Refutation of Wiltshire's "Timescape cosmology"

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Abstract. I use previously-published observed astronomical facts to refute Wiltshire's recently-hyped "Timescape cosmology" in 1 page.

Introduction

Recently, there has been worldwide hype trumpeting the claim, mainly by New Zealand cosmologist David L. Wiltshire, that the universe's "accelerating expansion," detected experimentally by supernova cosmology projects in (what was at the time) a big surprise that won the 2011 physics Nobel prize, actually is a mere *illusion*: cosmic expansion actually is *slowing*, just as one would have naively expected. Wiltshire proposes as an improvement over the long-standing FLRW (Friedmann-Lemaitre-Robertson-Walker) ΛCDM model, his "timescape" model.

FLRW is a famous exact solution of the Einstein general relativity (GR) equations (and Λ/matter/radiation equations-of-state) under the Friedmann approximate assumption that the universe at any time is filled with a spatially-constant-density mixture of matter (gas, dust, and "cold dark matter"), radiation, and Einstein cosmical constant Λ. Because the FLRW equations have a known exact solution in terms of elliptic functions, it is mathematically rigorous. Fits of ΛCDM parameters to a vast number of observations (yielding a nonzero repulsive-signed cosmical constant Λ) have yielded excellent agreement. Two textbooks which cover this (which may not be the best anymore, but possess the advantage that I read them) are Misner, Thorne, Wheeler 1973 and Ciufolini & Wheeler 1995. For confrontations with observation more recent than those books, start with the 2011 Nobel prize lectures by Saul Perlmutter, Brian P. Schmidt, and Adam G. Riess (all also viewable as online videos on the Nobel prize website: P, S, R) as well as later publications by the Planck satellite team.

Timescape instead proposes an *in*homogeneous universe, with that inhomogeneity *increasing* with time. Gas condensed into galaxies, which segregated into galaxy-clusters and superclusters, organized into sheet-like and filament-like structures rich in galaxies, with "voids" in between containing far fewer galaxies. Timescape posits that the "accelerating expansion" of the universe, is *not* caused by nonzero Λ, but rather is an illusion caused by the fact that we humans live in the *Milky Way* galaxy (part of "local group" galaxy-cluster which in turn is a member of the "Virgo supercluster"), rather than the *middle of a void*. Relativistic time-dilation effects (**RTDE**) cause time to pass at different rates in those two places, and the increase of that rate-discrepancy (as the universe evolved to become more inhomogeneous), as interpreted by humans who (since their thinking was FLRW-based) did not take it into account, is what is responsible for this illusion. Wiltshire pointed out that the era of development of void/sheet/etc structure *coincided* with the era when FLRW claimed that Λ took over as the main driver term in the Friedmann equation, thus "accelerating expansion."

The recent **worldwide hype** was triggered by the 2024 paper by Seifert, Lane, Galoppo, Ridden-Harper, Wiltshire (SLGRHW24) claiming the confrontation between (a) observations (the "Pantheon+ type Ia supernovae spectroscopic dataset") versus (b) their computer simulations of timescape, shows "very strong evidence" that Timescape is *superior* to ΛCDM.

How large RTDEs is Wiltshire claiming? Here are three time-dilation numbers to consider:

a. **1.000008** based on this simple numerical "sanity check": the escape velocity from our galaxy is believed about 500 km/sec and from clusters and superclusters about 1000 km/sec<0.004c. This should cause the time dilation factor between void interiors and galaxy interiors to be <1.000008.
b. **1.001** based on the 10^{-3} in this quote from SLGRHW24: "In standard cosmology, differences from average FLRW expansion are assumed to be mostly attributed to local Lorentz boosts – i.e., peculiar velocities – of source and observer, with gravitational potentials contributing fractional variations of $\sim 10^{-5}$ of average expansion at galaxy and galaxy cluster scales. In timescape, the same fractional variation can be up to $\sim 10^{-3}$."
c. **1.35** (which struck me, a priori, as worryingly probably insanely too-large to possibly be true) based on the 19 Dec. 2024 press release from the Royal Astronomical Society "Dark energy 'doesn't exist' so can't be pushing 'lumpy' Universe apart – study" featured maximally-prominently (as of January 2025) on D.L.Wiltshire's web page at the University of Canterbury NZ, and on which he is listed as the sole "scientific contact." Quote: "a clock in the Milky Way would be about 35 per cent slower than the same one at an average position in large cosmic voids."

