Title

Reinterpreting Relativity:

Using the Equivalence Principle to Explain Away Cosmological Anomalies

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Abstract

According to the standard interpretation of Einstein's field equations, gravity consists of mass-energy curving spacetime, and an additional physical force or entity—denoted by Λ (the 'cosmological constant')—is responsible for the Universe's metric-expansion. Although General Relativity's direct predictions have been systematically confirmed, the dominant cosmological model thought to follow from it—the ΛCDM (Lambda cold dark matter) model of the Universe's history and composition—faces considerable challenges, including various observational anomalies and experimental failures to detect dark matter, dark energy, or inflation-field candidates. This paper shows that Einstein's Equivalence Principle entails two possible physical interpretations of General Relativity's field equations. Although the field equations facially appear to support the standard interpretation—that gravity consists of mass-energy curving spacetime—the field equations can be *equivalently* understood as holding that gravitational effects instead result from mass-energy logarithmically accelerating the metric-expansion of a second-order Euclidean spacetime fabric superimposed upon an absolute, first-order Euclidean space, resulting in the observational *appearance* of spacetime curvature. This alternative interpretation of relativity is shown to be empirically equivalent to the standard interpretation of relativity, albeit with a changing value for Λ over time (which is similar to how Λ is understood in the conception of Λ as 'quintessence', but in this case takes Λ to *be gravity*). The reconceptualization is then shown to potentially resolve every major observational anomaly for the ΛCDM model, including recent observations conflicting with ΛCDM predictions, as well as failures to directly detect dark matter, dark energy, and inflation field/particle candidates.

Keywords: cosmology; dark energy; dark matter; gravity; inflation; relativity.

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Abstract: According to the standard interpretation of Einstein's field equations, gravity consists of mass-energy curving spacetime, and an additional physical force or entity—denoted by Λ (the 'cosmological constant')—is responsible for the Universe's metric-expansion. Although General Relativity's direct predictions have been systematically confirmed, the dominant cosmological model thought to follow from it—the ΛCDM (Lambda cold dark matter) model of the Universe's history and composition—faces considerable challenges, including various observational anomalies and experimental failures to detect dark matter, dark energy, or inflation-field candidates. This paper shows that Einstein's Equivalence Principle entails two possible physical interpretations of General Relativity's field equations. Although the field equations facially appear to support the standard interpretation—that gravity consists of mass-energy curving spacetime—the field equations can be equivalently understood as holding that gravitational effects instead result from mass-energy logarithmically accelerating the metric-expansion of a second-order Euclidean spacetime fabric superimposed upon an absolute, first-order Euclidean space, resulting in the observational appearance of spacetime curvature. This alternative interpretation of relativity is shown to be empirically equivalent to the standard interpretation of relativity, albeit with a changing value for Λ over time (which is similar to how Λ is understood in the conception of Λ as 'quintessence', but in this case takes Λ to be *gravity*). The reconceptualization is then shown to potentially resolve every major observational anomaly for the ΛCDM model, including recent observations conflicting with ΛCDM predictions, as well as failures to directly detect dark matter, dark energy, and inflation field/particle candidates.

Keywords: cosmology, dark energy, dark matter, gravity, inflation, relativity.

> '[I]t is impossible to discover by experiment whether a given *system of coordinates* is accelerated, or whether its motion is *straight and uniform* and the observed effects are due to a gravitational field.' – Albert Einstein [33]

Physics is in crisis [4, 77]. First, although the Standard Model of particle physics has been highly successful, it faces considerable theoretical [19, 107-8], explanatory [14, 20, 94, 112], and predictive [1, 22] difficulties. Second, decades of theorizing about physics beyond the Standard Model has yet to yield any verified predictions of new physics [60, 119]. For example, instead of finding new supersymmetric particles widely hypothesized to address various theoretical problems—including but not limited to the hierarchy problem [59] and lack of any particle in the Standard Model to account for gravitation [28, 112]—the Large Hadron Collider and other experiments have to date only definitively detected the Higgs Boson and other findings predicted by the Standard Model [6, 60]. Although several potential anomalies to the Standard Model relating to the positive muon magnetic moment and lepton universality have recently emerged [1, 73], none of these potential anomalies have yet passed the threshold for claiming a discovery, and their implications for new physics beyond the Standard Model are unclear. Third, the dominant theory of cosmology based on quantum mechanics and relativity—the ΛCDM (Lambda cold dark matter) model of the Universe's composition and history [93]—faces equal if not more considerable challenges. Despite positing dark matter [114], dark energy [91, 113], and an inflation field [54-5] to account for a variety of cosmological observations, every experimental search for dark-matter, dark-energy, and inflation-field candidates has thus far turned up empty [12]. Finally, recent observations of the cosmos appear to contradict the ΛCDM model. First, in 2019 the Hubble Space Telescope indicate that the Universe is expanding faster than the ΛCDM predicts, and that the Universe itself may be about 5 billion years younger than previously estimated [105-6] using the ΛCDM model—and no one knows why [71, 96]. Second, recent observations of galaxies diverge from the predictions made by conventional models of dark matter [80].

This crisis—our best physical theories failing to explain various phenomena and making incorrect predictions, including fruitless searches for new theoretical entities—should seem all too familiar to historians and philosophers of science. Many millennia ago, Ptolemaic astronomers were convinced that they broadly had the correct theory of the orbits of heavenly bodies. However, their paradigm failed to predict the retrograde motion of the planets [118]. Similarly, just over one-hundred years ago Newtonian physicists seemed confident that they had the correct theory of physics—until Newtonian theory failed to predict observed deviations in Mercury's orbit during perihelion procession [121]. In these and other historical cases, similar crises in physical science were generated by 'anomalies'—that is, by the prevailing physical paradigms either making false predictions or otherwise failing to explain relevant phenomena. Equally notably, such crises have tended be resolved by what Thomas Kuhn famously termed 'revolutionary science' [69]—that is, by paradigm shifts whereby the relevant physical phenomena in question were dramatically *reconceptualized*. For example, in the case of Ptolemaic astronomy and observed retrograde motion of other planets, these 'anomalies' were ultimately resolved neither by further observation nor by refinements in Ptolemaic astronomy, such as the introduction of 'epicycles.' Instead, they were resolved by Copernicus rejecting the geocentric assumption at the heart of the Ptolemaic paradigm: the assumption that the Earth is stationary, and the Sun and other planets move in circular orbits around it. Copernicus saw that once we simply reconceptualize what is going on—assuming instead that the Earth and other planets revolve around the Sun—we can explain the same observational data (retrograde motion) far more simply and elegantly, such that retrograde motion is not an 'anomaly', but exactly what one would expect *if* the Earth and other planets do in fact revolve around the Sun and ordinary laws of physics on Earth hold in the heavens. Similarly, in the case of Mercury's perihelion contradicting Newtonian predictions, the relevant anomalies were ultimately resolved not by further data-collection nor by refining Newtonian mechanics, but instead by Einstein reconceptualizing space and time as warped by mass-energy rather than absolute [34-9].

Might physics be due for another paradigm shift? That is, might the current crisis in physics be resolvable though a simple change of how we *interpret* theory or observational data? Recently, some physicists have called on philosophers for assistance [70, 107], noting that past scientific revolutions have been inspired by the philosophy of science [69, 88]. Einstein's theory of relativity, for example, was inspired both by David Hume's and Ernst Mach's epistemology and metaphysics: specifically, by their contention that physical phenomena (such as causation in Hume's case, and space and time in Mach's case) cannot be assumed to have the properties we may be inclined to ascribe to them *a priori* (such as absolute Newtonian values), but must instead be derived from sense experience [88]. In his 1905 paper on special relativity (which he later generalized in the General Theory), Einstein used this philosophical assumption as follows: he showed that *if* (i) we assume the observation that light has the equivalent speed in every reference frame, that (ii) the laws of physics are invariant in all inertial frames of reference [39, 64], and (iii) we do *not* assume that space and time have their properties *a priori* (qua Newton), but instead (iv) assume that space and time are whatever we measure them to be in experience (qua Hume and Mach) [88], then it follows that (v) space and time are in fact relative [34-9, 53]. Notably, Einstein was not the first to recognize that simultaneity and light having the same observed speed in all frames of reference appeared to have the implication that *observed* space and time must be relative. Mach, Poincaré, Lorentz, and others broadly recognized this well before 1905 [58, 63]. The difference, as one commentator puts it, is that 'neither Lorentz nor Poincaré made the full leap: that there is no reason to posit an ether, that there is no absolute rest, that time *is* relative…and so is space' [63]. Much like Copernicus, who simply reconceptualized *how* to understand the observed orbits of heavenly bodies (rejecting the geocentric assumption that the Earth is stationary in favor of the heliocentric assumption that the Earth revolves around the Sun), Einstein's primary insight was philosophical in nature: that if we take the observed invariance of the speed of light and laws of nature to tell us what space and time are (rather than assuming space and time to absolute *a priori*), then we must conclude that Newton was wrong: that space and time are not absolute, and by extension, that there is no need to invoke the existence of the (then-predicted but systematically undetected) 'luminiferous ether.'

This paper argues that what Einstein took to be his 'greatest blunder' [85]—the seemingly arbitrary introduction of the cosmological constant, Λ, into his gravitational field equations to counterbalance gravity to ensure a stable universe [36]—may have been radically misinterpreted, and with it, the physical significance of General Relativity as a whole. In brief, this paper argues that whereas Einstein's field equations have been standardly interpreted as holding that space and time are curved by mass-energy [116]—with the cosmological constant (Λ) representing some additional physical force (such as quintessence or dark energy [17, 31, 91]) beyond gravity [36, 89]—Einstein's Equivalence Principle shows that the field equations can be equivalently reinterpreted in a very different way, attributing to them an altogether different physical significance.

Einstein's Equivalence Principle is at bottom conceptual principle which holds that two different ways of interpreting our observations are empirically equivalent: namely, that 'it is impossible to discover by experiment whether a given *system of coordinates* is accelerated, or whether its motion is *straight and uniform* and the observed effects are due to a gravitational field' [33]. This principle lies at the heart of General Relativity [34], and entails that the effects of a gravitational field are *observationally equivalent* to the 'pseudo force' that an observer in a non-inertial (or accelerated) frame of reference will experience—such as, to use one of Einstein's famous example, an observer standing in an elevator accelerating upwards in empty space [35]. Notice, as such, that it follows from the Equivalence Principle that the equations of General Relativity can be interpreted in both ways. The present paper illustrates how this is the case, showing that instead of interpreting various terms in the field equations as literally representing curved spacetime, we can equivalently interpret them as holding that 'spacetime curvature' is a measurement-artifact generated by mass-energy *logarithmically accelerating the coordinate expansion* of a dynamic, second-order (non-curved) Euclidean spacetime fabric overlaid upon an absolute Euclidean space. On this new interpretation of the field equations, gravity does not actually curve spacetime, and Λ is not an additional physical entity beyond gravity (such as dark energy or quintessence). Rather, Λ—the accelerating metric expansion of spacetime—*just is* a fundamental feature of gravity itself, and the other terms in the field equations (e.g. scalar curvature [R], Ricci tensor [$R_{\mu\nu}$], stress-energy tensor [$T_{\mu\nu}$], etc.) merely represent *measurement artifacts* generated by the accelerated metric-expansion of a second-order Euclidean spacetime by mass-energy. Gravitational 'curvature', on the new interpretation of relativity to be proposed, is a kind of observational illusion: mass-energy does not actually curve spacetime; it merely makes it *look* that way in every observation by virtue of mass-energy locally accelerating a second-order metric-expansion of spacetime around objects located in a static, unobservable, first-order Newtonian spacetime.

I will argue for this alternative interpretation of relativity through a variety of simple thought-experiments, contending in turn that if we understand Λ to vary in specific ways related to the total mass-energy of a system (ways not predicted antecedently by relativity but supported by observational data), this reconceptualization of General Relativity explains away 'dark energy' (since, on the new interpretation, we do not need to introduce any new physical entity to account for Λ in the field equations), as well as 'dark matter', as I show that cosmological phenomena currently taken to be indicative of dark matter can also be explained in terms of the locally accelerated expansion of Euclidean spacetime by mass-energy. In short, once the physical significance of Einstein's field equations is reconceptualized, 'dark matter' and 'dark energy' really are just two more examples of non-existent phenomena—such as the aether [72, 87], phlogiston [9], and élan vital [11]—that have been postulated in the past on the basis of incorrect paradigms (though, as we will also see, my reconceptualization of relativity holds that Λ should have a changing value over time, *qua* theories of 'quintessence'). Further, I will show how the reconceptualization that I propose explains other recent observational 'anomalies': specifically, the unexpected increase in the rate of the Universe's metric-expansion not predicted by the ΛCDM model. Finally, I will argue that the reconceptualization of the field equations may even explain another poorly understood feature of the Universe: *inflation*, or theory that the Universe's spacetime metric expanded exponentially from 10^{-31} to 10^{-36} seconds after the Big Bang before slowing down and expanding more slowly since then [54-5]. Although the ΛCDM model requires yet another fundamental theoretical entity beyond dark energy and dark matter to account for this 'inflationary epoch' of the Universe—namely, an 'inflation field' comprised by a hypothetical particle called an 'inflaton' [54]—this explanation is argued by critics to be *ad hoc* and not corresponding to any experimentally observed physical field [111]. As we will see, on my reconceptualization of the field equations, exponential spacetime inflation just after the Big Bang and the 'expansion slowdown' that occurred thereafter *just are* the spacetime-locally accelerating effects of mass-energy surrounding the 'white hole' singularity that spawned the Big Bang. And indeed, as we will see, my reconceptualization explains why the hypothesized curve of the Universe's early expansion-rate roughly matches galactic rotation curves currently taken to be evidence of dark matter (albeit with a more quickly increasing value for Λ in the early Universe following a stronger logarithmic function due to the early Universe's exponentially larger mass and size compared to galaxies). On the reconceptualization of relativity proposed, both curves are the result not of an inflation field (viz. early inflation) or dark matter (viz. galaxies), but simply the result of *gravity*, properly interpreted.

Before proceeding, several caveats are in order. First, this article contains no complex mathematics. Although I apply simple geometry to thought experiments, I am professional philosopher, not a mathematician. Importantly, however, this paper's argument is purely conceptual, holding that Einstein's Equivalence Principle directly establishes the multiple possible interpretations of his field equations that I discuss. Given that some readers may be skeptical that detailed mathematics is unnecessary, consider a remark that Stephen Hawking and Leonard Mlodinow make about Ptolemaic astronomy:

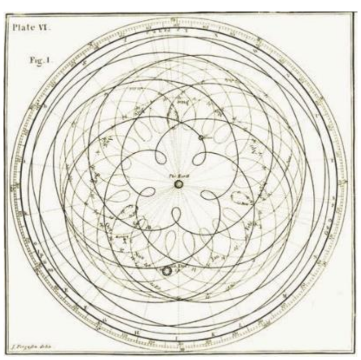
> Although it is not uncommon for people to say that Copernicus proved Ptolemy wrong, that is not true…one can use either model of the universe, for our observations of the heavens are explained by assuming either the earth or the sun to be at rest . . . the real

advantage of the Copernican system is simply that the equations of motion are much simpler in the frame of reference in which the sun is at rest [57].

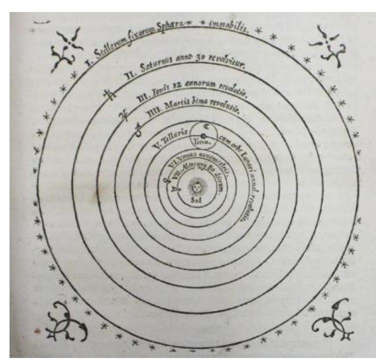
As we will see in more detail in §1, Hawking and Mlodinow are correct: Ptolemaic and Copernican astronomy can be rendered observationally equivalent, as it is a well-established theorem in philosophy of science that one can always render multiple physical theories consistent with the same observations by revising the theories' background assumptions [110]. Further, while Ptolemaic and Copernican astronomy do posit different mathematics for explaining the motions of heavenly bodies, it does not take complex math to appreciate the relevant differences between the paradigms. On the contrary, their differences can also be simply *visualized*, such that we *see* that Copernicus's interpretation of observations provides a simpler, more unified, and more powerful explanation of physical phenomena than the Ptolemaic one. Even a grade-schooler can see this by comparing the following two pictures:

Figure 1.
Copernican and Ptolemaic Paradigms

Ptolemaic Paradigm[1]



Copernican Paradigm[2]



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[1] Image: https://www.researchgate.net/figure/Ptolemaic-system-of-planetary-paths-from-James-Ferguson-Astronomy-Explained-upon-Sir_fig3_322895290, retrieved 14 October 2021.

[2] Image: https://astronomy.edwardworthlibrary.ie/astronomy-and-astronomers/reading-copernicus/, retrieved 14 October 2021.

Second, although my argument only utilizes simple thought experiments and geometry, it is worth noting that relativity was initially formulated in an analogous manner: Einstein utilized *conceptual* thought-experiments to make the case for special relativity, such as what an observer on a moving train and a second observer on a stationary hillside would observe from their inertial frames of reference—and then by applying relatively simple math to those conceptual insights [63]. Similarly, although the general theory of relativity ultimately requires advanced tensor and Riemannian mathematics to fully explicate, the primary insight that inspired it was also conceptual—and established again, by simple thought-experiments, including the famous observation that an individual in an enclosed elevator hurtling through space would clearly be unable to tell whether they are being pulled down by gravitational field or whether their elevator is accelerating upward against their feet—a phenomenon that anyone who has ridden in elevator has experienced themselves without the need of complex math [5]. Consequently, although this article may strike readers trained in advanced physics as strangely (or even 'unacceptably') devoid of mathematics, I ask readers to bear with my mathematical limitations as a philosopher and instead ask whether any of the conceptual and associated physical insights of the thought-experiments I provide are valid, particularly insofar as they may help explain away many current 'anomalies' in cosmology.

Third, I also want to note that because I am admittedly theorizing about academic fields that lie outside of my areas of advanced training (philosophy and philosophy of science), some details of my account theory may be altogether incorrect and in need of serious correction. Indeed, this paper may well contain simple errors that anyone trained in mathematical physics or cosmology could easily detect and avoid. However, while I am self-consciously engaging in what one philosopher has recently termed 'epistemic trespassing'—namely, judging matters outside of my own field of expertise [8]—I have decided to hazard these risks for two reasons: first, because many important insights in the history of science have been due to novel conceptual arguments and paradigm shifts [26]; and second, because some physicists have openly suggested that philosophers may be able to provide some important insights to help resolve the kinds of foundational problems and crises currently afflicting physics [70, 107]. Consequently, although the physical speculations I defend below may be inaccurate on some (or even many) details—or even embarrassingly misguided—I have decided to hazard these risks on the chance that they may contain a grain of important insight.

Finally, bearing this in mind, I want to note some important dissimilarities between philosophical and scientific methods as forms of inquiry. In empirical science, getting the technical details right and making correct physical predictions are the default standards for making a publishable contribution to human knowledge. Philosophers, on the other hand, often get things wrong, but in service to important conceptual insights that can lead to more empirically adequate development later on. For this reason, philosophy is sometimes called 'the handmaiden of the sciences': philosophy is different than science, but it can serve the sciences by helping scientists see old phenomena in new ways. As Frederick [46] writes:

> A philosophy paper… ought to offer a solution to a problem that gives us new Insight … It can do that only by making a surprising claim … And it will tell us more, the bolder the claim made, provided that the claim survives criticism. The solution offered in a philosophy paper will therefore be better, other things being equal, the bolder and the more surprising the solution is; and thus the more open it is to the risk of refutation. To get substantial progress, we must take risks; *many of the risky claims will not survive criticism*; but *the ones that do* will make a substantial contribution to our knowledge.

Indeed, there are details of my account—some early on, some later on—that I am very uncertain about and may involve serious mistakes, perhaps even 'fatal' ones. Although some specialists may be tempted to stop reading upon coming across them, I humbly ask readers to consider the entirety of the paper. Again, philosophy and physical science work very differently. Whereas in physical science it is considered vital to get every physical and mathematical detail correct, in the history of philosophy significant conceptual advances often come replete with large errors. My hope, then, is merely that willing readers will take this paper for what it is: a philosopher attempting to bring their training and specialization to bear on an ongoing scientific crisis that has, up this point, flummoxed the fields of theoretical and experimental physics given their prevailing paradigms.

1. Interpreting Einstein's Field Equations: Philosophical Preliminaries

Einstein's field equations are a set of ten equations that define gravitation—i.e. the fundamental interaction or 'effects' of gravity—in terms of the 'curvature' of spacetime by mass and energy [38]. Here is one equation, the so-called 'Einstein tensor':

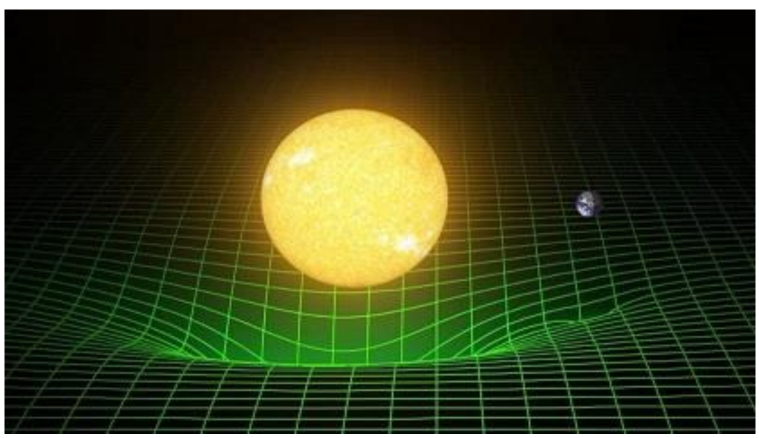
$$G_{\mu\nu} = R_{\mu\nu} - \frac{1}{2}Rg_{\mu\nu}$$

Here is another:

$$G_{\mu\nu} + g_{\mu\nu}\Lambda = \frac{8\pi G}{c^4}T_{\mu\nu}$$

In these equations, 'G' stands for Newton's gravitational constant, '*R*' stands for scalar curvature (the simplest non-Euclidean curvature in non-Euclidean Riemannian geometry), '$R_{\mu\nu}$' for the Ricci curvature tensor (viz. the amount by which the volume of a narrow conical piece of a geodesic ball in a Riemannian manifold deviates from that of the ball in Euclidean space), 'Λ' for the cosmological constant, '$T_{\mu\nu}$' for the stress-energy tensor (describing the density and flux of energy and momentum in spacetime), and 'c' for the speed of light. Now, given that the field equations describe metric tensors in *non-Euclidean* spacetime, the most natural interpretation of their physical significance—the one presented by Einstein and now widely accepted in physics [82]—is that they describe gravitation (viz. G – Newton's constant) in terms of the density and flux of energy *curving spacetime* in a non-Euclidean fashion (viz. $R_{\mu\nu}$). Indeed, given the facial meaning of these terms—e.g. 'R' denoting scalar *curvature* in a Riemannian (non-Euclidean) manifold—this interpretation of the physical significance of the field equations might appear inescapable. It has been, at any rate, the standard interpretation of the field equations (and hence, of General Relativity) ever since Einstein proposed the theory (Figure 2).

Figure 2.
The Standard Interpretation of General Relativity:
Gravity as Mass-Energy Curving Spacetime[3]



Nevertheless, dating back at least to Quine, philosophers have recognized that a single term in any language always admits of *multiple interpretations*—which Quine terms the 'radical indeterminacy of translation' [97-100]. In fact, following the famous Quine-Duhem thesis in the philosophy of science—which holds that no single empirical hypothesis can ever be tested in

[3] Image: LIGO/T. PYLE.

isolation, only relative to other background assumptions [30, 101]—Quine argues that when it comes to interpreting the meaning of any linguistic term (including scientific equations and theories), there are always three indeterminacies: ones that, as we will see, may have crucial implications for interpreting the field equations.

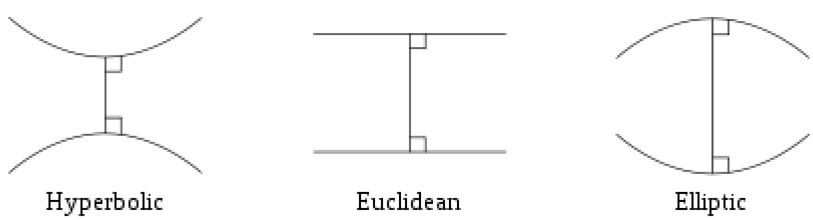
First, there is *inscrutability of reference*, or the fact that any given sentence in a language can always be translated into a variety of other sentences referring to very different entities. As a famous example, Quine gives the example of linguist who visits an isolated human tribe, discovering that they use the word 'gavagai' whenever they see rabbits [100]. As Quine puts it, the linguist may assume that 'gavagai' refers to *rabbits*—because the linguist has the background assumption that speakers use words to name animals and other objects. However, Quine points out, there are in principle many alternative possible referents of the term, such as *undetached rabbit-parts* or '*rabbit-tropes*.' We can illustrate Quine's point better perhaps with a famous example by the philosopher Nelson Goodman [52]. Consider the words 'blue' and 'green.' It is entirely natural to suppose that 'blue' refers to *blue* objects and 'green' to *green* objects. But now consider the following definition of the properties 'grue' and 'bleen':

> **An object is 'grue'** if and only if it is blue up until the year 2100 AD but green thereafter.
>
> **An object is 'bleen'** if and only if it is green up until the year 2100 AD but blue thereafter.

