http://www.god-does-not-play-dice.net/#EFE
January 31, 2013, 12:45:20 GMT

$$\underbrace{R_{\mu\nu} - \frac{1}{2}g_{\mu\nu}R}_{\text{Marble}} = \underbrace{\kappa T_{\mu\nu}}_{\text{Timber?}}$$

Subject: Marble vs Timber, arXiv:1301.5481v1 [gr-qc]
Date: Thu, 24 Jan 2013 14:03:01 +0200
From: Dimi Chakalov <dchakalov@gmail.com>
To: Hermann Nicolai <nicolai@aei.mpg.de>
Cc: [snip]

Dear Hermann,

You explained the main problem (p. 3) as follows:

"(T)he point-likeness of particles and their interactions seems to be required by both relativistic invariance and locality/causality – building a (quantum) theory of relativistic extended objects is not an easy task! In classical GR, the very notion of a point-particle is problematic as well, because any exactly point-like mass would have to be a mini black hole surrounded by a tiny horizon, and thus the putative point particle at the center would move on a space-like rather than a time-like trajectory. Again, one is led to the conclusion that these concepts must be replaced by more suitable ones
in order to resolve the inconsistencies of GR and QFT."

And later you added (p. 10):

"So the challenge is to come up with criteria that allow to unambiguously discriminate a given proposal against alternative ones!"

The criteria that unambiguously discriminate my proposal against all the rest is the solution to the main problem (p. 3): neither "point-like mass" nor "relativistic extended objects", but a new geometry with *quasi-local* points, which unifies the current geometry (marble) and matter (timber) from the outset.

If you or any of your colleagues disagree, just try to solve *the* most widely known public secret in theoretical physics -- **localization**,

http://www.god-does-not-play-dice.net/#localization

In my opinion, you can't solve it 'your way', because nobody can. Nobody.

Of course, I will be more than happy if you or any of your colleagues can resolve the localization problem by using theories published on paper, and I will immediately start using your version of quantum gravity.

Please drop me a line if you nevertheless can resolve the 1929 problem at the link above.

All the best,

Dimi

Note: The notion of 'reality' leads to models having an exact, point-like representations of events -- between, before, during, and after measurements/observations -- in order to answer questions about the system, as a function of underlying spacetime. The puzzle of 'localization' concerns the main question in Quantum Theory: What is the state of **reality** that underlies our knowledge about "superposition" and "entanglement" ? In gravitational physics, the puzzle of 'localization' concerns the **transition** of *intangible* gravitational energy into tangible energy of matter (Hermann Bondi), due to which we can model spacetime as made of *physicalized* 'world points' (Bergmann and Komar).

Let me try to answer the main question in Quantum Gravity: What is the state of **reality** that underlies our knowledge about **blank** geometrical "points", as shown with the pure smile of the Cheshire cat in the left-hand size of field equations ?

In classical physics, one can offer a simple distinction between (**i**) continuous and (**ii**) discrete. The first case refers to something that can take any value in a range of numbers, specified within an interval. For example, if I consider the color of my hair, it will fit in two cases, black and white, with a very fuzzy borderline, and I can claim that the color of my 'salt and pepper' hair is specified with numbers ranging from 'pure black' to 'pure white', which comprise a 'color interval'. The number of these threadlike structures, called 'hairs', is always a finite number at particular instant, and because the width of a hair is relatively small compared to my head, I can think of them as 'continuous data'. Case (**ii**) is different, because it corresponds to 'discrete' numbers, such as, for example, the number of email messages I receive in particular interval. So, if I use a 'fine grained' approach and assume that one email takes one second, I can claim that yesterday have received ten emails, which have taken ten seconds out of all seconds from the whole day. The latter is also an interval, but now these 'data' are separated by many 'seconds of **no** data', and subsequently we talk about 'discrete data'.

