

In the first place, we entirely shun the vague word "space," of which, we must honestly acknowledge, we cannot form the slightest conception.  
Albert Einstein, [1920](#)

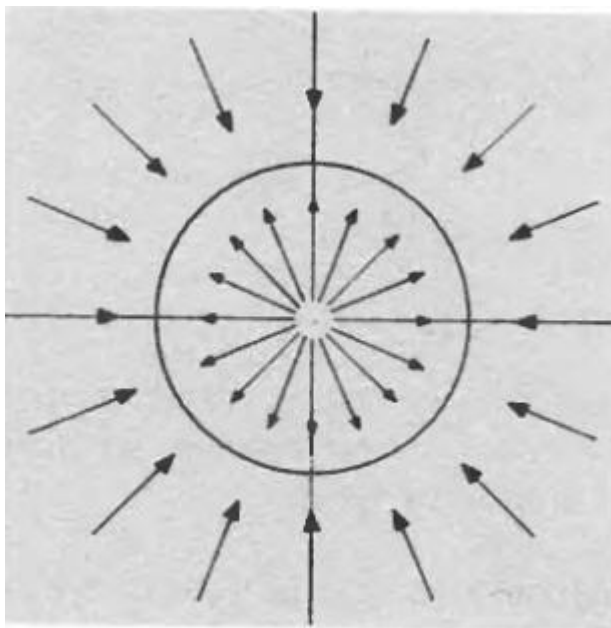
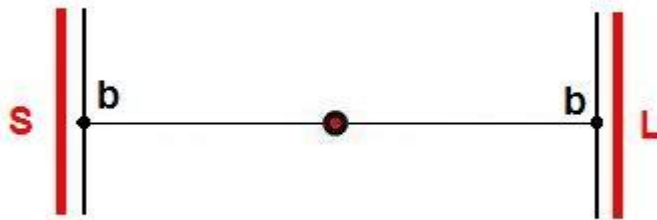
Nur die Fülle führt zur Klarheit,  
Und im Abgrund wohnt die Wahrheit.

[Friedrich Schiller](#)

### **FINITE INFINITY (Second Edition)**

By D. Chakalov, 25 February 2012, 12:53 GMT  
<http://www.god-does-not-play-dice.net/FI.pdf>

Online version [here](#)



## Space inversion

Finite 3-D space (depicted with [circle](#)) obtained by **snapping** the inversion of points along the **w** axis (sphere-torus transitions, [Fig. 5](#)). Space becomes *both* "infinite" (local mode of spacetime) *and* bounded from **S** and **L** (global mode of spacetime).

## Abstract

To introduce "boundaries" on the physical spacetime at all (timelike, spacelike, and null) directions, I will consider an ideal dimensionless point of 'pure geometry', and will postulate a *structure* of such point: a *dual* presentation of 'the universe as ONE', interpreted along an axis (**w**) as *both* 'an infinitesimal' (**S**) *and* 'arbitrarily large volume of 3-D space' (**L**). Then I will suggest topological transformations of points (called 'space inversion') in an infinite-dimensional Euclidean space to obtain a 'collapse over infinity'-reduction of this unphysical Euclidean space to 'asymptotically flat 4-D spacetime' endowed with "boundaries" placed at the *dual* object, 'the universe as ONE'. The spacetime of 'the universe as ONE' is called 'global mode of spacetime', with equation  $L = S = 1$  ([Eq. 2](#)), while the equation of the [Arrow of Space](#), generating *perpetual emergence* and *re-creation* of an asymptotically flat spacetime ('collapse over infinity'), is postulated as  $LS = 1$  ([Eq. 1](#)), in line with Virgil's dictum *Mens agitat molem* or [Der Geist bewegt die Materie](#). I will also outline the so-called 'scale relativity principle' ([SRP](#)) aimed at removing an absolute structure of space known as 'size of objects': nobody has 'the right meter'. Relative to an observer placed at the macroscopic length scale (the "middle" of **w**), objects in 3-D space would look like "large" in the direction toward **L** and "small" in the opposite direction toward **S**, while a co-moving observer will not notice any change in her 'one meter and one second', and will always experience the same "speed of light". Since 'space' is interpreted as an [emergent phenomenon](#) along the Arrow of Space, I will introduce [finite templates](#) for 'size of objects', and will argue that their *scale-dependent* alteration resolves the paradox of the (accelerated) "expansion" of space toward **L** and the (non-accelerated) "shrinking" of space toward **S**, as seen by an observer placed at the macroscopic length scale (the "middle" of **w**), while their *local* alteration recovers the correct geometrical manifestation of gravity (not "curvature"). Hence one can eliminate all "dark" effects of gravity such as "black holes", "cold dark matter", and "dynamical dark energy", and amend Einstein's General Relativity with the 'total field of as yet unknown structure' from the [Arrow of Space](#).


The quest for Finite Infinity has a long history, starting from [Gunnar Nordström](#) (Über die Möglichkeit, das elektromagnetische Feld und das Gravitationsfeld zu vereinen, *Phys. Z.* **15** (1914) 504-506). It is [an age-old problem](#) of [General Relativity](#). Nothing could be more important than understanding the *topological manifold* of the Universe, and its [dynamics](#).

Traditionally, experts in GR start with what I hope to **derive** at the end of this project: asymptotically flat spacetime with [quasi-local](#) positive mass. For example, Rick Schoen would presuppose a "smooth manifold", which has already been equipped with a "Lorentz signature metric", "asymptotic flatness", and "appropriate falloff" conditions, and then ask question like: 'why do we see [positive mass](#) only'? A short answer: because we have an [Arrow of Space](#). The detailed answer requires careful analysis of all initial presumptions in Rick Schoen's talk and in present-day GR textbooks.


Part 1: Introduction to the Problem

We first recall the basic set up in General Relativity.

Mathematical Model:  $S^2$  is a smooth manifold with a Lorentz signature metric  $g$ . This means that for any point  $p \in M$  we can find a Lorentz basis  $e_0, e_1, e_2, e_3$  for the tangent space so that  $g_{ab} = \epsilon_a \delta_{ab}$  where  $\epsilon_0 = -1$  and  $\epsilon_i = 1$  for  $i = 1, 2, 3$ .

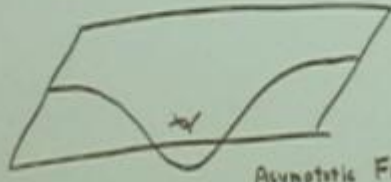


Lightcone Structure  
 $v \in T_p \mathcal{L}$   
 $\langle v, v \rangle > 0$  Spacelike  
 $\langle v, v \rangle < 0$  timelike  
 $\langle v, v \rangle = 0$  Null



Asymptotic Flatness

The most natural boundary condition for the Einstein equations is the condition of asymptotic flatness. This boundary condition describes isolated systems which are the analogues of finite mass distributions in Newtonian gravity. The requirement is that the initial manifold  $M$  outside a compact set be diffeomorphic to the exterior of a ball in  $R^3$  and that there be coordinates  $x$  in which  $g$  and  $p$  have appropriate falloff

$$g_{ij} = \delta_{ij} + O_2(|x|^{-2}), \quad p_{ij} = O_1(|x|^{-2}).$$


Asymptotic Flatness

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A New Mean Curvature Proof of the Spacetime Positive Mass Theorem  
 By [Richard Schoen](#), November 13, 2011, at  
*Celebrating Jim Isenberg's 60th birthday*  
 Pacific Northwest Geometry Seminar, Corvallis, OR, [November 12-13, 2011](#)

A rigorous definition of 'isolated gravitating system', which would ensure an "asymptotic regime such that **all** gravitational effects are localized inside of it" ([Adam Helfer](#)) and proper boundary conditions, is still an unresolved task: there are no *physically* motivated boundary conditions in the case of the Einstein equations; for example, "we do not know how to build a mirror for gravitational waves" ([A. Rendall](#)), nor can we resolve the paradox of [geodesic incompleteness](#) and "[black holes](#)". Moreover, how can we define an 'isolated gravitating system' and its (obviously) [positive mass](#) if the *space itself* is endowed with a new, [dynamical "dark" energy](#)? The calculating machinery of ADM, suggested [half a century ago](#), doesn't work anymore. Enter the Finite Infinity (FI).