Here is the philosophical point: insofar as the year 2100 AD has not yet come, every use of the words 'blue' and 'green' in the English language up until now has been entirely consistent with those terms meaning 'grue' and 'bleen.' That is, we have *no empirical evidence* based on what has been observed in the past for assuming that our word 'blue' refers to the property *blue* rather than the property *grue*. The two interpretations of 'blue' are observationally identical, viz. the use of 'blue' up until today. Thus, if we base our theory of what 'blue' and 'green' mean purely on empirical observation, then we must conclude that meaning of these terms are *indeterminate*—because, again, there are multiple possible interpretations of them consistent with all of the empirical evidence of their use that has been collected. Finally, although this may seem like an artificial conceptual problem to theoretical physicists, as we will soon see it has potentially revolutionary implications for interpreting General Relativity. For here is a point that should resonate with any physicist or mathematical geometer: any coordinates in a non-Euclidean manifold can clearly, in principle, be *translated* into (or mapped onto) coordinates in Euclidean space, as in Figure 3.

Figure 3.

Euclidean 'Translations' of Non-Euclidean Geometry[4]



Each of these drawings is in two-dimensional Euclidean space—and so is expressed *in* Euclidean 'language' (you clan plot each diagram on an 'X' and 'Y' axis). What the figures on the left and right comprise are *Euclidean translations* of what a straight line *is* in Euclidean space (e.g. two straight lines never intersect) with what a straight line is in *non*-Euclidean space (viz. in elliptic space, two 'straight' lines *do* intersect). We can also put the relevant translation in

[4] Image: derivative work: Pbroks13 (talk)Noneuclid.png:Joshuabowman at en.wikipedia, CC BY-SA 3.0 http://creativecommons.org/licenses/by-sa/3.0/, via Wikimedia Commons, retrieved 14 October 2021.

natural language: 'A *straight line* in non-Euclidean space is *curved* when translated into Euclidean space' (which is exactly what the 'Hyperbolic' and 'Elliptic' figures above illustrate). We will soon see why these points about inter-translatability are so important: the Einstein field equations can be interpreted as describing gravitation in terms of the curvature of spacetime (the traditional interpretation), but they can be equivalently interpreted in terms of 'spacetime curvature' being a measurement artifact of mass-energy logarithmically accelerating the local metric-expansion of a dynamic, second-order Euclidean space superimposed upon an absolute first-order Euclidean space.

This brings us to a crucial corollary. Following his point about the indeterminacy of reference, Quine argues that this indeterminacy in turn generates *holophrastic indeterminacy*, which is that while there is always more than one correct method to translate one sentence into another, the translated sentences will nevertheless differ in terms of their 'net import' [97]. We can how this is by considering the *ontological import* of the two interpretations of Einstein's field equations we will discuss. On the traditional interpretation of those equations, gravitation results from mass and energy curving spacetime. On the alternative interpretation I propose, gravitation results from mass-energy accelerating the local metric-expansion of Euclidean space. If I am correct, both equations are equally 'correct' interpretations of the field equations, at least in the formal sense that they are *inter-translatable*. However, despite being formally equivalent (as equally valid translations of Einstein's equations), each interpretation has dramatically different ontological import. The traditional interpretation of the Einstein field equations holds that *it is a physical reality* that (A) mass and energy curve spacetime in a non-Euclidean fashion, such that (B) gravitational effects can be explained in terms of spacetime curvature, but (C) in addition, there must be some further physical entity (e.g. dark energy, quintessence, etc.) denoted by the cosmological constant. In contrast, my alternative interpretation of the field equations defended below holds instead that (A*) mass-energy *accelerate the local expansion of a second-order Euclidean spacetime fabric around objects located in an unchanging first-order Newtonian coordinate system*, such that (B*) all gravitational effects (ranging from massive objects attracting each other to the apparent bending of space and time) are explainable by that accelerated expansion, (C*) without the cosmological constant (Λ) denoting *any* additional force above and beyond (A*). This is crucial, we will see, in that whereas the traditional interpretation of the field equations gives rise to unexplained 'anomalies'—ranging from the absence of any detection of dark matter or dark energy particle candidates in experiments to divergences between the Universe's observed age and expansion rate and predictions generated by the ΛCDM (Lambda cold dark matter) model of the cosmos—my interpretation *explains* these 'anomalies' without positing new fundamental entities such as dark matter or dark energy.

Which brings us to one final preliminary: Quine's third indeterminacy—which he argues follows from the first two, namely, *the underdetermination of scientific theory* by empirical evidence [97, 110]. As we have seen, the reference of any given scientific term appears to be indeterminate—as there are always multiple formally equivalent interpretations of the same term or equation. What this means, in turn—insofar as each interpretation is its own 'theory' of what the terms or equations mean—is that scientific theories are always *underdetermined* by our empirical evidence: that is, that there is always *more than one* theory consistent with the same observations. This, again, is Einstein's own point in stating the Equivalence Principle. Insofar as it is 'impossible to discover by experiment whether a given *system of coordinates* is accelerated, or whether its motion is *straight and uniform* and the observed effects are due to a gravitational field', both interpretations of 'gravity' are empirically equivalent, and hence, which interpretation is true is underdetermined by all empirical evidence.

We can see how this pertains to our discussion moving forward. One possibility—consistent with all of our evidence to date—is that the traditional physical interpretation of Einstein's field equations (gravity curving spacetime) is correct, and we just have not yet discovered the other theoretical entities (dark matter, dark energy, etc.) entailed by that interpretation. Another possibility, however, is that the traditional interpretation of the field equations is *incorrect*, and we have not discovered dark matter or dark energy particles because they do not exist. Nothing, at present, can be used to demonstrate definitively which interpretation is more accurate. That can only be determined moving forward: by formulating both interpretations and determining which interpretation generates better predictions (such as, on my alternative interpretation, the prediction that dark energy does not exist and thus will *never* be discovered in empirical tests).

2. Equivalently Reinterpreting the Field Equations of General Relativity

Let us now return to Einstein's field equations, taking the two equations mentioned earlier as our starting points:

$$G_{\mu\nu} = R_{\mu\nu} - \frac{1}{2}Rg_{\mu\nu}$$

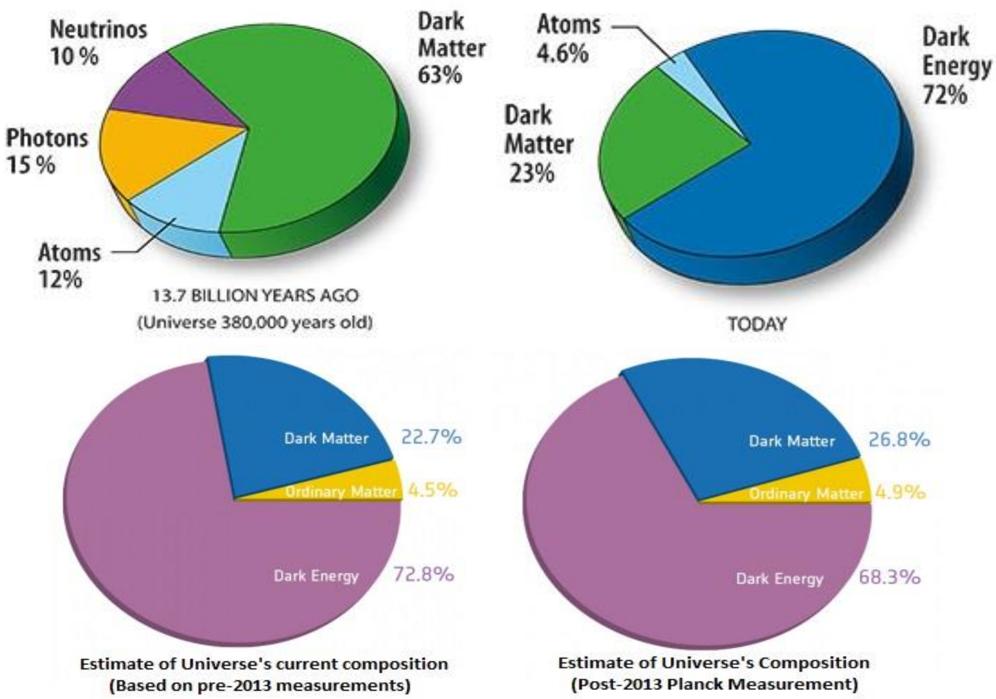
$$G_{\mu\nu} + g_{\mu\nu}\Lambda = \frac{8\pi G}{c^4}T_{\mu\nu}$$

Specifically, let us return to the terms the equation involves, and the theoretical entities its terms are traditionally understood as positing. 'G' is understood as standing for Newton's gravitation constant, that is, for the observed fact that the 'gravitational force' between any two massive bodies bodies—their dispositions to attract each other—is the product of their masses and the inverse square of their distance. 'c' is understood as standing for the speed of light, that is, for the observed fact that light moves at an invariant rate of 186,000 miles per second in every reference-frame. Next, all of the other major terms *besides the cosmological constant*—''$T_{\mu\nu}$', '$g_{\mu\nu}$', and '$R_{\mu\nu}$'—stand for metric, stress-energy, and curvature tensors, where tensors are (to simplify greatly) *functions in coordinate space*. So, if we set aside the cosmological constant for a moment, what these equations *seem to say* is that the force of gravity (viz. Newton's constant) is a *function* of the stress-energy on objects generated by curved spacetime. Notice, next, that these basic claims—and similar claims of Einstein's other field equations—appear to have been systematically confirmed through observation. Einstein's field equations predict that *if* mass and energy curve spacetime in the way expressed by the equations, *then* we should observe the bending of light near massive objects such as stars and galaxies, as well as time dilation, and so on. Because all of these predictions have been confirmed repeatedly, it is entirely natural to think that we have interpreted the field equations correctly: that is, that mass and energy *really do* curve spacetime, which in turn constitutes gravitational force.

Notice, however, that there is a remaining term in the equations that we have not yet interpreted: the cosmological constant ('Λ'). Einstein included this term in his equations because he saw that without it the Universe would collapse in upon itself [36]. Einstein's inclusion of Λ is obviously justified, since the Universe hasn't collapsed on itself. However, in the decades since Einstein introduced Λ into the field equations, observations indicate that Universe's spacetime metric is not only not collapsing but instead expanding [60]. Consequently, theorists have supposed—based on the traditional interpretation of the field equations described above—that ‘Λ’ must refer to some yet-to-be-observed theoretical entity that causes spacetime to expand: either dark energy, a field of constant negative energy pressure, or quintessence, an entity akin to dark matter but the value of which changes over time rather than remaining constant [17, 91, 102]. As we will see later, dark energy is standardly thought as operating only at the largest of cosmological scales, and so it may thought to be a mistake to suggest that it plays a fundamental role in gravitation, as such. However, as we will also see later, we can *explain* this supposed feature of ‘dark energy’ in terms of how the value of Λ related to the mass-energy and scale of a gravitational system. In any case, no such substance—neither dark energy nor quintessence—has been directly detected in any experiment to date. This is one ‘anomaly’: the fact that, on our current interpretation of the field equations, around 70% of the Universe’s total mass-energy is constituted by a theoretical entity *that has never been confirmed in any experiment* [45]. Next, observational evidence of the cosmos has—at least on the traditional interpretation of the field equations—discovered another set of ‘anomalies’: the facts that galactic rotation curves [24], velocity dispersion profiles of elliptical galaxies [13], galactic gravitational lensing effects [122], and other observations suggest that the amount of and distribution of mass in different structures of the Universe are dramatically different than predictions suggest they should be given the amount of observed (baryonic) matter. These anomalies have led theorists to posit a *second* as-yet-detected substance—dark matter—as constituting approximately 27% of the Universe’s mass-energy [114]. However, although many theories of dark matter have been proposed, no experiment to date has directly verified its physical existence [29]. Consequently, according to the standard interpretation of Einstein’s field equations, our best theory of cosmology—the ΛCDM model—entails that ordinary baryonic matter and energy, the only kind that have ever been directly observed, make up only 4.9% of the mass-energy of the Universe and the other 95% of the Universe's mass-energy is constituted by theoretical entities *never confirmed in any experiment to date*. Further, these values not only appear to have changed dramatically over the course of the Universe's history, but also appear to still be changing for yet-to-be understood reasons (Figure 4).

Figure 4.

Changes in Universe's Hypothesized Composition given Observations [44, 119]



Indeed, these values not only appear to have changed; they appear to have done so in ways that explicitly deviate from the predictions of the ΛCDM model of cosmology. The Universe's expansion (qua 'dark energy') appears to be accelerating *more quickly* than earlier observations and the ΛCDM model jointly predict it should [106].

Again, one possibility here—the one generally accepted in theoretical physics today [103]—is that the traditional interpretation of the Einstein field equations is correct, and that the theoretical entities they are thought to entail when combined with observation—dark energy, dark matter, etc.—will eventually be found. Notice again, however, how eerily similar our current situation is to the cases of past false paradigms in scientific history. From the 3rd century BC through 1543 AD, Hipparchian and Ptolemaic astronomers theorized that in addition to main circular orbits, planets needed to have *additional* sub-orbits—'epicycles' around their main orbits—to account for their observed motion [51]. Then, in the 17th and 18th centuries, physical scientists theorized that heat and combustion must involve a special substance, 'phlogiston'—an extra, then-yet-to-be-detected substance in addition to all other physical substances [8]. Similarly, in the early 20th century, some theorists theorized that life had to involve a special substance, 'élan vital'—an extra, then-yet-to-be-detected substance in addition to all other physical substances [11]. Finally, for many millennia, ranging from ancient Greece through the early 20th Century [79, 87], philosophers and physical scientists believed that space had to be filled with a special substance, the 'aether'—once again an extra, then-yet-to-be-detected substance in addition to all other known substances. In each case, we see the same pattern: the dominant scientific paradigm of the era positing the existence of additional theoretical entities beyond physical substances and processes already theorized to exist. As we now know, in each of these cases, the theoretical entities believed to exist turned out not to exist at all. The scientists who posited their existence were working with incorrect paradigms. It was only when Copernicus reconceptualized the cosmos—positing that the Earth and other planets orbit the Sun—that astronomers realized that the motions of heavenly bodies could be fully explained without the existence of epicycles. Similarly, it was only once biologists reconceptualized life as the result of organic chemistry, and chemists reconceptualized heat in terms of molecular kinetic energy, that they recognized that life and heat could be fully explained without the existence of phlogiston or élan vital. This is why no educated person believes in these theoretical entities today. We believe that Ptolemaic epicycles, phlogiston, élan vital, and the aether do not exist because we now see that the theories that posited their existence conceptualized the world the wrong way. I will now argue that the same may be true of the standard interpretation of General Relativity and the ΛCDM model of the Universe.

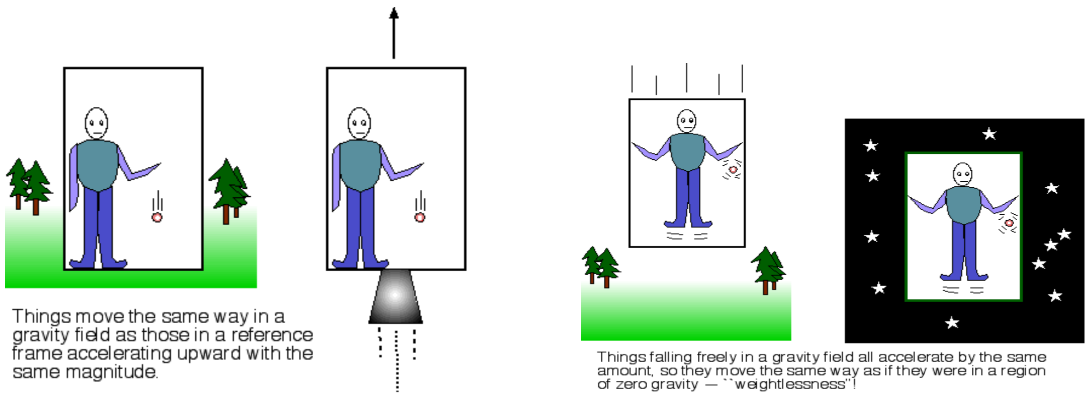
Let us begin with Einstein's *strong equivalence principle*, which Einstein explains as follows:

> A little reflection will show that the law of the equality of the inertial and gravitational mass is equivalent to the assertion that the acceleration imparted to a body by a gravitational field is independent of the nature of the body. For Newton's equation of motion in a gravitational field, written out in full, it is:
>
> > (Inertial mass) x (Acceleration) = (Intensity of the gravitational field) x (Gravitational mass).
>
> It is only when there is numerical equality between the inertial and gravitational mass that the acceleration is independent of the nature of the body [35].

What this means, in lay terms, is that the force of gravity experienced by a person standing on a massive object is *observationally equivalent* to the force experienced by an observer in an accelerating frame of reference. Einstein famously illustrated this equivalence through several simple thought-experiments [95], the primary one involving a person locked in a windowless elevator with no idea of what is going on outside. Unbeknownst to the person in the elevator, the elevator is hurtling through outer space (where there is no Earth-like gravity). Einstein then noted that if the elevator were to accelerate upward, the person inside the elevator would experience themselves as 'pulled' toward its floor by a seemingly invisible force. Further, if the elevator were to accelerate upward at the correct rate (e.g. $9.8 m/s^2$), the downward force the person would experience would be *equivalent* to the 'force of gravity' on Earth. Conversely, Einstein pointed out that if the elevator *stopped* accelerating upward but instead continued upward at a constant velocity, the person inside would feel 'weightless', *just as though* they were standing in an elevator on Earth (a gravitational reference-frame) in a free-fall (Figure 5).

Figure 5.

The Strong Equivalence Principle Illustrated[5]



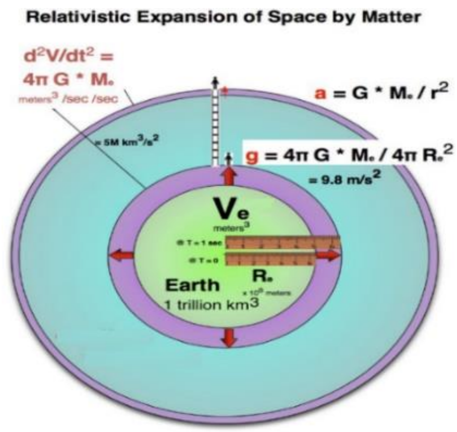
To put it another way, the 'downward' pull of gravity on Earth is in principle equivalent to the 'upward' acceleration of an (non-inertial) reference frame. Consequently, although this is too simplistic, it follows that the 'force' of gravity that we experience could in principle be the result of the *surface of the Earth* expanding upward against us at an accelerated rate (Figure 6). As we will see momentarily, this way of construing relativity cannot be correct, given the prevailing paradigm for understanding spacetime and objects located within it. Still, the point to begin with is merely that there are in principle *observationally equivalent* ways of understanding gravitational affects: the effects of a gravitational field are *equivalent* to the 'pseudo force' that an observer will experience in an accelerated frame of reference.

[5] Images: https://www.astronomynotes.com/relativity/s3.htm, retrieved 14 October 2021.

Figure 6.

An Inadequate Interpretation of Relativity:

Gravity as the Metric Expansion of Spacetime and Objects *in* Spacetime[6]



Now again, understanding gravity as the surface of the Earth expanding upward cannot be correct. For, given how spacetime is currently understood, this would mean that all objects *in* space would need to expand along with the surface of the Earth at the very same rate—in which case the above model clearly cannot account for the most basic features of gravity: namely, the way that gravity 'pulls' objects with mass toward each other—including, in our case, pulling us and other objects toward the Earth. For if, as the above model supposes, the surface of the Earth expands as a direct consequence of spacetime's metric expansion, then all objects on and around the Earth would also have to expand in spacetime equivalently. Because objects on the Earth, such as me and this table in front of me, would be 'accelerating outward' at the very same rate as the surface of the Earth, no object on Earth would—as a result of expanding spacetime—accelerate *toward* the Earth. There would, on the model described, be no gravitational attraction or 'force' at all.

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[6] https://www.mathpages.com/home/kmath077/kmath077.htm, https://medium.com/@davidlevitt/space-itself-is-expanding-gravity-and-general-relativity-explained-6395aa2e4d69, both retrieved 14 October 2021.

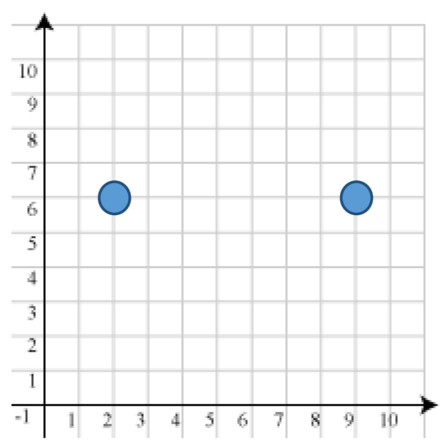
Interestingly, however, as mistaken as the above model is, there another possible model interpretation of the field equations in the general vicinity that I will now argue may be correct. The alternative interpretation I propose holds that instead of gravity curving spacetime (viz. the traditional interpretation of the field equations), gravity is instead (A) the *locally accelerated logarithmic expansion* of a kind *dynamic Euclidean spacetime fabric* through and around objects with mass-energy, that are in turn (B) located in and moving through an *absolute, fixed, non-expanding, unobservable* Euclidean space. Allow me to now lay out and illustrate this interpretation through a series of thought-experiments.

2.1. Gravity as the Accelerated Metric-Expansion of Second-Order Euclidean Spacetime

Consider to begin first two objects ('particles') located in absolute Euclidean space, represented on a standard Cartesian plane:

Figure 7.

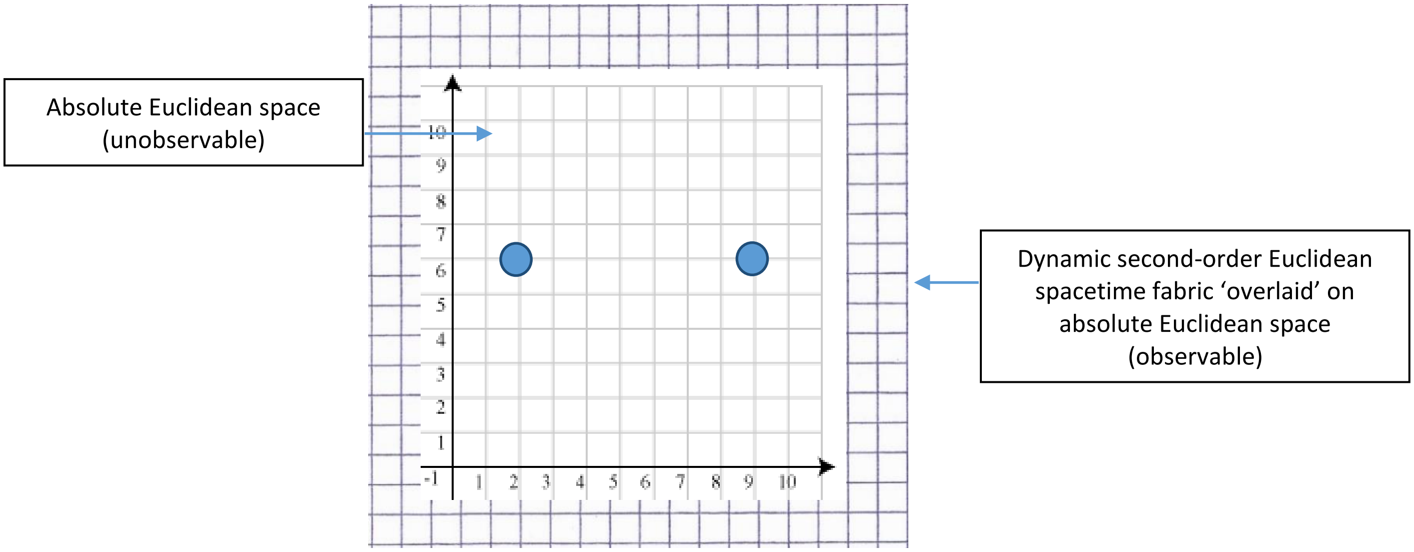
Two 'Particles' in *Absolute* Euclidean Space



Next, let us suppose that while those particles remain 'fixed' to where they are in this absolute Euclidean space—i.e. particle 1 existing at (x = 2, y = 6) and particle 2 at (x = 9, y = 6)—we superimpose a second Euclidean space—however, this time a *dynamic* (or changeable) *Euclidean spacetime fabric*—on top of that first Euclidean space, as in Figure 8:

Figure 8.

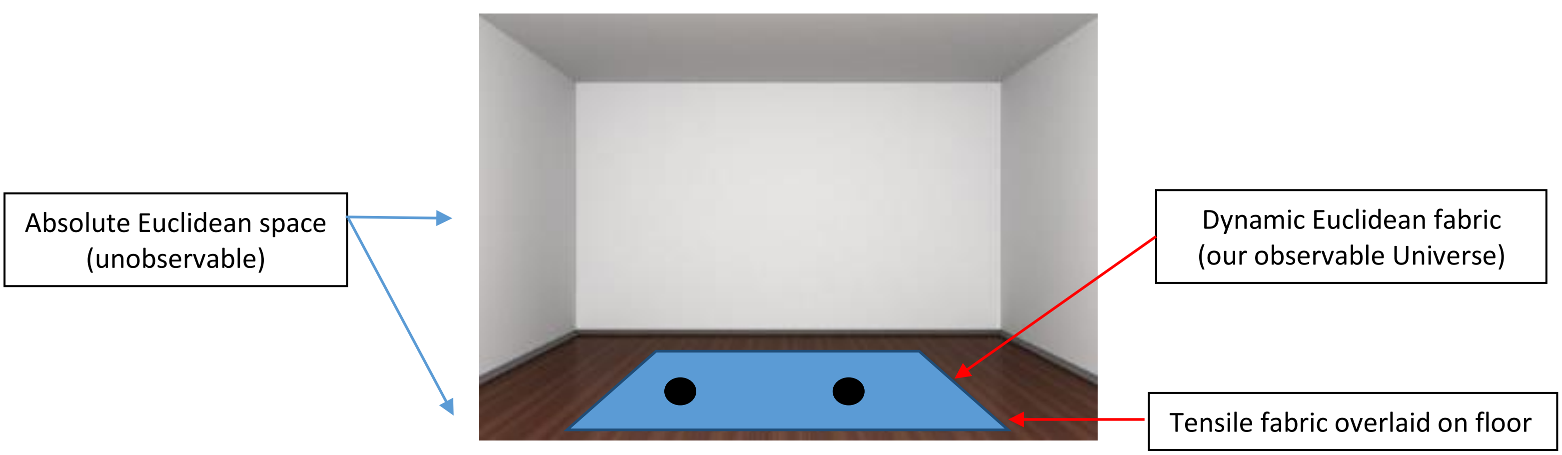
Superposition of Dynamic Euclidean Spacetime Fabric on Absolute Euclidean Space



Because this figure may leave the model a bit unclear, the simplest way to understand what I have in mind is by analogy to laying a tenside fabric (e.g. spandex) on the floor of an everyday room, and then by placing to objects (e.g. two balls) on top of the fabric some distance apart:

Figure 9.