When by email I asked Wiltshire to explain the (very large!) discrepancies among these three RTDE numbers, he responded as follows (quoted from his email):

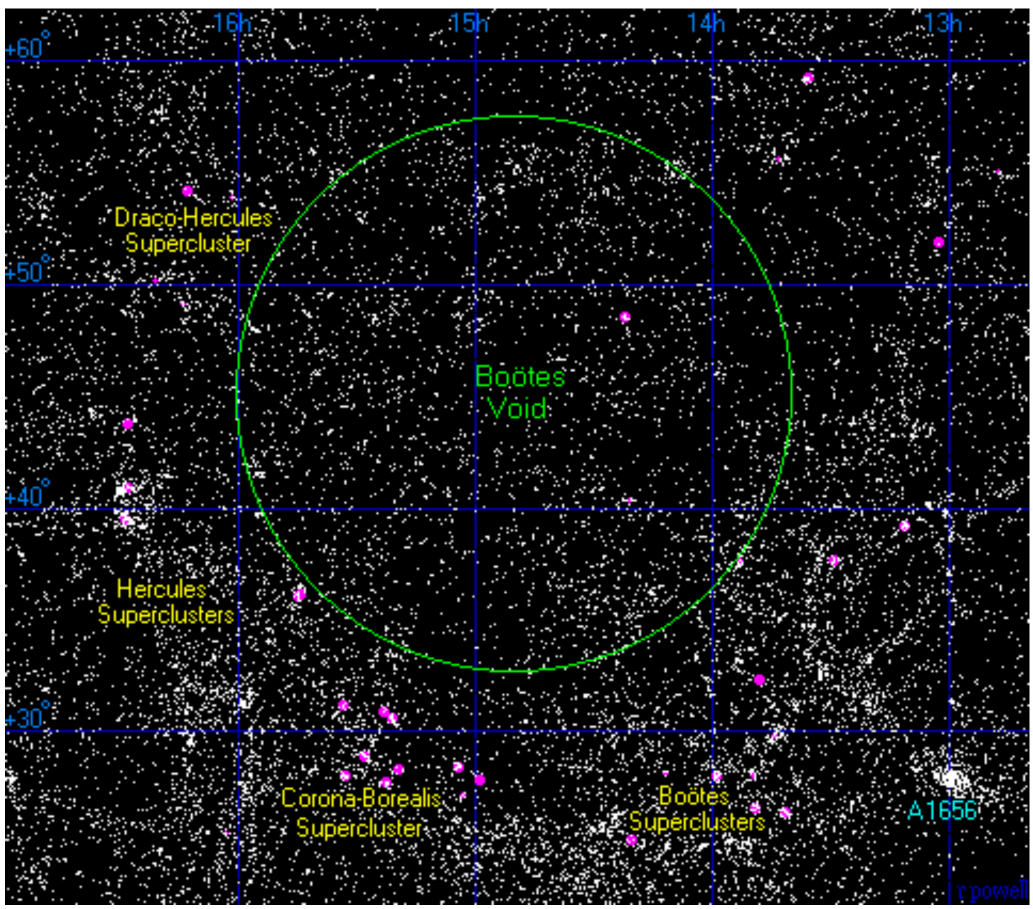
a. The notion of escape velocity that you are using is entirely based on gravitationally bound structures existing as isolated compact bodies in empty space, or embedded in the standard cosmology, with the dipole in the CMB anisotropy spectrum being purely kinematic. Likewise the notions of time dilation that you apply are based on some sort of static approximation. E.g, in talking about the local group of galaxies we know that if we factor out the motion of the earth around the galaxy, and the motion of the Milky Way with respect to the barycentre of the local group, then in order for the dipole in the CMB to be kinematic the local group [must be] moving at 630 km/sec in the direction of Hydra. That is our "peculiar velocity" in the standard FLRW cosmology, and it is where the order of magnitude numbers of "escape velocity" that you throw around come from. In the timescape model, however, there is "peculiar expansion" of the local structures in our vicinity – the anisotropy of our own filament within the local void that is the key to understanding the cosmological dipole anisotropies. In timescape there is a quasilocal uniform Hubble expansion right down to scales of 5 Mpc which means that any peculiar velocity is actually only of order 10 km/s on a background within which expansion is uniform after recalibration of rulers and clocks across the voids. The voids have positive kinetic energy of expansion, or equivalently negative spatial curvature. It is the quasilocal uniform Hubble expansion condition in timescape, which allows one to extract a simple expansion law in what is considered to be the "nonlinear regime" in standard cosmology.
– and –
Everything you said about escape velocities etc is based on a completely empty universe in