In a nutshell, the idea of FI is to suggest a mechanism for obtaining a **finite** volume of [Archimedean 3-D space](#). The very notion of 'finite 3-D space' implies the existence of two distinguishable volumes of 3-D space, separated by a "trapped" surface (cf. lion's cage [below](#)), such that we can *always* define the notions of 'inside vs outside' (hence "large" vs "small") and 'left vs right'. (In order to eliminate the absolute structure of 'size', we will

introduce later the so-called Scale Relativity Principle, [SRP](#).) Now, how can we introduce some process and mechanism by which 'finite space' can be fixed at **all** length scales, in such way that 'physical space' will never *actually* reach zero nor infinity but will *always* remain 'finite' ? We will use an infinite-dimensional Euclidean space and will introduce **smooth** sphere-torus conversions in it, along a new axis **w** , such that these sphere-torus conversions **snap and fix** all [Archimedean](#) volumes of 3-D space from both "below" and "above" (cf. [Fig. 5](#)). Hence space becomes *both* "infinite" (local mode of spacetime) *and* bounded from **S** and **L** (global mode of spacetime). The latter is physically unobservable, because we're stuck in the [Archimedean 3-D space](#) and don't have access to 'actual infinity'. Only Chuck Norris has been there ([twice](#)).

As in a good crime novel, all will (hopefully) become crystal clear at the end. Well, eventually.

Some history. The notion of 'finite infinity' (Fi) was suggested by George F R Ellis in 1984; please see: George F R Ellis, gr-qc/0102017v1, Sec. 5, "Finite Infinity and Local Physics", <http://arxiv.org/abs/gr-qc/0102017>

"This led me some years ago to ask the question: 'How far away is an effective 'infinity' to use in discussing boundary conditions for local physical systems of this kind?' (...) Then incoming and outgoing radiation conditions can be imposed on that surface F, rather than at infinity or conformal infinity I as is usual [57]. (...) Furthermore the famous [positive mass theorems](#) [64] should also be generalized to this case.

...

"This may also be the best setting for numerical calculations for 'isolated systems', which often talk about 'integrating to infinity', but in most cases do nothing of the sort. As in the rest of theoretical physics, it would be advantageous to have a theoretical framework that corresponds more closely to actual calculations - namely an integration to a surface at a finite distance from the centre of coordinates. It is usual to make that surface a null surface; the suggestion here is that it would be better to make it timelike, corresponding to the region in the real universe where the exterior is physically separated from the local system.

"So the obvious proposal [54] is that we should put boundary conditions on all fields at [that distance](#), rather than at infinity itself, leading to the concept of a 'finite infinity' FI ... "

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[54] Ellis G F R, *Relativistic Cosmology: Its Nature, Aims and Problems*, in: *General Relativity and Gravitation*, Ed. B. Bertotti *et al.*, Reidel, Dordrecht, 1984, [pp. 215-288](#); cf. Sec. 5.2 and Fig. 11(c).

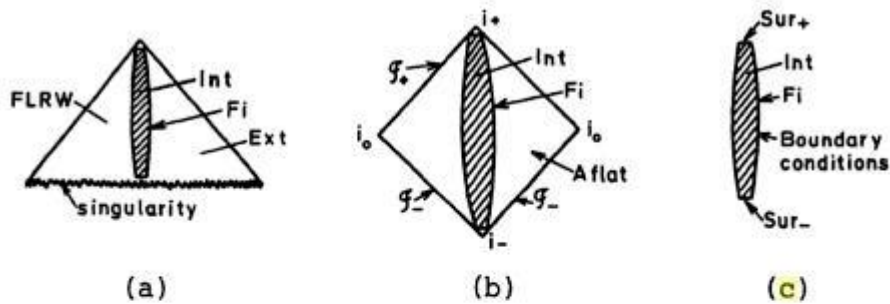


Fig. 11. (a) In a FLRW universe,  $F_i$  is surrounded by a region  $Ext$  which is matter-filled and is not asymptotically flat. Note that we cannot take the limit as  $Sur_- \rightarrow -\infty$ , because the universe started a finite time ago. (b) In the asymptotically flat representation, we surround  $F_i$  by an exterior empty space-time region  $Aflat$ , with properties at infinity similar to those of the Schwarzschild solution. (c) In the finite boundary representation, we simply consider the region  $Int$  bounded by  $F_i$ . Boundary conditions are stated as conditions on  $Sur_-$  and on  $F_i$ .

See also: Ehlers J (Ed) (1979). *Isolated Gravitating Systems in General Relativity*. Proc Int School Enrico Fermi Course LVII (Academic Press, New York).  
<http://www.directtextbook.com/prices/0444853294>

By using exclusively the notion of '[potential infinity](#)', [Stephen Leacock](#) posed the dilemma of 'infinite space' in the following fashion:

"We cannot imagine that the stars go on forever. It's unthinkable. But we equally cannot imagine that they come to a stop and that beyond them is nothing, and then *more* nothing. Unending nothing is as incomprehensible as unending something."

In order to resolve the conundrum of 'ending something', notice that the nature of the *local Archimedean* mode of spacetime (cf. [below](#)) is determined by 'potential infinity': every step toward the Finite Infinity provides the necessary and sufficient condition for the *next* step, just as in the [Thompson's lamp paradox](#). If we go in the "direction" toward '[the infinitesimal](#)' ( $\mathbf{S}$ ), one can (with some luck) work out a [cutoff and end-point](#), but it will belong, again and always, to the *local* ("[colored](#)") mode of spacetime (see the story about 'John's jackets' [below](#)).

If we wish to work out a proper Finite Infinity, the obvious choice is to introduce a new '[cutoff and end-point](#)' conjugated with [the infinitesimal](#),  $\mathbf{S}$ , and to employ the two forms of 'infinity': potential and **actual**. The latter is '[already completed](#)', in the sense that (i) it does not entail any "dynamics" that can be recorded with a [physical clock](#), and (ii) applies only to the *global non-Archimedean* mode of spacetime.

We begin with postulating an [uncountably infinite](#) "number" of points packed in any **finite** -- arbitrarily "large" or arbitrarily "small" -- line segment, plane, or volume of space in the *local* (physical) mode of spacetime, in such way that 'there is **nothing** [\]between\[](#) these points'. Then we will "insert" the *global mode* [\]between\[](#) the points from the local mode, and will make sure that the *global mode* is **non-existent** in the local mode, with the *sole exception* of the instant 'now' from the Arrow of Space, in which the two modes of spacetime coincide (cf. Fig. 1 below).

Notice the crucial difference between the two *modes* of spacetime: in the local mode, a test particle equipped with a clock reading its proper time will need a finite [Archimedean](#) time interval to pass through a finite [Archimedean](#) volume of space, even if the test particle travels with the speed of light. It cannot pass through a *finite* volume of space for 'zero time', even if the volume of space is 'tending *asymptotically* toward zero', as in the case of [the empty set \(R\)](#). Thus, it will always need 'more [Archimedean](#) time' to pass through **all** [uncountably infinite](#) points from the *perfectly smooth* continuum of the local (physical) mode of spacetime. This is the essence of 'potential infinity', and it is valid only for the local mode of spacetime.

Hence the interpretation of 'the infinitesimal' as [the empty set \(R\)](#): in the local mode of spacetime, it *is* and will always remain a **finite** entity, tending *asymptotically* toward zero, being comprised from [uncountably infinite](#) points. In the global mode, however, it is a purely geometrical, dimensionless point -- just **one single** geometrical point (Fig. 1).

**NB:** This **one single** geometrical point [cannot](#) be reach from/within the local (physical) mode of spacetime, for any **finite** duration of time, as read with a physical clock. Why? Because its physical content ([jacket](#)) is **UNdecidable**, after the [Thompson Lamp paradox](#).

Thus, [the empty set \(R\)](#) is endowed with a *structure*, as hinted in Fig. 1 below, and with 'space inversion' (Fig. 1.1). It is the flashmob for the two modes of spacetime, at which they "coincide". It is also the instant 'now' (now-at-a-distance) from the [Arrow of Space](#). And thanks to the so-called "[speed of light](#)", it has **zero** duration and [zero spatial extension](#).

Compared to the local mode, the global mode of spacetime is *ontologically* different: it is a [non-Archimedean](#) realm of 'potential reality' ([GPIs](#)), which can traverse any finite -- arbitrarily "large" or arbitrarily "small" -- line segment, plane, or volume of space from the *local* (physical) mode of spacetime for **zero time**, as it *would have been* read by the clock attached to a test particle from the local mode. Namely, the global mode is equipped with 'actual/completed infinity': it can traverse the [uncountably infinite](#) points of any **finite** object for **zero time** (as it *would have been* read by the clock attached to the test particle from the local mode), and endows the *local mode* with a web of "instantaneous" correlations (as they *would have been* read by an inanimate clock from the local mode). With the Arrow of Space, such kinematics gives rise to a new dynamics resembling a [living organism](#): a [school of fish](#)'-type bootstrapping of physical systems in their quantum and gravitational regimes, and *quasi-local* geodesics, in line with the rule 'think globally act locally' (hence one can introduce a background-free, *relational* reality and Machian quantum gravity).

The question of what kind of 'global time' runs in the global mode of spacetime, equipped with "instantaneous" *actual* infinity, can be answered by explaining its corresponding 'global space' and the [non-Archimedean](#) structure of the *purely geometrical* [GPIs](#) in it.