An Analogical Illustration: Tensile Fabric Overlaid on Non-Tensile Background[7]

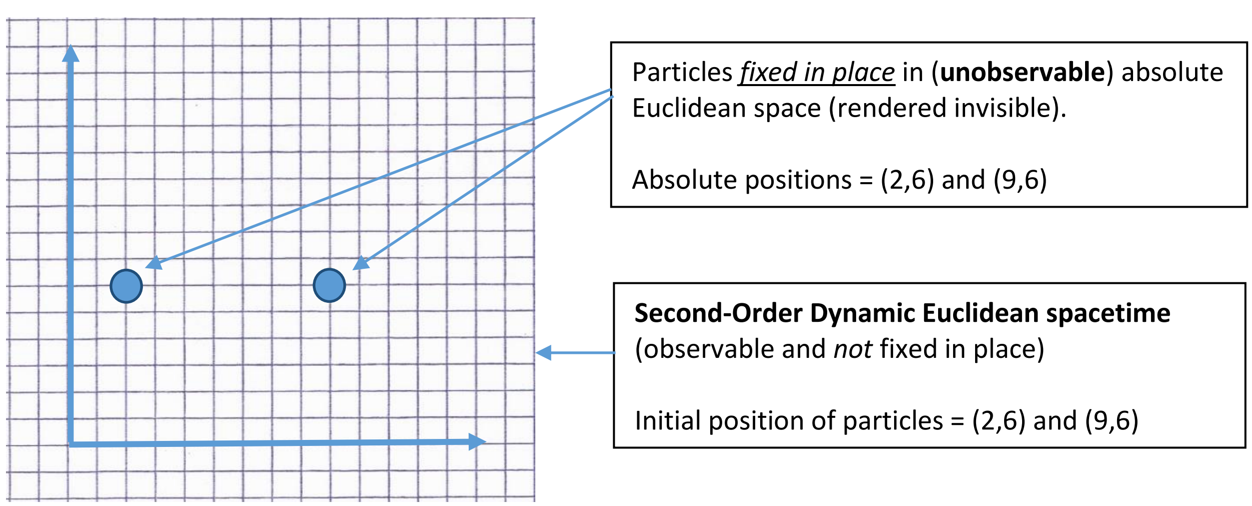


[7] Room image from https://i.pinimg.com/originals/34/99/d1/3499d12f28a741f0063ee8f2bbd711d9.jpg, retrieved 14 October 2021.

In this picture, we see there are two distinct 'realms' of Euclidean space: the 'absolute', unchanging Euclidean space beneath the tensile fabric (i.e. the floor), and a second flat Euclidean space superimposed on top of it (i.e. the tensile fabric). Finally, let us assume that although objects are indeed *located* in first-order Euclidean space (viz. the two balls are located in definition positions relative to the absolute, unchanging floor), observers 'living' on the fabric cannot *observe* the first-order Euclidean space because it is 'hidden' beneath the dynamic fabric upon which they are situated: that is, that absolute Euclidean space 'exists', but cannot be physically detected by any scientific instrument located on top of the dynamic fabric. Instead, only the movement of *objects* (e.g. the two 'particles', or in this case, balls) can be measured relative to the dynamic space (i.e. the tensile fabric). Bearing this in mind, let us imagine next the two particles described above as *remaining precisely where they are* in absolute Euclidean space—i.e. particle 1 at (X=2, y=6) and particle 2 at (x=9, y=6)—while making the absolute Euclidean space 'invisible.' We can do this, in pictorial form, by simply *taking away* the absolute 'Euclidean' grid from Figure 7, leaving the two particles *fixed in place*, and picturing them *only* relative to the dynamic, second-order Euclidean space (Figure 10).

Figure 10.

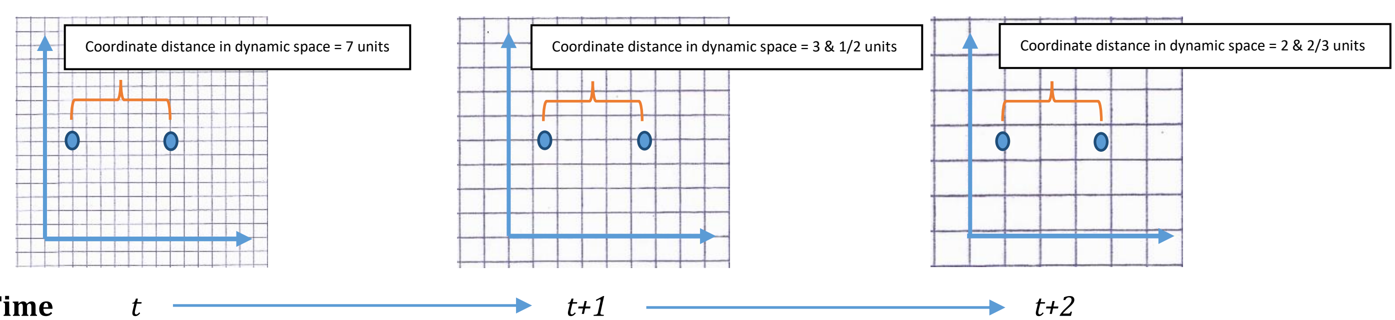
Two Objects Located Non-Observable Absolute Space *Embedded in* Dynamic Spacetime



Remember, these two particles are now to be understood as located precisely where they were always located in absolute space. This new spatial grid is *not* a representation of absolute space, but now instead as a dynamic second-order *fabric* that surrounds those objects located in first-order Euclidean space.

Let us now suppose, following Einstein's field equations, that a central component of gravity is Λ, the 'cosmological constant' which holds that gravity is associated with the metric-expansion of space—which, again, on the traditional interpretation, is supposed to be some entity (dark energy or quintessence) *distinct* from spacetime curvature. Let us now suppose, in contrast to the traditional interpretation, that instead of mass and energy causing spacetime to curve, they instead cause the accelerated expansion of the dynamic, second-order Euclidean spacetime described above—*while the two 'particles' remain entirely unmoved from their previous locations in absolute first-order space.* If we make of the above assumptions—and we assume that the two particles in the above diagram have mass-energy, causing the second-order fabric around them to expand in an accelerated fashion (while still remaining Euclidean)—then observers in that dynamic second-order space will observe the following.

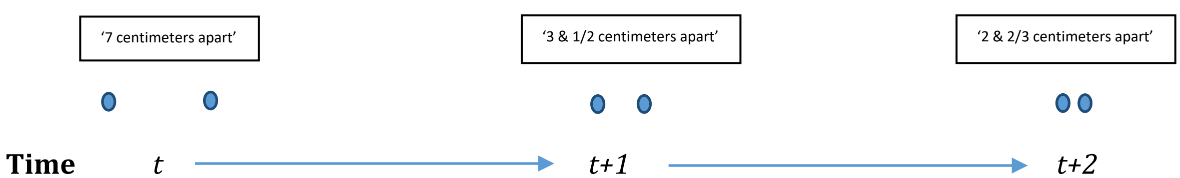
Figure 11.
'Gravitational Force' as Locally Accelerated Expansion of Dynamic Euclidean Fabric



Think now about what is going on here. Remember, the two particles pictured here *have not* *moved at all* from where they were located in the (now-invisible) first-order Euclidean space. Particle 1 has *remained stationary* at (2,6) in absolute space, and particle 2 has *remained* at (9,6). However, their spatial location in that first-order Euclidean space is *invisible*, as it is 'beneath' the dynamic, second-order Euclidean fabric those same particles are situated upon—the only spatial locations that observers in this world *can* observe. But now if we consider that space—the expanding second-order Euclidean space—our observations will indicate that the two particles have 'moved toward each other.' At time *t*, the two particles were 6 *observable* spacetime units apart, whereas at *t+1* they are just over *three* observable spacetime units apart, whereas at *t+2* the two particles are just over *two* observable spacetime units apart. Observers *in* that dynamic spacetime will thus witness the following 'behavior' of the two particles (Figure 12).

Figure 12.

***Measurements* of object locations by observers *in* dynamic spacetime**

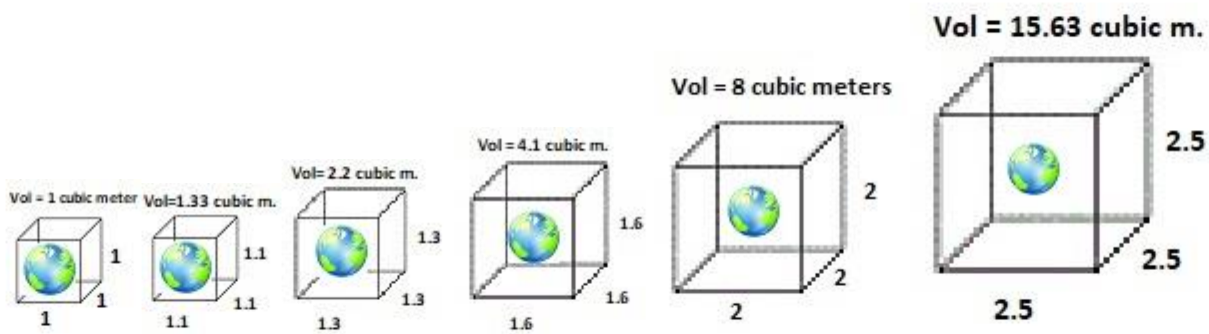


Observers, in other words, will witness the particles 'drawing closer together' as if tugged toward each other by an *invisible force*—the *force of gravity*. Which of course is precisely what we witness in our world. So, although the two particles have not budged one inch from where they have been in absolute Euclidean, this new interpretation of gravity—of objects with mass-energy causing the expansion of second-order Euclidean space *around* objects located in an unobservable first-order Euclidean space—will replicate our observations of 'gravitational attraction', all without any kind of non-Euclidean curvature.

However, if this is the real mechanism of gravity, then in order for objects with mass-energy to continue accelerating toward each other vis-à-vis the 'force of gravity', the mechanism described above—objects with mass-energy expanding the local fabric of dynamic spacetime—cannot occur at a constant rate. This is for the simple reason that dynamic spacetime expands, the volume of each unit of spacetime expands at an accelerated rate:

Figure 13.

Gravity as Mass-Energy Accelerating 2nd order Spacetime Fabric[8]



Time t → t_n

We see what the observational consequences of this volume expansion would be in Figure 11. As we see there, if spacetime expansion occurred at a *constant* rate around objects with mass-energy, those objects would initially 'accelerate' toward each other (the two particles in figure 10 cut their observed spacetime distance by roughly half from t to $t+1$, from 7 spacetime units apart to just over three). However, from t to $t+1$, the rate at which they move toward each other appears to 'slow down' (as the two particles move from approximately 3 spacetime units apart at t+1 to approximately 2 units apart at t+2). This is a direct consequence of the expansion of a spatial metric increasing the volume of each subsequent metric. If spacetime

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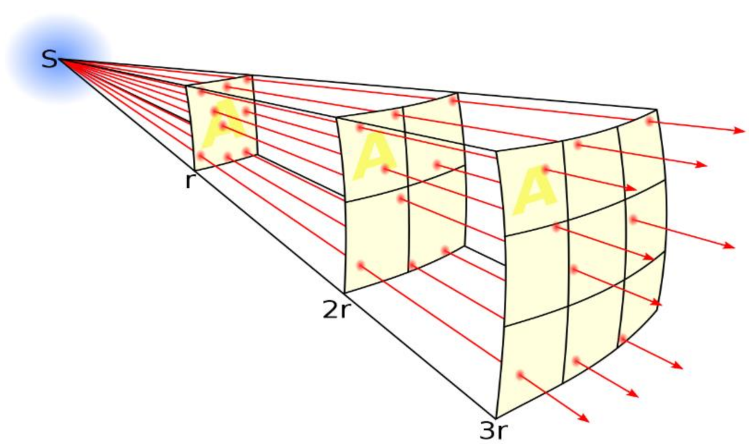
[8] Earth Image: https://www.dreamstime.com/illustration-world-globe-isolated-white-background-flat-planet-earth-icon-image111978477, retrieved 14 October 2021.

around any two objects with mass-energy (e.g. particles) expands at a constant rate, then the reduction in observed metric distance between them will drop over time—leading their 'observed motion' toward each other to appear to slow down the closer they appear to get, rather than continue to accelerate toward each other due to gravity, which is precisely how gravity does not work. Gravitational attraction is observed to *increase* the closer that objects with mass energy get to each other. Consequently, in order for this reinterpretation of Einstein's field equations to correctly model observed behavior of gravity, the expansion of second-order spacetime fabric around objects with mass energy *must increase*. Let us now ask how exactly we might understand this function in the field equations.

Let us begin with the law that we observe gravity to universally instantiate, at least in smaller gravitational systems (i.e. on Earth, the scale of the Solar System, etc.): namely, the Inverse Square Law that two massive bodies bodies—their dispositions to attract each other—is the product of their masses and the inverse square of their distance.

Figure 14.

The Inverse-Square Law[9]

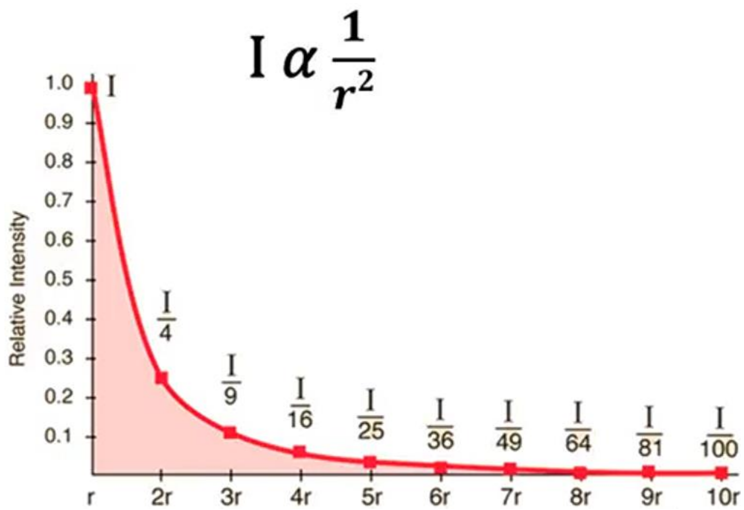


[9] Image: https://commons.wikimedia.org/wiki/File:Inverse_square_law.svg, retrieved 14 October 2021.

Next, let us plot a standard inverse-square function geometrically on a Cartesian plane:

Figure 15.

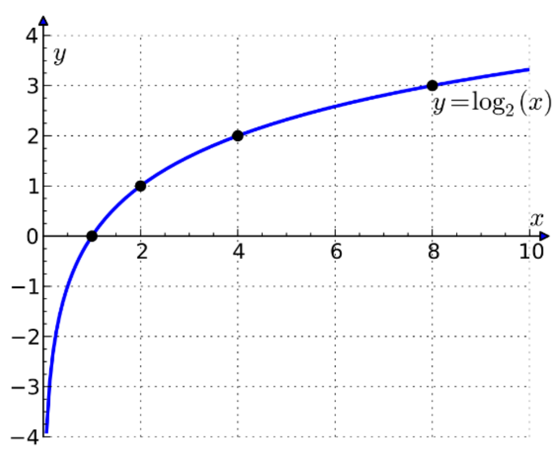
Inverse-Square Function[10]



How might we explain this feature of gravity in terms of the local expansion of a second-order spacetime fabric? The answer is in terms of a *logarithmic* function.

Figure 16.

Logarithmic function[11]



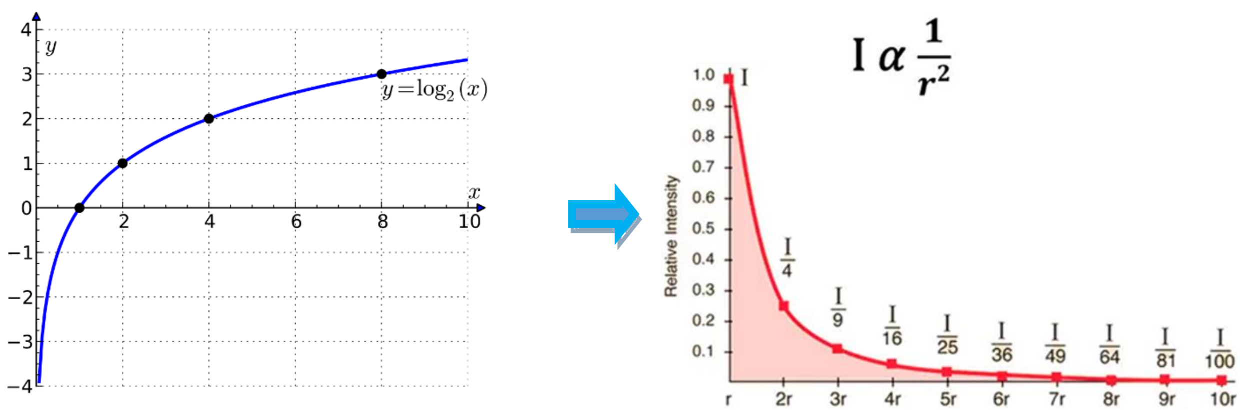
[10] Image: https://www.wifi-professionals.com/2018/11/inverse-square-law, retrieved 23 August 2021.

[11] Images: https://en.wikipedia.org/wiki/Logarithm#/media/File:Binary_logarithm_plot_with_ticks.svg and https://en.wikipedia.org/wiki/Logarithm#/media/File:Logarithm_plots.png, retrieved 23 August 2021.

The relationship here is plain. If we imagine two objects of mass-energy *accelerating the local expansion* of spacetime around them at a logarithmic rate—expanding the space near them rapidly, but this effect dropping off in a 'flat' curve at progressively larger distances—then this will have the effect of *rapidly reducing* the coordinate distance between the two objects the closer they are to each other, and these effects falling off according to *the inverse square* of their mass and distance. In other words, two objects of mass-energy locally accelerating the expansion of a dynamic set of coordinates according to a logarithmic function will *generate* the inverse-square effects of gravitational effects, in exactly the same way that Einstein's elevator *accelerating upward* generates *the felt force* of 'gravity' *pulling downward*. So, we have:

Figure 17.

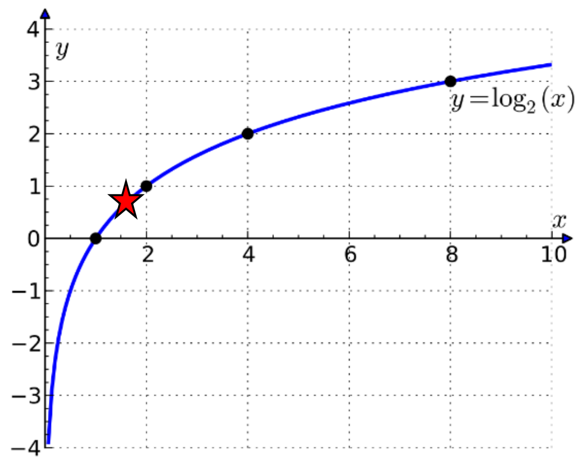
Logarithmic Coordinate Expansion Explains Inverse-Square Law of Gravitation



Notice, next, that this seems to cohere with the 'anomaly' mentioned earlier of the 'Universe's observed rate of expansion' violating the predictions of the ΛCDM model, such that the Universe appears to be *expanding more quickly* than the ΛCDM predicts. For, on the current reinterpretation of relativity, the value of Λ itself should change over time according to a logarithmic function (in order to explain 'gravitational attraction'). And indeed, we can fit the best estimates of Λ to a spot on a logarithmic curve, such that the reinterpretation of relativity should predict where Λ's value should be found in the future. For example, Baker et al. [7] have estimated the value of Λ to be 0.7. We can plot this value something like as follows, and in turn predict where Λ should be found to change over time given other cosmological parameters.

Figure 18.

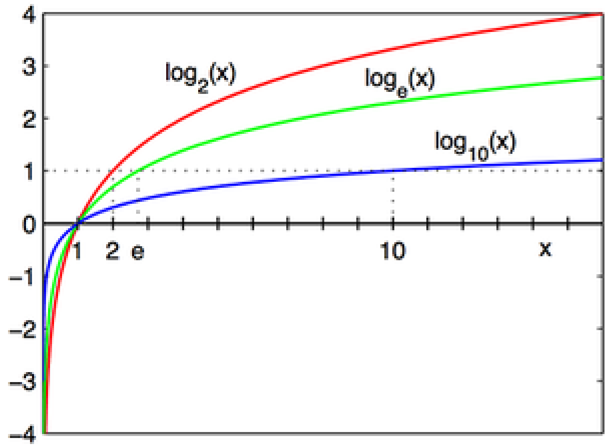
A Simplified Fit of Λ's (Currently Estimated) 0.7 Value to a Logarithmic Curve



As we will see below (in §2.3), this implication of the reinterpretation I am proposing enables us to explain away 'dark energy' and 'dark matter' without positing the existence of any such entities—though, as we will see, in order to explain certain observational anomalies, we may need to understand the particular logarithmic function that accelerates the expansion of dynamic spacetime (*qua* Λ) to be dependent in some deep way upon the mass-energy of a given system, such that gravitational systems with exponentially higher amounts of mass energy and size give rise to an exponentially *higher* logarithmic expansion of spacetime (viz. a higher base number in the logarithmic function).

Figure 19.

Logarithmic Functions with Different Base Numbers



As we will see, whereas smaller gravitational systems appear to involve the local expansion of spacetime (viz. Λ) according to a $\log_2(x)$ function (thus generating Inverse Square gravitational effects), galaxies and the early Universe appear to conform to something closer to the $\log_{10}(x)$ function (generating observations indicative of 'dark matter' and 'dark energy'). Interestingly, this suggests that Milgrom's Modified Newtonian Mechanics (MOND) [81] contains a grain of truth, in that gravity (on my reinterpretation of relativity) *does* operate differently at different scales. However, unlike Mond, my account understands these differential effects not in terms of Modified Newtonian Mechanics, but rather in terms of interpreting relativity itself in terms of a variable value for Λ. On my account, dark energy and dark matter are not things that exist in addition to gravity on relativity's field equations. Rather, gravity just is the accelerating expansion of dynamic spacetime fabric around objects with mass-energy—which, as we will see, not only explains the Universe's accelerated expansion and 'unexpected' deviations from the ΛCDM model of the Universe *without positing dark energy*. It also, as we will see, promises to explain phenomena associated with 'dark matter'—e.g., unexpectedly strong gravitational lensing and velocity dispersions in galaxies, etc.—*without positing dark matter*. And it may even explain the hypothesized exponential expansion of spacetime just after the Big Bang—*without positing a special 'inflation field.'* All of these things, or so I argue below, may be explained by gravity alone—if we reinterpret Einstein's field equations in the manner being proposed.

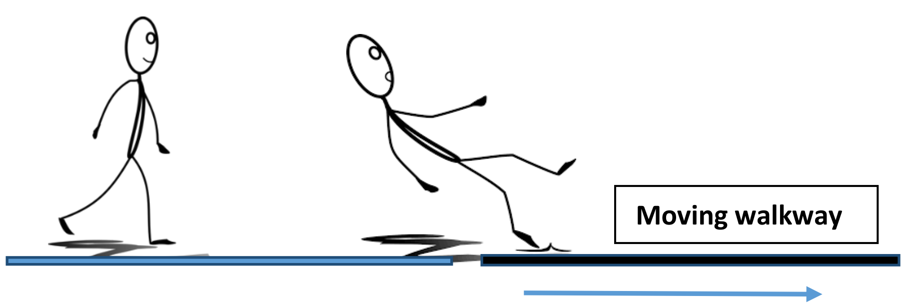
Before we get to those issues, however, we have quite a bit more work to do. First, as we have just seen, the reinterpretation of the field equations being offered explains gravitational attraction—why two or more objects with mass energy will be observed to 'attract' each other, bringing them 'closer together' in spacetime. What we have not yet explained is the *feeling* of 'gravitational force', the fact that two objects not moving in absolute Euclidean space ('below' the superimposed dynamic spacetime fabric that is expanding around them) should feel the 'tug' of gravity as a 'force' tugging them toward each other. After all, the objects in question are not moving at all: it is merely *dynamic spacetime fabric* that is expanding around them (due to their mass-energy) in an accelerating fashion. Can we explain the felt 'force' of gravity in terms of these phenomena—the phenomena posited by the reinterpretation of the field equations being offered? Indeed, it can.

As Einstein's elevator example shows, in order for acceleration to cause a felt force (i.e. a person in an elevator feeling themselves pulled downward), the thing accelerating (in this case, the elevator accelerating upward) must make physical contact with a non-accelerating object (in this case, the person inside). Consequently, in order to explain how the accelerating expansion of spacetime around objects with mass-energy not only 'attracts' objects to each other (which we have already seen) but does so in a way that *imparts felt force* upon them, we need to specify a mechanism by which the accelerated expansion of spacetime might impart such force. Fortunately, we already have conceptual foundations to explain this.

Let us begin with an analogous case from everyday life—one that does not involve the expansion of a 'fabric' but rather movement of a dynamic surface beneath an object: namely, the experience of stepping onto a 'moving walkway' at the airport (Figure 20). When you step on a moving walkway at the airport, the surface of the walkway is accelerated relative to the unmoving floor you were previously walking upon: specifically, it is accelerating *away* from it. Consequently, when you first step on the moving walkway, you will—for only a split second (until the walkway is no longer accelerating relative to you)—feel yourself *pulled backward*:

Figure 20.