which we can calibrate clocks relative to that of an observer at spatial infinity where space is Minkowski, and has a timelike Killing vector. That is essential in defining the notion of gravitational mass in a conventional setting. Every statement you make is based on this notion then superimposed on a FLRW background. However, the universe is not empty. Furthermore, it is changing with time on cosmological scales – there is no global time symmetry. The time dilation I discuss is not related to bound systems. It relates to gradients in local expansion of expanding regions, which may be viewed as gradients in spatial curvature or equivalently, in an average sense, to the quasilocal kinetic energy of expansion. The question of how to keep two clocks calibrated over billions of years when there is a very small relative volume deceleration is a fundamentally different problem to that of time dilations for static situations within bound structures.

b. I do not know how you come up with your numbers... I do *not* claim that time dilations are of order 1.001 in my papers. This is incorrect. From my first paper on this in 2007, Cosmic clocks, cosmic variance and cosmic averages, I have always claimed time dilations of an order similar to 35%.

I thank Wiltshire for those clarifications about the RTDE numbers. The insanity of the number "1.35" now makes it a simple matter to refute his entire proposal.

The Refutation



How can two people ("Amy" and "Bob") measure their relative time-dilation factor? Amy shines her laser toward Bob with pre-agreed frequency (say) 10^{15} Hertz. Bob measures the frequency (say) 0.8×10^{15} Hertz. "Aha!" says Bob. "I deduce dilation factor 1.25."

Since at least one reader did not seem to understand that, and it actually is not quite that simple, let me talk about it in more detail. In the famous Hafele-Keating "flying clocks" experiment, Hafele & Keating 1972 flew some cesium atomic clocks around the world eastward on commercial flights; and on a second trip westward round the world; and after each trip compared the time spans registered by the flying clocks, versus the time spans recorded by stationary clocks at the US Naval Observatory. The discrepancies were -59±10 nanoseconds (eastward trip) and +273±7 nanoseconds (westward trip). These agreed, to within measurement and prediction errors, with the special- plus general-relativistic predictions of Einstein, which were, respectively, -40±23 nanoseconds (eastward) and +275±21 nanoseconds (westward). These predictions were based on the velocity and altitude schedules of the airplanes, in view of both Lorentz time-dilation and gravitational time-dilation effects. Revisions of this experiment were later done with much greater accuracy, but still enjoying measurement-prediction agreement.

Now "lasers" are really the same thing as "atomic clocks that also shine." Cesium clocks are based on the characteristic frequency 9192631770 Hz associated with the transition between the two hyperfine ground states of cesium-133 atoms shielded from electromagnetic fields. They may be regarded as simply a "binary counter" run at that frequency. The light from one of the most popular kinds of lasers, the HeNe laser, instead has a characteristic frequency 473.6122 THz. So suppose that "Amy" was traveling in Hafele & Keating's airplane with cesium clocks and a HeNe laser, while "Bob" stayed at the US Naval Observatory with his own cesium clocks and HeNe laser. And also suppose that throughout her whole round-the-world trip, from the moment she left Bob to the moment she returned to him, Amy shined her HeNe laser directly at Bob. (Actually, that would encounter the slight practical problem that it's hard to shine a laser through the opaque Earth. So imagine this all were done on a better planet made of very-transparent glass.) And suppose Bob *counted* the E-field oscillations of the light he saw from Amy's laser, while also counting the oscillations from his own HeNe laser, during her journey. Those two oscillation counts would *disagree*. The disagreement-ratio should be exactly the same as the disagreement ratio between Bob's and Amy's Cesium clock timespans. Because (#oscillations)=(average frequency)×(elapsed time), that also means the *frequency* Bob measures for Amy's laser will differ from the fixed frequency Bob measures for his own HeNe laser – which equals the fixed frequency Amy measures for her own HeNe laser, because Amy's He/Ne atoms work the same as Bob's He/Ne atoms. [More generally, with measured frequency F(t) at time t, the total oscillation-count equals ∫F(t)dt integrated over the entire experimental time-span.] The ratio of these two frequencies tells Bob the Amy/Bob time dilation factor.