In general, the quest for amending [Finite Infinity](#) with an Arrow of Space is highly non-trivial, because we should also consider the following tasks:

1. The two *modes* of spacetime are separated by the fleeting instant 'now' from the [Arrow of Space](#), namely, the *global mode* is placed in the realm of 'potential reality' ([GPIs](#) residing in the *potential future* in the Arrow of Space), while the *local mode* refers to the irreversible world of explicated GPIs in terms of **facts**, placed in the steadily increasing 'irreversible past' from the [Arrow of Space](#). Such 'ever-increasing past' is what makes an 'arrow', due to irreversible 'information gain': every instant 'now' pertains to an explicated *physical* universe, which contains *more* information than its immediate predecessor in the 'ever increasing past',

and at the same instant 'now' the physical universe is offered an *enriched* spectrum of potential states to choose from for its *next* instant 'now', just as in the cognitive cycle of [Ulric Neisser](#) (Fig. 2 and Ch. 2 and 4).

Metaphorically speaking, the [Arrow of Space](#) is depicted with the Dragon devouring its tail ([Ouroboros](#)), from the Chrysopoeia ('Gold Making') of Cleopatra during the Alexandrian Period in Egypt. The enclosed words mean 'The All is One.'



The ultimate source for such information gain is 'the true monad without windows' which remains at **absolute rest** [within](#) the instant 'now' (see [below](#)), depicted with Fig. 1 below.

**1.1.** The only "meeting point" of the two modes of spacetime is the instant 'now', in which they **coincide** (Fig. 1). The result is [an already completed](#) and already [negotiated](#) *physical* universe, spanned across the **absolute** instant 'now' from the [Arrow of Space](#), with 3-D space and **zero** "thickness" along **w** (cf. below), in which "there's energy in the gravitational field, but it's negative, so it **exactly** cancels the energy you think is being gained in the matter fields" ([Sean Carroll](#)); check out the Photoshop layers metaphor [below](#) and the resulting non-linear dynamics [here](#).

**2.** The unique "boundaries" on 3-D space in all (timelike, null, and spacelike) directions, introduced with [Finite Infinity](#), should make the universe an 'isolated system', which (i) contains 'absolutely everything', included its Aristotelian First Cause, (ii) is self-enclosed ([Albert Einstein](#)), and (iii) is "bounded" by some ambient *unphysical* spacetime (called here 'global mode of spacetime') which is part and parcel from *the same* 'isolated system'.

**2.1.** To describe such 'universe as ONE' -- self-wrapped (cf. (iii) above) and endowed with the faculty of '[self-acting](#)' due to its "gravitational field" -- one needs to place its **source** "inside" the instant 'now' from the Arrow of Space (Fig. 1), and make sure that the so-called "dark" energy of 'the universe as ONE' is unobservable [in principle](#).

**3.** Last but not least, the ultimate source of 'the universe as ONE' should be interpreted as '[zero nothing](#)', that is, a special kind of "zero" *opposite* to the mundane case of '[zero something](#)'. Perhaps the only way we could grasp the notion of '[zero nothing](#)' or 'the true monad without windows' is by recalling the relation between the content and volume of concepts: the larger the volume, the smaller the content; hence the source of 'absolutely everything, the *unknown* unknown included' should possess **zero** intrinsic content (cf. the [undefinable matrix](#)).

I haven't been able to find suitable mathematical formalism to describe these widely known ideas. All I can offer is a simple (but [incomplete](#)) geometrical explanation of Finite Infinity.

Firstly, there should exist a *maximal volume of 3-D space* (**L**), at which we place the Finite Infinity (**FI**), such that any *finite* volume of space, no matter how large, is identified as an [Archimedean](#) sub-volume **smaller** than the 'maximal space volume', **L**. Likewise, there should exist a *minimal volume of 3-D space* (**S**), at which we place *the same* Finite Infinity (**FI**), such that any *finite* volume of space, no matter how small, is identified as an [Archimedean](#) volume **larger** than 'the minimal space volume', **S**.

Secondly, the two physical, finite, [Archimedean](#) volumes of space tend *asymptotically* toward **L** and **S** in the local (physical) mode of spacetime, but **cannot** reach them for any **finite** [Archimedean](#) duration of **time** due to the "structure" of [the empty set \(R\)](#) at which the *global mode* and the *local mode* coincide (Fig. 1).

The 'no-go' axiom about [the empty set \(R\)](#) ("cannot reach them for any [Archimedean](#) duration of **time**") stems from our belief (not 'fact') that there exist, in the *local mode* of spacetime, an '[uncountably infinite](#)' "number" of points between any finite [Archimedean](#) volumes of space and their "two" cutoffs, **L** and **S**: [the empty set \(R\)](#) cannot be bridged by any finite [Archimedean](#) system for any **finite** duration of time, even if it jumps over the points with the "[speed of light](#)". That is, in the *local mode* of spacetime [the empty set \(R\)](#) is '**finite**' entity, and will always occupy a **finite**, albeit "very small", volume of space packed with '[uncountably infinite](#)' points arranged by '**potential** infinity'. On the other hand, the same [empty set \(R\)](#) is consumed/traversed *instantaneously* in the *global mode* of spacetime, which has [non-Archimedean](#) nature and is endowed with 'actual/completed' infinity.

Thus, we shall place the "two" cutoffs, **L** and **S**, *within* the **red** point in Fig. 1 below, stressing again its **UNdecidable** nature ([Thompson Lamp paradox](#)) of 'potential reality': [pre-quantum non-colorizable](#) General Platonic Ideas ([GPIs](#)).

**FI Postulate:** Due to the [Thompson Lamp paradox](#), any finite, arbitrarily "large" or "small", [Archimedean](#) volume cannot **physically** reach **L** and **S** residing in the *global mode* of spacetime, equipped with *actual* infinity.

**NB:** A precise explanation of '*physically* reach': in the local (physical) mode of spacetime, we *always* reach/nullify [the empty set \(R\)](#) at the point of '2 min', which is why the state of Thompson's lamp is *always* defined by the rules of '[bartenders](#)', but it is just a fleeting "**jacket**" cast by **John** from the *global* mode of spacetime. The latter is endowed with *actual* infinity. In other words, in the *global* mode of spacetime the interval **[0, 2]** is closed, while in the *local* mode the same interval is [open](#) -- **(0, 2)**.

Thanks to the [Arrow of Space](#), the 'large finite volume' will chase **L** in the local mode **indefinitely**; in the *local mode* of spacetime [the empty set \(R\)](#) can only tend *asymptotically* toward **zero**. The same holds for the *opposite* case of the **separation** of any arbitrarily small [Archimedean](#) volume of space from **S** by the same [empty set \(R\)](#): in the local mode, it would require an infinite -- [actual infinity](#) -- amount of **time** for the *elimination* of [the empty set \(R\)](#) and reducing it to **zero**, at which point the [Arrow of Space](#) would **stop**, and the universe would cease to exist.

Notice that the **FI** Postulate introduces [new structure of spacetime](#) at the level of '[differentiable manifold](#)' **prior to** any matter; example [here](#).

The very notion of 'space' requires that all physical objects acquire *finite* [Archimedean](#) size; a table with length '[one meter](#)' fills in a [template](#) for 'one meter'. In the case of an one-meter *template*, we observe a **finite** table with length one meter, which is again a '**sub-volume** of finite space'. The purpose of Finite Infinity (**FI**) is to define the [largest template](#) and the [smallest template](#) for all finite **volumes** of 3-D space.

The *maximal volume of 3-D space*, **L**, and *minimal volume of 3-D space*, **S**, belong to the *global* mode of spacetime for which the *actual* infinity holds ('[already completed](#)'), and are related by

**LS = 1** (Eq. 1).

Thanks to [the empty set \(R\)](#), no physical, Archimedean stuff can '*physically* reach' **L** and hence go "beyond" **L**, and also no physical stuff can '*physically* reach' **S** and hence go "below" **S** (compared it to the [conformal recipe](#)): **L & S** is ONE object which belongs to the [non-Archimedean global mode](#) of spacetime.

In a nutshell, the modified Finite Infinity satisfied two conditions: in the local mode of spacetime the universe approaches [asymptotically](#) its causal boundary (cf. Eq. 1 above) within an [open interval](#), while *at the same time* the universe is being (present continuous) permanently wrapped *by itself* in the global mode of spacetime. Hence 3-D space can be literally [wrapped by itself](#), exactly as [Albert Einstein](#) required.

Again, there is no path whatsoever to the *global mode* of spacetime **from** the *local mode* of spacetime; hence the [FI Postulate](#) above. The difference between **S** and **L** is that in the case of the former we can find some 'numerically finite but physically unattainable boundary/cut off' (the Planck length), but for **L** we have only an [eternally expanding 'sub-volume](#) of finite space', which can only chase **L** but can never *physically* reach it: **L** and **S** belong to the [non-Archimedean global mode](#) of spacetime.

