Zero Matter

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In this paper I intend to postulate a conception of the universe that does not make a distinction between "matter" and "space", but rather posits a model of the universe as composed of a single continuum. The view I espouse is in a sense the converse of a plenum view; not that the universe is entirely filled with smaller and smaller particles, but that it is entirely "empty", by common usage of the word empty, being only space permeated by forces. I will discuss in this essay the notion of an essential "substance" or solid matter, as something distinguished from "void" or empty space. I will do this first by examining philosophically the relation of 'attributes' of a thing to the so-called 'essence' of said thing. I will then examine the analogous case of the forces exhibited by a particle of matter, and the relation of those forces to the actual substance, if any, of the matter itself.

I will do this in two parts, the first considering the "extension" of matter and the second considering the "mass" of matter, showing in both cases that these supposed fundamental properties are reducible to descriptions of forces in space. From this I intend to prove that making a sharp and technical distinction between matter and space, or substance and void, is a clear absurdity, and that what we are in fact describing when we speak in gross or common terms of matter as opposed to space is merely the concentration of forces in particular regions of space.

I intend by this to show how this model of a single, continuous universe, with no strict distinction made between 'solid matter' and 'empty space', resolves entirely the conflict between relationalists and absolutists concerning the nature of space, and in fact renders the argument moot, as both positions are founded on the misconception of matter as distinct from space.

Let us first consider a hypothetical material object, one readily accessible to all the senses.

Let us consider a delicious, rare, freshly cooked steak, right off the grill. Our steak is a nice, dark, reddish-brown color, with black grill marks on it, proof of the authenticity of this restaurant. On its plate it is soaking in its marinades, and warm steam rises from it, filling the air with its savory smells. When you cut it you can feel the resistance of the meat to your knife, chewy and tender, and when you place that first bite into your mouth not only can you feel the rich texture of the meat, but its flavor soaks through every taste bud.

Imagine now a steak in most ways identical to the one I have just described, the very same appearance, the very same savory smell, the very same tenderness and chewy texture when you place it in your mouth — but for some reason, this steak lacks all flavor. Nevertheless, we would likely still call this a steak, and if not, then certainly it is at least *something*, whatever it may be. But imagine now that your waiter instead brings you what appears to be an empty plate, perhaps a few juices or marinades resting on it, but no steak that you can behold with your eyes. Yet as the plate is set under your nose, the warm savory smell of steak rises up through the air, and your waiter informs you with a smile that he has brought you the rarest of steaks indeed, an *invisible steak*. You reach your hands toward the plate, and there you feel the warm, wet surface of the steak in your hands. Unable to use your knife and fork, you lift the steak with your hands and bite into it, feeling the chewy texture as expected — but apparently, what you have gotten is the invisible version of that awful, flavorless steak we considered earlier.

Consider further, if you could not even smell the steak, but still you could feel the warm, soft, wet figure of a steak in your hands. Now certainly, the nature of this invisible, odorless, flavorless thing is in question, and it may not be a steak at all, but you clearly do still have *something* in your hands. After all, you can feel it there. It has some attribute which can be ascribed to it. But what if you could not feel it? And though we do not consider steaks to be particularly noisy creatures to begin with, imagine also that it makes no sound. If your waiter served you this, an odorless, flavorless, soundless, invisible, and incorporeal steak, I imagine you would demand that he take his empty plate back to the kitchen, and bring you one with a steak on it! To speak of a steak devoid of any of the attributes which are ascribed to a steak, is not to speak of a steak at all; and unless it instead has some other, non-steak attributes (thus making it some other sort of thing instead of a steak), then to speak of such a thing so devoid of any attributes at all is to speak of nothing whatsoever.

Clearly, to speak of some 'substance' of a thing, as distinct from detectable attributes ascribed to that thing, is meaningless nonsense. There is no substance to an odorless, flavorless, soundless, invisible, incorporeal steak, or an odorless, flavorless, soundless, invisible, incorporeal anything. A hypothetical chunk of 'nothing' would also be odorless, flavorless, soundless, invisible, and incorporeal, and any thing so indiscernible from nothing is, in fact, no thing at all.