Alternatively, it also would have been possible for *Bob* to shine his HeNe laser at *Amy* throughout her entire journey, with *Amy* counting the laser E-field oscillations. In that altered experiment, again, the exact same results would be obtained via cumulation at the end of the trip. However, at most particular instants *during* the trip, *different* Amy/Bob time-dilation factors would be obtained. For example, for simplicity suppose there were no gravity and during some time-subinterval Amy was traveling directly away from Bob. In that case, Bob would think Amy's laser was red-shifted. But Amy would think Bob's laser was red-shifted, thus deducing an *opposite sign* Bob-Amy time-rate discrepancy at that instant! Paradox?!? The underlying problem here is that there really is no such thing as an "instant" for *two* observers. That concept is inherently single-observer. There is, in general, no unique notion of the word "simultaneous"; you really are not allowed to use the concept of "simultaneity" in relativistic analyses. English, as normally used by most humans, does not treat that correctly: normal humans often say "X happened at the same time as Y" but in precise relativistic discussions, we are *not allowed*to say that!. Such imprecise/careless/typical language is the source of this "paradox." With Bob→Amy laser transmission, Bob and Amy's time-rates really are being "instantaneously" compared at *different* times (Amy's instant is "later"), while in the version with Amy→Bob laser transmission, Amy's instant is "earlier." For that reason, there was no "contradiction." Rather, these two experiment-versions are equally valid. They yield *different*

Amy/Bob time-dilation-factor versus time curves, but both are *self*-consistent; both always yield *equal* final whole-journey integrated answers; and therefore they each possess genuine meaning.

A different famous experiment first done successfully by Pound & Rebka in 1960 found that a fixed gamma ray source "Amy" at the top of a tower had a frequency that *changed* depending on whether "Bob" measured it at the top versus bottom of the tower. (Again, the measured frequency shift agreed with Einstein predictions.) This again is an example of Bob measuring an Amy/Bob time dilation factor by measuring the frequency of light emitted by Amy. The Pound-Rebka version is *simpler* than Hafele-Keating in the senses that

1. With Pound & Rebka, The Amy/Bob frequency ratios remain *constant*, in contrast to the fact that during Hafele & Keating's airplane trips, the Amy/Bob frequency ratio kept *varying* as the airplane changed velocity and altitude;
2. With Pound & Rebka, there is no "paradox" where Amy→Bob transmission yields different instantaneous time-rate-ratio answers than with Bob→Amy transmission.

That kind of enjoyable self-consistency happens in an especially-nice subclass of spacetime metrical scenarios in which a "gravitational potential" Φ is definable, and in which Bob and Amy stay at fixed values of Φ at fixed relative velocities (and in these scenarios there is a *notion* of "fixed relative velocities"). In that subclass of scenarios, Bob and Amy can measure their time-dilation ratio via laser transmissions in either direction, always enjoying the same unchanging, answer. But unfortunately, for most general-relativistic spacetime metrics there is *no such thing* as a "gravitational potential" Φ and *no clear notion* of Amy & Bob's "relative velocities" at one instant (and "at one instant" is a concept we usually are not allowed to use).

I hope my addition of that discussion of the Hafele-Keating and Pound-Rebka experiments has helped clarify Amy, Bob, and their relative time dilation. Fortunately, the precise details of how you reckon time dilation actually will not terribly matter for my purpose of refuting Wiltshire, because all we'll really need to know is that the Amy-Bob relative time discrepancies are *small*, and a lot smaller than Wiltshire claims. As we shall see, that clearly happens. So let us now return from hypothetical generalities to more concrete observation-based arguments about Wiltshire's cosmology.