But what can happen if we instruct the size of 'hairs' and 'seconds' to approach *asymptotically* zero (the empty set **R**), to fill in an Archimedean interval *completely,* included its crucial **end points** that belong to "open sets" (James Dungundji)? We will have to **remove** all mathematical poetry [Ref. 1] and introduce an ultra fine grid, called 'spacetime', which is comprised of infinitesimal 'world points' (Bergmann and Komar). We do need "point-likeness of particles" and "relativistic invariance and locality/causality" (Hermann Nicolai), but we do **not** have 'seconds of **no** data' anymore, to make them 'discrete' as in classical physics.

Question is, can we obtain a model for continuous-and-discrete physical reality at Planck scale ?

Our logic offers only one solution: introduce **blank** (dark Zen) "points" **]between[** all "neighboring" world points, to make all world points *both* absolutely discrete (global mode of spacetime; see explanation here) *and* absolutely continual (local mode of spacetime). Namely, the *structure* of the *physicalized* 'world points' is exhibited with purely geometrical, **blank** (dark Zen) "points"]between[them, and these **blank** "points" are made totally absent -- **zero** -- in the **resulting** local (physical) mode of spacetime **by** the Arrow of Space. How? With the "speed" of light.

Stated differently, a "bartender" will claim that any "converging sequence" [Ref. 1, p. 3] necessarily *contains* the empty set **R** that is nevertheless **not** present at the 'end point' presented with numbers (e.g., two pints). Surely the empty set **R** is absolutely needed to *complete* the sequence and make it 'converging', yet it is *always* '**not** there' (Henry Margenau), like the "shadow" (Warren Leffler) cat Macavity, or simply 'potential reality'.

Why? Because any **finite** (no matter how "small") Archimedean sequence contains exactly the same "number" of UNcountably infinite points (Georg Cantor), and we'll face two **alternatives**: (i) never **actually** complete the sequence, as explained with the on-off states of Thompson's Lamp, or (ii) complete the sentence with 'potential infinity', after which the whole converging sequence will **actually** hit the so-called 'nothingness' or "singularity", and become geodesically incomplete.

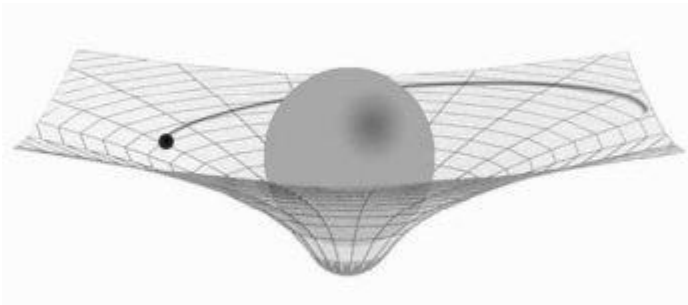
Obviously, these alternatives must be avoided. Only the non-Archimedean and empty set **R**, living in the global mode of spacetime, can *both* finish the job with **actual infinity** from 'the universe as ONE' *and* completely disappear at the end-point of "two pints". Mathematically, it is 'the set of all sets' that is at the same time **not** a 'set' *per se*: see details from Quantum Theory below.

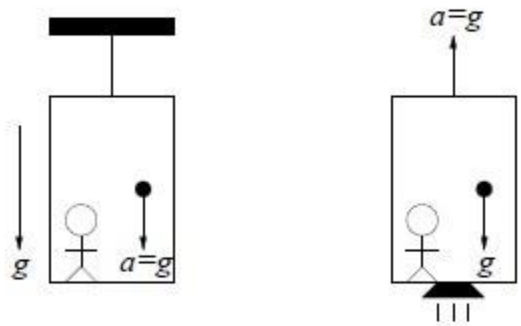
> Strangely enough, if you show the "**set**" errors in the "the worst theoretical prediction in the history of physics", these people wouldn't care. Or will stubbornly claim that cannot understand this crucial issue from 1935. Or both.

NB: This is *the only* option to explain the build up of **finite** intervals, which we call 'emergence of spacetime' (Isham and Butterfield). Only the phenomenon producing the speed of light could somehow "read" all UNcountably infinite points (Georg Cantor) ***en bloc*** and 'take into account' their different **size**, which we define with distance function. We have no alternative proposal to explain the puzzle noticed by Lucretius some 2070 year ago: there **must** be a limit to stop a sequence and make it converging, or else there can be no difference between 'small' and 'large'. We need to amend the current incomplete ideas of point-set topology and differential geometry with the Arrow of Space.