It is the Arrow of Space which creates such *asymmetry* in the treatment of **L** and **S**. We have a numerically finite but physically unattainable "bottom", while space "expands" in the local mode toward **L** *indefinitely*: at each and every instant 'now' from the Arrow of Space, the universe occupies a finite **sub-volume**, being literally **wrapped** from both "below" and "above" with Eq. 1 above. Depending on the direction we look at the edge of the universe in the local mode of spacetime, either toward **L** or toward **S**, we see "two" edges, while in the *global mode* they are ONE -- the universe as ONE, as stressed by [Lucretius](#) some 2060 years ago. We don't have such structure of spacetime in [differential geometry textbooks](#).

Notice that we face here a kind of '[logical infinity](#)': no physical, [Archimedean](#) volume of space can reach **L**, because **L & S** belong to the 'the universe as ONE' (Eq. 1 above). In other words, one could *logically* reach something *only* if this "something" is 'not yet reached', while in our case it is *logically impossible* to "reach" something (**L**) which is being eternally residing "inside" us (**S**) from the outset. Thus, the notion of '[logical infinity](#)' refers to the statement that if the [Arrow of Space](#) is terminated, the universe will cease to exist and will return to its initial state of pure light and cognition, known as [John 1:1].

Without the global mode of spacetime, the universe would be governed exclusively by [Archimedean geometry](#), [conformal recipes](#) would have worked, tessellation of space with 3-D "[tiles](#)" would have been possible, and we would calculate the *exact finite* number of "atoms" filling a finite volume of space without *any* gaps from [the empty set \(R\)](#): we would hit an "end-point" beyond which "is nothing, and then *more* nothing" (S. Leacock). Thank God, this is impossible.

Again, we cannot *physically* "see" **L & S**, because we don't have access to 'actual infinity'. Only Chuck Norris has been there ([twice](#)).

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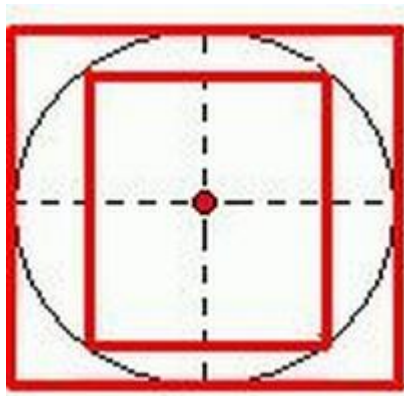
Now, let me try to explain geometrically [the empty set \(R\)](#), which would "point" to the "dimension" of space, denoted with **w** (from *wunderbar*, after [Theodor Kaluza](#)), of the postulated global mode of spacetime (pictured with **red**; local mode with **black**).

The size of physical bodies along **w** are [zero](#), because **w** lives *only* at the fleeting instant '[now](#)' -- a purely geometrical "point" at which the two modes of spacetime, global and local, **coincide**. Attached to the same instant '[now](#)' is a 'pocket of propensity states' in the global mode of spacetime, called General Platonic Ideas ([GPIs](#)); check out GPIs in the human **brain** (not "mind") [here](#).

First, the dimensionless instant 'now', at which the two *modes* of spacetime coincide:



Fig. 1



**Fig. 1.1**

[Space inversion](#) with respect to the instant 'now' (Fig. 1).

The so-called 'space symmetry' in the global mode of spacetime (pictured with **red**) is defined as two interchangeable and simultaneous presentations of any **finite** volume of space from the local mode (pictured with **black** circle), such that a **global** observer can monitor *any finite* volume of space in the two directions of **w** *simultaneously*, as explained in [Wiki](#): (i) from the center of the circle (Fig. 1) "outside" in all radial directions, and (ii) from "outside" the **black** circle (2-D trapped surface of [lion's cage](#)) toward the center of the circle along the same **T**-inverted radial directions (not shown). In 2-D space, the "trapped surface" is a circle; in 3-D space it is a sphere with radius **r** (Fig. 4.2). In order to derive the circumference of the **black** circle, consider the two red rectangles (sides **n** = 4), and start doubling their parameter **n**, after [Archimedes](#). At the instant 'now' from the Arrow of Space (Fig. 1), **n** reaches **actual/completed** infinity and the inscribed and the circumscribed polygons shift to 'pure geometry' of 'the grin of the cat without the cat', as observed by Alice (in the LHS of [Einstein field equation](#)).



The sides of the polygons are converted into [uncountably infinite](#) "geometrical points", each of which can take a *fleeting* physical ([colored](#)) "jacket" in the [local mode](#) of spacetime (cf. the parable of John's jackets [below](#)).

If we apply space inversion along the two "directions" in the drawing from Mark Armstrong below, we can grasp the notion of Finite Infinity: every volume of 3-D space is being snapped like [the circumference of a circle](#), along the two "directions" of **w** (see Fig. 5 below), thanks to which it becomes a **finite** entity. Voila!

1. Homeomorphic spaces have the same homotopy type.
2. Any convex subset of a euclidean space is homotopy equivalent to a point.
3.  $\mathbb{E}^n - \{0\}$  has the homotopy type of  $S^{n-1}$ . Define  $g: \mathbb{E}^n - \{0\} \rightarrow S^{n-1}$  by  $g(\mathbf{x}) = \mathbf{x}/\|\mathbf{x}\|$ , and let  $f: S^{n-1} \rightarrow \mathbb{E}^n - \{0\}$  be inclusion. Then  $g \circ f = 1_{S^{n-1}}$ , and  $1_{\mathbb{E}^n - \{0\}} \simeq f \circ g$  via  $G(\mathbf{x}, t) = (1-t)\mathbf{x} + t(\mathbf{x}/\|\mathbf{x}\|)$ . The case  $n = 2$  is illustrated by Fig. 5.7; the arrows indicate how points move during the homotopy  $G$ .

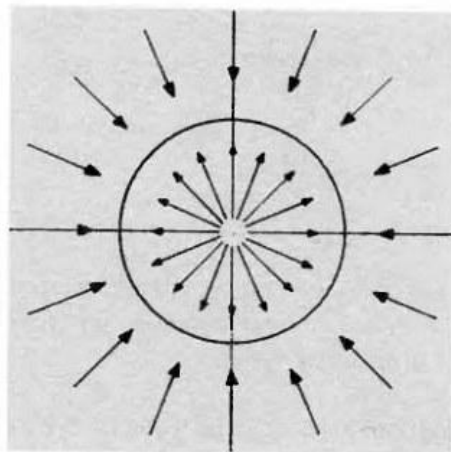


Figure 5.7

M.A. Armstrong, *Basic Topology*, Springer, 1997, [p. 104](#)

In the local mode of spacetime (pictured with **black**), we multiply the dimensionless point in Fig. 1 along one dimension in two **opposite** directions, to obtain 2-D spacetime. For the purpose of this presentation, the time direction will not be shown. Notice that 1-D **space** is endowed with T-invariance: we can flip all the points to the right with those to the left (Fig. 2.1), and *vice versa*, with respect to the initial point in the middle (Fig. 2.2).



Fig. 2.1



Fig. 2.2

The next step is constructing 2-D space from Fig. 2.2, by introducing a second spatial dimension, again with two *directional* degrees of freedom, and move **all points** from 1-D space, *en bloc*, in two **opposite** directions (Fig. 3.1).

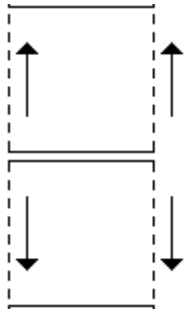


Fig. 3.1

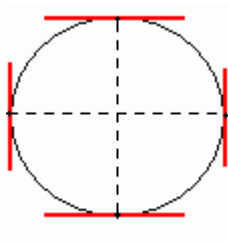


Fig. 3.2

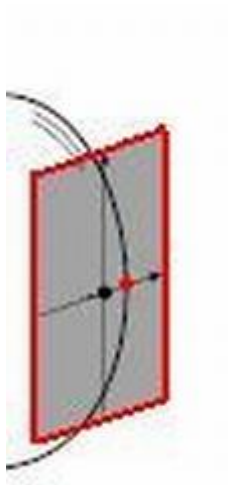


Fig. 3.3

Notice that Fig. 3.2 is a Flatland universe (time dimension not shown) in which Flatlanders enjoy PT-invariance: swapping the points along the horizontal line (Fig. 3.2), with respect to the vertical line, will bring T-symmetry, while the vertical flip, with respect to the horizontal line, will produce a mirror image with 'right' and 'left' interchanged. If we try to apply Finite Infinity to such Flatland universe, the two spatial dimensions will be "bounded" by the non-physical (to Flatlanders) **third** spatial dimension in which their space would look *extrinsically* "curved", with "tangential surfaces" attached to one "point" but spanned in the **third** spatial dimension.

