Imaginary Time Implies an Imaginary Speed of Dark

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Abstract

I propose that imaginary time during the early universe implies an imaginary analog of the speed of light c, the speed of dark id. Using id in Lortentz transformations yields predictions of how events at the transition from imaginary to real time would propagate into the real timeline. If dark matter and energy are measurable effects of events that occurred during the transition from imaginary to real time, an imaginary id replacing c in Lorentz transformations predicts that they should be globally measurable but not locally observable. I focus here on dark matter and show that it is plausible that the apparently much greater mass of dark than regular matter is the consequence applying id in Lortentz transformations at the point of transition from imaginary to real time. Should it be possible to recreate conditions where imaginary time applies, it should be possible to construct an experiment in which predictions using id in Lortentz transformations can be made and tested repeatably.
keywords: imaginary time, dark matter, Lorentz transformations, speed of dark, speed of light

1 Introduction

Imaginary time is used in cosmology to remove infinities that arise from singularities. The concept (popularized by Steven Hawking Hawking [1996]) is widely cited in the literature; I add here an idea that suggests a different basis for this phenomenon. There is evidence that most of the matter in the universe is dark matter, with ongoing attempts at measuring it [The CDMS II Collaboration 2010; Mann 2011; Akerib et al. 2014; Iocco et al. 2015].

In this paper I propose that events in imaginary time are observable at the start of the real timeline based on the following assumptions:

- a homogeneous, isotropic initial universe
- the universe in the imaginary timeline appears to grow at infinite speed as measured in real time
- relativity applies to measuring events at the transition to the real time line as if the immediate preceding state was one of the universe growing at infinite speed
- there is an imaginary analog of the speed of light c that applies to transforming observed positions in the imaginary-time universe to the real-time universe
- Lorentz transformations apply to measuring the future effect of the imaginary-time universe on the emergent real timeline

For convenience I call the imaginary analog of the speed of light, id, the *speed of dark* – though it is not necessary to interpret it as a "speed". The need for a speed of dark arises because the imaginary-time universe cannot have a physical constant with dimensions that include real time, and corresponds to the speed of light in Lorentz transformations.

Arising from these assumptions, I propose that dark matter and dark energy are respectively matter and energy measured by relativistic transformations from the state of the imaginary time universe from the start of the real time universe. In order to keep things simple, I focus the discussion here on dark matter but the same arguments apply to dark energy.

2 Justification

Events in the imaginary-time universe have to propagate somehow to the real-time universe, otherwise there is a discontinuity in causality. While it could be argued that the Lorentz transformations are based on the geometry of the real-time universe it is also possible that the geometry of the real-time universe is a property of the Lorentz transformations as applied to a real timeline. Absent any information to the contrary, it is a reasonable starting point to assume that the Lorentz transformations apply equally in the imaginary-time universe.

Even if Lorentz transformations do not apply throughout imaginary time, the intersection of real and imaginary timelines can only occur instantaneously at $t_{\mathbf{R}} = t_{\mathbf{I}} = 0$. Since instantaneous events cannot occur in real space-time, I argue that the imaginary analogue of the Lorentz transformations must apply at the instant of intersection of the two timelines. Since I am applying relativity to measure from a specific time, the start of the real timeline, and acceleration does not apply, general relativity is not necessary.

There is no reason to assume that d has the same value as c so for what follows I make no presumption on the magnitude of of d.

The Lorenz factor [Forshaw and Smith 2009]

$$\gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}} \tag{1}$$

in special relativity is the basis for defining time dilation and length contraction. It is also the theoretical basis for the view that faster-than-light communication is impossible, as any value for relative velocity v that exceeds the speed of light c results in a negative square root, and $\lim_{v \to c} \gamma = \infty$.

The imaginary Lorenz factor $\gamma^{(i)}$ is

$$\gamma^{(i)} = \frac{1}{\sqrt{1 + \frac{v^2}{d^2}}} \tag{2}$$

and for $v = d$, $\gamma^{(i)} = \sqrt{\frac{1}{2}}$. More interestingly, $\lim_{v \to \infty} \gamma^{(i)} = 0$. As with the real version, $\lim_{v \to 0} \gamma^{(i)} = 1$, i.e., for sufficiently small v, Newtonian mechanics applies. Here I do not further examine how transformations apply in imaginary time but rather explore the possibility that events in the imaginary-time universe are observable at the point where the real timeline begins, so v is not an imaginary number in any transformations.

We now have a basis for deriving special relativity-based transformations of events in in the imaginary-time universe at the point where real time starts.

If the transition from imaginary to real time occurs more than once, these effects must be modelled cumulatively, as for example if the event horizon of a primal pre-universe is not static [Davidson et al. 2012].

3 Mapping Imaginary-time events to the Real Timeline

I assume that the real timeline starts at $t = 0$ and that any event in the imaginary-time universe is transformed by imaginary versions of the special relativity length and time transforms. From here on, I refer to the imaginary-time universe as the "dark" universe.