Of course, Hermann Nicolai and his colleagues may not "like" it and would prefer to stick to their poetic textbooks ("arbitrarily near to **x** in an appropriate way," [Ref. 1], p. 3), but they don't have *any* alternative to offer. They can only keep quiet and ignore the facts, as Max Planck explained.

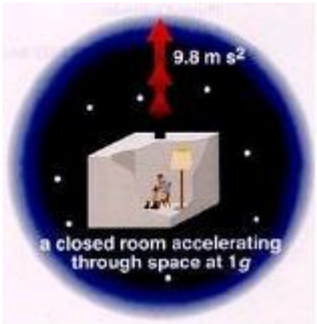
In summary, recall two ideas in Einstein's Allgemeine Relativitätstheorie: "curvature" and "free fall".





Both ideas *imply* the global mode of spacetime that is **totally absent** in the local (physical) mode of spacetime. In the first case, we "see" a crude metaphor of "curved" spacetime, which is **bumped** into some *physically* nonexistent "radius" of the universe (Ned Wright), and then of course cannot explain the fundamental manifestation of gravity by **torsion**, which produces rotation. The second drawing is an equally deceptive analogy, because we cannot replace the elevator cage or "closed room" below with 'the universe as ONE' with respect to which we define the "dark" global mode of spacetime.

NB: The **red arrow** points to **all** directions in 3-D space, because there is no global inertial coordinate system. This omnipresent **red arrow** is from the Arrow of Space. Ignore it at your peril.



The notions of 'time' presented with '*local* duration' [Ref. 2], and 3-D space modeled as 'differentiable volume made by *extremely* packed points "separated" by **nothing**', are produced by the Arrow of Space that can "read" all UNcountably infinite points ***en bloc*** with actual infinity in the global mode of spacetime. I will refer to this '**nothing**', endowed with the faculty of embracing all points ***en bloc*** with *actual infinity*, as "**it**", stressing that **it** corresponds to the unique case of 'zero nothing', as opposed to the physical case of 'zero *something*' (e.g., the current number of theoretical physicists interested in quantum gravity).

This is the only available solution to the *paradox of space*, which also solves the *paradox of time* (not "problem") in current textbooks [Ref. 2]. The **blank** geometrical points, which "separate" the *physical* world points by '**nothing**', are 'the whole universe as ONE' (global mode of spacetime). Depending on the direction we look at **it** from the local (physical) mode of spacetime, **it** can project two *deceptive* (notice 'either/or' contraposition) images: either 'an infinitesimal point tending *asymptotically* toward zero' or 'the largest volume of 3-D space, tending *asymptotically* toward infinity' ('*asymptotically*' refers to **potential** infinity only). However, **it** is a dual object that *wraps* the local mode of spacetime, and can only be pictured as a dimensionless "point" stretched to the dimensions of an "infinite" universe -- there is no metric to define 'distance' in the global mode of spacetime. Everything happens there "instantaneously", just as we can see our face in the mirror only at the very instant we look at it. Likewise, all living and quantum-gravitational systems can "see" the instant spectrum of *potential* "clouds" or "jackets", and choose **one** of them to become physical reality in the **next** instant 'now' from the Arrow of Space. Thus, 'the universe as a brain' can "sense", anticipate, and ultimately alter its potential future, just as the finite brains and living organisms do, following their common 'flow of time' (cf. option YAIN (**iii**) above).

Physically, **it** is *the* ONE entity providing the sufficient conditions for spacetime and **binding** the *physical* world points by '**nothing**' (Luke 17:21), thanks to which we experience accumulated-in-time spatial dimensions of the universe -- one-point-at-a-time along the Arrow of Space.

Nature is designed in a way that is *both* the only possible *and* the optimal one. Can't do it by chance.

Dead matter makes quantum jumps; the living-and-quantum-gravitational matter is smarter.