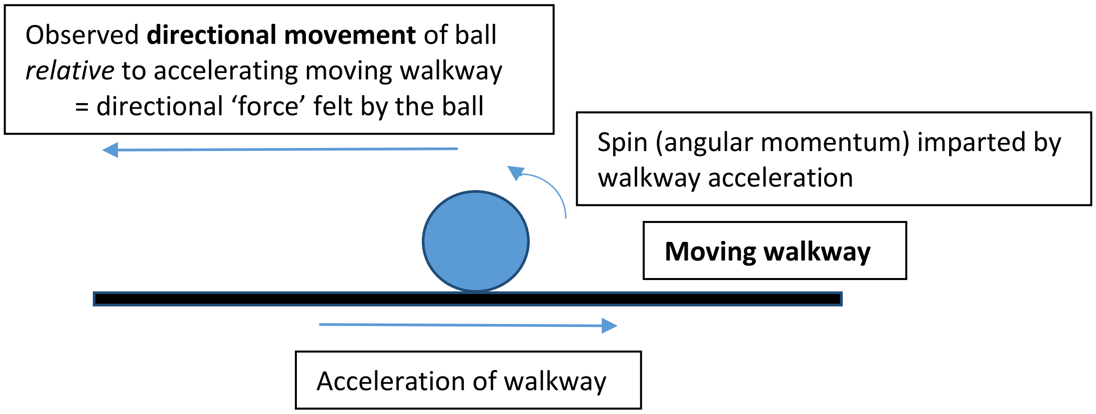
Experienced force upon stepping onto a moving walkway[12]



Now consider what happens if you place a circular object (a ball) on a moving walkway *and continuously accelerate* the speed of the walkway: *relative* to the moving walkway, the ball will 'tumble backwards' (see Figure 21 below).

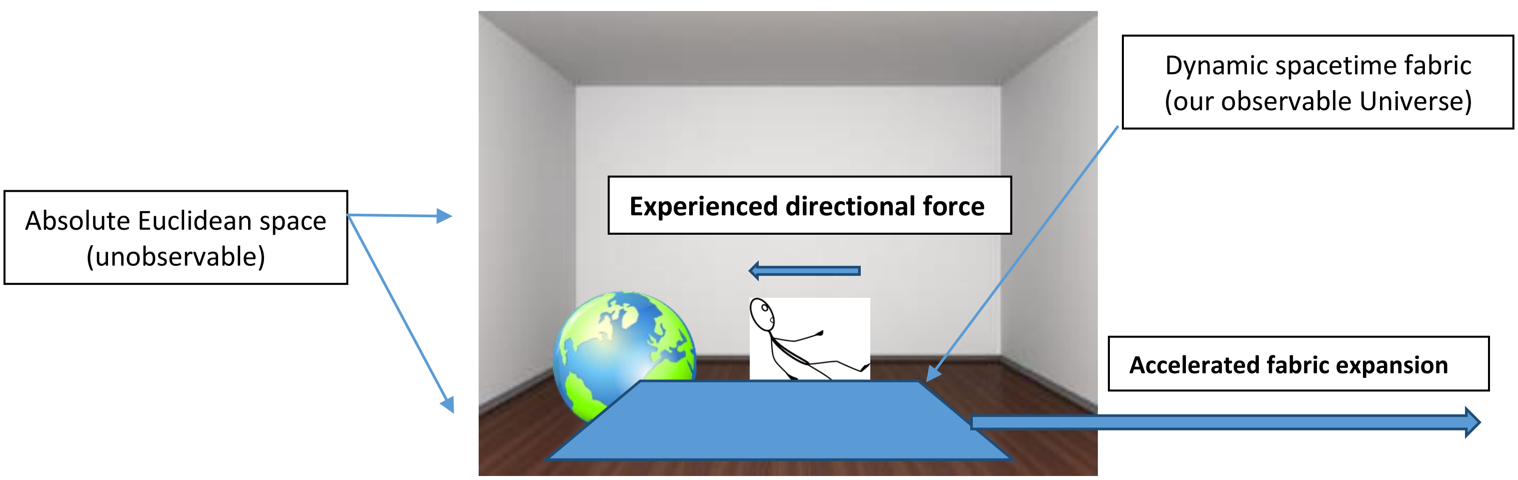
[12] Images: https://pixabay.com/vectors/walking-hiking-stickman-151828/ and https://motorimpairment.neura.edu.au/unexplained-falls-older-people/stick-figure-falling/, both retrieved 14 October 2021.

Figure 21.
Force imparted by an *accelerating* moving walkway



Now, of course, as we all know in this case—the case of a moving walkway—the ball on top of the walkway will always get further away from its initial starting point. However, this is *not* the case if, instead of placing an object on a moving walkway, we instead place it on an *expanding* fabric (i.e. fabric). You can see this yourself by placing an object on top of a piece of expansive fabric, or even a rubber band. If you pull the fabric to the right, accelerating the fabric's expansion in that direction, the object on top of it move to the right relative to absolute Euclidean space but nevertheless fall to the left relative to the expanding fabric (Figure 22):

Figure 22.
Force imparted by accelerating expansion of dynamic second-order spacetime fabric



Consequently, if we amend the new reinterpretation of the field equations I proposed above—where objects with mass-energy locally cause the second-order dynamic Euclidean space under and around them to expand at a logarithmically accelerating rate—with a further assumption, that there is some friction (formally represented by the field equations stress-energy tensor, $T_{\mu\nu}$) between those objects otherwise 'stuck' in absolute Euclidean space and the second-order dynamic Euclidean spacetime fabric accelerating around them as a result of their mass-energy, then that expansion will not only lead objects with mass energy to appear to 'move closer together' (as in Figure 11), but also *feel tugged* toward each other as if by an invisible force (the 'force of gravity', as in Figure 22).

In short, if we assume—in line with the alternative interpretation of the field equations being explored—that objects are simultaneously located in (A) an objective, absolute, but unobservable Euclidean space, and (B) a second, dynamic Euclidean fabric *overlaid* on that absolute space, such that (C) those objects' mass-energy in the dynamic space cause the *locally accelerated expansion* of the second-order Euclidean spacetime metric *away* from that mass-energy, (D) according to a *logarithmic* function, then (E) that second-order expansion will be experienced by those in a gravitational system as *imparting a gravitational force* upon them, (F) *inversely proportional* to the square of mass and distance between such objects. That is, we will have interpreted the physical significance of Einstein's field equations—and the way in which they account for gravitational behavior—in a new, observationally-equivalent way.

We will now see that in addition to explaining gravitational attraction and force, the reinterpretation can explain the appearance of spacetime curvature, other verified features of General Relativity (e.g. time dilation), the apparent existence of 'dark matter', and finally, recent observational 'anomalies' inconsistent with the dominant ΛCDM model of the Universe.

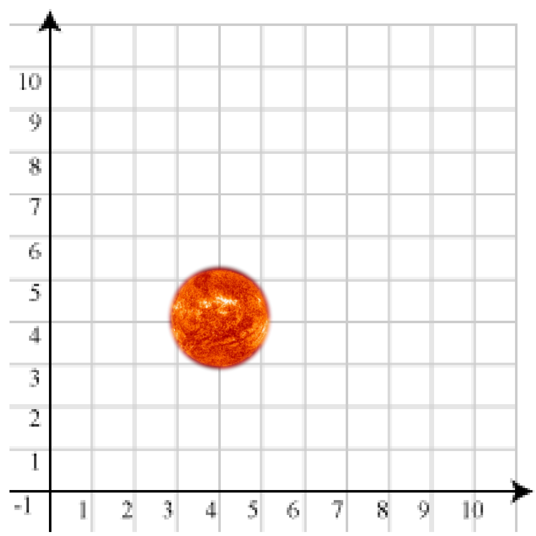
2.2. 'Spacetime curvature' as observational artifact of accelerated spacetime expansion

The dominant interpretation of General Relativity holds that spacetime is curved by mass-energy, and gravitational attraction the result of said curvature. We have already seen how the reinterpretation of the field equations I have proposed can account for gravitational attraction without spacetime curvature. It is just as easy to see, using the thought-experiments we have already examined, how the reinterpretation I am proposing can explain the appearance of spacetime curvature without there actually being any such thing. Allow me to explain.

Let us suppose that a massive object (say, the Sun) is located at a determinate location in that absolute Euclidean space (x=4, y=4) (Figure 23):

Figure 23.

Massive Object Located in (Unobservable) Absolute Euclidean space[13]

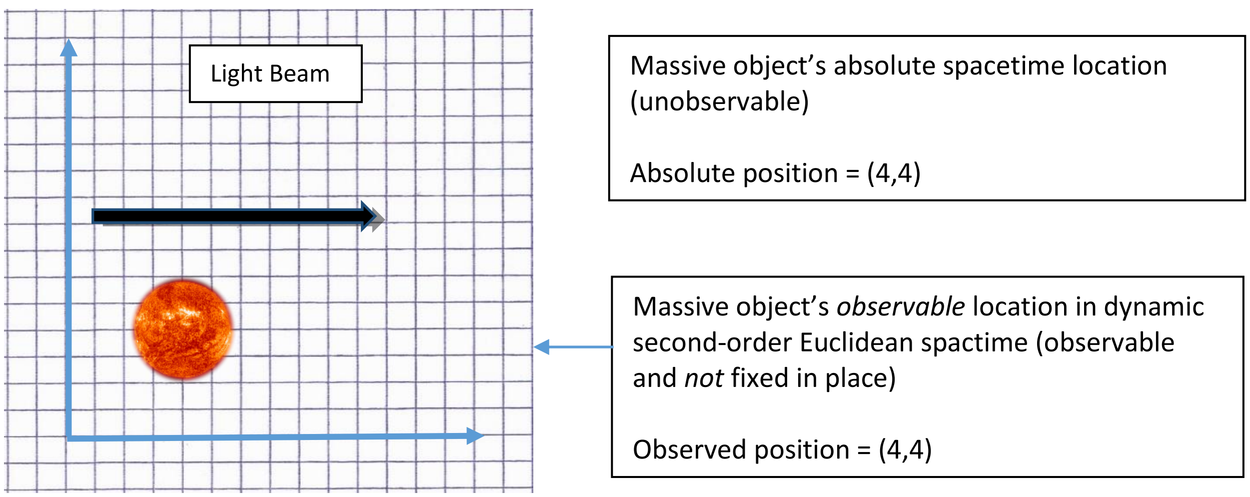


Now let us suppose that light is unique—that, unlike all other physical entities, which are located in absolute spacetime, light only propagates in the dynamic second-order spacetime fabric (note: although ascribing this unique property to light may appear arbitrary at this point in our investigations, it is worth bearing in mind that light *is* fundamentally different than all

[13] Sun image: https://timedotcom.files.wordpress.com/2014/02/sun.jpg, retrieved 23 July 2021.

other observed objects in having the same observed speed regardless of one's motion relative to it). Consequently, much as we did in our thought-experiments with particles, let us 'remove' the absolute Euclidean space from Figure 23 (bearing in mind that it is still there) and instead *substitute* in the second-order dynamic Euclidean spacetime fabric posited by my reinterpretation of the field equations (Figure 11), along with a beam of light propagating *in* that dynamic spacetime—which we may do as follows:

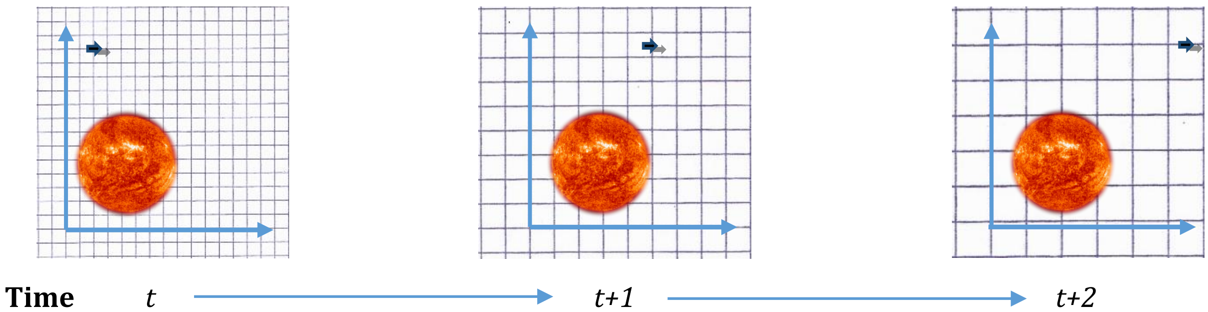
Figure 24.
Light Traveling Near Massive Object in *Observable* Dynamic Spacetime



Now let us witness what happens if we suppose that the object's mass-energy causes this dynamic spacetime to expand locally in an accelerated fashion (***N.B.:*** the plots that follow do not follow a logarithmic function, and so should not be taken to be *physically realistic* in terms of modeling precisely how e.g. the Sun deflects light rays. The point of the following diagrams are merely to show—at a conceptual level—how the locally accelerated expansion of a dynamic second-order spacetime generates observations of 'spacetime curvature' as a measurement artifact). Let us suppose for the sake of simplicity, then, that although light travels in a continuous fashion, the Sun accelerates the local expansion of spacetime as follows:

Figure 25.

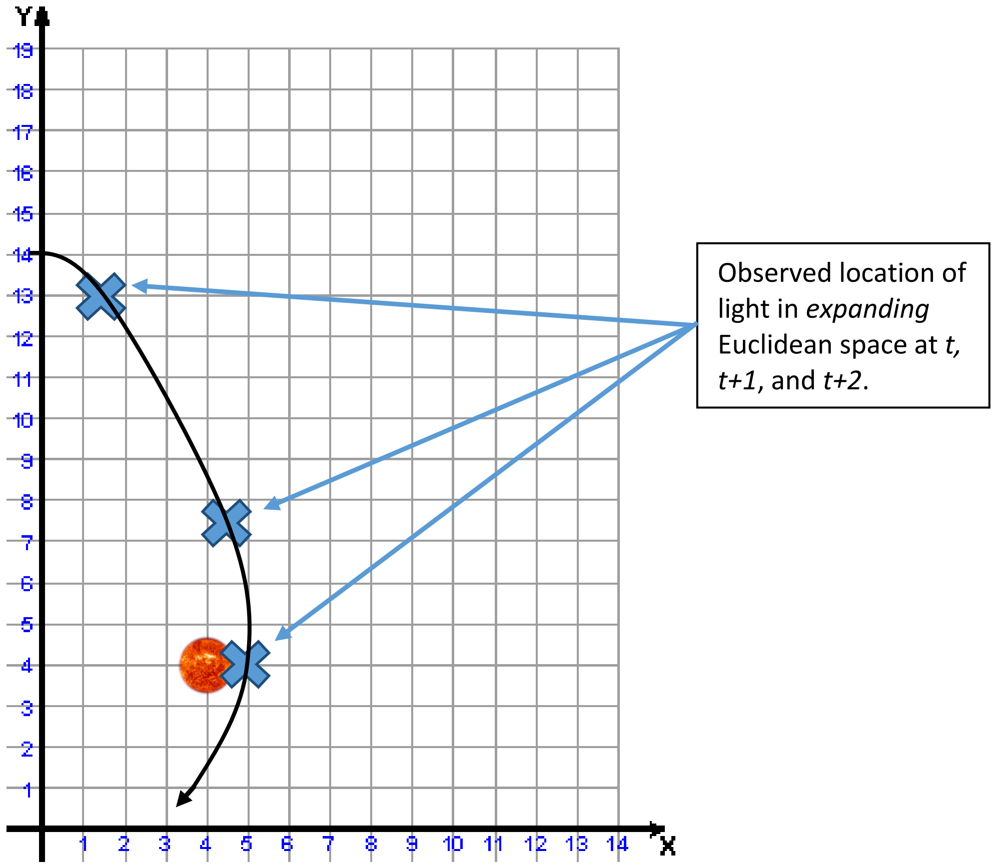
Light Traveling Straight Through Accelerated Expansion of Dynamic Spacetime Fabric



Notice what is happening here. At time *t*, the light beam will be measured by observers to be located at (2,13). At time *t+1*, the same beam of light (which by hypothesis has been moving in a 'Euclidean' *straight line* relative to Euclidean space (despite not being *physically located* in that space), will be observed as located at coordinates (5, 7.5). Then, at time *t+2*, that same beam of light will be observed at coordinates (5.5, 5). Although again this is a vast idealization (since light travels continuously and I have not taken care in these diagrams to model logarithmic expansion), here is what we get when we plot this observed behavior *according to where we measure the light to be relative to the Sun in observed dynamic spacetime* (Figure 26):

Figure 26.

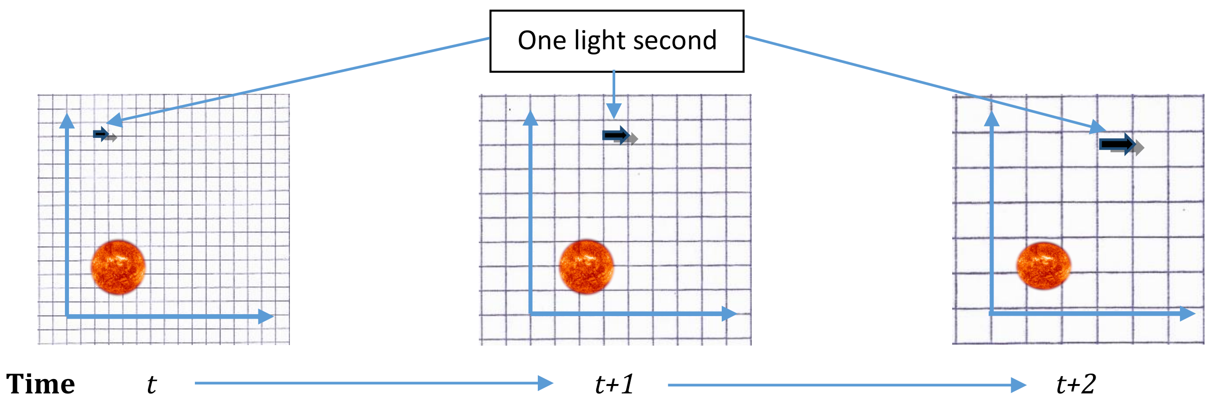
Observed Consequences of Light Traveling Through Logarithmically Expanding 2nd Order Euclidean Fabric



In other words, the accelerated local expansion of Euclidean space as a result of mass-energy will, on the reinterpretation of General Relativity being proposed, lead to *observations* of the apparent 'curvature' of space by gravity. On this interpretation of the field equations, it is not spacetime that is curved by mass-energy, nor the beam of light that is curving. Instead, the apparent 'curvature' of spacetime is simply an observational artifact of mass-energy causing the accelerated-expansion of a second-order Euclidean spacetime fabric around objects moving in a *straight line* through an absolute first-order Euclidean coordinate-system. What about the 'curvature' of time? Once again we can use the reinterpretation of the field equations to explain how mass-energy appears to curve time. To see how, consider first the fundamental difference I hypothesized above between light and all other physical things. As we know from observation, the speed of light is observed to be constant regardless of one's reference frame. On the reinterpretation of relativity being proposed, this means that the *length* of light must expand as space expands (Figure 27), such that light is always observed to travel 1 light-second per second but the *spatial length* of one light-second expands.

Figure 27.

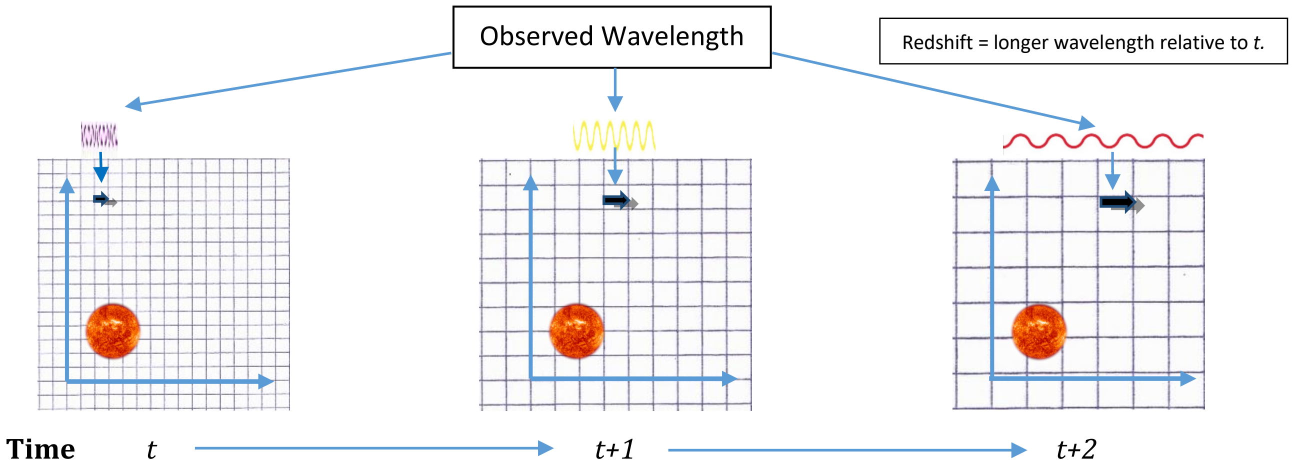
Spatial Expansion of Light with Accelerated Dynamic Space Expansion



Notice something that we will return to later. Because light is a particle and a wave, as light travels through a gravitational field its *wavelength* will appear stretched, qua the 'redshift' observed in measurements of all galaxies around us (Figure 28 below). This redshift, however, will not be explained in the manner it currently is—that is, by the ΛCDM model. According to the ΛCDM model, observed redshift is caused by *some entity beyond gravity* ('quintessence' or 'dark energy') accelerating the expansion of spacetime everywhere in the Universe. Instead, on the reinterpretation of relativity being defended here, the observed redshift of light from distant galaxies is the result of *gravity* locally accelerating the expansion of a second-order, dynamic spacetime around objects with mass-energy.

Figure 28.

Redshift = Gravity as Locally Accelerated Expansion of 2nd Order Euclidean Spacetime

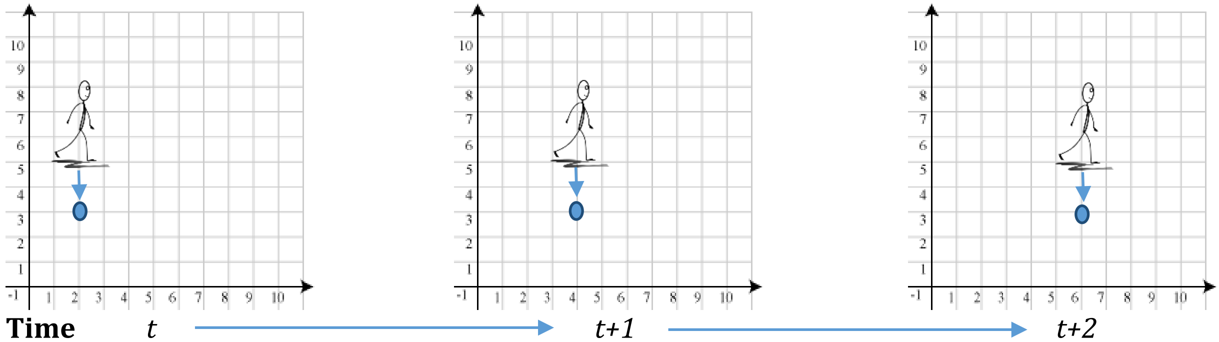


Importantly, to reiterate, this redshift is not—on the new interpretation of relativity being proposed—the result of spacetime being curved by gravity (which is itself a measurement artifact of gravity *being* the accelerated expansion of spacetime). Nor, for reasons we have already seen, will the redshift be constant. Rather, because gravity just is (on the new interpretation) mass-energy logarithmically accelerating the expansion of dynamic Euclidean spacetime, the reinterpretation predicts that gravitational redshift should be *constantly increasing*—which is precisely what cosmological observations reveal but the dominant ΛCMD model of the Universe leaves unexplained (having to posit 'dark energy' or 'quintessence' to explain it).

Now let us turn away from light—which again is observed to have an invariant velocity in all reference frames—to the observed speed of ordinary objects. Let us begin by plotting the spatial position of an object over time in (unobservable) absolute Euclidean space. Let us suppose, specifically, that this object is me walking from one place to another at a constant rate relative to absolute space (Figure 29), e.g. 2 spatial units per 1 unit of 'objective' time.

Figure 29.

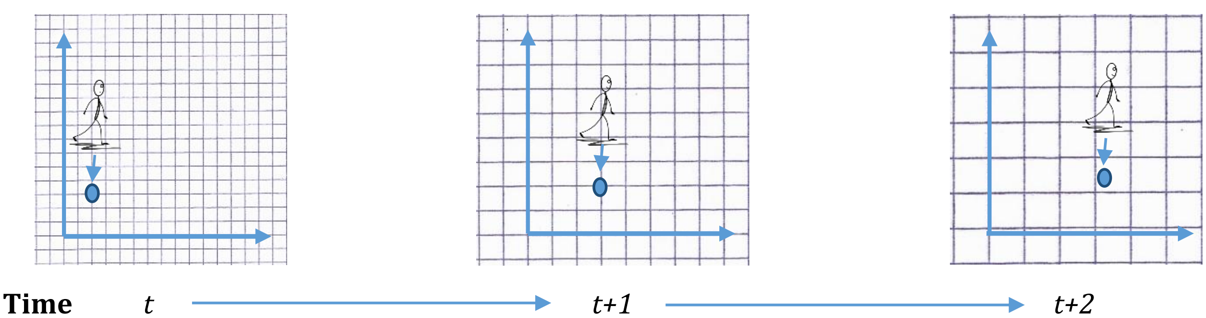
Movement of Object Through Absolute (Unobservable) Euclidean Space



Remember, on the reinterpretation of the field equations being offered, these ‘absolute’ spatial and temporal locations are unobservable. The only thing that inhabitants of our Universe can observe is the behavior of objects relative to the *dynamic second-order Euclidean* spacetime overlaid on the ‘absolute’ spatiotemporal dimensions above. Next, let us suppose that I am walking on an object (the Earth) with a high mass-energy. Consequently, on the reinterpretation of the field equations being proposed, here is what will be observed:

Figure 30.