A. The largest known void in the observed universe is the Boötes supervoid (so-called because it lies near the constellation Boötes in the sky), an approximately spherical region of space containing only 60 galaxies instead of the 2000 expected from a volume this large. Its width is about 400 million light-years. The picture mapping the situation is taken from wikipedia which in turn got it from Richard Powell's Atlas of the Universe. Robert Kirshner discovered it in 1981 in a survey of galactic redshifts. Its center is located 700 million light-years from Earth.

B. On the boundary of the Boötes supervoid (on our side of it) are the Hercules Superclusters approximately 330 million light years in diameter. Hercules is regarded as an "unusually large" supercluster.

C. In front of them, in turn, (left bottom part of the picture) is the Northern Local Supervoid, containing a few small galaxies (primarily spirals) and galaxy clusters, but mostly empty. This is the supervoid nearest to Earth, with center 199 Mly away and width 339 Mly.

Now enquire: what are the observed redshifts of spectral lines produced by galaxies in those three regions?

A. Cruzes et al 2002 "investigate the physical properties of a sample of 26 galaxies in the Boötes void and classify these galaxies based on the emission lines in their spectra." For the 26 galaxies in their table 1 the observed redshift z values range from 0.0432 to 0.0574.
B. Kopylova & Kopylov 2013 in their table 1 find redshifts (expressed as equivalent recessional velocities) ranging between 8066 and 13563 km/sec, or re-expressed (by dividing by the speed of light c=299792.458 km/sec) as z-values, between 0.0269 and 0.0452.
C. Redshifts≤15000 km/sec (§2 of Lindner et al 1997's arXiv version), i.e. z-values between 0 and 0.050.

From these we may deduce, very conservatively, that relative time-dilation factors between void centers versus galaxies in superclusters on the void-wall are ≤1.0574, and presumably actually ≤1.014. And if we take the view that these z-values ought to be *corrected* for the large scale Hubble/Doppler trend before use (i.e. we really want to compare redshifts between void-interiors and supercluster-interiors both *equally far* from Earth), then even the latter is a large overestimate, with the truth being more like $(1-0.014^2)^{-1/2}\approx 1.0001$. In any case, it is clear that the answer is nowhere near as large as 1.35, even for the largest void in the known universe bounded by an unusually large supercluster.

(Also, if "TimeScape" had been correct, then it seems rather peculiar that blueshifts are seen as rarely as they are.)

Discussion

In his same email to me, Wiltshire claimed that he was a proponent of "rigour" and that papers failing to possess it should be rejected, often even without refereeing. As a mathematician who has studied the issue of rigor in physics (or its lack) I am more qualified than most to talk about that topic.

For most nonlinear PDEs (partial differential equations), in particular the Navier-Stokes equations of hydrodynamics and Einstein's general relativity (GR) field equations, present-day mathematics unfortunately is largely incapable of making rigorous statements. We **can**:

1. Sometimes find (and once found, it is easy to verify), exact solutions. Unfortunately: for the vast majority of real physical problems, especially "messy" ones, usually nobody can find an exact solution.
2. Prove certain formal identities, for example some tensor identities in GR.
3. Sometimes prove some statements about the nature of solutions when they exist, for example the Schoen-Yau, later reproven by Witten (& friends and successors) "positive mass theorems" in GR. Actually, this is not really about the GR PDEs per se, but more a "topological property of a class of asymptotically-flat spacetime metrics."
4. In the cases of Navier-Stokes hydrodynamics and GR, solutions have been proven to exist for an initial-data-dependent positive amount (albeit perhaps very small) of time into the future, in a large class of situations ("local existence"). The latter is due to Yvonne Choquet-Bruhat and discussed by Misner, Thorne, Wheeler 1973; for the former see, e.g, Kato 1984.

5. Sometimes, using *very* difficult and long proofs, which historically very few people have been capable of producing (and I have not been one of those few) one can prove eternal existence of solutions *provided* the initial data is "smooth enough" and "small enough" in certain precisely stated norm-senses. That was first accomplished for Navier-Stokes in work of O.A.Ladyzhenskaya, and for GR vacuums near-enough to Minkowski flat space by Christodoulou & Klainerman. I would guess that those proofs are well beyond Wiltshire's ability level. Regardless of whether that ability-guess is valid, all such theorems so far have been almost useless for practical purposes because essentially no hydrodynamical/aeronautical engineer, and no astrophysicist, ever cares about simulating data that small.