D. Chakalov
January 25, 2013
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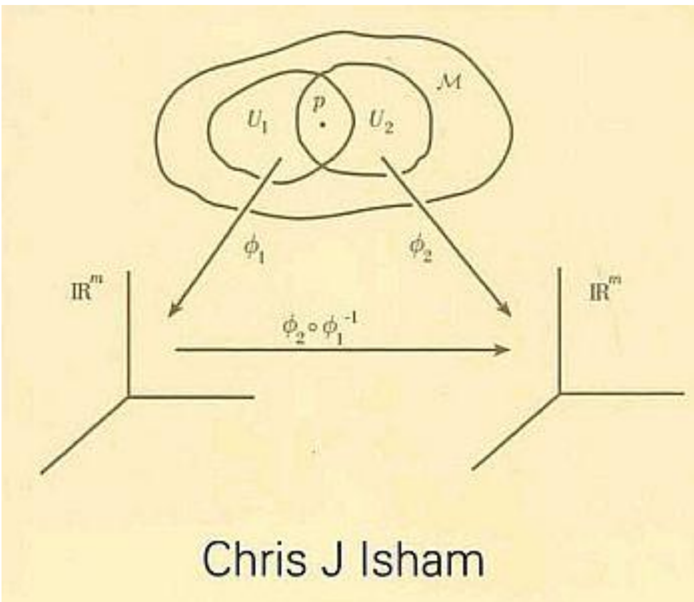
[Ref. 1] Chris J Isham, *Modern Differential Geometry for Physicists*, 2nd ed., World Scientific, 1999.



(Note: To explain 'the point p' above, the maximal resolution used by Chris Isham is with 'points' as well, which I think is sheer poetry - D.C.)

1.1.2 Remarks on topology

The subject of topology can be approached in a variety of ways. At the most abstract level, a 'topology' on a set X consists of a collection of subsets of X—known as the *open sets* of the topology—that satisfy certain axioms (they are listed in Theorem 1.3). This special collection of subsets is then used to give a purely set-theoretic notion of characteristic topological ideas such as 'nearness', 'convergence of a sequence', 'continuity of a function' *etc.* From a physical perspective, one could say that topology is concerned with the relation between points and 'regions': in particular, open sets are what 'real things' can exist in.

Many excellent books on topology take an abstract approach from the outset[1]. However, on a first encounter with the idea of a topology, it is not obvious why that particular set of axioms is chosen rather

[1]Two classic examples are Bourbaki (1966) and Kelly (1970).

than any other, and the underlying motivation only slowly becomes clear. For this reason, the particular introduction to general topology given in Section 1.4 is aimed at motivating the axioms for topology by starting with the broadest structure one can conceive with respect to which the notion of a converging sequence makes sense, and then to show how this definition is narrowed to give the standard axioms for general topology.

1.2.1 The simple idea of convergence

A key ingredient in any topological-type structure on a set X is the sense in which a point[2] $x \in X$ can be said to be 'near' to another point $y \in X$—without such a concept, the points in X are totally disconnected from each other. In particular, we would like to say that an infinite sequence $(x_1, x_2, \ldots)$ of points in X 'converges' to a point $x \in X$ if the elements of the sequence get arbitrarily near to x in an appropriate way. We shall use the idea of the convergence of

[2]The notation $x \in X$ means that x is an element of the set X.

sequences to develop the theory of metric spaces and, in Section 1.4, general topological spaces. As we shall see, in the latter case it is necessary to extend the discussion to include the idea of the convergence of collections of *subsets of X*—with this proviso, the structure of a topological space is completely reflected by the convergent collections that it admits.