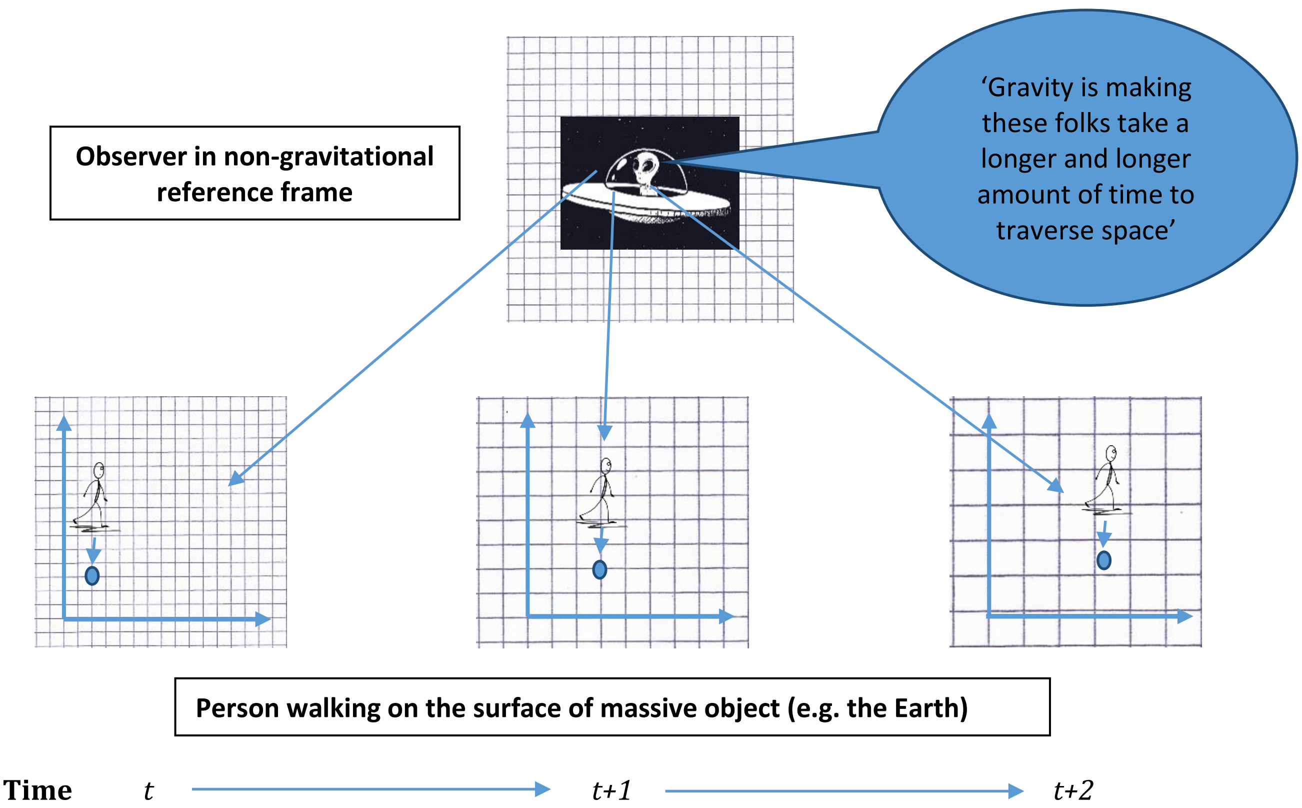
‘Time Dilation’ as Consequence of Accelerating Metric-Expansion of Euclidean space



Observers within this expanding Euclidean space (i.e. you and me) would witness nothing odd: we would experience ourselves as moving at a constant rate. For although it would, in actuality, take us longer and longer to traverse a single metric of expanding spactime fabric, everything around us would be doing this at a constant rate—thus leading us, within this reference frame, perceiving everything moving at a constant rate (not appearing to slow down). To observers outside of our gravitational reference-frame, however, things would be very different. Because their spacetime would not be caught in the local expansion of our gravitational field, they would witness everything in *our* vicinity taking longer and longer to occur. That is, relative to outside observers, the gravity surrounding us would appear to slow time down (Figure 31):

Figure 31.

New Interpretation of Relativistic Spacetime Dilation[14]



For, as we see in the above figure, *in the accelerated expansion of Euclidean space* it takes a progressively longer and longer time to cover the same area of ground (I move *one* unit of

[14] Flying-saucer image: https://www.vectorstock.com/royalty-free-vector/alien-in-a-flying-saucer-vector-19617162, retrieved 23 July 2021.

space from *t* to *t+1*, only .25 units of space from *t+1* to *t+2*, and so on). The reconceptualization of Einstein's field equations being proposed thus explains 'time dilation': it just does so via a different mechanism than that posited by the traditional interpretation of the field equations—not by the curvature of space and time but instead simply by mass-energy accelerating dynamic Euclidean spacetime metric while objects (e.g. you and me) move at a constant rate through an unobservable, absolute Euclidean space.

2.3. 'Dark Energy' and 'Dark Matter' as Observational Artifacts of Gravity as Mass-Energy Accelerating Local Spacetime Expansion

As discussed earlier, the ΛCDM (Lambda cold dark matter) model is the dominant cosmological model of the Universe's composition and history. This model, which is based on the traditional interpretation of General Relativity, holds that the Universe is constituted by three things:

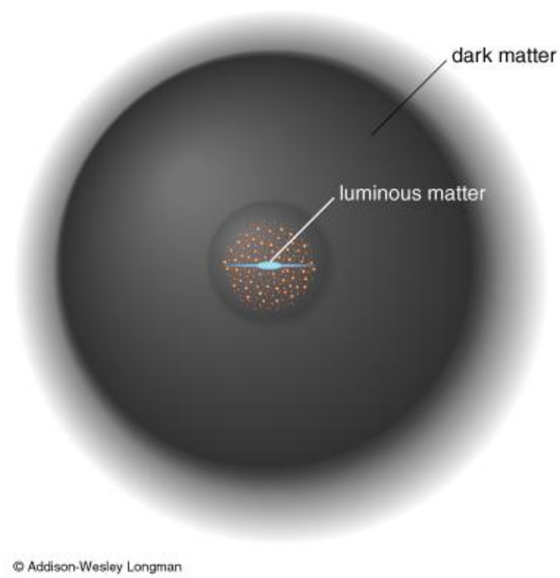
1. ***Ordinary 'baryonic' matter*** and energy (quarks, atoms, electromagnetism, etc.)
2. A cosmological constant (Λ) associated with ***dark energy***, a special kind of energy that is thought to accelerate the metric expansion of the Universe *equally* throughout all space.
3. ***Cold dark matter*** (CDM), a special type of matter that moves very slowly and has gravitational effects but interacts very weakly with ordinary matter and electromagnetic radiation.

Here, in brief outline, is how this cosmological model has been arrived at.

First, as we have seen, the traditional interpretation of Einstein's field equations—the interpretation which holds that mass-energy curves spacetime—treats Λ as an additional theoretical entity beyond gravity. This is because all of the other major terms in the field equations—e.g.'G', ''$T_{\mu\nu}$', '$g_{\mu\nu}$', and '$R_{\mu\nu}$'—have been interpreted as describing 'gravitational force' (G) in terms of the density of mass-energy ($g_{\mu\nu}$, $T_{\mu\nu}$) curving spacetime in a non-Euclidean fashion ($R_{\mu\nu}$). As we have seen, on this interpretation of the field equations, Einstein added in Λ to achieve a stable (rather than contracting) Universe. Consequently, in the decades since the observational discovery that the Universe is expanding [61], theorists have supposed (based upon the traditional interpretation of the field equations) that Λ has to stand for some extra theoretical entity: either dark energy, an unseen force that expands spacetime throughout the Universe at a constant rate of acceleration, or 'quintessence', an unseen force that expands the Universe at a variable (i.e. changing) rate. Notice, furthermore, that ever since Einstein proposed it, cosmologists have primarily aimed to *fit* Λ to 'observed data.' Whereas Einstein inserted Λ to achieve a stable Universe, the Hubble telescope's observation of gravitational redshift has been taken by cosmologists to imply that Λ (i.e. dark energy) is *stronger* than Einstein thought. Further, recent observations that the Universe's rate of expansion is accelerating faster than the ΛCDM predicts [105] has once again led theorists—purely on the basis of observation—to entertain the possibility that perhaps Λ is not constant, after all, but instead variable (as theories of 'quintessence' hold). Notice, again, that on the traditional interpretation of the field equations we have no *a priori* reason to favor dark energy (Λ being constant) over 'quintessence' (Λ being variable). This is instead treated as an *experimental* question to be resolved by cosmological observation—despite, of course, all existing searches for dark energy and quintessence having turned up empty. However, on the current reinterpretation of relativity, we have *grounds* for taking Λ to have a changing value over time (namely, its value has to evolve along a logarithmic function).

Finally, in addition to treating Λ as an additional theoretical entity, on the traditional interpretation of the field equations there must be yet another as-yet undetected theoretical entity: dark matter, an entity postulated nowhere in the field equations themselves. This extra type of matter is thought to exist because—at least on the traditional interpretation of the field equations—galaxies and other cosmological structures appear to have vastly more mass than observations of ordinary baryonic matter suggest. The dominant explanation of this 'extra mass' is that our Universe contains vast quantities of 'cold dark matter'—either some new type of fundamental particle such as axions [109] or WIMPs [65], or else massive compact objects such as black holes and neutron stars (MACHOs) [21]—and that this matter clumps together in massive spherical halos in galaxies (Figure 32).

Figure 32.
Hypothesized Galactic Dark Matter 'Halos'[15]



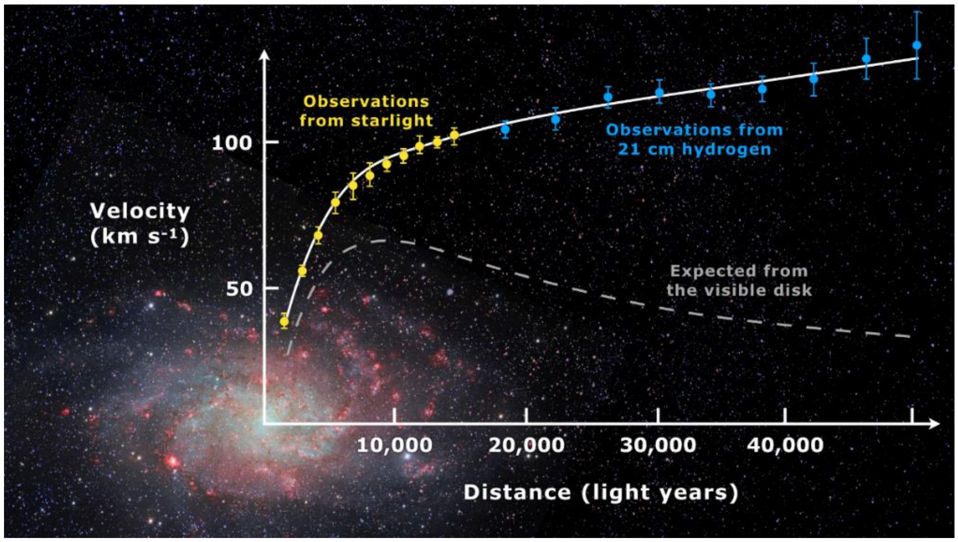
Evidence for this 'extra mass' comes in several forms. First, spiral galaxies have unexpectedly 'flat' rotation curves [24]. Whereas planets in solar systems move more quickly the closer they are to a star and more slowly the further they are away (like a whirlpool), the arms in spiral

[15] Dark halo image: https://www.proprofs.com/discuss/q/438026/-what-the-universe-mostly-made, retrieved 14 October 2021.

galaxies are observed to rotate at a similar rate throughout most of the galaxy's diameter, much like the spokes on a bi-cycle wheel rotate 'locked together' (Figure 33).

Figure 33.

'Flat' Galaxy Rotation Curves Interpreted as 'Dark Matter'[16]

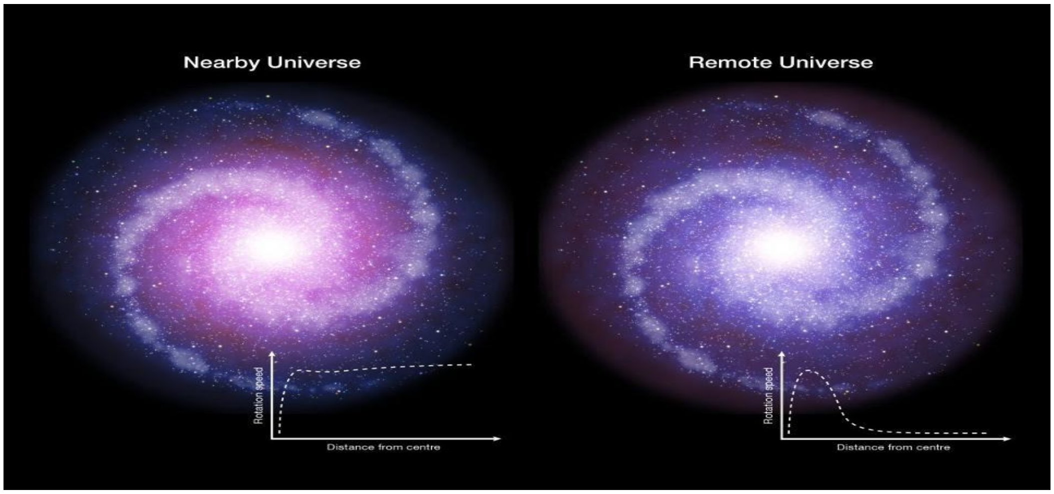


Second, the rotation curves of galaxies appear to have changed dramatically from the early Universe to today [41, 48]. Galactic rotation curves of more distant galaxies (which are thus earlier in the Universe's history) are closer to what one would expect given visible baryonic matter. In these distant galaxies, stars close to the galactic center orbit more quickly than stars further away, much as planets do in solar systems. However, in more nearby galaxies (closer to us in spacetime), rotation curves become more flattened, with stars close to the galactic center and further away rotating around the galaxy with broadly similar velocities. According to the ΛCDM model, these changes in galaxy rotation curves are the result of more recent galaxies having more dark matter than more distant ones—with the extra dark matter in more recent galaxies serving as the mass-energy 'engine' of the flatter rotation curves (see Figure 34):

[16] Image by Mario De Leo, https://commons.wikimedia.org/w/index.php?curid=74398525.

Figure 34.

Differences in Galactic Rotation Curves from Nearby-Present to Remote-Past[17]

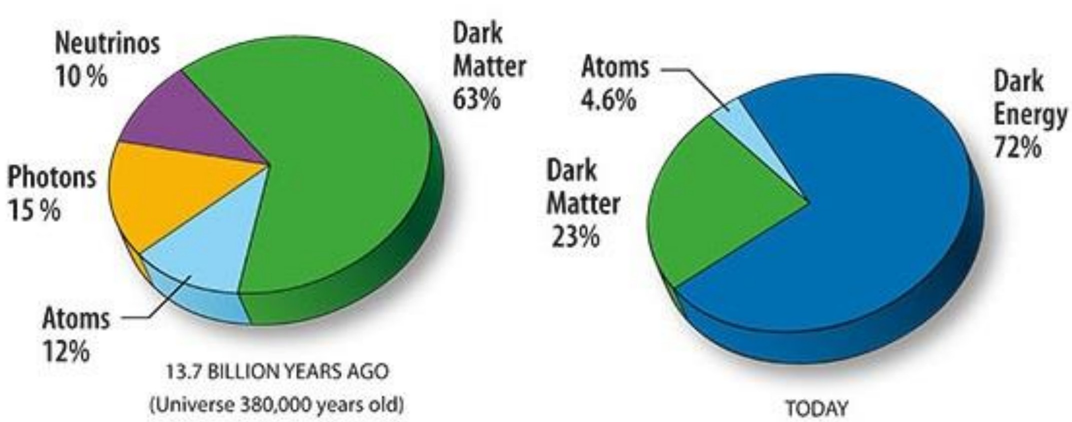


'More dark matter' **'Less dark matter'**

These observations have been taken by theorists to imply that early galaxies were dominated by ordinary matter, only to become more dominated by dark matter as the Universe has progressed [42], such that (according to the ΛCDM model), the *entire composition* of the Universe has dramatically changed over time:

Figure 35.

Changes in Universe's Hypothesized Composition



[17] Image credit: ESO / L. Calcada, https://medium.com/starts-with-a-bang/does-dark-matter-exist-or-is-gravity-wrong-c2df01595286, retrieved 21 October 2021.

A third source of evidence for dark matter is that velocity dispersions (the rate at which objects move) in elliptical galaxies do not match predictions based on those galaxies' observed ordinary baryonic matter [14]. Fourth, galaxies in general have much stronger gravitational lensing effects (the amount that they bend starlight) than predicted using observations of their ordinary baryonic matter [104, 121]. Finally, in addition to these and other cosmological observations that theorists standardly take to be evidence for dark matter, there is at least one further oddity that lacks any explanation on the ΛCDM model. It is widely believed today that nearly all large galaxies—including our own—have supermassive black holes at their center: black holes having hundreds of thousands to billions of times the mass of the Sun [67-8]. Interestingly, however, recent observations indicate a 'strange' relationship between these black holes and dark matter [15-16]: namely, that 'the more dark matter a galaxy has, the bigger its black hole tends to be' [83]. This relationship is yet another 'anomaly' not explained by the ΛCDM model, as the ΛCDM model takes dark matter to be an entirely different kind of stuff that does not interact with (or interacts only very weakly with) ordinary mass-energy, including the immense mass-energy of black holes.

Crucially, all of these 'anomalies'—the fact that galactic rotation curves do not match predictions based upon galaxies' observed baryonic matter, the strange (and yet-to-be-understood) relationship between 'dark matter' and galactic black holes, the fact that dark matter has never been directly detected in any experiment to date, and so on—are all based upon the traditional interpretation of General Relativity's field equations. Specifically, they are based upon the assumptions that 'Dark matter does not bend light itself; mass (in this case the mass of the dark matter) *bends spacetime*. Light follows the curvature of spacetime, resulting in the lensing effect' [6, 117].

Let us not mince words at this point. The ΛCDM of the cosmos is the dominant cosmological theory of the Universe today. It is widely accepted because it appears to follow logically from two things: (1) General Relativity (as traditionally interpreted), and (2) cosmological observations. Because General Relativity's predictions have been systematically confirmed, the ΛCDM model seems logically unavoidable given cosmological observations and the traditional interpretation of relativity. But let us be clear: the ΛCDM mode is a theoretical and predictive mess. First, the ΛCDM model posits not one but two theoretical entities—dark matter and dark energy—that have *never* been directly observed in any experiment. Second, the ΛCDM model asserts that these two entities comprise the vast majority of mass-energy in the Universe: 95.1%, compared to only 4.9% ordinary (baryonic) mass-energy. Third, as we have seen, the ΛCDM model holds that the relative amounts of different forms of mass and energy have changed dramatically over the course of the Universe's history for reasons that no one understands—with the early Universe having nearly no dark energy to it being (apparently) dominated by dark energy today [42]. Fourth, estimations of the Universe's rate of expansion based on the ΛCDM model and previous observations conflict with the rate of expansion found in more recent observations, which find the Universe's rate of expansion to be increasing larger than expected [106]. Fifth, the ΛCDM model contains no obvious explanation of why galaxies with larger central black holes should have more dark matter. Sixth, dark matter simulations indicate that the density of dark matter should be more 'peaked' in galaxies than observed [47].

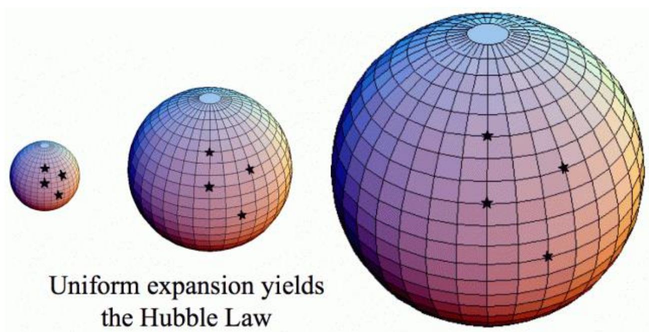
We could go on—but the point is this: if you wanted to design a false scientific paradigm akin to Ptolemy's epicycles or the luminiferous aether of Newtonian physics, you could hardly do better than this. For consider what we have just summarized: according to the dominant theory of the cosmos, our Universe consists of (A) vast amounts of matter and energy that (B) have never been directly observed, (C) have failed to be detected in every experimental search carried out to date, (D) change dramatically in quantity and proportion over the Universe's history for some completely unknown reason, and (E) conflict with and fail to explain a variety of other cosmological observations. All of these facts together suggest that the ΛCDM model may be deeply misguided. However, as we have seen, it is thought to follow inexorably from two things: from General Relativity and observations of the cosmos. Since observations are what they are (observed facts), this means there are only three possibilities: (1) the ΛCDM is correct and we will someday find the dark matter and energy we are looking for, (2) General Relativity is false, or (3) we have *misinterpreted* the physical significance of General Relativity. I have just laid out a litany of reasons to think that the ΛCDM model may be false. Let us assume for the sake of argument that it is. That leaves options (2) and (3). It is of course possible that General Relativity is incorrect—and many alternative theories have been proposed, ranging from Farnes' dark fluid theory [43] (which it is said will be testable beginning in 2022 [40]) to Milgrom's Modified Newtonian Mechanics (MOND) [81], Bekenstein's TeVes model [11], and Moffat's STVG model [84]. However, there are two related reasons why General Relativity is favored over these alternatives. First, General Relativity's many predictions—ranging from predictions of Mercury's perihelion to the slowing of clocks on fast-moving objects to gravitational lensing to gravitational waves—have been systematically verified. Second, to the extent that the alternative theories have been tested, they appear to make at least some incorrect predictions [3, 17, 74]. So, it seems, we have reasons to reject option (2). That leaves option (3): the possibility that General Relativity is correct but its physical significance has been misunderstood.

I have provided an alternative interpretation of the field equations, one according to which Λ is not an additional theoretical entity (dark energy) beyond gravity, but instead simply an expression of what gravity is: namely, not the warping of spacetime by mass-energy, but instead the logarithmically accelerating local metric-expansion of dynamic second-order Euclidean spacetime fabric overlaid on 'absolute' Euclidean space—which in turn leads to the *appearance* of 'spacetime curvature' as a measurement artifact. I have shown how this alternative interpretation of the meaning of the field equations explains the *apparent* bending of spacetime, as objects (such as beams of light) traveling through expanding Newtonian space will appear to curve to anyone located within the same dynamic Euclidean fabric. Further, I have shown how the alternative interpretation explains gravitational attraction (viz. Newton's constant), and the felt force of gravity. Finally, I have shown how, if we represent ordinary objects as located in first-order absolute Euclidean space surrounded by and affected by second-order dynamic Euclidean fabric, but light as located in (and expanding with) second-order dynamic Euclidean space time—so as to model light's unique property of always appearing to move at the same rate through observable spacetime regardless of reference-frame—the model explains *spacetime-dilation*. Now, to be sure, I did not go through complex math—and perhaps going through all of the math may require modifications to the model (which I am happy to countenance). The point, though, is this: we have seen in concrete terms, through a series of simply thought-experiments, how all of the central conceptual features of General Relativity—the conceptual features represented by various terms in the field equations, ranging from gravitational attraction (G) to spacetime 'curvature' (R) the density of mass-energy (T), etc.—can be *reinterpreted* in a new way, one that explains gravitational attraction, curvature, etc., *in terms of* Λ, that is, in terms of gravity *just being* mass-energy locally accelerating the metric-expansion of spacetime. The question we now turn to is whether this reconceptualization can explain the many observational 'anomalies' that have arisen relative to the ΛCDM model.

Let us begin with dark energy. The current paradigm—embodied in the ΛCDM model—is that 'Λ' in the field equations stands for a constant in nature: a repulsive force that is expanding the Universe's spacetime metric everywhere at a constant rate (Figure 36).

Figure 36.