In the current GR textbooks and [tutorials](#), the **black** and **red** points in Fig. 3.3 are fused with the rules of [diff calculus](#), after [Leibniz](#); then people claim that in "[sufficiently small](#)" (notice the poetry) neighborhood around such fused **black/red** point "*it is possible to choose a "locally inertial coordinate system" such that, within a [sufficiently small](#) region of the point in question, the laws of nature take the same form as in unaccelerated Cartesian coordinate systems in the absence of gravitation*" (cf. [below](#)). What a mess.

Going back to the Flatland: we, as "global" observers, can "see" all points from Fig. 3.2 *en bloc*, while the Flatlanders will encounter obstructions from a **line**: it will be like an *infinite* 1-D wall which prevents them from seeing "behind" the wall. We can "see" all the points from Fig. 3.2 simultaneously, *en bloc*, which would translate to Flatlanders as 'keeping simultaneously two *inverted* images from their Flatland', one with T-symmetry and a second one with P-symmetry. Regarding their 'time', the Flatlanders will be totally puzzled by our ability to oversee *en bloc* their two paths from **A** to **B** in their **(t+)**-direction, and from **B** to **A** in their **(t-)**-direction. They don't have such clock, and will claim that *our* "time" is dead frozen (much like 3-D people do in [canonical quantum gravity](#)).

It requires far more efforts to elaborate on the example from [Wiki](#) about an infinite 2-D plane in our 3-D space, which poses no restrictions to "observers" in the *global* mode along **w**, equipped with *actual* infinity and capable to "see" simultaneously all points from our 3-D space both *en bloc* and **inverted** with 'space inversion' (cf. Fig. 5). Notice that we have **three** such restrictive planes in 3-D space (**xy**, **xz**, and **yz**, cf. Fig. 4.2), and enjoy CTP-invariance upon "swapping" the points *via* the global mode of spacetime, as we did in Figs 2.1 and 3.1 above.

The new symmetry, called '[space inversion](#)', should eliminate all **fixed** relations in the Archimedean 3-D space, such as 'large vs small' or 'inside vs outside'. Otherwise our 3-D space will not be dynamical, but will impose a [fixed background](#) for the length scale in terms of **absolute size** of objects in 3-D space. Once we eliminate the absolute Newtonian time, we should eliminate **all** absolute structures from 3-D space as well.

To elaborate on the example from [Wiki](#), I suppose one could "see", from the global mode of spacetime, two superposed P-invariant images of "[the lion](#)", obtained after the inverted (w.r.t. the cage surface) 3-D space. Such symmetry is literally about **inverting** all the "points" trapped **inside** a *finite* volume of space approaching asymptotically **S** with all the "points" from the *finite* volume of space approaching asymptotically, in "opposite direction", **L**, which remain **outside** that "shrinking" finite volume of space (**Fig. 1.1**). The "number" of points in any *finite* volume of space is '[uncountably infinite](#)', so there should be no obstacles to perform such '[space inversion](#)'.

Let's start with endowing the Flatland with a spatial dimension, by moving all the points from Fig. 3.2 *en bloc* along two opposite "directions", up (toward **L**) and down (toward **S**):

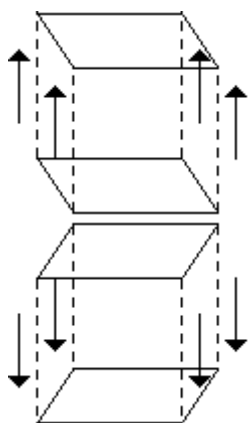


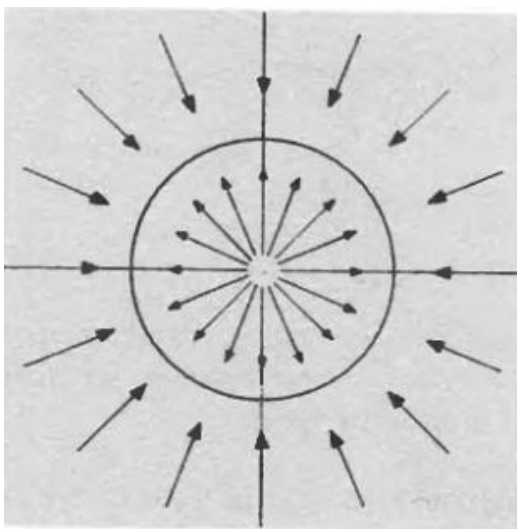
Fig 4.1



Notice that, in addition to the three **planes** in 3-D space (**xy**, **xz**, and **yz**) and their corresponding transformations or "swapping the points" (CPT-invariance), we have a new 'space inversion' symmetry, as mentioned in the discussion of Fig. 1.1 above.

**NB:** This exercise will be really tough. Try to imagine the "trapped circle" from Fig. 1.1 as "trapped 3-D space", that is, a 3-D "rubber glove" hypersurface which can be seen along the **two** directions of **w** as two simultaneous "gloves", right and left, corresponding to the **unbroken** symmetry of the GPI field (see [below](#)) inhabited by the unphysical, [GPI states](#) of negative & positive mass.

You will have the unique freedom to "look" at the 3-D hypersurface *simultaneously* along the two directions of **w** : from 'inside-out' and from 'outside-inside' (cf. the drawing from Mark Armstrong below), corresponding to 'sphere' and 'torus' (cf. Fig. 5).



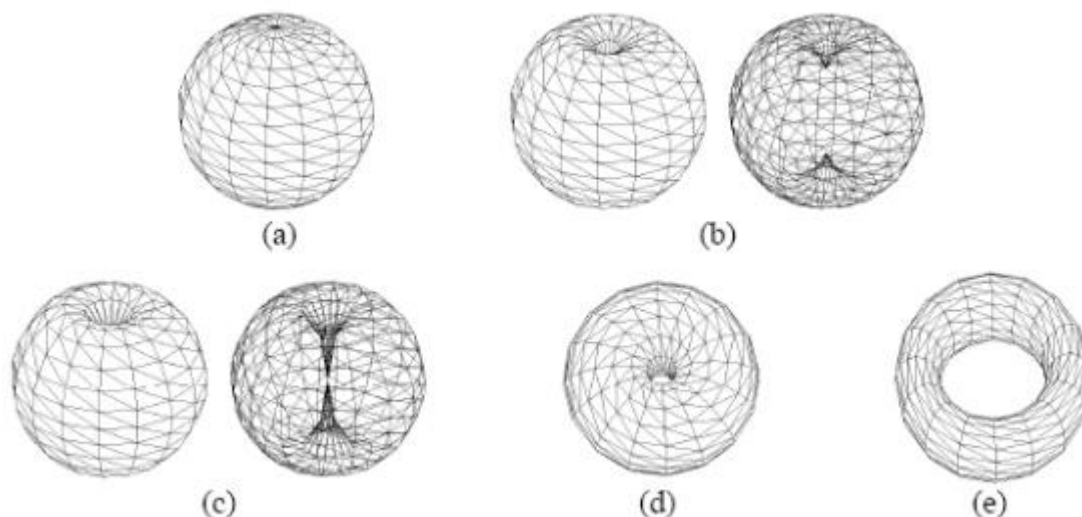
M.A. Armstrong, *Basic Topology*, Springer, 1997, [p. 104](#)

Such simultaneous viewpoint is impossible to imagine, as hinted in [Wiki](#), but if we **lower** the dimensions of the physical space to 2-D spherical surface trapped by the six **red** planes in Fig. 4.2, the 'inside-out' view will display **all** points from the 2-D spherical surface, as seen from the center of Fig. 4.2 along **all** radial directions 'inside-out', and by executing 'space inversion' with respect to the 2-D spherical surface ("[lion's cage](#)") we will see again **all** points from the **finite** 2-D surface from 'outside-inside', along the *inverted* radial directions, keeping the two presentations of the 2-D "rubber glove" (left and right) simultaneously available to our **w** - inspection. However, we *cannot* "move" the unique object at the center of Fig. 4.2, shown with the **red point** in Fig. 1 above: it is in 'absolute rest' and is residing *both* inside every point from the physical 3-D space *and* outside the physical 3-D space, as **The Beginning** (see [below](#)) of the two viewpoints at the 3-D "rubber glove" hypersurface along **w** , from 'inside-out' and from 'outside-inside'.