A familiar example is provided by the complex numbers: the 'nearness' of one number z_1 to another z_2 is measured by the value of the modulus $|z_1 - z_2|$, and to say that the sequence $(z_1, z_2, \ldots)$ 'converges' to z means that, for all real numbers $\epsilon > 0$, there exists an integer n_0 (which, in general, will depend on ϵ) such that $n > n_0$ implies $|z_n - z| < \epsilon$; this is illustrated in Figure 1.1. Thus the disks[3] [4] [5]

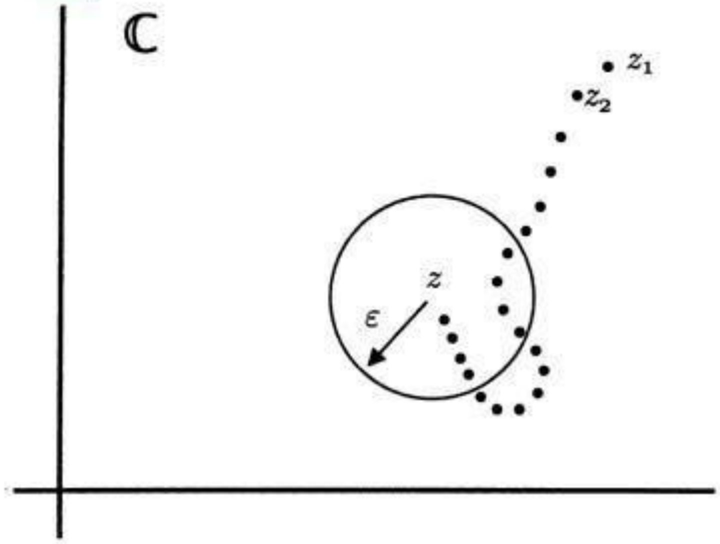


Figure 1.1: A convergent sequence of complex numbers.

$B_\epsilon(z) := \{ z' \in \mathbf{C} \mid |z - z'| < \epsilon \}$ 'trap' the sequence. (Wrong-D.C.)

1.4.8 The idea of a compact space

A most important concept in topology—and one that fundamentally involves generalised convergence—is that of a 'compact' space, which means a space that is, in some sense, of 'finite size'. The classic examples of compact spaces are spheres, tori, or any other subspaces of Euclidean space $\mathbb{R}^n$ that are closed and bounded[25].

[25] A subspace A of a metric space is *bounded* if $\sup_{x,y\in A} d(x,y) < \infty$. ?

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One characteristic feature of such a set is that any infinite subset of points must necessarily cluster together in some way.

[Ref. 2] Sean Gryb and Flavio Mercati, Right About Time? FQXi Essay Contest, 2012.

"As Minkowski put it in 1908 [2], "space by itself, and time by itself, are doomed to fade away into mere shadows, and only a kind of union of the two will preserve an independent reality." Nowhere is this more apparent than in the main equation physicists use to construct the solutions of general relativity (GR):

$$S_{\text{Einstein-Hilbert}} = \int d^4x \, (R + \mathcal{L}_{\text{matter}}) \sqrt{-g} \, . \tag{2}$$

"Can you spot the **t**? It's hidden in the 4 of d^4x. But there are important structures hidden by this compact notation. We will start by pointing out an invisible minus sign in equation (**2**). When calculating spacetime distances, one needs to use

$$x^2 + y^2 + z^2 - t^2, \tag{3}$$

which has a **-** in front of the t^2 instead of Pythagoras' + . The minus sign looks innocent but has important consequences for the solutions of equation (**2**). Importantly, the minus sign implies causality, which means that only events in the past can effect what is going on now. This, in turn, *implies* that generic solutions of GR can only be solved by specifying information at a particular time and then seeing how this information propagates into the future. Doing the converse, i.e., specifying information at a particular place and seeing how that information propagates to another place, is, in general, not consistent. (Footnote 2: Technically, the difference is in the elliptic versus hyperbolic nature of the evolution equations.) Thus, the minus sign already tells you that you have to use the theory in a way that treats time and space differently.
......

p. 3: "Expert readers will recognize this as one of the facets of the *Problem of Time* [4]. The fact that there is no equivalent *Problem of Space* can be easily traced back to the points just made: time is singled out in gravity as the variable in terms of which the evolution equations are solved. This in turn implies that <u>local duration</u> should be treated as an *inferred* quantity rather than something fundamental. Clearly, time and space are not treated on the same footing in the formalism of GR despite the rather misleading form of equation (**2**)."