The Dominant Interpretation of 'Λ': *Uniform* Metric Expansion by Dark Energy[18]

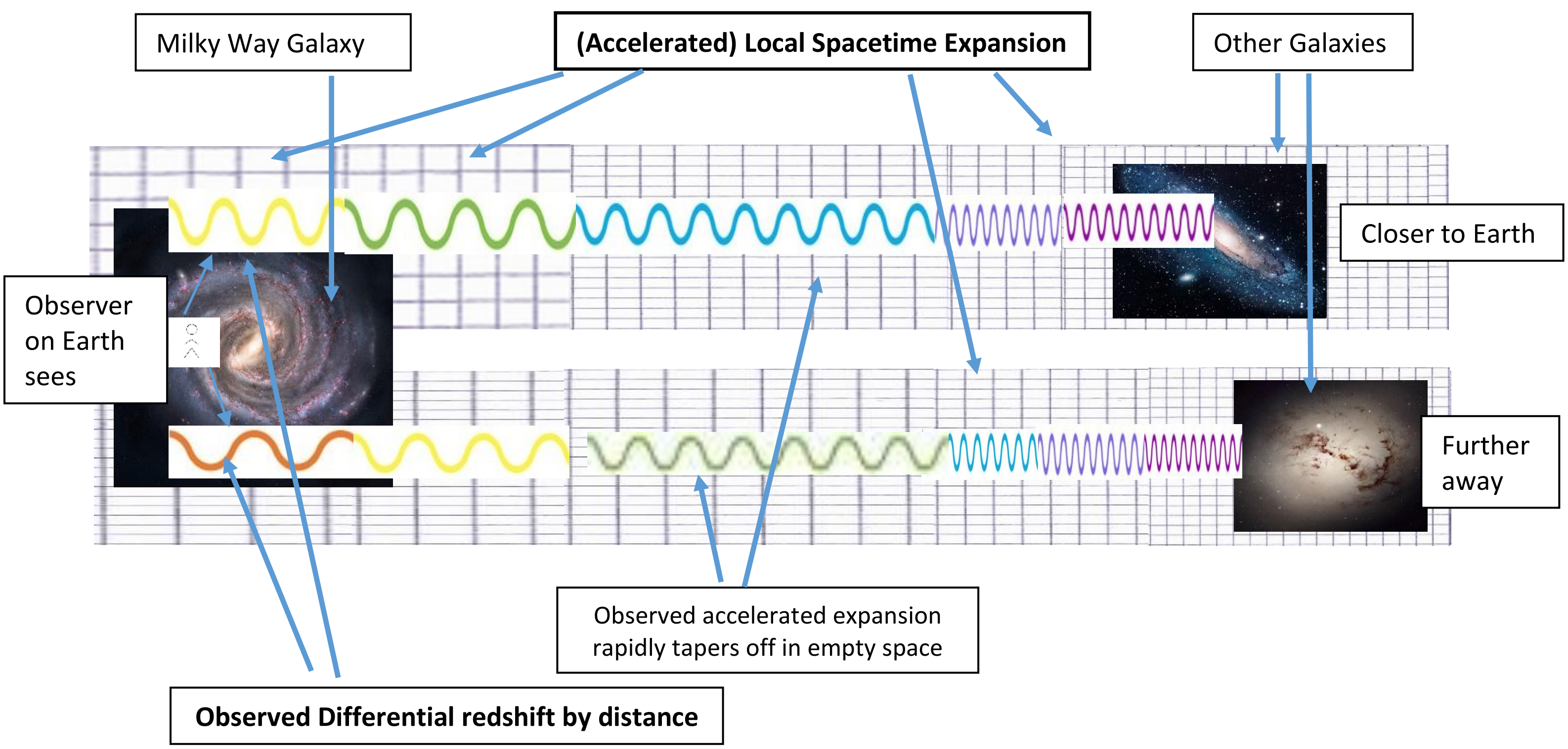


In other words, on the traditional interpretation of general relativity, the Universe is akin to a balloon expanding. It is not that galaxies are moving further apart from one another in space. Rather, it is that coordinate-space between them is expanding, everywhere at a uniform rate. The main evidence for this account has been observational data indicating a linear relationship between the distance between us and observed galaxies and those galaxies' redshift [105-6]. Further, the idea that space is expanding in this uniform fashion has been codified in what is known as Hubble's Law (recently renamed the Hubble–Lemaître Law [62]). Alas, there is a serious problem here: recent observations with the Hubble Space Telescope indicate that the Hubble Law is false. These observations indicate that the Universe is expanding significantly

[18] Image: https://jonahastroblog.wordpress.com/2018/05/02/expanding-our-minds-the-science-behind-the-expansion-of-the-universe/, retrieved 21 October 2021.

faster than predicted using the law and previous observations [90, 105]. Some have already suggested that this unexplained deviation from the Hubble Law may require revisions to physics or to the ΛCDM model [115]—but in any case, as of now, it is considered a mystery [78]. Yet, these results are not a mystery on the reinterpretation of General Relativity being proposed in this paper. First, on the reinterpretation of relativity, the Universe's spacetime metric is not expanding everywhere at a uniform rate. Instead, spacetime expansion occurs locally—around objects with mass-energy (i.e. galaxies)—at a logarithmically *accelerating* rate. The theory thereby predicts observed gravitation redshifts, but explains them differently: as caused by the extreme stretching of Euclidean space *around* galaxies (Figure 37).

Figure 37.
Redshift as Artifact of Mass-Energy *Locally* Accelerating Spacetime Metric Expansion[19]



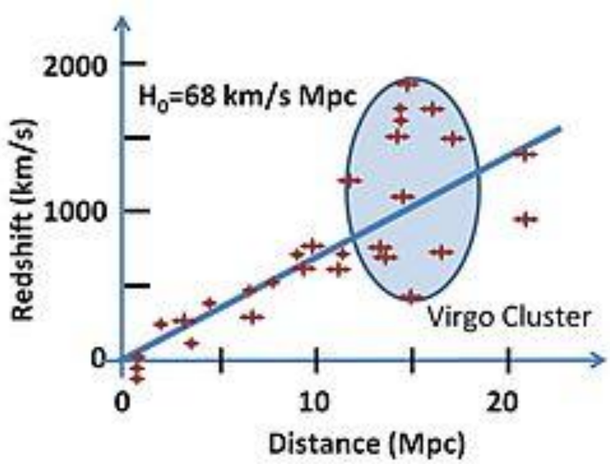
[19] Milky Way: https://www.universetoday.com/106062/what-is-the-milky-way-2/, Andromeda image: https://www.engadget.com/2018/07/23/andromeda-galaxy-ate-milky-way-sibling-m32/, Elliptical galaxy: https://www.nasa.gov/sites/default/files/images/112040main_image_feature_299_ys_full.jpg, all retrieved 14 October 2021.

In other words, on this paper's reinterpretation of relativity, what is going on is the exact inverse of what the theory of 'dark fluid' posits. Dark fluid holds that we should make sense of accelerated universal expansion by holding there is a new entity (dark fluid) that *expands in voids* and *contracts in gravitational systems*. On the reinterpretation of general relativity being offered, gravity just is the logarithmically accelerated expansion of spacetime in gravitational systems which does not occur in voids (since gravitational effects drop off rapidly with distance by the Inverse-Square Law. Both ways of explaining the observed metric-expansion of space are observationally equivalent—they are just conceptually 'inverted.'

Second, in addition to explaining something crucial that the ΛCDM model does not—the recently observed increase of the Universe's 'rate of expansion' mentioned above—this explanation also explains another otherwise-unexplained set of 'anomalies' [66]: the fact that galaxies in particular clusters (e.g. the Virgo cluster) deviate significantly from the otherwise linear relationship between distance and redshift posited by Hubble's Law (Figure 38).

Figure 38.

Deviations of Virgo Cluster Galaxies from Hubble's Law[20]



[20] By Brews Ohare - Own work, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=6042242, retrieved 14 October 2021.

My reinterpretation of the field equations explains these and other redshift deviations from Hubble's Law straightforwardly. According to the ΛCDM model of cosmology, the metric expansion of spacetime occurs uniformly *everywhere* in the Universe—that is, it is a feature of the Universe's spacetime as a whole, not a local effect of particular gravitational systems (such as individual galaxies). In contrast, on my reinterpretation of relativity's field equations, spacetime expansion is a *local* effect of gravitational systems on their surrounding spacetime coordinates according to a logarithmic function. Consequently, gravitational systems such as galaxies should have *broadly similar* redshift profiles that increase with age and distance (as Hubble's Law indicates), but nevertheless *differ case-by-case* depending upon (i) how *much mass-energy* the system has, (ii) how that mass-energy is *distributed* in the galaxy, and (iii) *how long* that system's mass-energy has been logarithmically accelerating the expansion of its local spacetime metric (viz. the age of the particular galaxy itself). This paper's reconceptualization of relativity can thus explain the observed deviations from redshift predictions of Hubble's law. If galaxies in the Virgo cluster differ in age, total mass-energy, and/or mass-energy distribution (i.e. if some galaxies have mass energy more concentrated at their center, whereas the mass-energy of other galaxies is more diffused across the galaxy as a whole), then these facts can explain why their observed redshifts differ. Third, and perhaps most importantly, my reinterpretation of the field equations explains why the *apparent* amount of 'dark energy' is many orders of magnitude greater than the amount of ordinary baryonic matter observed in the Universe. Remember, according to the ΛCDM model of the Universe, 13.7 billion years ago there was nearly no dark energy in the Universe at all—whereas today the estimate is that 72% of all of the Universe's mass-energy is dark energy compared to only 4.6% ordinary matter. Further, as we have seen, the amount of dark energy the Universe appears to have has continued to increase significantly from predictions based on previous observations. To put it simply, if we assume the ΛCDM model of the Universe (based on the traditional interpretation of the field equations), we must posit that the Universe's amount of dark energy has *increased logarithmically* over time and continues to do so—for reasons that, on the ΛCDM model itself, are completely unexplained. In contrast, my reinterpretation of the field equations explains directly—by identifying *gravity itself* with mass-energy locally accelerating the metric-expansion of spacetime at an ever-accelerating rate—why redshift observations should result in the *appearance* of the Universe having expanded much more slowly in the past (viz. 'no dark energy'), the *apparent* exponential increase in the Universe's early rate of expansion and slower rate of expansion today (viz. there appearing to be vastly more dark energy than ordinary matter today), and why the Universe's apparent rate of accelerated expansion is higher than the ΛCDM predicts. Finally, as we will see below, my reinterpretation of the field equations not only explains why an alternative to General Relativity—Modified Newtonian Dynamics (MOND)—has the features it does (modeling gravity in Newtonian terms but weakening over long distances), but also an as-yet-unexplained stunning coincidence that arises in the mathematics of MOND: namely, that one of its central functions (a_0), a new fundamental constant that MOND takes to be a *substitute* for 'dark matter', is within a single order of magnitude of estimates of Hubble's law, viz. the expansion of the Universe [80]. In other words, MOND suggests that there is somehow a deep physical connection between the accelerating expansion of the universe (viz. 'dark energy') and the 'extra mass' that galaxies appear to have (viz. 'dark matter')—though MOND does not explain what this connection might be. There is again another theoretical proposal for how 'dark matter' and 'dark energy' may be related: *dark fluid theory*, which takes 'dark energy' and 'dark matter' to be a single substance that acts differently in gravitational systems like galaxies and in ‘empty’ intergalactic voids, expanding in voids and contracting in gravitational systems [44]. However, we will see that my reinterpretation of the field equations explains the relation without any special substance, but instead purely in terms of mass-energy accelerating the expansion of second-order Euclidean spacetime locally relative to regions of space with less mass-energy, where spacetime is simply *not expanding* due to the absence of significant mass-energy (which, to be clear, makes the reinterpretation of General Relativity I am proposing very different than dark fluid theory).

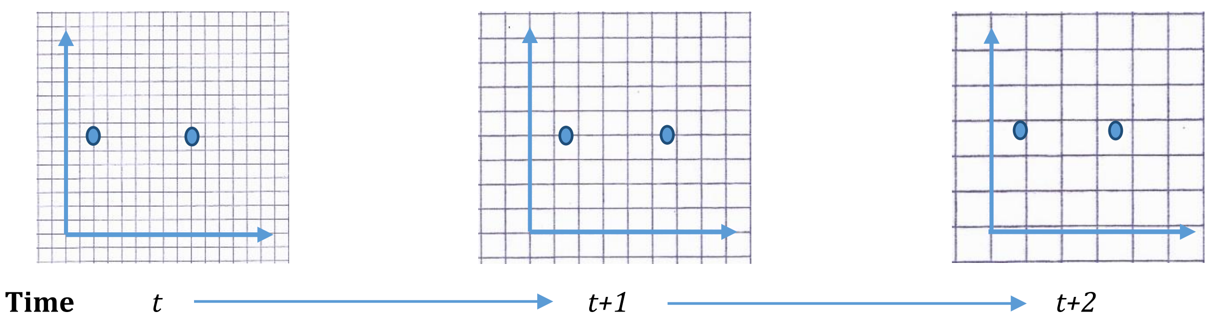
Now that we have seen how the reinterpretation proposed may explain away the existence of dark energy, let us turn to ‘dark matter.’ To recap my earlier overview, dark matter is thought to exist because, on the traditional interpretation of General Relativity, galaxies appear to have vastly stronger gravitational effects—viz. gravitational lensing, spiral rotation curves, and so on—than their visible matter suggests. The only way to explain this, on the traditional interpretation of General Relativity, is to hold that there is *something*—something that cannot be ‘seen’ like ordinary baryonic matter (viz. interacting with electromagnetism)—giving those galaxies extra mass. This extra something, of course, is supposed to be ‘dark matter’—the most influential theory being that it is a new fundamental particle with immense mass (i.e. WIMPs). Moreover, in order to explain the rotation-curves of galaxies, this massive stuff must—again, on the traditional interpretation of the field equations—be distributed in a certain way: namely, in a massive ‘halo’ around and encompassing the galaxy; a halo which, however, appears to have changed dramatically from the ancient Universe (where galaxies appear to have little dark matter) to today (where they appear to have an immense amount of it) (again, see Figure 34). Finally, although individual galaxies are thought to have much more dark matter today than in the distant past, the Universe as a whole is thought to contain far less dark matter than in the past [42]. All of this is deeply puzzling—in addition, of course, to the fact that every experimental search for dark matter candidates thus far has turned up empty.

The new interpretation of General Relativity outlined above promises to elegantly explain all of the above phenomena. Here is how. Consider first the Solar System. The Sun's mass is 1.989 × 10^30 kg, constituting 99.8 percent of the Solar System's total mass. The Sun's diameter is 1.391 million km. The Solar System's diameter is 149,597,870 km. So, the Sun's diameter constitutes approximately *9.3%* of the Solar System's diameter while containing nearly all of the Solar System's mass. Now consider the Milky Way galaxy. On April 20th, 2019 scientists released the first confirmed image of a black hole: an image of the supermassive black hole at the center of our own Milky Way galaxy, Sagittarius A* [86, 92]. Observational estimates indicate that Sagittarius A*'s diameter is about 60 million km [76], and its mass between 3.7±0.2 million and 4.31±0.38 million solar masses [49-50]. In contrast, the diameter of the Milky Way Galaxy is estimated to be 150-200,000 light years [75], and the total mass of its ordinary baryonic matter approximately 60 billion solar masses [27]. This means that the center of gravity in our Galaxy—the supermassive black hole at its center—constitutes only .00006% of the galaxy's baryonic mass and only .000000012% of the galaxy's diameter. This means that the distribution of ordinary matter in solar systems and in galaxies are vastly different in orders of magnitude. In solar systems, ordinary baryonic mass-energy is around 98% centrally located (in the star at the solar system's center), whereas in galaxies the ordinary baryonic mass-energy is not centrally located, but instead more widely distributed throughout the galaxy. According to Kepler's Second Law, rotation velocities should decrease the further one gets away from the center of gravitational system. In our own Solar System, the outer planets obey this law—but this is *not* what is observed in galaxies. Instead, in galaxies rotation velocities remain broadly 'flat' across the galaxy's diameter.

My reinterpretation of the physical significance of the field equations explains this as follows. Let us begin again with how we modeled gravitational attraction in Figure 11:

Figure 11.

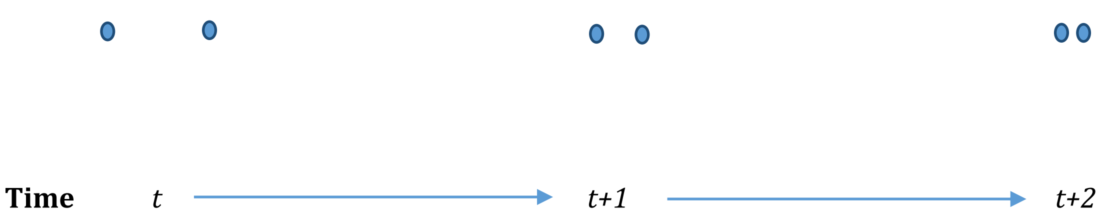
'Gravitational Force' as Local Expansion of Dynamic Euclidean Spacetime Fabric



On the new interpretation of the field equations proposed, gravity 'pulls' on things, moving them through dynamic Euclidean spacetime fabric by expanding that fabric around objects with mass-energy, 'bringing them closer together' by reducing the number of spacetime units between them. This phenomenon results in objects appearing to move closer together as if 'tugged by an invisible force':

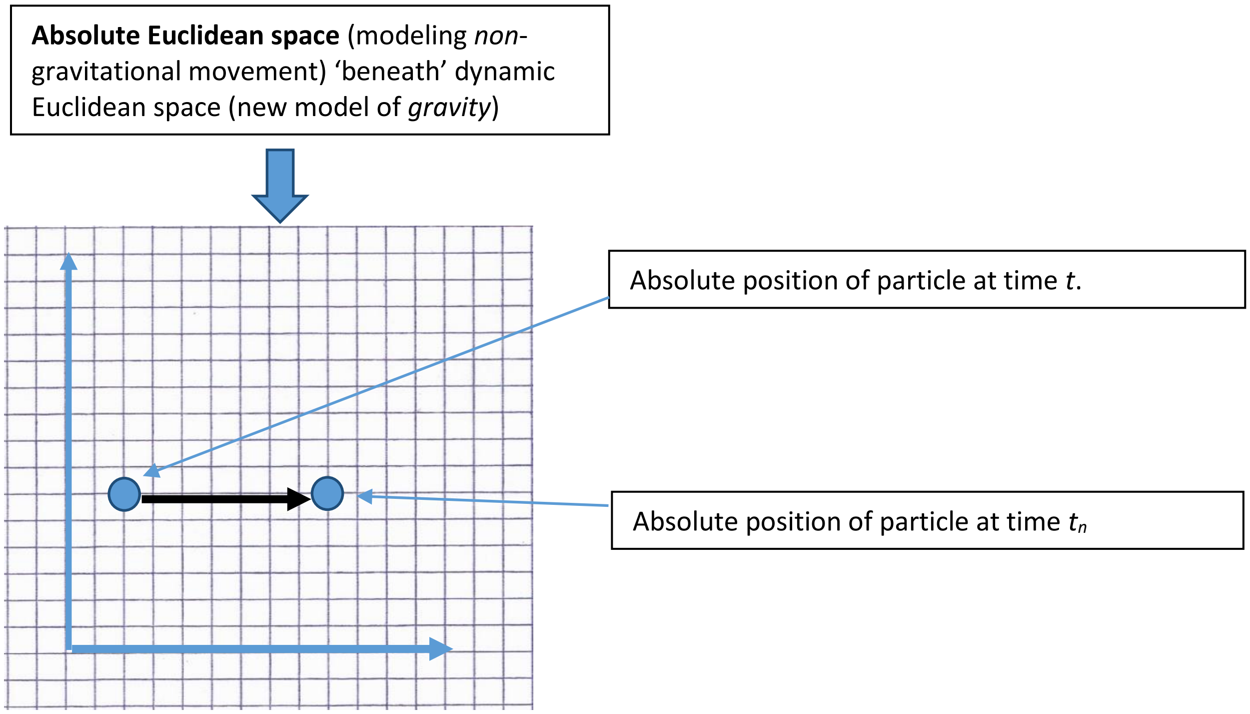
Figure 12.

Observed measurements in dynamic spacetime



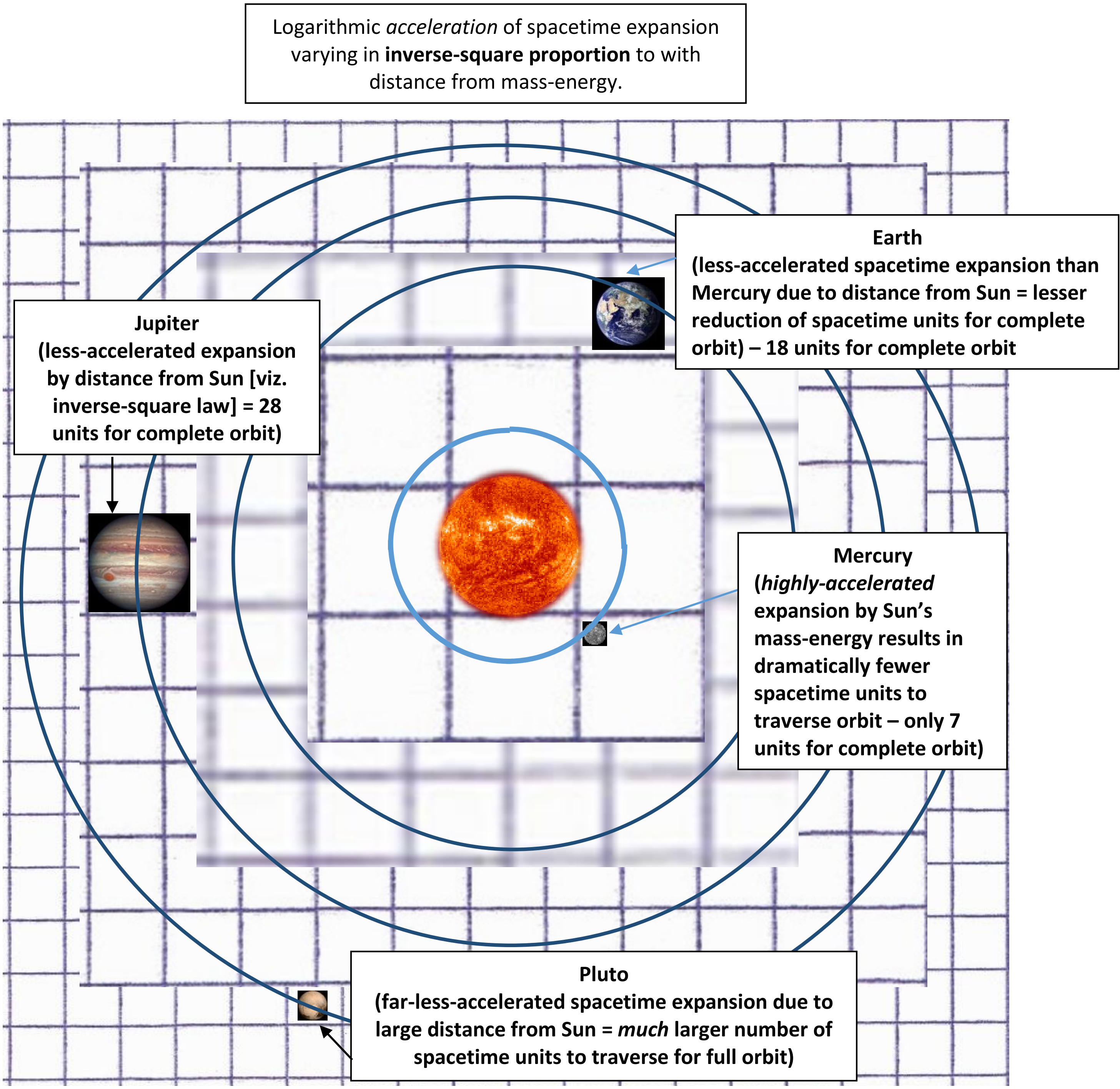
Now, remember, this is not a theory of motion in general. On the account I am proposing, non-gravitational motion involves objects moving through absolute Euclidean space: an objective reference-frame overlaid with a second-order dynamic spacetime (Figure 39).

Figure 39.
(Re-)Interpretation of *Non*-Gravitational Motion



Bearing this in mind, let us now model the *gravitational* affects in different types of systems on objects moving through objective Euclidean space described above. Since mass-energy is highly centrally concentrated in the solar system, my new interpretation of the field equations holds that the expansion of spacetime will accelerate dramatically closer to the Sun, and far less dramatically the further away from the Sun one gets (Figure 40 below). Further, because on the interpretation of the field equations I propose, gravity ‘moves’ objects by reducing the *number* of spacetime units those objects cross in a given period of time, objects moving with velocity around massive objects will *appear* to local observers to orbit more quickly ‘due to gravity’ the closer they are to the massive object, and more slowly the further they are away:

Figure 40.
Re-Interpretation of Gravitational Motion (Illustrated in a Solar System)[21]

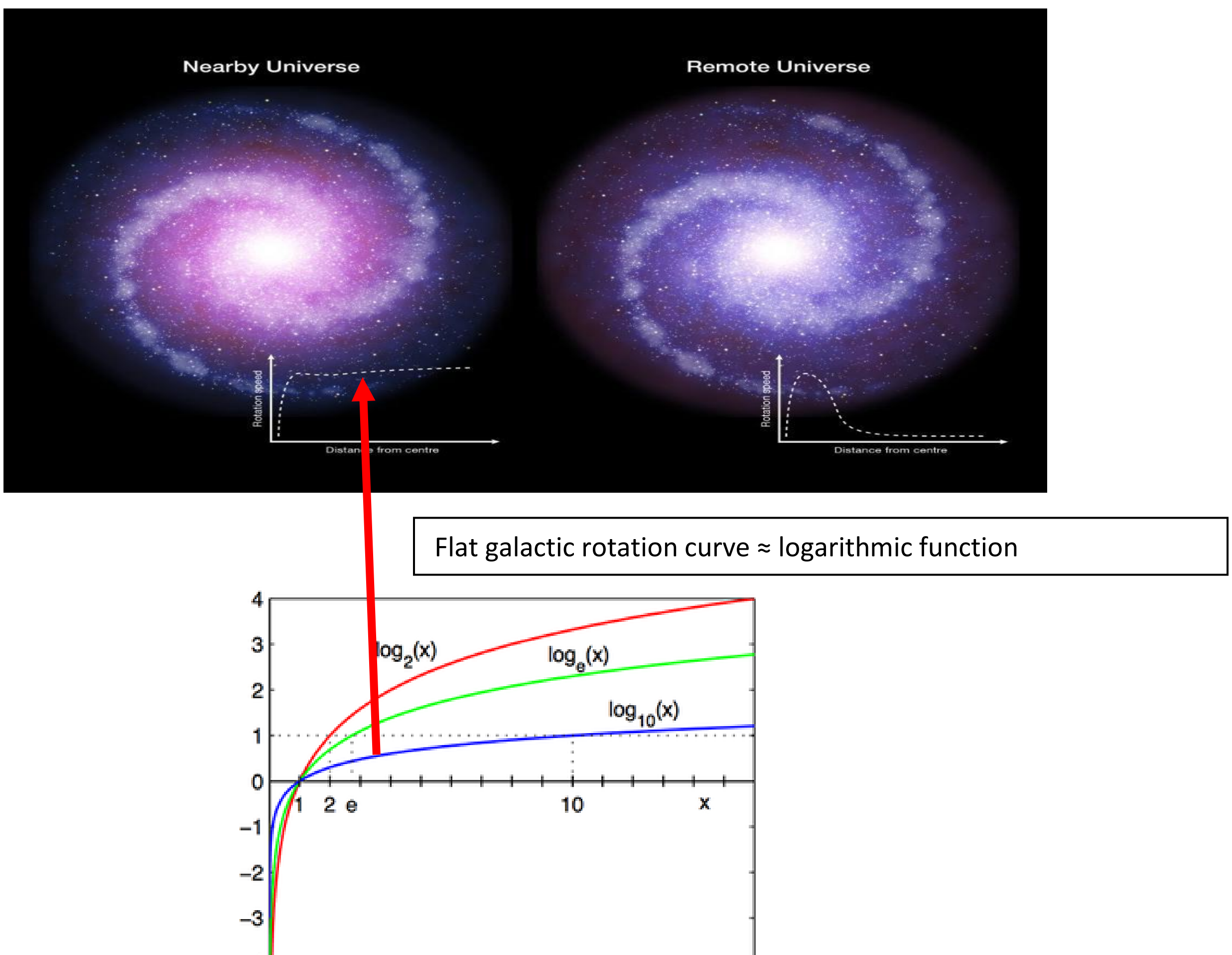


[21] Jupiter image: https://www.spacetelescope.org/images/heic1708a/, Mercury image: https://www.nationalgeographic.com/science/space/solar-system/mercury/#/01_mercury_pia15190_orig.jpg (Carnegie Institution of Washington, Johns Hopkins University Applied Physics Laboratory via NASA), Pluto image: https://www.instagram.com/p/5HTXKMoaFL/ (NASA), all retrieved 23 July 2021.