We can apply the usual Lorentz transformations for length and time, to a new coordinate system with relative velocity v:

$$\begin{aligned}
t' &= \gamma^{(i)}(t - \frac{vx}{id^2}) \\
&= \gamma^{(i)}(t + \frac{vx}{d^2}) \\
x' &= \gamma^{(i)}(x - vt)
\end{aligned} \tag{3}$$

First, in the time dimension, since $\lim_{v \to \infty} \gamma^{(i)} = 0$:

$$\begin{aligned}
\lim_{v \to \infty} t' &= \lim_{v \to \infty} \gamma^{(i)} \frac{vx}{d^2} \\
&= \lim_{v \to \infty} \frac{vx}{(\sqrt{1 + \frac{v^2}{d^2}})d^2} \\
&= \lim_{v \to \infty} \frac{x}{\frac{1}{v}(\sqrt{d^4 + d^2 v^2})} \\
&= \lim_{v \to \infty} \frac{x}{(\sqrt{\frac{d^4}{v} + d^2})} \\
&= \lim_{v \to \infty} \frac{x}{\sqrt{d^2}} \\
&= \pm \frac{x}{d}
\end{aligned} \tag{4}$$

Now, the length dimension:

$$\begin{aligned}
\lim_{v \to \infty} x' &= \lim_{v \to \infty} -\gamma^{(i)} vt \\
&= \lim_{v \to \infty} -\frac{vt}{\sqrt{1 + v^2/d^2}} \\
&= \lim_{v \to \infty} -\frac{t}{\frac{1}{v}\sqrt{1 + \frac{v^2}{d^2}}} \\
&= \lim_{v \to \infty} -\frac{t}{\sqrt{\frac{1}{v^2} + \frac{1}{d^2}}} \\
&= \lim_{v \to \infty} -\frac{t}{\sqrt{\frac{1}{d^2}}} \\
&= \mp td
\end{aligned} \tag{5}$$

So for events in the dark universe, as relative velocity $v \to \infty$, relative time t' becomes proportional to the distance of the observer from the observed event, and relative length proportional to elapsed time t since the event.

At the instant of creation of the real-time universe, since $v \to \infty$, the above transformations apply.

4 Implications

Figure 1 illustrates how two points, A and B (illustrated in two dimensions) would see the mass of the imaginary universe, as transformed by the speed of dark version of the Lorentz transformations.

Each point sees the mass as it emerged from the imaginary universe displaced by amount predicted by the length transformation. We expect over the time that the apparent distance away of a point in the instantly-emerged light universe will appear to be proportional only to elapsed time since the real universe emerged. If the initial universe is homogeneous and isotropic, then the observer at points A and B will see the instantly-emerged real universe the same way. This will create an effect of dark matter appearing to be globally ubiquitous but locally unobservable.

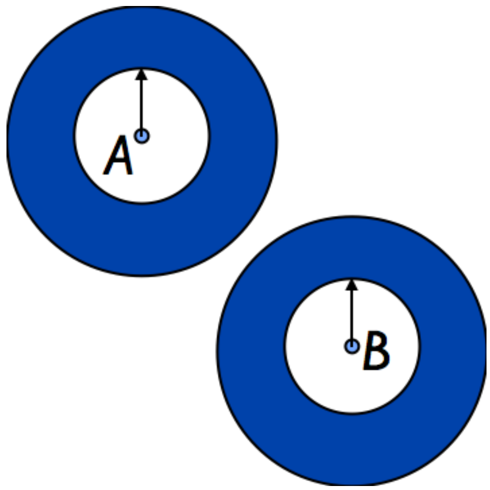

Figure 1: Dark matter as seen from two points A and B. Both observers see the same distribution of matter from $t_{\mathbf{R}} = t_{\mathbf{I}} = 0$.

4.1 Dark Matter: An Explanation

In addition, the gravitational effect of dark matter will be much larger than that of an equivalent mass in the real timeline, since all observers will see the same mass distribution rather than variations in the relatively proximity of mass of the rest of the universe. Although I make no assumption about the magnitude of d, if $d = c$ then if relative distance x between A and B can be calculated. An upper bound on recent estimates of the age of the universe is approximately 15Gyr [Kilkis 2014], which means that $td \approx 15$ Gly. The size of the observable universe has been estimated in recent years as 10 Gpc [Eingorn and Zhuk 2014] ($\approx$ 33 Gly), and a bound on the total size of the universe as 26 Gpc [Vaudrevange et al. 2012] ($\approx$ 85 Gly). If all matter at $t_{\mathbf{R}} = t_{\mathbf{I}} = 0$ now appears to be at a distance 15 Glyr from the observer, we need an approximate average distance from the observer of all current mass at a given point to calculate the effect of dark matter as proposed here.

If about 85% of the matter in the universe appears to be dark matter [The CDMS II Collaboration 2010], that means that the measured gravitational effect of dark matter is about 5.7 times that of regular matter. As a first approximation, if we apply an inverse square law to the gravitational effect of matter, the same amount of matter about 2.4 times closer will have the same gravitational effect as matter 5.7 times as massive. My very approximate calculation is in the right ballpark to be plausible.

4.2 Time Evolution and Other Consequences

Time evolution of the creation instant of the real universe is only proportional to the initial distance apart of two objects, x. Thus, any matter measured in the real universe will not appear to have any elapsed time relative to its initial state, as seen from any other point in the universe.

Once the real timeline starts, relativity based on real time starts and the universe becomes the “light” universe. "Dark" matter and energy are the measurable consequences of the imaginary Lorentz transformations at $t_{\mathbf{R}} = t_{\mathbf{I}} = 0$.

An experiment that artificially creates and collapses a singularity could verify this theory. The distance transformation could be measured directly by measuring gravitation effects at $t_{\mathbf{R}} = t_{\mathbf{I}} = 0$ and their propagation through time.

5 Conclusions

In this paper I present the possibility of an imaginary analog id to the speed of light c that could explain the propagation of events from a real universe as it emerges from a singularity and imaginary time. Dark matter could be explained as the effect of applying Lorentz transformations using id to provide a measurable state of the emergent universe in the real timeline.

The imaginary Lorentz transformation explains the apparently much larger amount of dark than light matter in the universe without requiring a much larger amount of dark than "light" matter to have been created in the early universe, and still to persist to this day in a form that is globally measurable but not locally observable.

This idea is highly speculative until verified experimentally. Should it be verified, it opens up new areas of investigation in cosmology, and has implications for exploring other conditions under which the conventional interpretation of special relativity can vary.

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