Consider now this same line of argument, applied not to subjective sensory characteristics such as the color and flavor of a steak, but rather to more objective properties of matter in general. The defining characteristics of what makes something "material" are usually said to be either extension, mass, or both extension and mass. I intend to examine both mass and extension separately and show that each of them reduces entirely to the effects of forces in space, and thus strictly speaking, no thing has extension or mass as separate characteristics from the forces exhibited by it, which may in turn reduce to nothing but features of space itself (and certainly do, in the case of gravity).

The characteristic with which I am most concerned is extension, or volume. Matter is said to be solid, or extended, or to occupy a certain volume, because it does not permit other solid or extended matter from occupying the same volume as itself. In other words, two solid objects seem impenetrable to each other; that is, they will collide upon contact, and will not simply pass through each other. Let us then examine the classical example of common-scale colliding objects, two billiard balls. When two billiard balls attempt to occupy the same location, they collide with each other and go their separate ways, and thus we say that they are “solid”, or “extended”, or they “occupy space”. But we know from modern science that these balls are not in fact entirely “solid”, with a distinct edge inside of which there is 100% solid matter and no empty space. We know that these things are actually composed of many tiny atoms, bound together by electrical forces into molecules and larger structures, and that in the gaps between these molecules and atoms there is plenty of “empty” space. This is how two material things which otherwise tend to retain their own volumes, such as water and salt, do not have the same volume when mixed as the sum of their separate, individual volumes. The salt dissolves into the water, and salt molecules occupy what was once “empty” space in between the water molecules, resulting in a smaller volume of salt-water than the combined volumes of the separate salt and water.

Already we are on shaky ground as to the “solidness” of matter, as we have just seen a case where two material things do indeed occupy the same space to some degree. So let us then look at the atoms of that matter. Perhaps they are “solid”, and all other matter is just a loose collection of such solid particles filled with many “empty” spaces. By their very name, we would expect atoms to be entirely solid and composed of no further parts, utterly indivisible. But again, we know from modern physics that atoms are not indivisible, and that they are indeed mostly “empty space”, with a “solid” nucleus at the center and unextended point-particles, electrons, surrounding that. What we see, grossly, as a collision between two atoms, or between many atoms in the case of a macroscopic collision, is in fact nothing but the electrical forces of those atoms repelling them apart from each other, as their electron shells “collide”; though as unextended point-particles, describing this interaction as “collision” is questionable. Yet waves, in the gross macroscopic sense of water waves or sound waves, can also be said to “collide”, though this collision is not superficially the same as the collision of two billiard balls. Thus as electrons may also, perhaps more accurately, be spoken of as waves rather than particles, to speak of this interaction of electromagnetic forces of atoms as “collision” is not unjustified.

Now we are beginning to see the picture of how I envision all matter to be; a picture with which, as far as I can tell, modern physics (of both the quantum and relativistic type) agrees entirely. If the space filled with the electrical forces of otherwise unextended electrons can be said to be “empty”, what justification do we have for calling the nucleus at the center of these atoms “solid” or “extended”? Certainly, two nuclei will collide with each other, but so will two atoms, or two billiard balls, and we have already seen that these things are not entirely solid, but mostly “empty” space. The nucleus itself is, likewise, made up of nucleons (protons and neutrons) bound together by the strong nuclear force. If we are to say of the nuclear force, like the electrical force, that its presence in space does not constitute that space being occupied by “solid” matter, then there is still more “empty” space between the nucleons in the nucleus. But are those nucleons themselves solid? Certainly they too collide in the classical sense, just as atoms or billiard balls do, and so seem to occupy a certain volume of space exclusively, and thus have extension. But those nucleons themselves are “solid” only in the same way that an atom is, as they are composed of still smaller quarks, which are bound together into nucleons by the weak nuclear force. These quarks, in turn, are unextended point-particles of the same fundamental class as electrons — fermions — and like electrons, such fundamental point-particles are more accurately described in quantum theories as fields or waves rather than as true extended particles.