Since, on my interpretation of the physical significance of the field equations, 'gravitation' is the result of mass-energy logarithmically accelerating the local expansion of spacetime (viz. an *increasing* value of Λ as a function of time and distance from a mass-energy source), it follows on my reinterpretation that *general relativity* entails that 'gravity' works differently across different spacetime scales (much as in MOND). We can begin to see how as follows.

Look again at Figure 40 on the previous page. We see there that on the reinterpretation of relativity being defended, the Sun's mass-energy accelerates the local expansion of spacetime more quickly the closer one is to the Sun than the further away one goes. But, as we saw earlier, this results in the appearance of 'gravitational effects' as a measurement artifact. Just as Einstein's elevator hurtling upwards at an accelerating rate explains the *inverse*, 'downward pull' (or 'pseudo-gravity') a person in the elevator feels, *the logarithmic expansion* spacetime (on the reinterpretation of relativity being defended) explains why we measure *the inverse* for objects in spacetime: namely, objects in 'gravitational fields' obeying the Inverse Square Law: 'the gravitational attraction between two point bodies is proportional to the product of their masses and inversely proportional to the square of the distance' [2]. The two functions here—(A) gravity *itself* logarithmically accelerating the expansion of a second-order, dynamic local spacetime coordinates around objects fixed in an unchanging first-order space, and (B) our *measuring* those objects attracting each other in inverse proportion to the square of their mass and distance—are *two sides of the same coin*. The first function (logarithmically accelerated spacetime expansion) is the physical ground of gravitational effects, and the second (the Inverse Square Law of gravitation) the *observed consequences* that the first function has on measurements of objects in spacetime (viz. 'gravitational effects). So, the reconceptualization of relativity this paper defends thus explains the inverse square law of 'gravitational attraction' *in terms of its inverse function:* mass-energy accelerating the local expansion of spacetime according to a *logarithmic function*. How does this relate to 'dark matter'? It suggests that the larger a gravitational system is and/or the longer that gravitational system is operating (in spacetime scale), the closer the functional characteristics of the system should appear to approximate a logarithmic function. But this is precisely what we see in the rotation curves of *very large objects* in the *nearby universe*: namely, galaxies that have existed far longer than galaxies in the distant 'young' universe (Figure 41).

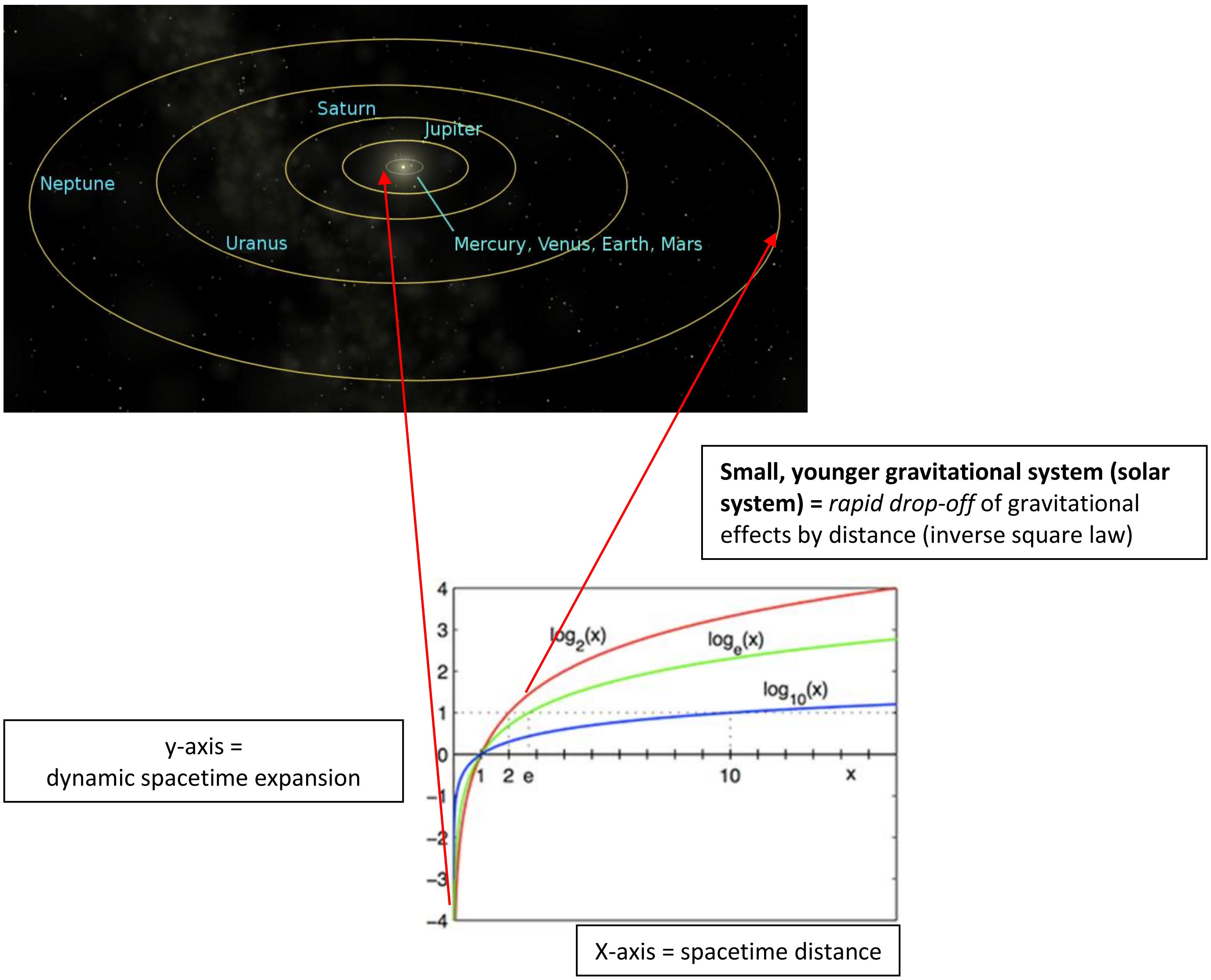
Figure 41.
'Flat' Galactic Rotation Curves as Measurement Artifact of Mass-Energy Logarithmically Accelerating Spacetime Expansion



The implications here are straightforward. In *smaller or younger gravitational systems* (such as a solar system), gravitational attraction should drop off steeply the further one gets from a center of mass-energy (Figure 42).

Figure 42.

Interpretation of Gravity in Smaller, Younger Gravitational Systems[22]



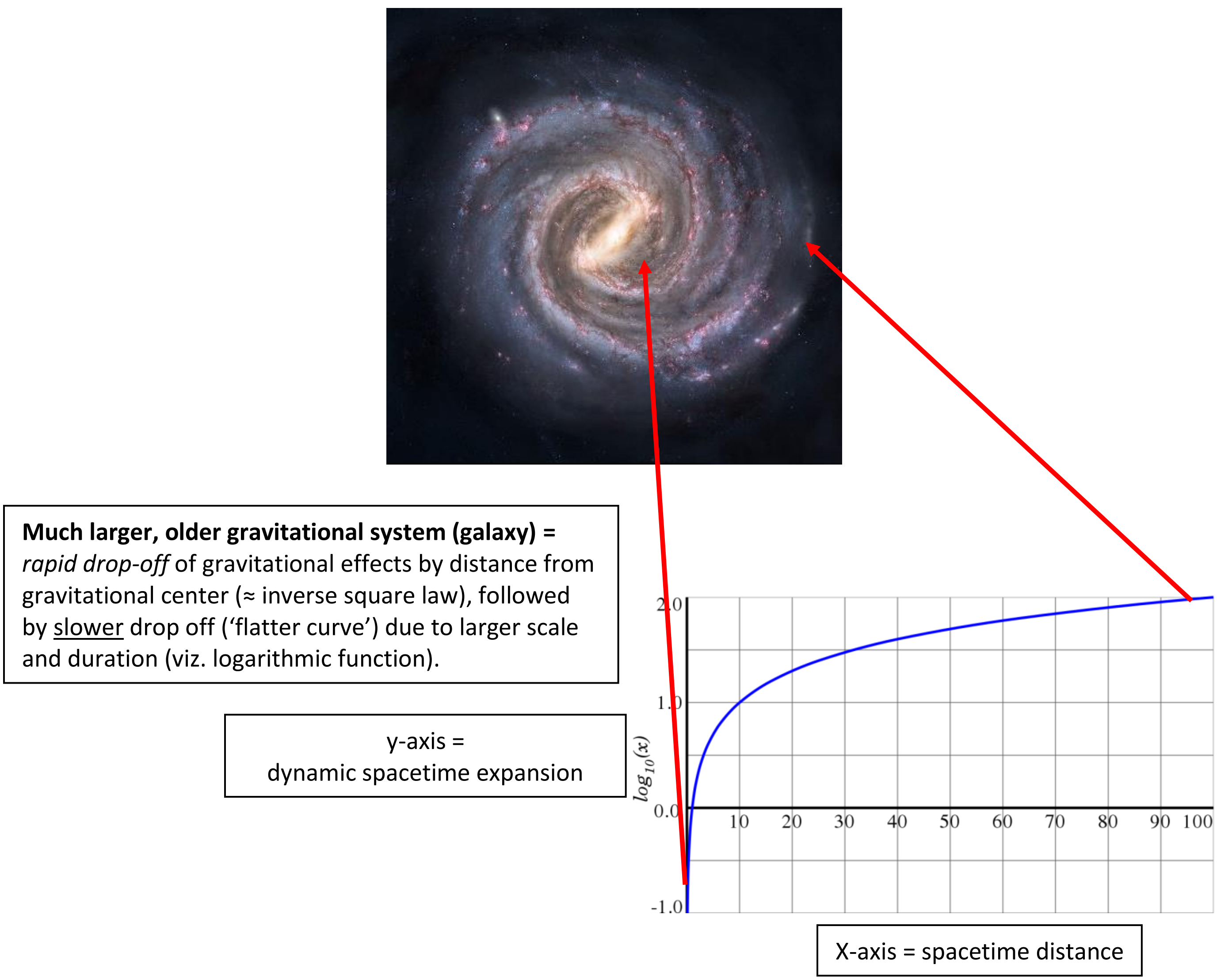
However, on the reinterpretation of the relativity being offered, the larger a gravitational system is, the more diffusely its mass-energy is distributed, or the longer a gravitational system has been in operation, the more that system needs to logarithmically accelerate the

[22] Solar system image: https://moonblink.info/Eclipse/why/scales, retrieved 14 October 2021.

expansion of its second-order local spacetime region to result in 'gravitational effects.' This means that *larger gravitational systems* (such as galaxies) should more closely approximate logarithmic effects, particularly the longer they have been around—and since, distant galaxies existed in the very young universe whereas close by galaxies are in the older Universe as it now is, this means that nearby galaxies should approximate a flatter curve—as in:

Figure 43.

Interpretation of Gravity in Older, Larger Gravitational Systems[23]

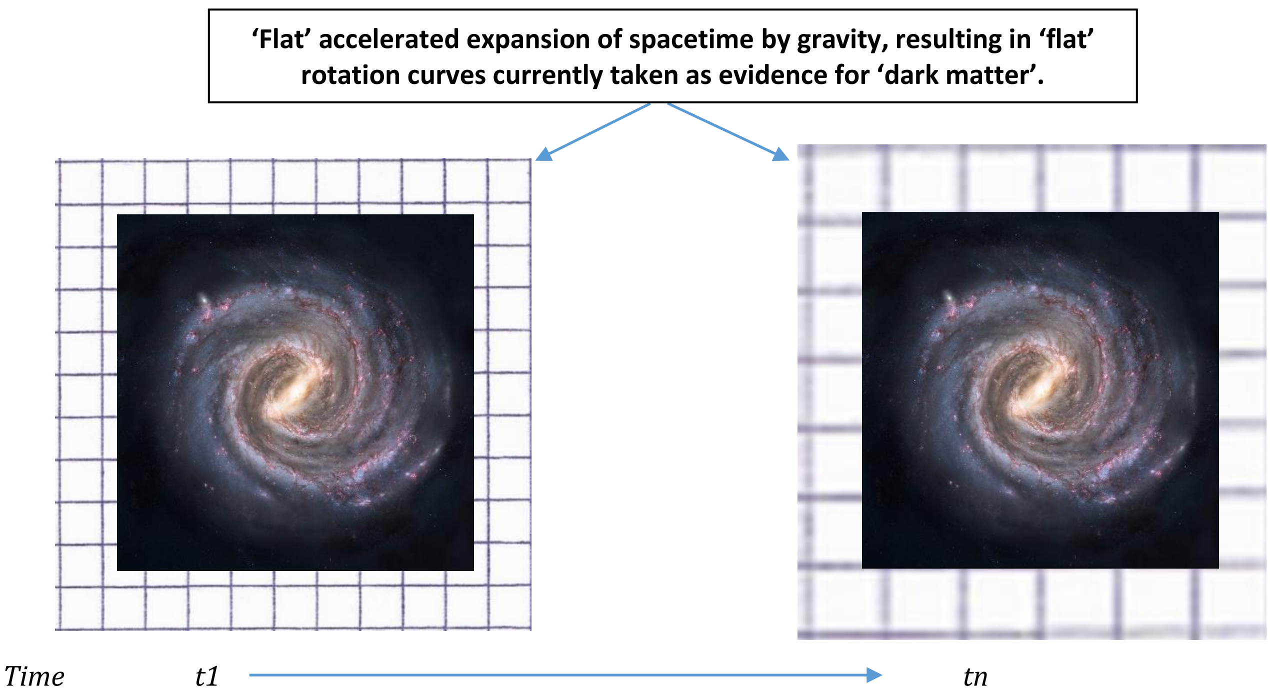


[23] Log 10x image: https://en.wikipedia.org/wiki/Common_logarithm#/media/File:Graph_of_common_logarithm.svg.

So, in larger gravitational systems that have existed longer and where mass is widely distributed (such as nearby galaxies), spacetime be locally expanded (throughout the galaxy) *everywhere* far from the center at approximately the same level of acceleration (see Figure 44)—which is what is observed: nearby galaxies having 'flat' rotation curves.

Figure 44.

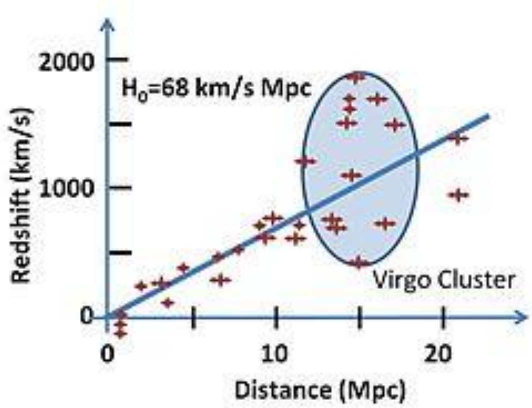
New Interpretation of Galactic Gravitation & Rotation Curves (*Without* Dark Matter)



If this is what gravity is, then we have a ready explanation—without dark matter—for why the rotation curves of nearby spiral galaxies should be flat, but older galaxies less flat. Newton's inverse square law simply does not hold when mass-energy across a large scale is distributed like it is in galaxies and when such systems have been operating over a long spacetime scale. We do not need the 'extra mass' of dark matter to account for any of this. All we need is ordinary visible matter, and to understand gravitational effects in terms of mass-energy locally *logarithmically* accelerating the expansion of space time. And here is the crucial thing: recent observations of galaxies—which have 'amazed' researchers—indicate that galaxy rotation speeds, while 'flat', do not match conventional models of mass distributions and dark matter [23-4]. Instead, galaxy rotation speeds have been found to be highly correlated with their *ordinary visible matter* [80]—just as my reinterpretation of the field equations predicts. It should not be underestimated just how much these recent findings confound dark matter theory, with researchers stating, 'It's an impressive demonstration of something, but I don't know what that something is' [23]. My reinterpretation of relativity holds that galaxy rotation speeds *should* be dictated by their ordinary baryonic matter, and that their 'flat' rotation curves are not explained by dark matter but instead how gravity *accelerates the expansion of Euclidean spacetime fabric*—a phenomenon that, on my reinterpretation, should occur throughout galaxies in a 'flat' manner generated by their diffuse (rather than centralized) distribution of matter. Further, as we have seen, my account explains why galaxies of roughly the same age can appear from Earth to have differential redshifts—as on my reinterpretation of relativity, the redshift of galaxies are not the result of the *Universe's* age and expansion, but instead local spacetime expansion around galaxies as a result of gravity, the observed effects of which will differ with the *galaxy's* age, total mass-energy, *and* mass-energy distribution.

Figure 45.

Observed redshifts in Virgo cluster compared to ΛCDM/Hubble's Law predictions



What about gravitational lensing? As we saw earlier, the bending of light is—on the new interpretation of the field equations I am proposing—is a function of mass-energy expanding dynamic spacetime at logarithmically increasing rate. In a mass-energy system like the solar system—where mass is centrally located—the metric expansion of space occurs primary toward the center of gravity, weakening dramatically the further out one moves away from the central source of gravity. However, according to the interpretation's analysis of galactic gravitation, spacetime expansion is logarithmically accelerating across a much wider area: the entire area of the galaxy. This suggests, given the analysis of light's bending described earlier, that galaxies should appear to bend light *more* than the inverse-square law suggests—which is what gravitational lensing suggests.

On this interpretation of 'dark matter', there is—obviously—a direct connection to 'dark energy': they are *one and the same thing*, namely gravity. Gravity accelerates the expansion of spacetime fabric locally around galaxies (thus generating the Hubble redshift taken as evidence of accelerating expansion of the Universe), while local expansion throughout galaxies produces a 'halo' throughout those galaxies where spacetime is expanding at a 'flat' rate (as in a logarithmic function), thus explaining why galaxies *appear* to have vastly more mass than they do and why galaxies have the 'flat' rotation curves they do. This unified explanation of the *appearance* of dark matter and dark energy not only explains them away (without us having to posit any such extra entities); it also explains some astonishing and otherwise unexplained coincidences. First, it explains why galaxies with larger supermassive black holes appear to have more 'dark matter.' Dark matter is nothing *but gravity* (properly interpreted according to a changing value for Λ), and galaxies with larger supermassive black holes *have more gravity*. Second, my reconceptualization explains a fascinating 'coincidence' that arises in the mathematics of Modified Newtonian Dynamics (MOND). In brief, MOND holds that gravity operates differently in slowly accelerating systems like galaxies—where it holds that instead of varying inversely with the *square* of radius distance, gravity varies inversely simply with radius. There are many outstanding issues with MOND that we need not concern ourselves with here. Let us instead consider a few basic points. Here is MOND's central equation [78]:

$$\vec{F} = m\mu\left(\frac{a}{a_0}\right)\vec{a}$$

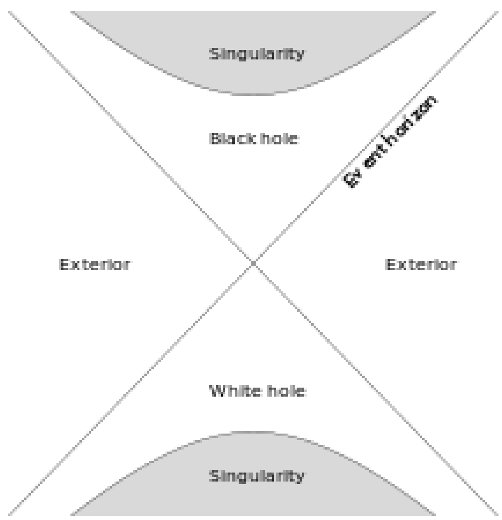
In this equation, F is Newtonian force, *m* is mass, *a* is acceleration, *μ* is an 'interpolating' function, and a_a a new fundamental constant of nature demarcating the transition between Newtonian and MOND gravity. In other words, this equation describes how gravity (supposedly) operates totally differently in conditions of low acceleration. Of most interest to us here is a_0. When a_0 is fit to the observed properties of galaxies, its value turns out to be within an order of magnitude of cH_0, where *c* is the speed of light and H_0 is the Hubble constant. In other words, MOND's equations demonstrate that—at least on its alternative theory of gravity—the altered properties of gravity in galaxies *is approximately identical in value* to the acceleration rate of the universe (viz. Λ). MOND does not provide any account of why this should be so, and as we have seen the standard interpretation of General Relativity does not explain this fascinating coincidence either. This paper's alternative interpretation of the field equations, on the other hand, *explains it directly*: the observed accelerated metric-expansion of the Universe (Λ) *just is* gravity, and the strange behavior of gravity on galactic scales (which MOND attempts to describe without dark matter) *just is* the consequence of the value that Λ must take on my new interpretation (as I have argued its value must be logarithmically increasing locally around objects with mass-energy, such as galaxies).

2.4. Cosmic Inflation as Gravitational Effects of Big Bang 'White Hole'

Finally, this paper's reinterpretation of Einstein's field equations may even explain cosmic inflation. Currently, the dominant theory of the Universe's history holds that our Universe began from an *infinitely dense point* (i.e. the Big Bang). Following Hawking, who demonstrated that a Big Bang is mathematically equivalent to a time-reversed black hole [56], the Big Bang has been theorized to be a 'white hole' (Figure 46) [32].

Figure 46.

The Universe as 'White Hole' Generated by an Eternal Black Hole[24]



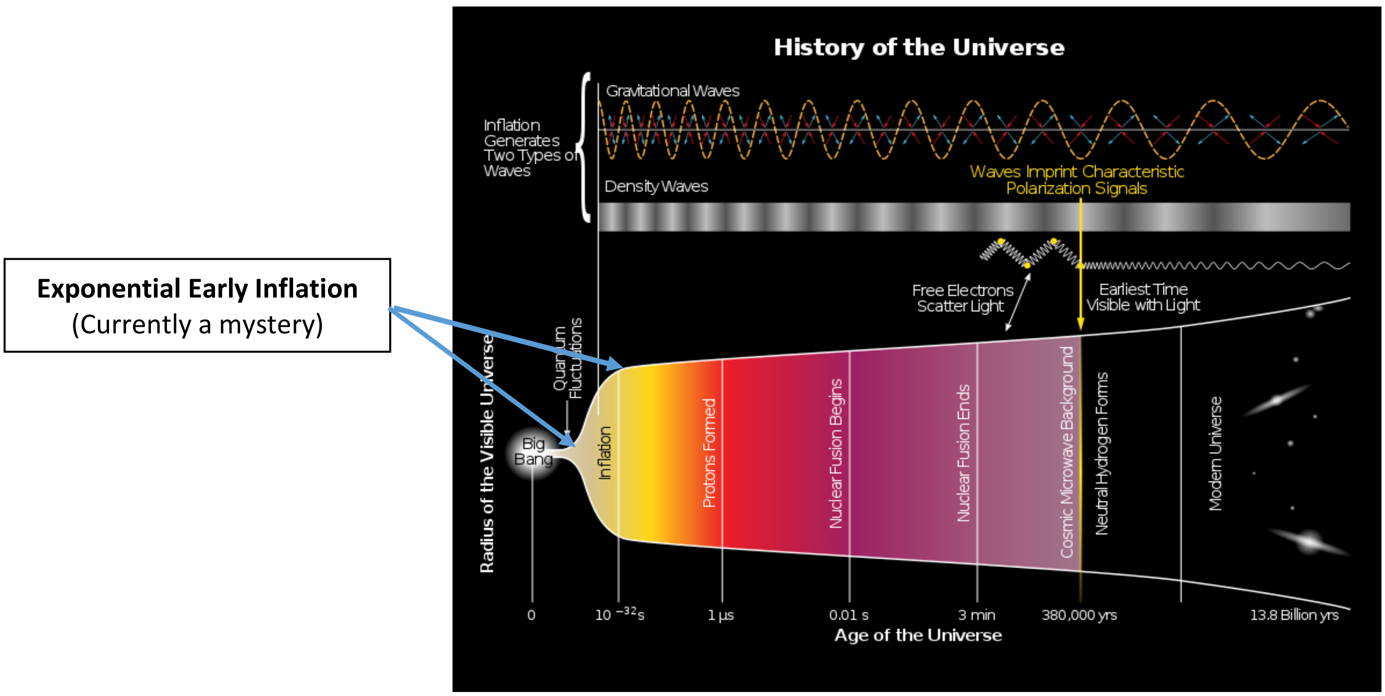
Let us now think what this means. The only properties that a black hole has are mass, spin, and charge. If the Universe *is* a time-reversed black hole (i.e. a white hole), then the Big Bang singularity *itself* has an immense (potentially infinite) mass. Consequently, *if* as the present paper has argued gravity itself is mass-energy logarithmically accelerating the metric-

[24] Image by Timothy Rias – Own work: https://en.wikipedia.org/wiki/White_hole#/media/File:Krukdiagram.svg, retrieved 14 October 2021.

expansion of second-order spacetime—and, as we all know, gravity's effects lessen with respect to distance via the inverse-square law—then *the acceleration of the metric expansion of space* should be immense just after the Big Bang, but then slow dramatically as mass-energy moves further away from the origin. But this is what inflationary theory holds (Figure 47):

Figure 47.

