A Novel Interpretation of the Lorentz Transformations

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What this Talk is About

In this talk, I introduce a novel interpretation of the Lorentz transformations and then briefly touch upon some of its implications.

Lorentz Contraction as Dimensional Abatement I

Definition

Absolute Dimensionality: *The absolute dimensionality of an object is a dimensionless natural number that refers to the independent length dimensions which characterize it.*

Definition

Volume-Boundary ratio: *The Volume-Boundary ratio of a compact object with absolute dimensionality* $n > 1$ *is the ratio of its n-dimensional volume to its* $n - 1$*-dimensional boundary.*

Definition

Relative Dimensionality: *Relative Dimensionality is the dimensionless ratio of the Volume-Boundary ratio of a compact object with absolute dimensionality* $n > 1$ *to that of a compact reference object, also with absolute dimensionality n.*

Lorentz Contraction as Dimensional Abatement II

Definition

Dimensional Diminution: *For an $n-$dimensional compact object, dimensional diminution is the decrease of its relative dimensionality compared to its original state to a real number in the open interval* $(0, 1)$.

Definition

Dimensional Reduction: *For an $n-$dimensional compact object (n>1), dimensional reduction is the decrease of its absolute dimensionality to $n-1$. Equivalently, it is the decrease of its relative dimensionality compared to its original state to* 0.

Definition

Dimensional Abatement: *A less specific umbrella term which can either refer to Dimensional Diminution or to Dimensional Reduction.*

Lorentz Contraction as Dimensional Abatement III

Proposition

Lorentz contraction can be conceptualized in terms of dimensional abatement. More specifically, it signifies dimensional diminution for $0 < v < c$ ***and dimensional reduction for*** $v = c$***.***

Proof: Consider a compact body B moving in a frame S and a moving frame S' in which B is at rest. We imagine B in S' as being made out of infinitesimal cubical volume elements oriented, without loss of generality, such that the direction of contraction in S will be normal to one of the sides. It is trivial to show that the Lorentz contraction of each cubical element in S causes it to be dimensionally abated. Since this is true of every infinitesimal volume element of B, it is true of B. ■

A Criterion for Physical Existence in Spacetime

Arguably, our understanding of nature has become so deep that in order to make further progress, we need to incorporate the concept of existence into physics. The following existence criterion, presented as an axiom, is an attempt to do so:

Criterion

A physical object exists in Minkowski spacetime if and only if it is characterized by a timelike spacetime interval.

Time Dilation as Ontochronic Abatement I

Definition

Spacetime Ontic Function: *The spacetime ontic function is a map* $\exists_S : \mathfrak{O} \to \{0, 1\}$ *where* $\mathfrak{O}$ *is the set of all physical objects taken to be within the domain of physics and* $S \subset \mathfrak{O}$ *is the subset of* $\mathfrak{O}$ *of all objects that exist in spacetime. The spacetime ontic value of an object is determined by whether it satisfies the existence criterion* $(\exists_S(x) = 1)$ *or not* $(\exists_S(x) = 0)$.

Definition

Ontochronicity: *Ontochronicity is the quality of having a duration of physical existence.*

Definition

Relative Ontochronicity: *Relative ontochronicity is the dimensionless ratio of the the observed duration of existence of an object compared to that of a reference object, usually the observer.*

Time Dilation as Ontochronic Abatement II

Definition

Ontochronic Diminution: *Ontochronic diminution is the decrease of the observed duration of existence of an object in a given time interval by a dimensionless factor in the open interval* $(0, 1)$.

Definition

Ontic Reduction: *Ontic reduction is the reduction of the ontic value of an object to* 0. *Equivalently, it is the decrease of its ontochronicity to* 0.

Definition

Ontochronic Abatement: *Ontochronic abatement is a less specific umbrella term which can either refer to ontochronic diminution or to ontic reduction.*

Time Dilation as Ontochronic Abatement III

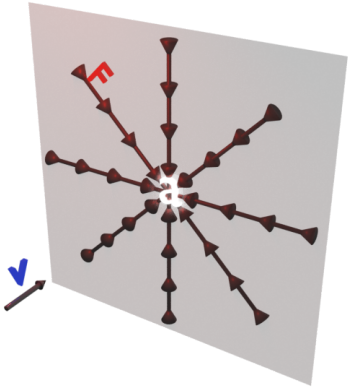
Proposition

Relativistic time dilation can be conceptualized in terms of ontochronic abatement. More specifically, it signifies ontochronic diminution for $0 < v < c$ ***and ontic reduction for*** $v = c$***.***

Proof: Follows trivially from re-interpreting the proper time of an object as its observed duration of existence in spacetime, and coordinate time as the duration of existence in spacetime of the observer, between two given spacetime events.■

A Reconceptualization of Electromagnetic Fields

- Dimensional Abatement can be applied to infinitely extended fields
- Can think of the magnetic **Force** field of a point charge as the line integral of a 1-dimension reduced analog of its electric **Force** field and derive from it $\mathbf{F} = q(\mathbf{v} \times \mathbf{B})$



Four Unappreciated Spacetime Principles

The reinterpretation focuses attention on two invariance and two symmetry principles:

1. **Invariance of Absolute Dimensionality:** *The absolute dimensionality of any compact body is invariant under spacetime coordinate transformations.*
2. **Homodimensionality of Space:** *The dimensionality of every space-like hypersurface of Minkowski spacetime is everywhere the same.*
3. **Invariance of Spacetime Ontic Value:** *The spacetime ontic value of any compact body is invariant under spacetime coordinate transformations.*
4. **Homodimensionality of Time:** *The dimensionality of every timelike hypersurface of Minkowski spacetime is everywhere the same.*

Existence as an Equivalence Relation I

- **Principles 1 and 3 together couple absolute dimensionality to spacetime ontic value.** Propositions 1 and 2 together already show that dimensional and ontochronic diminution couple to each other exactly as Lorentz contraction and time dilation couple to each other, but the two invariance principles together extend this to dimensional and ontic reduction.
- **Principles 2 and 4 together ensure that the coupling of absolute dimensionality to spacetime ontic value holds globally.** In a spacetime in which the homodimensionality of space or of time fails to hold, there could conceivably be regions in which spacelike or timelike hypersurfaces have a different dimensionality inside the region than outside, and in such regions absolute dimensionality and ontic value could decouple. The two homodimensionality principles together ensure that this does not happen.
  I will call a spacetime in which both homodimensionality principles hold ***isodimensional***.

Existence in spacetime as an Equivalence Relation II

Proposition

Physical existence in Minkowski spacetime is an equivalence relation by absolute dimensionality.

Proof: An equivalence relation is determined by the properties of reflexivity, symmetry and transitivity. Consider an n-dimensional compact object A subject to the above principles. By the the coupling of ontic value to absolute dimensionality, it must exist in an $n+1$ dimensional Minkowski spacetime region. By the isodimensionality of Minkowski spacetime, this region is, in fact, all of $n+1$ dimensional spacetime. In particular, A exists in the $n+1$-dimensional Minkowski spacetime in which it exists. This proves reflexivity. Now consider an m-dimensional compact object B. By the same argument as given for reflexivity, it must exist in an $m+1$ dimensional spacetime. Suppose A exists in the same spacetime as B. This requires that $n+1 = m+1$, and, consequently, that $n = m$. But that means B has the same absolute dimensionality as A, and therefore exists in the same spacetime as A. This proves symmetry. Finally, consider an l-dimensional compact object C. By the same argument as given for reflexivity, it must exist in an $l+1$-dimensional spacetime. Now suppose that B exists in the same spacetime as C, and that A exists in the same spacetime as B. This requires $m+1 = l+1$ and $n+1 = m+1$, respectively, from which it follows that $n = m = l$, so A has the same absolute dimensionality as C and therefore exists in the same spacetime as C. This proves transitivity. ■

A Partition on all Things that Exist *per se*

The ontic equivalence relation considered here partitions the set of all objects that physically exist *per se* into *ontic equivalence classes* such that for each $n+1$ dimensional Minkowski spacetime, there is a corresponding equivalence class of n-dimensional objects that exist in it.

0+1 Spacetime	1+1 Spacetime	2+1 Spacetime	3+1 Spacetime	4+1 Spacetime	...
0-dimensional objects	1-dimensional objects	2-dimensional objects	3-dimensional objects	4-dimensional objects	...

Figure: A partition of all physically existing objects into ontic equivalence classes by absolute dimensionality.

Two Implications of the Ontic Partition

- **Speed-of-light objects belong to a different ontic equivalence class than spacetime observers.** This can now be given as an *explanation* for the impossibility of transforming to the rest frame of a speed-of-light object: If a spacetime observer could transform to a speed-of-light rest frame, he or she would no longer be a *spacetime* observer.
- **Any theory which supposes *both* that the Lorentz Transformations hold *and* that n-dimensional objects exist in an m + 1-dimensional region of spacetime, such that n $\neq$ m, may be inconsistent.** This may be useful as a guide for theory selection and should be carefully checked in each theory which is a candidate for supposing both.

Separating the Quantum from the Classical Domain

- Photons are inherently quantum and belong to an equivalence class of objects distinct from the equivalence class of spacetime objects. This suggests the possibility that this applies to all quantum objects.
- A working hypothesis: Quantum systems fail to exist as a spacetime objects, but manifest as a combination of possibilities until spacetime objects emerge out of as yet unspecified interaction $\Rightarrow$ **Measurement**
- Spacetime ontic value may be what keeps the domains of applicability of quantum and classical physics mutually exclusive.
- If the domains of classical and quantum physics are mutually exclusive, the incompatibility between is no longer a problem
- This is the subject of my research program

Conclusion

- There was once before a re-interpretation of the Lorentz transformations, in 1905. It profoundly changed the course of 20th century physics and led to a *paradigm shift*.
- It is possible that the reinterpretation presented here may also lead to a paradigm shift. More work needs to be done to work out the consequences.
- The ideas presented here are discussed in papers available at *Deep Blue*, the University of Michigan's repository for scholarly work:
  - "Dimensionality in Physics": http://hdl.handle.net/2027.42/147435
  - "Existence in Physics": http://hdl.handle.net/2027.42/147436
- I am here for the duration of the conference and welcome your questions, comments and criticisms, either in person or at armin@umich.edu

Thank You!