In rebus mathematicis errores quam minimi non sunt contemnendi
Bishop George Berkeley

Can the spacetime emerge from 'something else'?

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Abstract

Stipulations about the emergence of spacetime from the Platonic realm are briefly presented.

First, some prerequisites from the notions of *neighborhood* and *continuity*. To quote John M. Lee:[1] "Aside from the simplicity of the open subset criterion for continuity, the other reason for choosing open subsets as the primary objects in the definition of a topological space is that they give us a qualitative way to detect "nearness" to a point without necessarily having a quantitative measure of nearness as we would in a metric space."

But to detect "nearness" to a point and define the notion of *continuity* from any given point to the *neighboring* one, we need to zoom on their *neighborhood*. The latter has non-trivial structure, dynamics, and topology (Fig. 1 and Slide 1). To obtain 4+**0** D spacetime with dynamical topology, we will let the topology to *evolve* by "adding a hole where there was none" (D. DeCarlo and J. Gallier). Namely, we will insert a new "hole" [$\mathbf{Q_0}$, $\mathbf{Q_\infty}$], denoted **W** (p. 24), at *each and every* physical spacetime point **Q** in Fig. 1.

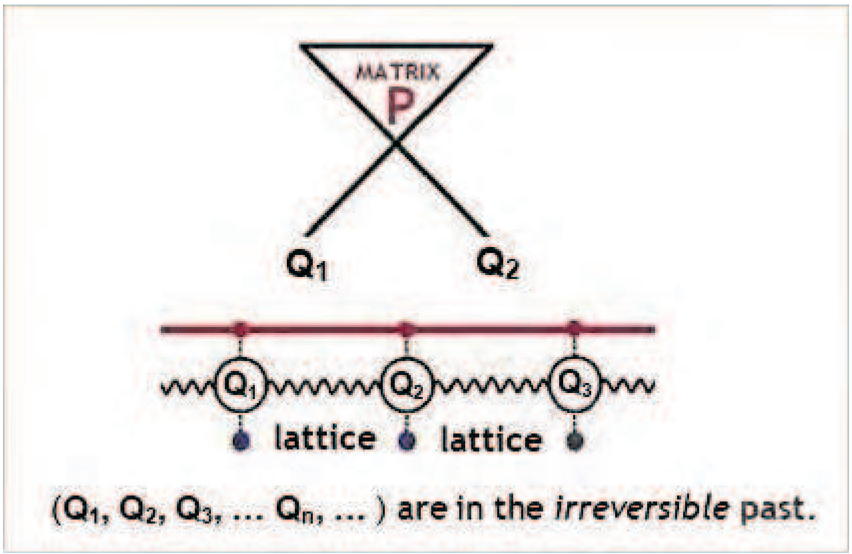


Fig. 1

The reason we propose a new model of spacetime is that the current one[2] contains unacceptable limitations, and can be pictured as 'spherical cow' at best. In my opinion, the suggestion about "open subsets as the primary objects in the definition of a topological space" and those of *neighborhood* and *continuity* (J.M. Lee) are sheer mathematical poetry. Let me explain. At the end, I will introduce sphere-torus dynamics of 4+**0** D **RS** Spacetime. Any error, no matter how small, is not acceptable in Mathematics, says George Berkeley. Corollary: Any idea, which may sound "intuitively clear" but leads immediately to logical contradictions, will be considered false.

For example, consider a blue circle with red diameter, like the one below.

Fig. 2

It may sound "intuitively clear" to speculate about some open interval (Wolfram) that includes *only* the blue points. Not the **two** red end points. It will be as if you have a chain of ten apples numbered from 1 to 10, and you imagine an "open" interval of eight apples [2, 9]. Besides, the set of apples is denumerable, and there are no apples *between* (Sic!) the ten apples. But in our case, we face a segment from the real number line, which is a set of infinitely many (Kurt Gödel) non-denumerable *geometric* points. How are these *geometric* points arranged into a *perfect* continuum? There can be no object "between" any "neighboring" points, which is *not* a point as well. You cannot "drill" the real number line and hit *anything* that is ***not*** a point. (I can, but with the so-called **hyperimaginary** numbers: read p. 6 in ***RS*** *Spacetime*.) The alleged "open subset criterion for continuity" (J.M. Lee) is Russian poetry. It may sound "intuitively clear" only to freshmen in math. Further, we can picture a set of consecutive balls (Fig. 3) with *different* states and show the notion of 'time as *change*', as read with a clock.

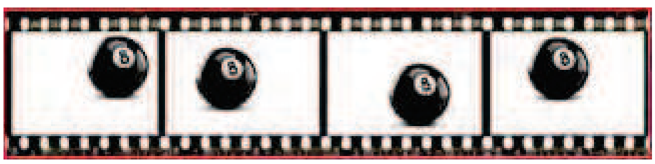


Fig. 3. See Fig. D on p. 3 in *The Arrow of Spacetime*.

In our case, the entire *background*, including the vertical black strips in the movie reel in Fig. 3, correspond to the crucial *ambient Euclidean space* in which all manifolds live.