So it seems that any talk of the extension or volume of “solid” matter is ultimately reducible to forces, fields and waves in space, not to some indivisible solid particles which themselves have extension or volume; though certainly the forces they exhibit extend out from these dimensionless points, and thus “fill” a certain volume. But if the extent of forces is to be our defining characteristic of extension or volume, then it is one made arbitrarily and by convention, however is convenient for the scale of the system under discussion. First we must decide which force it is that “counts”: the weak force, the strong force, or the electromagnetic force. Then we must decide at what threshold distance that force is strong enough to say that it is “solid”, for any such force can be overcome with sufficient energy, and so no space — no matter — is completely impenetrable or solid. Such conventions are of course useful, and even I will say of a billiard ball or a table that is is extended by such-and-such measure and occupies such-and-such volume. But I am aware that any statements of that nature are approximations, and that the precise and absolute measure of such things, even given perfect equipment, is in principle impossible, for nothing is strictly and literally extended as that term is commonly understood. Likewise, none of this is to detract from the usefulness of modeling physical systems in terms of atoms or subatomic particles, but we must remember that this model is an abstraction and not the literal truth, not even (as Kant might say) the phenomenal, as opposed to noumenal, nature of reality. If we look closely enough, we will always find such matter is ultimately just continual forces centered on dimensionless points, and nothing is truly extended. Thus we should be careful not to make statements such as “matter is mostly empty space”, or “atoms are mostly empty space”, for an astute listener will always be able to press us with the question, “Precisely how much of it is not empty?” — to which we can give no unqualified correct answer.

Let us now consider the notion that something is material if it has mass. To be entirely clear, let us imagine some sort of material which exhibits no interaction with the electromagnetic or nuclear forces, only the force of gravity. It has no charge, nor color or flavor (in the quantum use of the terms, describing charges of strong and weak nuclear forces), but it does have mass. To my knowledge no such matter is known to exist, but for this thought experiment let us consider such a concept, and if we would be comfortable calling such a thing matter at all. The question of where to draw the line between where the thing “is” and where it “is not” — that is, how to determine its extension or volume — seems clearly silly in this case, as its force of gravity extends universally, and so by that criteria any massive object would be infinite in size, occupying the entire universe (which is not so far off from the view I am propounding, inasmuch as all ‘objects’ are part of a single universal continuum). If the thing could be said to “be” anywhere in particular (as opposed to being everywhere), it would be only at a dimensionless point at the center of its gravity well, just as quarks, electrons, and other such things are similarly dimensionless points. In such a case, would we really be inclined to say that there is “matter” there, or would we rather say just that there is a certain force of gravity there (or as Einstein showed, a certain geometry of space-time)? It seems that this attribute of mass itself is nothing but the force of gravity exerted by something, or how much space-time is bent around it. Like extension, mass seems reducible to nothing but forces in space, and any “particles” said to be in the picture are infinitesimal points, merely the centers of the force-fields.

But there is an objection that might be raised here, while will require a long and interesting tangent to adequately address, in the process of which we will see further illustration of the almost “fluid” nature of the universe that I envision. The “mass” of an object affects (or rather, is thought to exist in virtue of) not only the gravitational attraction between that and other objects, but also the object’s inertia, its resistance to having its velocity changed. In response to this, I refer to an objection made against Clarke’s “rotating bucket” experiment. This experiment claimed to show the absolute nature of space (as something separate from matter) by way of imagining a spinning bucket, filled with water which is also spinning and thus at rest relative to the bucket, in a universe where nothing but this bucket and the water exist (and let us imagine a lid on the bucket so the water does not fly out without Earth’s gravity to hold it in). This experiment is meant to show that space must be absolute because the water and bucket are at rest relative to one another (and thus all matter in this imagined universe), but as we are led to imagine that the water appears drawn toward the sides of the bucket as though the bucket were rotating, we must conclude that the bucket is rotating relative to something. As no other objects exist in this imagined universe, that something must be space itself — or so Clarke intended to prove by this.

