/unit whole which acts as a barrier to entry to 2) an outside space next to the entity. That is, the unit whole that is the entity is a barrier to an outside beyond which that outside can't go. I further propose that if there is no pre-existing outside, the process of grouping zero or more things together into a new unit whole creates one with the grouping/unit-wholeness acting as the barrier to that newly created outside. This is illustrated in the next section.

5. The Surface of a Non-Simple, Multi-Component Object

Here, I build on the conclusions from Section 4 and examine how the process of grouping things together into a unit whole creates a new outside space. To do that, consider a new model system which contains 3 physical objects (i.e., components) A, B and C; your mind, which is acting as an observer of this system; and nothing else. There is no empty space surrounding these components and your mind as there was in the extended simple model in Section 4. Then, imagine components A, B and C grouping themselves, perhaps via their electric charges or their sharing electrons in a bond, to form a new unit whole called the ABC object. Because your mind is not included in the new ABC object unit whole, the grouping process results in its being outside the new unit whole. Therefore, despite the absence of a pre-existing outside space, the process of grouping things together to form a new unit whole creates a new outside space containing your mind. What does your mind, the observer, see? It sees itself in an outside space looking at the surface of the ABC object, which is acting as a barrier to entry to it. The barrier of ABC consists of the actual A, B, and C components and the forces between them that

led to the grouping. Together, they act as a barrier to your mind entering the ABC object. This example supports the proposal in Section 4 that if there is no pre-existing outside space, the process of grouping things together to form a new unit whole creates one.

6. The Surface of Vague Objects

What exactly is included in an object taken as a unit whole? If the unit whole acts as a barrier to the outside space, then what is included in the unit whole means everything within the barrier. This includes all the "component parts, their arrangements, orientations and interactions (i.e., bonds and bond angles)" (Granet, 2024) as well as the empty space between the components that are within the barrier. It should be noted that while the empty space is included because it is within the barrier, it is not really empty since it is filled with quantum fields and force particles that act to group the components together. Despite this seemingly tidy definition, though, it is sometimes difficult to determine which components are within the barrier. As mentioned in the Introduction, the boundaries of many objects seem fuzzy or vague either from a macro perspective, such as clouds, or a micro perspective, such as apples, if one considers that an apple is a grouping of jiggling atoms with empty spaces between them. Which water molecules or apple molecules are included in the unit wholes that are the cloud and apple, respectively? To my mind, this is not a problem. Fuzzy boundaries and transitions are purely matters of community and linguistic definition. Those concerned about the boundaries of clouds and apples need to work together to develop rules for and define what is contained within a unit whole and what is outside (Granet, 2024). That is, they need to define *de dicto* boundaries (Varzi, 2011). For instance, one possible definition the apple community could decide on for which molecules are contained within an apple could be those which are more strongly held by attractive forces from other apple molecules than are pushed away from other apple molecules by air currents. Furthermore, the empty space included in the unit whole that is the apple might be defined as that empty space within the outermost positions of the outermost jiggling apple molecules when all those positions are connected by straight lines. But whatever a community decides is contained within a unit whole, that unit whole will act as a barrier to the outside, and these two things together will be the surface of the entity. I suggest that humans make these kinds of what-is-included decisions instinctively when they see an apple as a unit whole or look at a cloud in a particular shape at a particular time as a unit whole.

Groupings/unit wholes can also change. Suppose Tibbles the cat has have long hair at time t1, all of which is grouped together with the rest of the cat to create the unit whole that is Tibbles. But, if Tibbles goes to the pet groomer at time t2, the unit whole can change. This is okay. Whatever is the unit whole at any given time will act as the barrier to the outside, and, together, these will form the surface of Tibbles at that time.

In sum, the two-component nature of surfaces applies to vague objects as well. Once the unit whole that is the object is determined by the community or the individual, that unit whole acts as a barrier to the outside, and together, they form the surface of the object.

7. The Surface of an Extended Simple Containing "Nothing"

If extended simples exist, what are they made of? They must be made of something. As discussed above, two possibilities would seem to be: 1) A continuous substance lacking smaller components. 2) Nothing; that is, the simple is a just surface containing nothing inside. Here, I consider the second type, a simple containing nothing, and suggest that such an entity, when combined with the two-part surface hypothesis presented above, may offer a solution to an important, unanswered and under-discussed question in philosophy: How do you start with one or a few fundamental existent entities and end up with the many entities we see in the universe around us? This, of course, assumes there are many entities in the universe. To do this, I use an argument recently put forth by Granet (2024) that the situation commonly known as "nothing" (the quotes are his usage) is actually a grouping/unit whole and thus an existent entity. A summary of his argument is:

> "…I first define 'nothing' as the result of subtracting away all matter, energy, space/volume, time, concrete and abstract entities, locations, laws or constructs of physics/math/logic, possible worlds/possibilities/potentialities, counteracting forces, philosophical constructs (i.e., properties, universals, etc.), consciousness, any other existent entities, and minds, including the mind of the person trying to imagine this lack of all, *your mind.* When we subtract away all this stuff, we think the result is the lack of all existent entities, or 'nothing'… Once everything, including the mind of the thinker, your mind, is gone, this 'nothing' would, by its very nature, be the whole amount, or entirety, of the situation. 'Nothing' completely defines the situation. The inherent nature of 'nothing' is that it's everything. It's all. Is there anything else besides that 'nothing'? No. It is 'nothing', and this 'nothing' is it, the all. A whole-amount/entirety/completely-defined-situation/all (henceforth, shortened to entirety/all) is a grouping, which means, by the definition given here, that the situation we previously considered to be 'nothing' is itself an existent entity. This grouping, like other groupings, is manifested as a surface, but because there is 'nothing', the surface is not a structure but is instead the entirety/all grouping itself. …Because it starts with 'nothing', the existent entity previously, and incorrectly, called 'nothing' would be the most fundamental of existent entities… In order to be physically existent, the fundamental entity must have certain other physical properties such as dimension and shape. These additional properties are all grounded in and supervene upon the entirety/all grouping property inherent to 'nothing'."

If the existent entity previously called "nothing" has dimension and shape, then

this entity would be an extended simple containing "nothing". Such a simple would fit in with the point made above that the contents of a world can have zero size and be "nothing" (Lee, 2016), while a world containing that "nothing" (i.e., the extended simple) has size. One advantage of Granet's hypothesis is that, when combined with the two-part nature of a surface described above, it suggests a mechanism for starting with a single, fundamental entity and ending up with the multiple entities we see in the universe around us and doing so in a way consistent with modern physics. What I mean is this. If we assume a starting point of absolute "nothing", and if this "nothing" is a grouping/unit whole and existent entity, then there would be no pre-existing outside of this unit whole as mentioned in Section 4 (how can there be a pre-existing outside if the starting point is "nothing"?). Therefore, this grouping/unit whole should create a new outside, and the unit whole would act as a barrier to that outside. What is this outside? Because the starting situation is "nothing", it can only be additional instance(s) of "nothing" next to the unit whole that is the initial entity. That is, the grouping/unit whole that is the initial "nothing" entity creates new instances of "nothing" around it and the unit whole acts as a barrier to these new instances of "nothing". The unit whole/barrier acts like a nucleation site that causes these new instances of "nothing" to form. As with the original entity, these new instances of "nothing" would themselves be groupings/unit wholes which would then create new outside spaces (instances of "nothing") next to them, at least where there were no already pre-existing "nothing" entities. This process could continue ad infinitum. If each of these entities is a unit of space and location, this self-replication process is very similar to a Big Bang-like expansion of space, similar to what happened in our universe. While speculative, this process logically follows from the argument that "nothing" is a grouping/unit whole and from the two-part surface hypothesis.

It may be hard to accept the formation of additional instances of "nothing". After all, how can there be more than one "nothing"? However, there are valid reasons for thinking this is possible. First, if the entity previously called "nothing" truly is a unit whole and existent entity, then its unit wholeness, in the form of a barrier to an outside, would create a new location, or nucleation site, for these new instances of "nothing" to form at. Second, the idea that surfaces are interfaces with an outside is an inherent characteristic of surfaces. If "nothing" is indeed a grouping/unit whole manifesting as a barrier to a newly created outside, and given that the starting situation is "nothing", the *only* thing the outside could be is(are) an additional instance(s) of "nothing". Third, from a more theoretical viewpoint, any model of the origins of the universe in which the universe starts with just one or a few fundamental entities has to have some mechanism for this (these) entities to produce the many contingent entities we see in the universe around us. That is, there has to be some mechanism for production of new entities. There seems to be no way around that. Unfortunately, this issue has been mostly ignored by philosophers. Even physicists, at least those who think that space is composed of discrete units, have provided no mechanism for production of more of these units,

to the best of my knowledge, as would be needed to be consistent with the expanding space thought to be part of the big bang model of the universe. I suggest that the entity previously called "nothing" is the only entity capable of replicating itself and producing these new entities. Fourth, try replacing "the entity previously called 'nothing' " with "string", "causal set" or some other physics term, and the self-replication model seems more palatable. Because we don't know what strings and causal sets are made of, they could very well be the entity previously called "nothing". Fifth, and finally, in physics, a concept called holography implies that our 3-dimensional universe is created as a projection from a lower-dimensional hologram. This sounds remarkably similar to how the unit whole/barrier of the entity previously called "nothing" could cause the formation of our three-dimensional universe by the process described above.