NB: It is a grave error to "remove" the *ambient* infinite-dimensional Euclidean space.[1] Besides, the sphere-torus dynamics of 4+**0** dimensional **RS** Spacetime lives in it: read the *Note* on pp. 8-9 in *The Fifth Force*.

If the reader still believes in spherical cows[1][2] and hopes to find solutions to the numerous problems mentioned above, I suggest to start by applying the preposterous (ε, δ)-"definition" of limit to Thomson's lamp. Bottom line is that you ***may not*** zoom on a single geometric point or even imagine individual *viz*. countable points. Unless of course you are Chuck Norris.

As mentioned earlier, we insert a new "hole" [Q_0, Q_∞] denoted **W** (p. 24) at *each and every* physical spacetime point **Q** in Fig. 1 and Slide 1. Not just two "holes", as depicted in Fig. 4 from D. DeCarlo and J. Gallier.

Fig. 4.

To explain the initial idea, see the 2D surface of the "expanding balloon", which stands for our good old 4D spacetime as 'shadows in Plato's cave'.

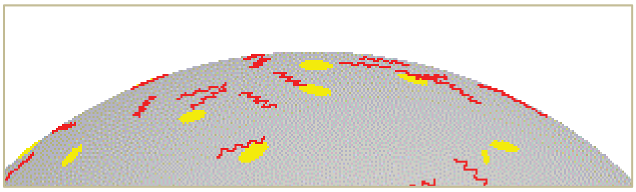


Fig. 5

We cannot show 3-sphere or 3-torus, which live in the (asymptotically flat) "surface" in Fig. 5, and will have to use in their 2D analogies. Also, notice that the crucial "hole" **W** (p. 24) is depicted with **red lines** in Fig. 6 below.

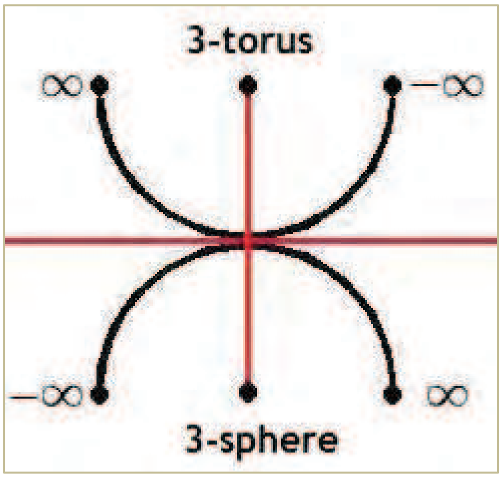


Fig. 6. Adapted from Eric Schechter.

Now the explanation of sphere-torus dynamics (Fig. 6) is straightforward, but will nevertheless require considerable mental gymnastics. Let me try. Sure enough, we can explain the fact that one can find an *exact* number as the limit of a function, thereby alleviating the fears of George Berkeley about the 'ghosts of departed quantities'. That will be easy: see Fig. 5 in *Quantum of Spacetime*. What follows below isn't. The task is non-trivial.[3] Today's theory about relating points and neighborhoods[1][2] can't help.[4][5]

To paraphrase the title, can the null cone *emerge* from 'something else', and the physical world becomes 'retarded light' with positive mass only?

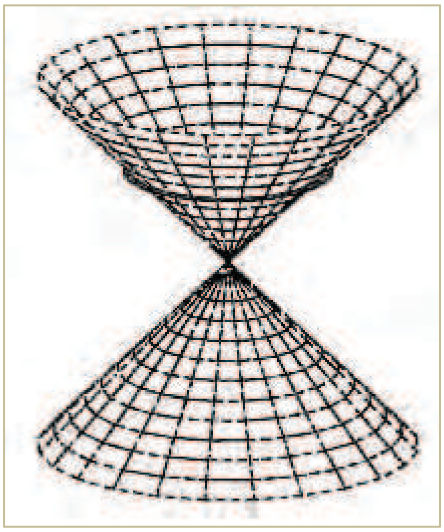
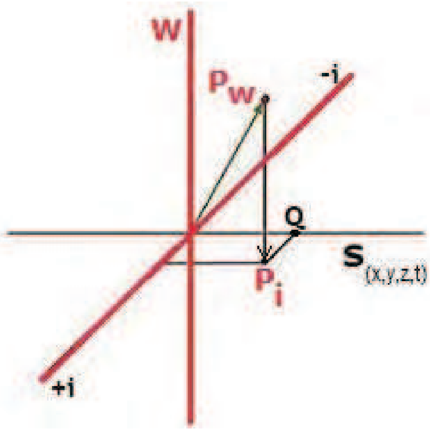


Fig. 7

Think of the null cone (Fig. 7) as a correlating web located "inside" every spacetime point 'here and now' (David Colasante). Our task is to map the sphere-torus transitions (Fig. 6) to the *atemporal* emergence (Macavity) of *physicalized* 4D "jackets" **Q** "after" the **P**-**Q** transitions (Slide 1) in Fig. 8.