But we presently usually **cannot**

6. Prove solutions *exist* and are *unique*, and that keep existing for arbitrarily long (user-specified) future timespans. Incidentally, one sign that this problem is nontrivial is the mathematical existence of (what Moncrief 2015/2019 calls) "exotic" topologies for a universe, for which no "Einstein metric" exists at all. In other words: if you set up a universe with that topology, fill it with vacuum, then enquire what Einstein's GR equations say will happen to it – their answer is "you weren't allowed to ask."
7. And if you cannot do that, then you basically can't prove *anything*, such as: "coarse graining" alleged approximations, models of fluid "turbulence," validity to within any error bound of some algorithm for allegedly finding approximate solutions numerically, etc. Indeed, nobody, ever, has shown that the Navier-Stokes or Einstein-GR PDEs are algorithmically simulable at all. No algorithm has ever been invented that anybody can prove successfully does either.

Let me try to make that even clearer. If somebody (for example Thomas Buchert, whose work Wiltshire's "timescape" largely rested upon) says they have coarse-grained approximate equations that understand cosmology in the presence of growing inhomogeneity then *those claims cannot presently be supported by rigorous mathematics.* If somebody claims they have a computer program that simulates GR and then tells you that, by running their computer, they deduced, with, (say) error bound of 5%, some claim about some physical situation, then *such claims usually cannot presently be supported by rigorous mathematics.*

And indeed, in the papers I have examined by Buchert and Wiltshire on the present topic, they proved a grand total of *zero* theorems.

Because of those lacks of rigor and rigorizability, the only options we have to attempt to assess errors from such computations, are either (a) comparison versus physical experiments, or (b) guesstimates based on comparing repeated runs of the computer program with different inputs and parameters. Until and unless we can attain rigor – which we presently cannot! – those attempts will always be unreliable.

The attempts of this kind most likely to **work well**, are, for example, GR black-hole collision simulations, involving pure vacuum (*no* matter) and *no* unknown or merely approximately known parameters, *simple* initial (and final) data – the latter sometimes with support from rigorous proofs of stability of black hole spacetimes (which by themselves are exact GR solutions) – and (thanks to LIGO) numerous experimental *observations*, and several competing computer programs trying to do it that can be compared, and with a good deal of human-powered analytical approximate help available too.

On the other hand, the attempts of this kind that I would **trust the *least*** (and perhaps even a priori presume to be total garbage!) are: simulations of the entire universe involving growing messy inhomogeneities in a crucial way!

Is there, then, any hope to attain rigor about this kind of question? Let me make two speculative suggestions (or perhaps a better descriptor would be "baseless hopes"):

1. Perhaps some *exact solution* of a cosmological model featuring growing inhomogenities (e.g. featuring some sort of periodic lattice of them) could be found.
2. Witten's "positive mass theorem" states in precise ways claims that it is *impossible* for ordinary matter, and GR, to simulate "negative mass" matter, such as the repulsive-signed Einstein cosmical constant Λ. That suggests that Wiltshire's goal of getting rid of Λ because its alleged effects are merely illusions "simulated" by ordinary matter, is not possible. Here I do *not* want to claim belief (or disbelief) in that "suggestion." I merely want to propose that perhaps some version of Witten et al's ideas, can be used to produce some sort of rigorous upper and/or lower bounds, on the capabilities of such simulo-effects, and/or on the validities of "coarse graining" approximation notions.

I am not optimistic about either plan, but these seem the two avenues most worth investigating if you want "rigour."

Obviously, the FLRW cosmology is not an exactly correct depiction of reality, because the universe really is inhomogeneous, and that really must exert some cosmological effect. Wiltshire et al are right about that. The problem is that these effects have been, up until now, only a small perturbation to FLRW (1% level or less). Furthermore, if FLRW is correct and if Einstein Λ truly is the reason for the accelerating expansion, then I expect the effect of such inhomogeneities also to remain small *forever*. That is because in the future, Λ will convert the universe into a closer and closer approximation to exponentially-expanding "de Sitter spacetime" containing a vacuum only slightly polluted by ordinary and dark matter and radiation, where the "pollution level" will become exponentially small. Eventually any inhabitant of the Milky Way will only be able to see the few galaxies gravitationally bound to it, with all others unseeable since beyond the de Sitter "horizon."