8. Conclusion

I propose and defend the idea that the surface of a physical entity is not a part of either the entity or the outside but instead has two components: 1) that entity taken as a unit whole, which acts as a barrier to entry to 2) an outside space next to the entity. The grouping/unit-wholeness of the entity is a barrier beyond which that outside can't go. I further propose that if there is no pre-existing outside, the process of grouping zero or more things together into a new unit whole creates one with the grouping/unit-wholeness acting as a barrier to that newly created outside. This is a different conclusion than most, or all, other studies that consider a surface/boundary to be a single part of either the entity or the outside, shared between the two, or an interface between the two and shared by neither.

Some implications of the two-part character of a surface include the following. First, as mentioned in the Introduction, Varzi (2011) and Simons (1991) have raised the point that the surface of an object may be more abstract than real due to the empty spaces, or gaps, between the components of an object. How can there be a physical surface when there is so much empty space between the components the surface is made of? I suggest that this concern is unwarranted for the following reasons. The first part of the two-part definition of a surface is that the object taken as a unit whole acts as a barrier. As discussed in Section 6, this implies that what is included in the unit whole is everything within the barrier, including the empty space between the components of the object. In a sense, the empty space is itself a "component" of the unit whole since it is within the barrier. Additionally, this empty space is not really empty. Instead, it is filled with quantum fields and force particles that help shape and hold the object together. Thus, a physical object is composed not only of its component parts but by all the so-called empty spaces between these components. Therefore, the "empty spaces" don't detract from the physical nature of a surface and cause it to be an abstraction. They add to it.

Second, how does the two-part character of a surface affect the issue of contact between adjacent entities? Many wonder how two objects with surfaces can be in contact even if they're adjacent to and touching each other. Their concern is that

if space is continuous, there are always an infinite number of smaller space-time points between any adjacent boundaries (Casati, 2009). First, this presupposes that space is continuous, which, as mentioned above, is far from certain according to modern physics. If space is quantized, and there are no discrete units of space between two surfaces, this worry about contact disappears. Second, if the surface of an object includes both the outside space next to that object and the object as a unit whole acting as a barrier to the outside space, then even if space is continuous, the space directly next to an object is included in that object's surface. Building on this, just because an object's surface includes an outside space next to the object, this doesn't prevent an adjacent entity from occupying part or all of that outside space. That is, if entities A and B are adjacent, B can occupy the outside space that is part of A's surface and A can occupy the outside space that is part of B's surface. This means that A is in direct contact with B's surface and B is in direct contact with A's surface, given that A's and B's surfaces include the space next to the unit wholes/barriers that are A and B. An example of this is the fiat boundary between the United States and Canada. Canada occupies the outside-the-U.S. space, and the grouping that is the U.S. is the barrier to Canada's entry. In the same way, the U.S. occupies the outside-Canada space and the grouping that is Canada is the barrier to the U.S.'s entry into Canada. This means that the U.S. and Canada are also in direct contact. Therefore, the two-part nature of a surface allows the contact issue to be resolved.

Third, the two-part nature of a surface is fully consistent with the study of surfaces in the hard sciences. Surface science is basically the study of the entities and processes that are present at the surfaces of substances or interfaces between two substances. If, as postulated, a surface is a unit whole acting as a barrier to an outside space, the entities and processes studied in surface science would occur at the barrier and within the outside space.

Finally, if Granet's hypothesis (2024) about "nothing" being a grouping/unit whole and existent entity is correct, then the two-part nature of a surface allows the formation of additional existent entities via a Big Bang-like expansion of space. While there has been some theoretical metaphysical exploration for the production of contingent entities from fundamental entities (Bennett, 2011; Paul, 2012), I have seen no other published *physical* mechanism in the philosophical literature for how, starting with one or a few fundamental entities, the multiple existent contingent entities that we see in the universe around us can be produced. Therefore, when taken in conjunction with Granet's hypothesis, this is a major advantage of the current two-part surface proposal.

In sum, I propose and defend the novel hypothesis that the surface of a physical object is composed of two parts: 1) the object taken as a unit whole, which acts as a barrier to entry to 2) an outside space next to the object. I further propose that if there is no pre-existing outside, the process of grouping zero or more things together into a new unit whole creates one with the grouping/unit-wholeness acting as a barrier to that newly created outside.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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