The objection raised to this experiment is that it cannot actually be conducted, as we cannot observe a spinning bucket of water in a universe where ourselves and the rest of the universe do not exist. Thus, we can't conclude that the rest of the universe has no effect, or that spinning the rest of the universe around the still bucket would not produce the same effect as rotating the bucket in a still universe. But given that no state of motion is special or privileged, it is clear that these two scenarios are entirely identical, and "spinning the universe around a still bucket" does produce an attraction of the water toward the outside of the bucket. Furthermore, I believe I can clearly show that if an imaginary still bucket of water in an otherwise empty universe were suddenly to become surrounded by massive objects rotating around it, that the masses of those objects — that is to say, the force of gravity exerted by them on the bucket and the water — would in itself draw the water toward the edges of the bucket in exactly the same manner. As we would classically describe water so drawn out in a spinning bucket as doing so because of its inertia interacting with the centripetal force of the bucket walls, to show that this same effect can be seen as caused by the force of gravity exerted by the rest of the universe on the water (and its subsequent interaction with the bucket walls) will show conclusively that inertia is a result of the force of gravity exerted by the rest of the universe upon the "massive" object in question. In short, I intend to show that inertia is the product of what we might call "background gravitation".

Consider first our still bucket, filled with water, sitting alone in space. We will imagine the bucket as being held "still" relative to any other motion, so that we can examine simply the effects of other masses in the universe upon the water. (This situation is indiscernible from imagining the bucket moving in an otherwise still universe). Now, imagine that two equally massive objects come into being on either side of this bucket. Their gravity would draw the free-floating water toward the sides of the bucket, and so the water would pool on either side of the bucket. Imagining three such equal masses, evenly spaced around the bucket, would produce a more neutral distribution of gravity fields across the water, and more and more such masses evenly surrounding the bucket along it’s axis would produce an outward force similar to the “centrifugal force” experienced by a rotating bucket — though this is not the point of my proof.

If we then imagine even more such masses surrounding the bucket above and below, a sphere of mass encompassing the bucket, then all the gravitational forces would cancel and the water would be left in free fall again; that is, drawn toward its own center of gravity, and the water and the bucket both pulled toward the center of the sphere. But if we imagine these massive bodies surrounding it not at equal distances, but instead distributed far and wide, a vast cosmos of masses, the net effect of their gravity would still be like that at the center of a sphere, though on such a large scale that the precise center of gravity of this constellation (if it is finite and bounded and thus has a true center) would be difficult to determine and often completely overcome by more local gravitational attraction. If we place such a local mass below the bucket, we will have a scenario indiscernible from a still bucket sitting on the Earth in a vast cosmos.

Imagine now our first two masses (with none of the others yet in existence) spinning around this bucket of water, which as I said earlier is being held still relative to this motion. The water will of course follow the masses and circle around the insides of the bucket, and if the bucket is frictionless, the water will retain its same shape as caused by the gravitational forces of the masses. If we imagine then three circling masses, the water will again retain the same form as it did when the three masses were still, but it will spin about inside the bucket. And on and on, as we imagine more masses, up to a complete cosmos, the water will retain its form — its shape and contours as caused by the various sources of gravity around it — and spin inside this frictionless bucket. This scenarios is identical to spinning a frictionless bucket in an otherwise still universe; the water inside stays still relative to everything else, despite being in motion relative to the bucket. In that situation we would commonly call the cause of this stillness ‘inertia’, but in this identical and indiscernible scenario the cause is clearly gravitational attraction.

Suppose we now imagine that the bucket walls do have friction, and this body of water is spinning inside of it, pulled by the gravity of the many masses spinning around the bucket. The water molecules touching the bucket will be slowed by this friction and so experience an effect indistinguishable from gravity — deceleration, which given the arbitrary nature of reference frames, could also be called acceleration. As the water molecules collide with the imperfections in the sides of the bucket, they will pile up like a colossal traffic accident, and accumulate along the sides of the bucket, eventually coming to a stop relative to the bucket walls, but still trying to follow their geodesic paths toward the massive bodies spinning outside the bucket. This scenario is identical to a spinning bucket full of water which has caught up with the spin of the bucket, and is being "pulled" toward the walls of the bucket by "centrifugal force".