Last but not least, the aim of the putative space inversion is to recover 'asymptotically flat spacetime' with the two 'viewpoints' along **w** . Look at Fig. 3.2 above, and picture it as a clock, such that Fig. 1 is placed at the center, and four red segments tangential to 12, 3, 6, and 9. Imagine one radius "connecting" (*not quite*: see Fig. 4.3) the center to **9**, and blow up the circle by instructing the radius to **reach** infinity and pass "over" it. The conventional wisdom tells us that the circle will "degenerate", or rather "collapse", to 1-D Euclidean space presented with the vertical red line at **9** (Fig. 3.2) at the very instant at which its radius is *exactly* infinite, but at *that same* instant the two points in the orthogonal direction, **12** and **6**,

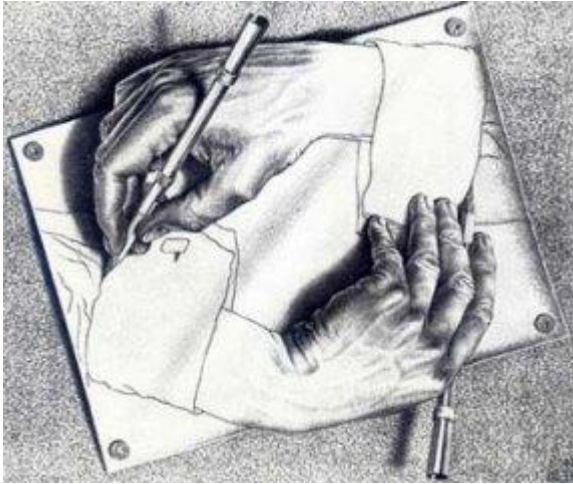
will ultimately **break up**. Once it passes "over" infinity, the object will regain its 2-D status, but will be converted into two finite cross-sections of a torus. Notice that at the instant of 'collapse over infinity' **all** points from the circle in Fig. 3.2 will be arranged in 1-D space, like those in Fig. 2.2 above.

Now, if we keep the radius constant, such non-smooth topological transition will match a well-known screensaver in Windows 97, half of which is depicted with the drawing from D. DeCarlo and D. Metaxas ([1996](#)) below.

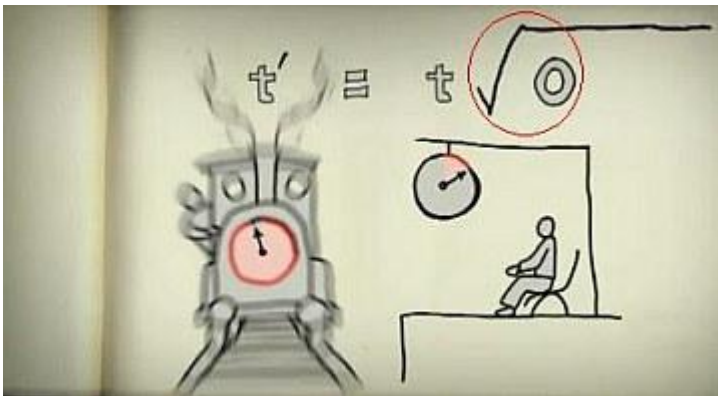


But our case is different, since we wish to recover the asymptotically flat spacetime "around" the critical 'collapse over infinity' instant, with positive and negative space curvature inherited from the circle and the torus. Namely, *after* passing through this critical instant, not just one but **all** "inflating" radial directions -- except for the center, see Fig. 1 -- will be **inverted**, as explained in the exercise [above](#). If we wish to start by inflating the torus from 'case (e)' above, along the opposite direction in **w**, we will again pass through the same 'collapse over infinity' instant, "around" which we imagine some 'asymptotically flat spacetime', after which we will wind up in the "clock" case from Fig. 3.2, only this time its radius will be shrinking toward the center of the clock. Please keep these two invertible **T**-invariant images passing through 'asymptotically flat spacetime' in your mind. All we need now is to replace the circle/torus with the 3-D "rubber glove" hypersurface from the exercise [above](#).

Again, the two opposite directions along **w** are totally hidden *inside* the luxonic world (cf. Max Tegmark above) with *indifferent* (zero) mass. Physically, the two directions of the circle/torus conversion in the global mode of spacetime, along **w**, are totally hidden, their duration is **zero**, and we can only imagine two [atemporal waves](#), depicted with the Escher hands, by which all [non-linear](#) negotiations in 'the school of fish' are completed for **zero** time, as read with your wristwatch: we can *never* see [Macavity](#).



Notice that I haven't tried so far to introduce any '[distance function](#)'. I have only an uncountably-infinite 'points' ordered with the [relation of intermediacy](#), [A (**zero**) B], which is interpreted as "**zero** is [between](#) A and B". The unique object with **zero** physical presence in the local (physical) mode of spacetime is The Aristotelian Connection of 'the universe as ONE' (cf. the **red** dot in Fig. 1). It is manifested by [purely affine connection](#) facilitating parallel transport of vectors in the local (physical) mode of spacetime, from *one* spacetime point to *the nearest* point, and is [independent from the metric](#). It also captures the essence of the "speed" of light. Let me try to explain.



0.47-0.52: "Relative to the platform, time on the train completely stops."  
 The ill-defined expression " $\sqrt{0}$ " [must be amended](#) by a new *mathematical* object relevant exclusively to the [non-Archimedean](#) global mode of spacetime.

Relative to the passengers in the [train](#) (see the picture above), the **local mode** of their 'time on the train' does indeed "stop": you move into the luxonic world (cf. Max Tegmark above), and can "see" all the *intermediate* topological transformations of the Universe, not just its 'collapse over infinity'-state depicted in [Fig. 5](#).

Consider again a **finite** chunk of space, say, [one meter](#): it is comprised from uncountably-infinite 'points' *ordered* with the [relation of intermediacy](#), [A (**zero**) B]. The Aristotelian Connection of 'the universe as ONE', [A (**zero**) B], *passes* the physical state at point **A** to its "neighboring" point **B** with particular "speed" which **acquires** an [upper limit](#) for any **finite** volume of space. The numerical value of the "speed of light" isn't interesting; just like the

Planck length, it is a 'numerically finite but physically unattainable **boundary** of the local mode of spacetime'. We cannot define, even as a Gedankenexperiment, 'one second' as the product of [[Planck time](#)]  $\times 10^{43}$ . The universe as ONE (global mode) is a totally different world which shows up only with its Aristotelian Connection.

What matters here is that The Aristotelian Connection operates in the global mode of spacetime: it "reads" **all** of the uncountably-infinite 'points' from any **finite** chunk of space **en bloc**. By an analogy with a movie reel, one could speculate that The Aristotelian Connection is "projecting" 3-D space as '**uncountably-infinite** infinitesimal "frames" per second', meaning that every "frame" is *the* 'collapse over infinity'-state (cf. [Fig. 5](#)). Unless we encounter relativistic effects (watch the movie from NOVA below), this **en bloc** "reading" does **not** slow down (for comparison, watch a water drop [here](#)).



The unique "speed" of light, due to The Aristotelian Connection, is preventing us from taking even a glimpse at the global mode of spacetime: we can see only an [already-completed](#) physical world, in line with the idea about relativistic causality ("causal processes or signals can propagate only within the light-cone," [Jeremy Butterfield](#)).

Notice the precise meaning in GR of '[already-completed](#)': all **non-linear** negotiations between the two sides of the Einstein field equations are being *post factum* completed for [zero time](#), as read with your wristwatch. "All agree that in general relativity, the metric tensor  $g_{ij}$  is (or better: represents a field that is) dynamical: it **acts** and is (at the same *instant* - D.C.) **acted on**. They also agree that it is a special field since it couples to every other one, and also cannot vanish anywhere in spacetime. Many authors go on to say that the metric tensor represents geometry, or spacetime structure, so that geometry or spacetime structure **acts** and is (at the same *instant* - D.C.) **acted on**" ([Jeremy Butterfield](#)). More succinctly: "the metric is treated as a field which not only affects, but also is (**at the same instant** - D.C.) affected by, the other fields" ([John Baez](#)). This non-linear paradox is depicted with the Escher hands above, and can be resolved only with the two modes of spacetime, as argued [previously](#). Michael Redhead argued in [1995](#) that the notion of 'localizable particle' makes sense only for a free particle, while I suggest a '[quasi-local](#)' alternative in terms of [Machian relational ontology](#) with the rule 'with respect to *everything else* in the universe'. In short, the issue of relativistic causality is [anything but trivial](#) in GR. As stressed by [Margaret Hawton](#), in quantum field theory probability density is defined at a fixed *instant*  $\mathbf{t}$ , and it is by no means obvious how to "insert" in such fixed *instant*  $\mathbf{t}$  the [already-completed](#) non-linear '**acting** and at *the same instant* being **acted upon**' in GR.