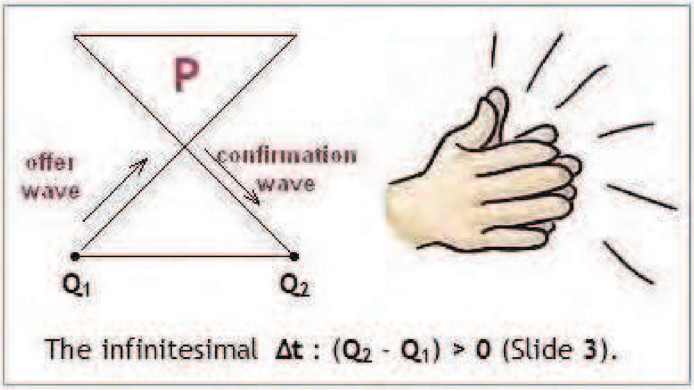


Fig. 8

We want to recover the infinitesimal transition **Δt** & fundamental spin, projected on spacetime points 'here and now'. No "spacetime curvature".

I will use the *ambient* infinite-dimensional Euclidean space in which all manifolds live (read above), and will ask the reader to imagine that the curved line in Fig. 5 (it has to be "curved", otherwise we cannot take derivatives) is a section from his wristwatch, at the top of which we see **12** (Fig. 9.1). Imagine also that you are inflating *indefinitely* the wristwatch.

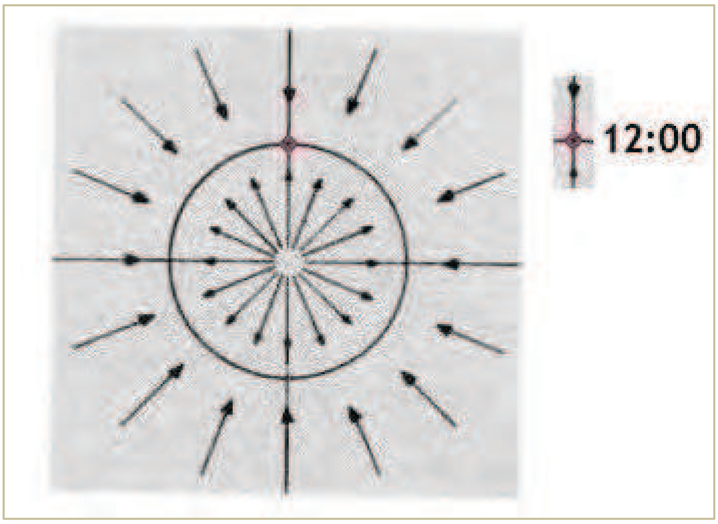


Fig. 9.1

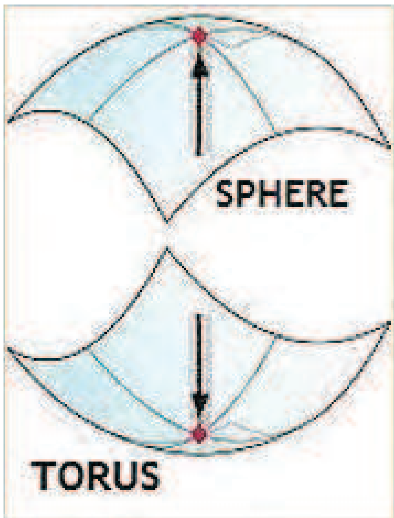


Fig. 9.2

Inevitably, at some instant the "closed" diameter of your wristwatch will reach the actual/completed infinity and will become part of the *ambient* infinite-dimensional Euclidean space. Just a flat line (Fig. 6). The diameter will break at points **9** and **3**, and the center will fuse with the flat line at point **12**. But you are a brave guy and keep going, until you trespass the breaking point and find out that you are now in a torus (Fig. 9.2). It is like flipping a right rubber glove 'inside-out' into a left rubber glove.

But what if the physical, 4D spacetime is topological ***superposition*** of your sphere-and-torus states? Then you will find out that you actually live in CPT invariant world. Just keep in mind that the sphere-torus transitions occur *simultaneously* at **all** point from the diameter of your wristwatch (Fig. 9.1). Voila.

This is the dynamical topology of 4+**0** D spacetime in a nutshell. Read again ***RS** Spacetime* and the *Note* on pp. 8-9 in *The Fifth Force*.

Soli Deo gloria (John 1:1). We only need Mathematics.

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References

1. John M. Lee, *Introduction to Topological Manifolds*, 2010, pp. 19-20.

2. Robert M. Wald, *General Relativity*, 1984, pp. 423-427.

3. C.J.Isham, J. Butterfield, On the Emergence of Time in Quantum Gravity. arXiv:gr-qc/9901024, 8 January 1999.

> Space and time are such crucial categories for thinking about, and describing, the empirical world, that it is bound to be ferociously difficult to understand their emerging, or even some aspects of them emerging, from 'something else'.

4. E. H. Kronheimer, Time-ordering and topology, *General Relativity and Gravitation* **1**(3), 261-268 (1971).

5. R. Geroch, E. Kronheimer, R. Penrose, Ideal points in space-time. *Proc. Roy. Soc. Lond.* A327, 545-567 (1972).