I put "centrifugal force" in quotations because it is not, properly speaking, considered to be a force such as gravity or electromagnetism, but is instead simply regarded as the inertia of the water being impeded by the centripetal forces of the bucket walls. But this thought experiment shows that that "inertia" is in fact nothing but the effects of the gravity of the rest of the universe pulling on the water. In a sense, inertia is simply an object being caught in the "web" of the gravitational fields of everything else in the universe pulling on it together, and thus resisting any motion against those forces entangling it — a sort of "background gravitation". Greater "mass", or (more properly stated) greater gravitational force exhibited, means that all these attractions are stronger and thus require more energy to overcome. And thus a lone object in an otherwise empty universe would experience no inertia, as a relationalist would expect — for what exactly could we say it was accelerating relative to?

In conclusion, it seems that to speak of the "mass" of an object as some property other than the force of gravity it exhibits is meaningless, and as this force of gravity has been shown by relativity theory to be explainable entirely in terms of spatiotemporal geometry, the mass of an object is nothing but how much it bends space-time around it. It is an extra irony that the counter-argument to the spinning bucket experiment was conceived of to counter the notion of a bucket rotating relative to space alone; yet, as the gravitational effects which are ultimately responsible for the observed behavior of the water in the bucket are nothing but bends in space-time, it seems that the bucket really does exhibit these effects precisely because it is moving relative to space, or at least, the “texture” of space, the variety of overlapping curvatures from the many centers of gravity distributed mostly uniformly throughout the universe.

Thus far I believe I have shown the absurdities in conceiving of either extension or mass as fundamental properties of matter, distinct from the forces they exhibit. Thus, all the properties attributed to matter reduce to these forces; and since we have shown that there is no substance of something separate from its properties or attributes, these forces are all that there is of matter. This leaves us then with a picture of a single continuum, not featureless and inert like the absolutists’ conception of space, but filled with a variety of forces and the contours of its own geometry (which may someday prove to be one and the same, as I strongly suspect they are). The philosophical implications of this conception are great, reaching even as far as mystical conceptions of “oneness” and subsequent theological, pantheistic conclusions. But I do not intend to delve into those more esoteric implications here.

The purpose of this essay, and the reason for elucidating these ideas here, is simply to show that the historical debate between those who held space to be an absolute, imperturbable backdrop against which the drama of the universe unfolded, and those who held it to be merely a set of relations between objects, was all along based on faulty foundations. For both sides of that debate rested on the notion of separate, discrete objects not connected with one another or with space itself, with distinct boundaries between where there was ‘solid matter’ and ‘empty space’. But as one can easily see in the model I have illustrated in this essay, there is no ‘solid matter’, for no matter is impenetrable, and there is no ‘empty space’, for all space is full of forces. In this conception, both sides of the debate over the nature of space get points conceded to them.

Absolutists gets their way in that the gaps between gross physical objects are not literally filled with ‘nothing’ but are instead ‘filled’ with ‘space’, smoother regions of the same singular substance of which all those objects are also made. Space is an absolute thing, because it is the only thing, if we are content to treat force fields at least as properties of space (if not products of its geometry), since there is nothing left for them to be properties of. But the relationalists also gets their way, for in this model, while space is not so much a relation between objects, objects are themselves nothing but relations between bits of space: folds, creases, ripples, vortices, or other quirks of the shape of space itself, or at least, of the force-fields which permeate it. And in this model, the relationalists' arguments hold true, that nothing can be said to move without something to move relative to, for such motion would be indiscernible from stillness.

But even then, those arguments hold true only because of certain facts about space, as those ‘objects’ are nothing but features of space. Both absolutists and relationalists felt certain in the existence of ‘objects’, and debated only the existence of “space” as something ontologically separate. But by denying the existence of ‘objects’, or rather reducing them to mere features of space, I feel that I have rendered their entire debate moot. Space exists. It is matter that does not.

Despite my confidence in these arguments, I must admit that this model I have presented is not entirely complete. I have not shown whether the electric and nuclear forces, as gravity, are in fact manifestations of the geometry of space time — though I suspect, as many scientists such as Albert Einstein, John Wheeler, and Burkhard Heim have, that it is very likely. Likewise, I can offer no explanation of the nature of the “point-particles” which seem to conjoin together the centers of the fields of various forces, and why such different things as a gravitational field and an electromagnetic field would be so bound together in one “particle” such as an electron. But I feel that this is a good philosophical beginning for the examination of such questions, and a convincing demonstration of the “oneness” and continuity of the material universe.