Thanks to The Aristotelian Connection [A ([zero](#)) B], there exists a **bond** between spacetime points, and the "speed" of light is its manifestation. If the "speed" were infinite or unlimited, there would be no difference between 'small' and 'large', and '3-D space' as the **medium** for 'finite things' would have not existed; if the "speed" of light were a **finite** entity, it would be

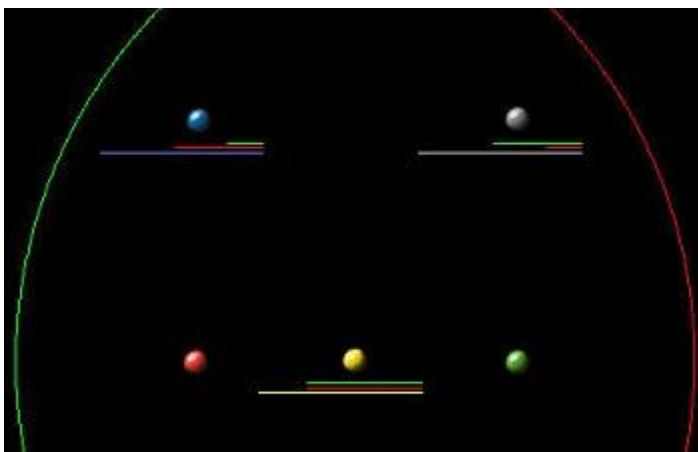
surpassable, and then there would be no separation between the two worlds with inverted spacetime basis, material and tachyonic (cf. Max Tegmark [above](#)).

Notice that 'space as the **medium** for finite things' is a very old idea, debated by [Ernst Mach](#). The difference between 'small' and 'large' is **not** fixed in the [local, Archimedean](#) mode of spacetime, but in the global, non-Archimedean mode by 'finite invariant templates' (cf. below).

**NB:** The *alteration* of these templates is [the essence of gravity](#). We have 'finite invariant templates' for 'finite space', fixed by The Aristotelian Connection: it is the **bond** between spacetime points that determines 'the time it would take a photon to traverse a distance equal to a [**finite** volume of space]'. (As [Erik Curiel](#) explained, "in general relativity all the fundamental units one uses to define stress-energy, namely time, length and mass, can themselves be defined using only the unit of time; these are so-called geometrized units. (...) A [unit of length](#) is then defined as that in which light travels *in vacuo* in [one time-unit](#)." ) Then a minuscule *alteration* of the **bond** between spacetime points can produce **enormous** change of 'the time it would take a photon', and subsequently of the 'finite invariant templates' (resembling "curvature", cf. [Bill Unruh](#)), leaving the deceitful impression of some "[cold dark matter](#)" or "[supermassive black hole](#)".

The effect is [purely geometrical](#), according to the so-called 'scale relativity principle' ([SRP](#)). Namely, an observer placed inside such **altered** (by 'the time it would take a photon') spacetime template will **not** notice any change of her ambient spacetime **assembled** by The Aristotelian Connection, in terms of her 'one meter and one second': she will **always** experience the same "speed of light", regardless of the extent to which *her* template has been altered with respect to an unaltered template of an observer placed at the length scale of tables and chairs. This is because the "number" of spacetime points in any **finite** volume of 3-D space, approaching asymptotically **S** and **L**, remains unchanged ([Kurt Gödel](#)), being a [non-Archimedean](#) phenomenon, and also because The Aristotelian Connection is endowed with 'actual infinity' and "reads" **all** uncountably-infinite 'points' from any **finite** chunk of space **en bloc**.

Notice that 'the time it would take a photon', which defines each and every '**finite** volume of space' (see above), is the **global (en bloc)** mode of time. It is the *background time* code of the animation from [John Walker](#) below, and it must be [totally hidden](#).



Again, the crux of the matter is the initial puzzle of '[one meter](#)' and its treatment with the two manifestations of infinity. Namely, with the *potential* infinity operating in the local (physical) mode of spacetime, '[one meter](#)' will be presented with "open sets" ([James Dungundji](#)), which do **not** include the crucial '[end points](#)', ( 1m ), despite the fact that any such *interval* can be defined only with respect to a [fixed point in The Beginning](#); with the actual/completed infinity

operating in the [global non-Archimedean mode](#) of spacetime, the same 'one meter' will be presented as 'completed' **en bloc** interval [ 1m ]. The puzzle of 'the infinitesimal' was identified by [Titus Lucretius Carus](#) some 2070 years ago, yet people still seek 'the smoothest manifold' like [bartenders](#), and of course cannot find 'the unmoved mover' in GR ([Karel Kuchar](#)).

There is a lot more to be said about the "speed" of light, as The Aristotelian Connection "happens" only *post-factum*, at [null-surface](#). We cannot witness the *alteration* of these templates online, as it "happens", and we will *always* observe an **already**-assembled, by The Aristotelian Connection, spacetime in which we cannot reach the [luxonic world](#).

By going into the center of Milky Way, all we can *post-factum* observe is a **finite** volume of space in which our 'one meter and one second' has **not** been altered, hence we would claim that these 'spacetime templates' are "invariant to us", while a distant observer will see us "shrinking". Ditto to [the "expansion" of space](#). There is no need to invoke any anomalous "dark" stuff with "positive energy density and negative pressure", as you may have heard from [Ned Wright](#), say.

More on SPR [later](#); for now it suffices to say that the "speed" of light **must** be 'numerically finite but physically unattainable boundary' in order to provide for **finite** volumes of space and time intervals of the local mode of spacetime.

First and foremost, I need to eliminate all absolute structures in 3-D space, such as '[absolute size](#)', by allowing the '[templates for finite space](#)' to shrink toward **S** and expand toward **L**, as viewed by an observer at the length scale of tables and chairs, and also providing *invariant* size of **all** object toward **S** and toward **L**, as seen by a [co-moving observer](#). In other words, we need a *dual*, scale-dependent metric to define 'distances in 3-D space'. Then the "[expansion of space](#)" can be explained as an illusion observed only from the length scale of tables and chairs. Ditto to the "non-accelerated" shrinking of the "size" of objects toward **S**, in line with the so-called 'scale relativity principle' ([SRP](#)). The latter is an elaboration on the old idea about 'the mutual penetration of the Large and the Small'. Who has "the right meter"? [Nobody](#). This is the essence of SRP. [Simple, no?](#)

**NB:** To explain the '[templates for finite space](#)' and their "[dark](#)" influence on matter and fields, recall the operational definition of 'second': the total duration of 9,192,631,770 transitions between the two hyperfine levels of the ground state of the cesium 133 atom, provided the cesium atom is "at rest at a temperature of 0K, such that the ground state is defined at zero magnetic field" (reference [here](#)). In the local, [Archimedean](#) mode of spacetime, we imagine that the **distance** between every **two** neighboring dots from the drawing below refers to **one** transition between the two levels of the ground state of the cesium-133 atom, and that the total of such physical, [Archimedean](#) distances, comprising 'one second', is **exactly** 9,192,631,700:

{.....}

This is clearly an unfeasible Gedankenexperiment, which cannot be reproduced. Most importantly, the "*intrinsic* time interval associated to any timelike displacement" (Ted Jacobson, pp. [18-19](#)), defined here as 'the elementary tick of time [|between|](#) two purely geometrical points ordered with the [relation of intermediacy](#) [A (**zero**) B]', can be defined only in the global, [non-Archimedean](#) mode of spacetime. These are 'invariant templates' for **finite** durations of time and **finite** volumes of space, which approach *asymptotically* **L** and **S**.

The **alteration** of these templates, relative to an observer at macroscopic length scale, produces *purely geometrical* effects (interpreted as "[black holes](#)" and "[expanding space](#)"), yet

a [co-moving observer](#) will **not** notice any alteration of her intrinsic '[distance function](#)'. Again, this is the well-known idea about 'the mutual penetration of the Large and the Small', which can start only from the macroscopic length scale in the two "directions" along **w**, toward **L** and toward **S**.

**NB:** An objection to such 'finite templates' would be that they are merely mental, or epistemological constructs representing our "knowledge", hence we cannot grant them an ontological status of '**ideal** geometrical reality'. Well, with [Finite Infinity](#) we can indeed suggest such 'finite templates' fixed **by** the topological transitions in the global mode of spacetime (cf. [Fig. 5](#)), hence resolve the underlying puzzle of '[extendable volumes of space](#)', which allow us to "look around, and see as far as we can" ([Lee Smolin](#)). This simple fact can be explained iff the spacetime "points" are **perfect** geometrical points **ordered** by The Aristotelian Connection as a [perfect continuum](#) (the current theory *requires* that "points become *fuzzy* and *locality loses any precise meaning*," cf. [Sergio Doplicher](#)).