Here is a (quite incomplete) chronologically-ordered list of papers preceding SLGRHW24, reaching mutually-disagreeing conclusions:

- Siegel & Fry 2005: "We evaluate the effect of inhomogeneity energy on the expansion rate of the universe. Our method is to expand to Newtonian order in potential and velocity but to take into account fully nonlinear density inhomogeneities... [We conclude] the contributions due to inhomogeneities never mimic the effects of dark energy or induce an accelerated expansion."
- Buchert & Räsänen "Backreaction in late-time cosmology" 2012: Dismisses Siegel & Fry (and many others of their ilk) with the single sentence "Estimates in first order perturbation theory cannot resolve the issue, because the average of the first order perturbation vanishes, and the contribution of the square of the first order perturbations is *not gauge invariant* without the contribution of the intrinsic second order perturbations." Buchert and Wiltshire then proceeded never to cite Siegel & Fry ever again, apparently considering the matter settled by this single sentence.

But: *why* should we have or want gauge invariance? Why does it matter? B&R simply do not say. The Nobel prize winning "BCS model" for superconductivity was not gauge-invariant either, and that did not seem to hurt its experimental validity in the slightest. (And the FLRW uniform-cosmology model has had very good quantitative success, far exceeding that of BCS.)

- Adamek et al 2015: Effectively dismisses Buchert & Räsänen's title and that single sentence and the Wiltshire 35% claim with: "The large-scale homogeneity and isotropy of the Universe is generally thought to imply a well-defined background cosmological model. It may not. Smoothing over structure adds in an extra contribution, transferring power from small scales up to large. Second-order perturbation theory implies that the effect is small... We investigate this using two different N-body numerical simulations: a 3D Newtonian and a 1D simulation which includes all relevant relativistic effects. We show that while perturbation theory predicts an increasing *backreaction* as more initial small-scale power is added, in fact the virialization of structure saturates the backreaction effect at the same level independently of the equality scale. This implies that backreaction is a *small* effect independently of initial conditions. Nevertheless, it may still contribute at the percent level to certain cosmological observables."
- Saulder et al 2018 computer simulates TimeScape reaching the opposite conclusion to the computer simulations of SLGRHW24 (which never cited it)! "Using large-scale galaxy surveys such as SDSS and 2MRS, we test the variation of expansion expected in the ΛCDM model versus a more generic differential expansion using our own calibrations of bounds suggested by timescape cosmology. Method. Our test measures the systematic variations of the Hubble flow towards distant galaxies groups as a function of the matter distribution in the lines of sight to those galaxy groups. We compare the observed systematic variation of the Hubble flow to mock catalogues from the Millennium Simulation in the case of the ΛCDM model, and a deformed version of the same simulation that exhibits more pronounced differential expansion. Results:... statistical tests... consistently yield results preferring ΛCDM over our approximated model of timescape."
- Wiltshire published a 2019 "comment" responding to Saulder et al, which he summarized to me as "Since they did not have better simulations Saulder et al deformed Newtonian N-body simulations. However, this misses a key aspect of timescape; there is no backreaction." However that misses a key aspect of backreaction: it is too tiny to matter (say Adamek et al, which no work by Wiltshire ever cited).

It is sadly amusing to watch this war of words between these two theoretical camps, who however mostly just ignored each other for 20 years while happily publishing their own stuff. The result is as clear as mud, and obviously, at least 50% of their conclusions are wrong (and that is only a lower bound).

How can it be that many different publications by many different authors over 2 decades about TimeScape and related cosmologies have managed, via competing computer simulations and competing human analyses, to reach such vastly disagreeing conclusions?! I believe a big reason is: "because this whole area is entirely nonrigorous"! That is why I wrote this paper: I considered my reasoning here from observational data so simple and convincing that it settles the dispute.

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19 Dec. 2024 press release from Royal Astronomical Society: "Dark energy 'doesn't exist' so can't be pushing 'lumpy' Universe apart – study" featured maximally-prominently (as of January 2025) on D.L.Wiltshire web page, and citing him as the sole "scientific contact."