Exponential Early Acceleration of Universe's Metric Expansion[25]



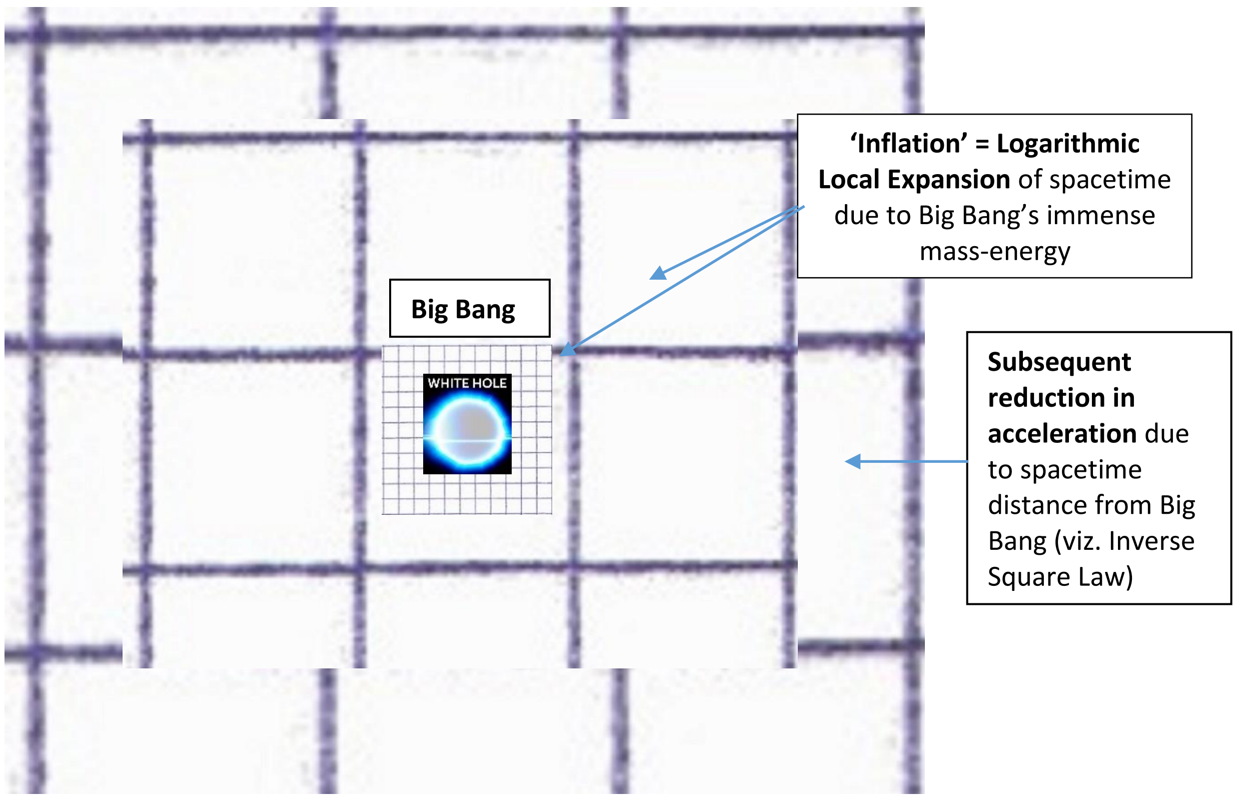
The reinterpretation of the field equations proposed explains why this is so, *and* why exponential inflation in the early Universe has been followed by a 'flatter' acceleration curve since then. Because the 'white hole' constituting the Big Bang was an object of extreme mass, and on my interpretation of the field equations gravity just is mass-energy causing nearby Euclidean spacetime fabric to expand at a logarithmically accelerated rate, it follows that the

[25] Image by the National Science Foundation: https://commons.wikimedia.org/wiki/File:HistoryOfUniverse-BICEP2-20140317.png, retrieved 14 October 2021.

near-infinite mass-energy of the 'white hole' should logarithmically expand Euclidean spacetime fabric, such that the coordinate system increases rapidly only to flatten as energy moves further away in spacetime distance, reducing its accelerating effects on spacetime expansion dramatically with distance (Figure 48):

Figure 48.

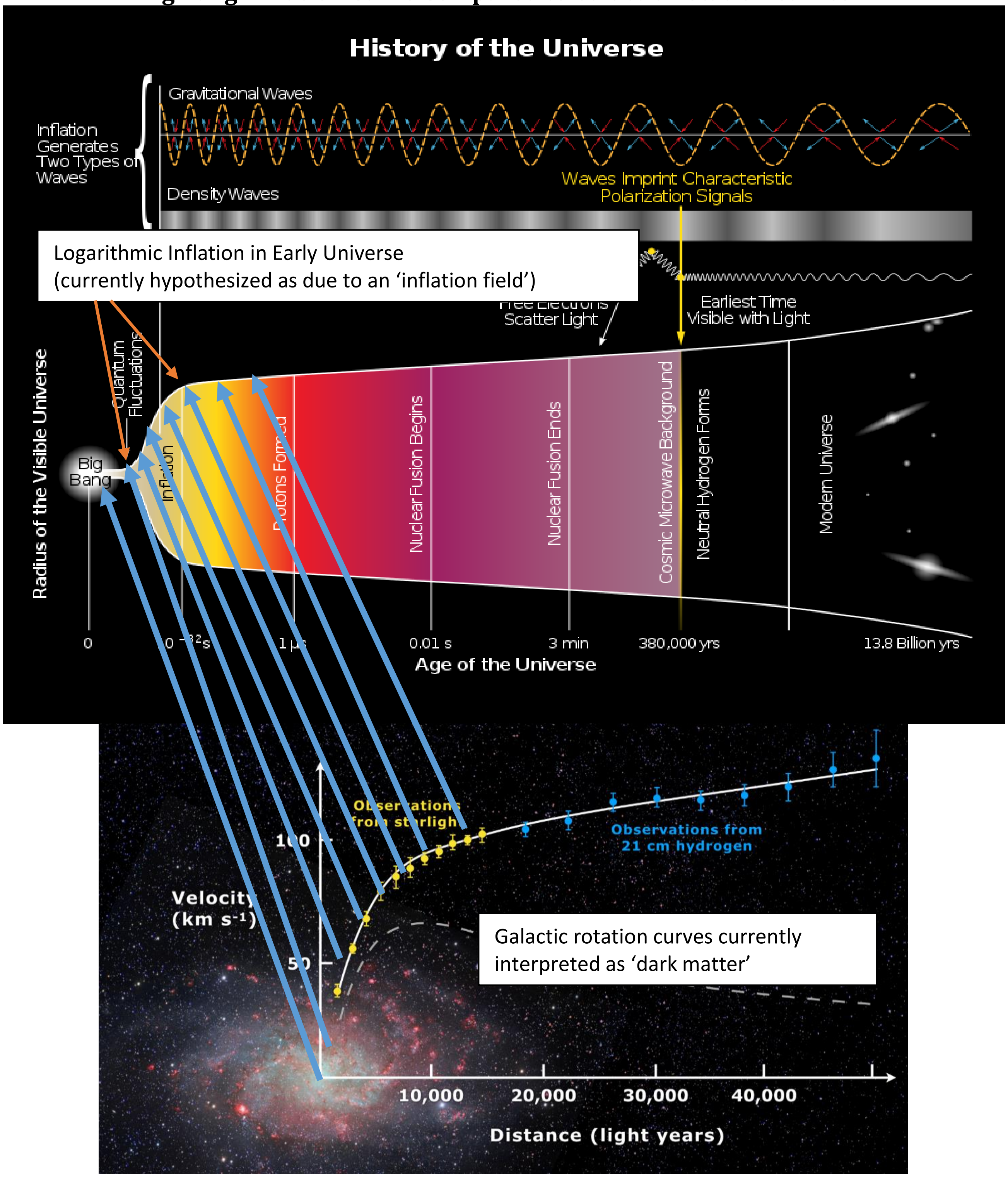
Early 'Inflationary Epoch' of the Universe as the Big Bang's *Gravity* Exponentially Accelerating Local Spacetime Expansion [26]



Could this—that is, *gravity itself*—be the right explanation of exponential inflation in the early Universe (rather than some new 'inflationary field')? One hint that it may be is the stunning similarity between the *acceleration-expansion curve* of the Universe and the *galactic-rotation curves* thought to be indicative of 'dark matter' (Figure 49):

[26] White hole image: https://i.ytimg.com/vi/upToWCYVnFU/maxresdefault.jpg, retrieved 14 October 2021.

Figure 49.
A Coincidence Too Big to Ignore?
Big Bang-Inflation Curve Compared to Galactic Rotation Curves[27]

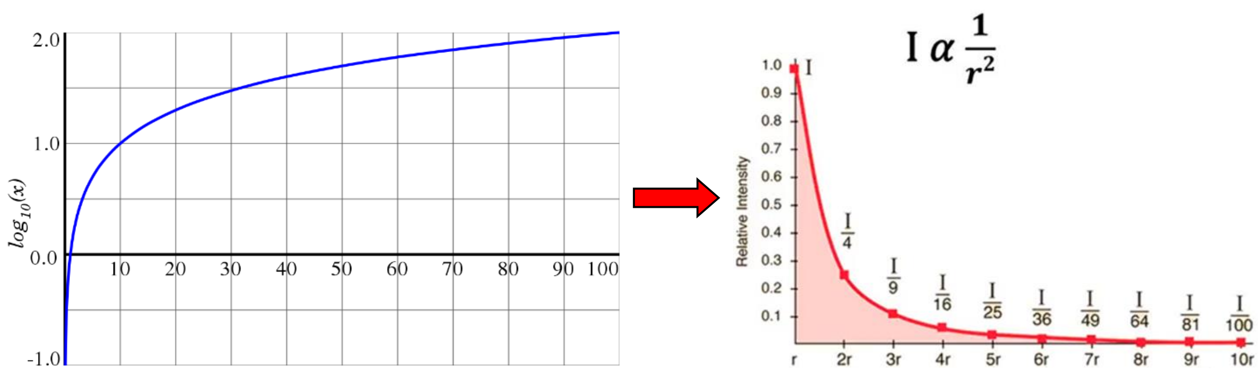


[27] Second image (galactic rotation curve) by Mario De Leo – Own Work: https://commons.wikimedia.org/wiki/File:Rotation_curve_of_spiral_galaxy_Messier_33_(Triangulum).png.

If my reconceptualization of the field equations is correct, this stunning ‘coincidence’ is no coincidence. Gravity, again, is known to obey the *inverse-square law* (at least in smaller gravitational systems), such that the force of gravity (viz. spacetime curvature) is inversely proportional to the square of the distance from the gravitational source (i.e. mass-energy). Further, as we have seen, this law is a *measurement artifact* generated by mass-energy logarithmically accelerating the expansion of spacetime.

Figure 50.

Gravity as logarithmic expansion explains Inverse-Square Law



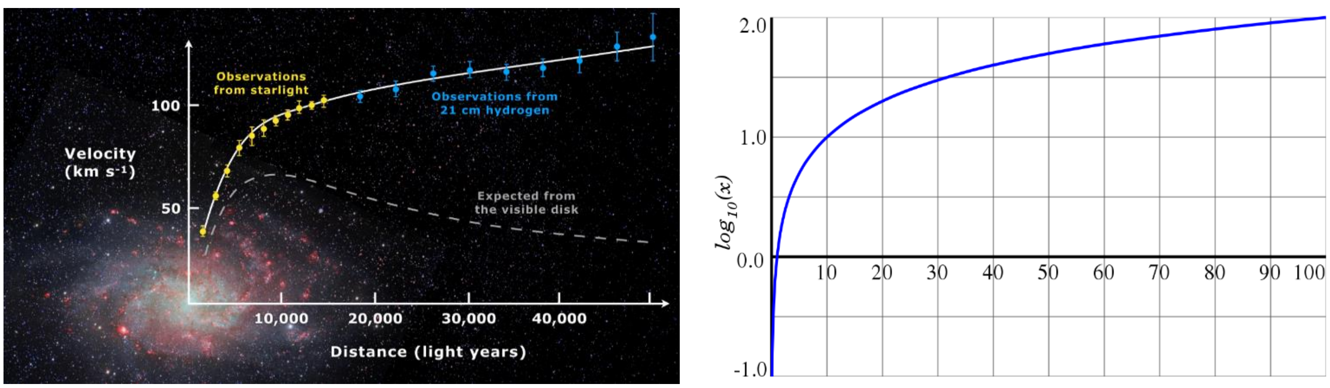
Mass energy logarithmically expands spacetime

Measured ‘gravitational attraction’ drops off exponentially by distance

On my account, these functions are even *more extreme* for vastly larger and older gravitational systems, such as galaxies and the Universe as a whole, viz. logarithmically higher values for Λ. On this account, black holes at galactic centers locally accelerate the expansion spacetime at an logarithmic rate, such that the rate of acceleration to slows further away due to distance and the diffusion of mass-energy across galaxies. Similarly, on my reinterpretation, the ‘inflationary era’ of the Universe’s spacetime metric *is the very same phenomenon*: the mass-energy of the Big Bang accelerating the expansion of *its* nearby (‘post-Big-Bang’) spacetime at a logarithmic rate, followed by slower acceleration thereafter due to distance (viz. an inverse square) and the diffuse distribution of mass-energy in the subsequent Universe. On the new interpretation of the field equations, *all* of this—the Universe's initial 'inflation field', later-emerging 'dark energy', and 'dark matter'—are just *gravity*, properly interpreted. Indeed, the match between gravity as logarithmic expansion of spacetime, galactic rotation curves, and inflation in the early universe is stunning. To begin, compare a logarithmic function to the rotation curves of nearby galaxies (Figure 51):

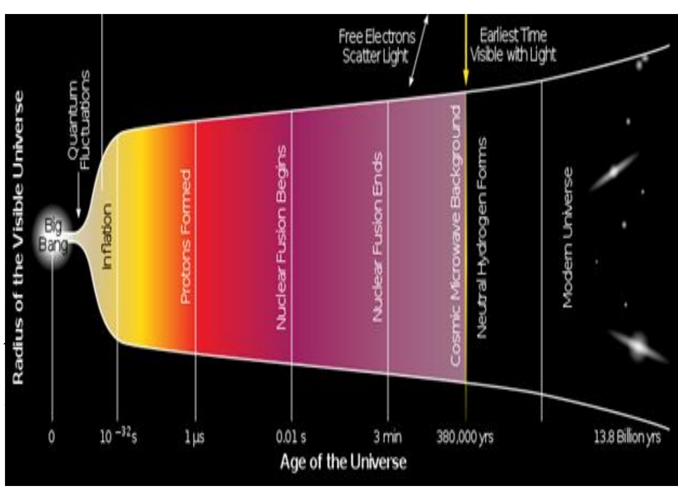
Figure 51.

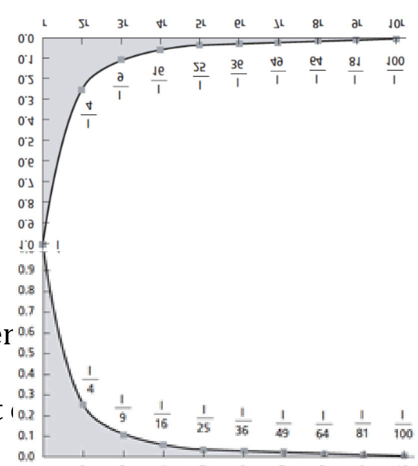
Fit of Gravity-as-Logarithmic-Expansion to Nearby Galactic Rotation Curves



Now compare a similar (albeit stronger, base 10) logarithmic function to the Big Bang, as it is an exponentially *stronger* and *older* gravitational entity (viz. near-infinite mass-energy):

Figure 52.
Fit of Gravity-as-Logarithmic-Expansion to Inflationary Universe





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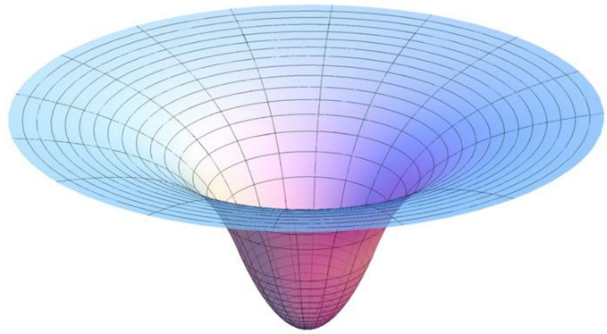
paper argues—gravitational effects are simply a *measurement artifact* of mass-energy locally causing logarithmic expansion of a second-order space-time.

Finally, there is another point to mention here, which is that my account explains certain mysteries about the concept of a 'white hole.' Currently, it is not well-understood how a white hole can occur in nature, as white holes are thought (following Hawking) to be equivalent to time-inverted black holes—leading, obviously, to questions about how time can become inverted in a way that mass-energy can *escape* the extreme gravitational effects of a singularity. On my reconceptualization of relativity, these problems evaporate. White holes are not *time-reversed* black holes. The assumption that they are time-reversed is based upon the background hypothesis that the Big Bang *expanded* spacetime whereas black holes are thought to *contract* spacetime. On my reinterpretation of relativity, this seeming asymmetry is based upon a conceptual mistake: namely, the failure to see that gravity *just is* the accelerated metric-expansion of space-time by mass energy. On my account, the Big Bang and ordinary black holes (including supermassive black holes) are fundamentally doing the same thing, and in the same temporal direction: namely, logarithmically accelerating the local expansion of spacetime around them in inverse proportion to the square of mass and distance (viz. the Inverse-Square Law). Rather, the difference is that the Big Bang is simply exponentially *larger* (in terms of total mass-energy) than supermassive black holes, as well as the most distant such object in *our* observable past. Here, after all, is the standard depiction of a gravitational potential:

Figure 53.

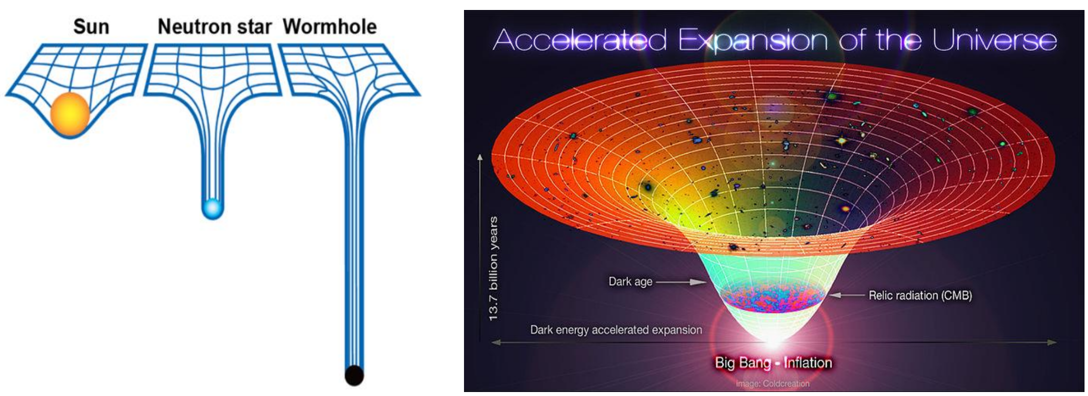
Ordinary Gravitational Potential[28]



Here, in turn, are the gravitational potentials of the Sun, a neutron star, and wormhole, offset against a representation of 'cosmic inflation' turned on its side:

Figure 54.

The Big Bang as a *Gravity* Well[29]



If my reconceptualization of relativity is correct, then the Big Bang is not a 'time-inverted' black hole: it is simply *the most massive black hole* observable in our light-cone's past, one with such immense mass-energy that it logarithmically expanded *all* of the Universe's spacetime

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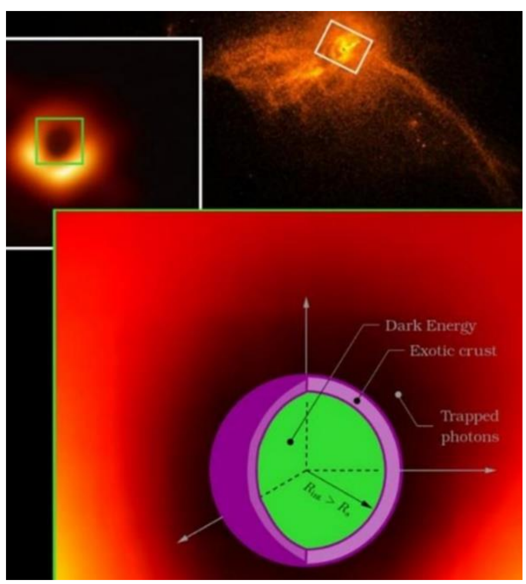
[28] Image: AllenMcC., https://en.wikipedia.org/wiki/Gravitational_potential#/media/File:GravityPotential.jpg, retrieved 23 August 2021.

[29] Gravity well image: https://commons.wikimedia.org/wiki/File:Deepening_gravity_well.png; Expansion of Universe image: https://en.wikipedia.org/wiki/Accelerating_expansion_of_the_universe, both retrieved 23 August 2021.

near its spacetime horizon (viz. the 'inflationary epoch' in the early Universe) before these effects rapidly dropped off as the rest of the Universe became further removed from the Big Bang singularity (viz. the Inverse-Square Law). On this reinterpretation of the field equations, the Sun, a neutron star, a black hole, and the Big Bang are all (i) doing *exactly* the same thing, (ii) in the *same direction* of time: namely, (iii) *logarithmically accelerating* the local expansion of space-time around them in proportion to their respective amounts of mass-energy, where (iv) these gravitational effects *drop off exponentially* in inverse proportion to the square of mass and distance. Finally, this can explain away another anomaly. Croker and Weiner [25] argue that when an error in applying general relativity's field equations to cosmology is corrected, black holes can be understood as surrounded by a thin halo of dark energy (Figure 55), *expanding* spacetime just near the black hole's boundary.

Figure 55.

Croker & Weiner's Black Hole Dark Energy Hypothesis[30]



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[30] Image: https://scitechdaily.com/are-black-holes-made-of-dark-energy-error-made-when-applying-einsteins-equations-to-model-growth-of-the-universe/, retrieved 14 October 2021.

However, this paper's reinterpretation explains this otherwise baffling result straightforwardly: black holes are not surrounded by a thin crust of 'dark energy.' Rather, what Croker and Weiner are *interpreting* as 'dark energy' is simply the second-order dynamic expansion of spacetime that my reinterpretation of the field equations hold *constitute gravity*, as it precisely that kind of accelerated expansion of dynamic space that produces gravitational effects as a measurement artifact.

At this point, I conclude with a rhetorical question. Which of the following two possibilities is more likely at this point, given the history of scientific inquiry?

1. **The status-quo hypothesis**, which holds, based on the traditional interpretation of general relativity's field equations, that:
    a. The Universe is suffused with a *variety of exotic substances* (dark matter, dark energy, an inflation field, etc.) that—much like the *aether*, *phlogistion*, and *élan vital*—have *never* been directly observed in any experiment.
    b. The amount and properties of these exotic substances appear to have *changed dramatically* over the course of the Universe's history for some yet-to-be-understood reason.
    c. In ways that generate various anomalies that conflict with ΛCDM model.
    d. But, *despite (a)-(c),* our understanding of relativity and the ΛCDM model are both correct.

Or,

2. **The reinterpretation of general relativity's field equations defended in this paper,** which holds that we may explain away all of these cosmological anomalies simply by reinterpreting a central term in the field equations, Λ, as expressing the fundamental

nature of gravity *as* logarithmically accelerating the expansion of a second-order Newtonian spacetime fabric overlaid on an absolute spacetime metric, in the manner explained and illustrated in this article.

Conclusion

This paper's reinterpretation of relativity's physical significance may be misguided. I may have also made mistakes of detail in presenting the interpretation and its various implications. Nevertheless, I believe we have seen ample conceptual reasons to believe there may be something to it. Physics, again, is in crisis. The ΛCDM model of the cosmos—based on the traditional interpretation of the field equations—is rife with theoretical, explanatory, and predictive problems. Dark energy and dark matter, two central elements of the model, are not only astonishingly strange—supposedly constituting nearly all of the Universe, and changing in proportion from one cosmological moment to the next; every experimental search for them to date has yielded null results. Further, a third new theoretical entity widely invoked in order to explain the Universe's exponential inflation just after the Big Bang—a so-called inflation field—multiplies theoretical entities even further, despite the fact that no inflation-field has ever been experimentally detected. The alternative interpretation of the field equations I have laid out does away with dark energy, dark matter, and a primordial inflation field, explaining all of the above phenomena in terms of *gravity*, and gravity in terms of a new interpretation of 'Λ': it being the fundamental interaction that mass-energy has on locally accelerating spacetime expansion. We have seen that this new interpretation of relativity holds that gravity does not involve the literal non-Euclidean curvature of spacetime, but instead an accelerated expansion of Euclidean spacetime in a manner that gives rise to observations of 'spacetime curvature' (viz. the bending of light, relativistic time and space dilation, etc.) as a measurement artifact generated by the accelerated expansion of a second-order, dynamic Euclidean spacetime fabric against an absolute, first-order Euclidean background. This new interpretation of the field equations may turn out to be incorrect. But, given all of the problems it appears it may be capable of resolving, I submit that the conceptual arguments provided for it warrant further investigation using the specialized methods of mathematical physics.

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