With SRP and its *dual* spacetime metric, one could alter the "distances" in 3-D space in such a way that a "[reactionless](#)" alien visitor craft (AVC) will travel with speed "one meter per second" (relative to the people in the AVC) to cover the size of a galaxy (relative to observers outside the AVC). You won't notice your "speeding", but you will notice that the space in front of you is running towards you, just like with the [Alcubierre](#) warp drive. In [SRP](#), the question of 'who has the right meter and the right second' is meaningless. In present-day GR, the question of 'who has the right meter' is answered with **absolute** size of objects in 3-D space, toward **L** and toward **S**, which is nothing but 'looking for a right answer to a wrong question'.

Fig. 4.3 below shows the main idea of Finite Infinity.

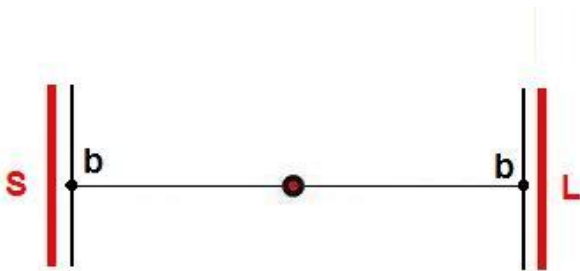


Fig. 4.3

The horizontal line shows the axis **w** in terms of two directions in 3-D space, toward **S** and **L**. The points denoted with **b** (from '[bartenders](#)') are the fleeting explications of GPIs in the local (physical) mode of spacetime: [John's jackets](#).

The black horizontal line (asymptotically flat 4-D spacetime, see [Fig. 5](#) below) cannot reach the realm of **S & L** ([Thompson Lamp paradox](#)).

And finally, let's see how the **w** axis will look in the global mode of spacetime ([Fig. 5](#)), by combining [Fig. 1](#) with the blow up of [Fig. 3.2](#) at the point "9 o'clock" (not shown).

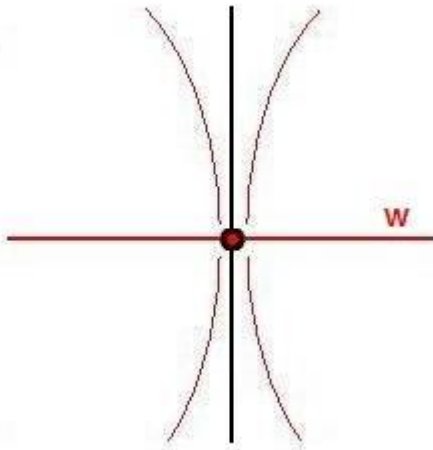
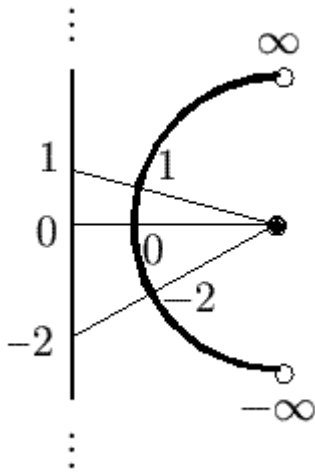


Fig. 5

The **red/black** point in Fig. 5 belongs to an asymptotically flat, physical, 4-D spacetime; the vertical black line is taken from Fig. 2.2. above. The *right* part from Fig. 5 shows the **T**-invariant (cf. the drawing from Mark Armstrong above) "blow up" of the circle from Fig. 3.2, by watching the point at "**9** o'clock" (see above): at the critical 'collapse over *actual* infinity' instant, at which the radius of the circle in Fig. 3.2 is *exactly* infinite, we would have obtained an absolutely flat 4-D spacetime, which is why I talked, for the lack of better wording, about "*around* the critical 'collapse over infinity' instant". The *left* part from Fig. 5 shows a segment from a torus -- see the drawing from DeCarlo and Metaxas above, 'case (e)', and the explanation of 'space inversion', about the two simultaneous viewpoints at the 3-D "rubber glove" Cauchy hypersurface, from 'inside-out' (right part from Fig. 5) and from 'outside-inside' (left part from Fig. 5). The horizontal **w** axis is the one along which 'the mutual penetration of the Small and the Large' begins from the *macroscopic* length scale, as discussed above. Hence the only remnant from **w** in our *asymptotically* flat spacetime (called 'local mode of spacetime') is depicted with the two red lines in Fig. 4.3 above, placed at **S** and at **L**.

Notice that the horizontal **w** axis is **not** a 4th spatial dimension, because the new degrees of freedom to "look at" the 3-D "rubber glove" Cauchy hypersurface entail moving *simultaneously* along **all** directions in the local mode of spacetime, from any point in 3-D space, from both 'inside-out' toward **L** and its time-reverted direction toward **S**. This is impossible in 3-D space, as explained in Wiki [below](#), but recall that these are the "directions" of the Arrow of Space: the elementary 'change **of** space' is nothing but *the* elementary increment of our physical **time**, as read with our clocks -- it isn't a "vector". Thus, the global mode of spacetime and the axis **w** of the Arrow of Space could only be perceived by us as "occurring" in some infinite-dimensional Euclidean space, much like a Flatlander (cf. Fig. 3.2) would be totally puzzled by our 3-D viewpoint, and would also have to imagine some higher-dimensional space to accommodate **our** 3-D viewpoints **inside** his Flatland.

To visualize these **smooth** torus-sphere transitions over the 'collapse over infinity' instant 'now' (Fig. 1), hence the **re**-created 'asymptotically flat 3-D space', look carefully at the drawing below, from Eric Schechter ([5 December 2009](#), emphasis added): "There are no points for plus or minus infinity on the line, but it is natural to attach those "numbers" to the **endpoints** of the semicircle."



The point denoted with 'zero' from the vertical line corresponds to the point at "9 o'clock" in Fig. 3.2 above (not shown). Notice that **every** point from the **circle** in Fig. 3.2 above will pass over the 'collapse over infinity'-instant, and at this instant its **two** conjugated **endpoints**, from the direction orthogonal to the horizontal line segment pictured here, will "break up" the circle and will convert it into a (hyper?) torus.

The 3-D space at the **exact** 'collapse over infinity' instant would be **absolutely** flat, and would contain just a **bare red** point from Fig. 1 above, known as [John 1:1]. Which is why I talked, for the lack of better wording, about "around the critical 'collapse over infinity' instant", to describe the asymptotically flat 4-D spacetime of present-day GR.

But look at Eq. 1 [above](#): in the *global* mode of spacetime, we can set **L** and **S** to take values of some dimensionless variable "measured" along **w** ; all we need is to ensure that **L** and **S** take reciprocal values, until they **snap** to

$$\mathbf{L} = \mathbf{S} = \mathbf{1} \text{ (Eq. 2).}$$

Eq. 2 describes 'the whole universe as ONE' in its global mode of spacetime, inhabited *only* by [GPIs](#). The Arrow of Space runs simultaneously along the two "opposite directions" from **w** , and at each and every instant '**now**' (see Fig. 1) a newly-born physical universe is being **re-created** in the local mode of spacetime.

Namely, Eq. 2 reduces to Eq. 1 [above](#), and the finite, **Archimedean**, 3-D space is born anew by [the "spontaneous" broken symmetry](#), stacked along **w** like [Photoshop layers](#).

We cannot look at the "**gaps**" of **re-creation**: the local (physical) mode of spacetime is being re-created as [a perfect continuum](#), thanks to the "[speed of light](#)".



Perhaps the global mode of spacetime can be presented with *four* segments (notice the favicon of my web site) in which two [atemporal](#) quantum-gravitational waves run against each other, **re-creating** asymptotically flat spacetime at the 'collapse over infinity' instant. Also, the fundamental phenomenon called 'spin' should be explained as topological property of 3-D space. As Peter Rowlands suggested (arXiv:0912.3433v1, Sec. 3, [p. 5](#)), "Space and time are simply quaternions multiplied by **i**, and spin is simply a topological property of space (as Dirac knew), and not quantum or relativistic in origin."

In the quantum-and-gravitational realm of the local (physical) mode of spacetime, physical objects [gradually](#) acquire increasing access to 'the whole universe as ONE'. They become

[bootstrapped](#) by their "gravitational field", due to opening a "**red** window" to their GPIs residing in the global mode of spacetime. Which is why a quantum particle can be in a superposition of its GPI states (say, a superposition of  $|\text{cat}\rangle$  and  $|\text{dog}\rangle$ , [Erich Joos](#)), and all (not just "small") bodies follow *quasi-local geodesics*: at each point from such *quasi-local geodesics* we can install a local Lorentzian frame, by going into "[freefall](#)" at such *quasi-local* point, and imagine that [the effects of gravity](#) have **re**-disappeared.

All this is a very brief and [incomplete](#) effort to amend the Finite Infinity, introduced by [George F R Ellis](#). Needless to say, I will be happy to [elaborate](#). Details [here](#).

D. Chakalov

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<http://www.god-does-not-play-dice.net/#Eckhardt>

<http://www.god-does-not-play-dice.net/#thesis>