1. The Age of the Universe – Big Bang Cosmology

> *No inference can be drawn in any respect from the nature of a thing after it has been generated, has attained its final state, and has achieved stability in its most perfect state, to the state of that thing while it is moved towards being generated. … Whenever you err in this and draw an inference from the nature of a thing that has achieved actuality to its nature when it was only in potential, grave doubts are aroused in you* (Maimonides, 12th century).

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Abstract[1]: The universe is confidently asserted to be at least 14 billion years old based on the outstanding successes of the big bang theory. But this confuses necessary conditions with sufficient conditions. There are at least six unproven *assumptions* needed for the theory, numbered (a) to (f) in the sequel, that have never been experimentally demonstrated. Two of the assumptions are foundational, three of the assumptions involve the need to postulate hypothetical entities that have never been experimentally observed, without which the theory would be in contradiction of experimental observations. The last assumption involves experimentally observed anomalies that flatly contradict the theory even in the presence of the postulated hypothetical entities. The absence of experimental confirmation[2] of these assumptions makes the whole basis for the 14 billion year age calculation highly speculative.

1.1. Scientists proclaim an ancient universe as virtually a fact

For many decades, scientists have confidently asserted that the universe is about 14 billion years old based on the big bang cosmology. Cosmologists and the scientific press regularly proclaim with certainty the truth of standard big bang theory. They interpret a few apparently outstanding successes as proof that the theory is virtually incontrovertible. Some of these successes include experimental observations such as the Hubble redshift relation and the 2.7K Cosmic Blackbody Radiation (CBR).

However, there is a flaw in all this exuberant confidence. Cosmologists mistakenly interpret apparent agreements with big bang predictions as a sufficient condition for the truth of big bang theory. What cosmologists have actually done is to show that they have met a few necessary conditions for the theory's success – conditions that are insufficient to warrant belief in the theory with confidence. In fact, the theory is an inference that comes at the end of a long sequence of untested steps based on unverified core assumptions, extrapolations from a small snapshot to vast eons of time, deep theory involving hypothetical entities, and stubborn anomalies in the experimental evidence.

[1] Science advances at a rapid pace. The information presented in the sequel is current to the best of my knowledge at the date of writing. I am not an expert in the field and thus had to rely on quotes from recognized scientists and cosmologists in the presentation in order to ensure that the information is accurate. These scientists probably believe in an old or even an eternal uncreated universe. However, the individual beliefs of these scientists are irrelevant to this article. The point of this article is to show that we cannot use big bang cosmology to conclude with confidence that the universe is old. Please email torah@rogers.com with any comments, criticisms or corrections (especially with regards to facts) which will be gratefully received.

[2] "The *sine qua non* of physical science is empirical testing of hypotheses. Without this acid test we would have no way of distinguishing scientific gold from fool's gold and we might come to view ourselves as being quite rich when, in fact, our pockets were mostly full of pretty, but non-negotiable, iron pyrite." Quote from Robert L. Oldershaw, *Am. J. Phys.* 56, 1075 (1988). Oldershaw also states "that an undesirable blurring of the distinction between physical science and mathematical abstraction has taken place in the fields of particle physics and cosmology over the past three decades".

A fundamental cornerstone of the big bang theory is the Friedmann-Lemaitre space-time expansion solution to the field equations of general relativity as developed by Albert Einstein. This solution is normally illustrated with an expanding balloon that has dots scattered over its surface with each dot representing a galaxy. As the balloon is blown up the dots all recede from each other. The expanding balloon represents the expanding fabric of space itself. Should you stand on one dot then and look around you it would appear that you are at the center of the universal expansion occupying a privileged place in the universe. This would not be true because an observer on any other dot (galaxy) would see exactly the same thing.

Experimental observation indicates that the light from distant galaxies is shifted towards the red. The redshift (interpreted as a measure of the recession speed[3]) is larger for the more distant galaxies. This Hubble redshift is assumed to verify the expanding Friedmann-Lemaitre space-time solution. If we see the stuff of the universe receding from us faster the further away it is, then, extrapolating backwards, all that stuff must originally have been in one place (i.e. on top of us). What we now see is a snapshot of the debris of an explosion like that of an exploding grenade (all explosions satisfy Hubble's law[4]). The 2.7K CBR is the remnant energy of that original explosion of the universe from an infinitesimally small point – this is called the "big bang".

Sir Martin Rees[5] recently wrote a review of big bang cosmology in which he states:

> The extrapolation by astrophysicists and cosmologists back to a stage when the universe had been expanding for a few seconds deserves to be taken as seriously as, for instance, what geologists or paleontologists tell us about the early history of our Earth. Their inferences are just as indirect and generally less quantitative. Moreover, there are several discoveries that might have been made over the last 30 years which would have invalidated the big bang hypothesis and which have not been made – the big bang theory has lived dangerously for decades and survived. Here are some of those absent observations [4 observations follow …]. The big bang theory's survival gives us confidence in extrapolating right back to the first few seconds of cosmic history and assuming that the laws of microphysics were the same then as now.[6]

Rees correctly points out that big bang cosmologists make huge extrapolations and assumptions. What cosmologists conclude is an inference and not scientific fact. He also points out that what geologists and paleontologists say are in the same category of indirect evidence, extrapolations and assumptions. Quite so! Rees has come close to identifying the Achilles heel of big bang cosmology without fully addressing it. Like many others, he has omitted to deal with a variety of grave difficulties.

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[3] The whistle of a passing train changes pitch as it approaches and then disappears into the distance. This is known as the Doppler effect. As the train approaches the pitch of the whistle is higher, as it moves away the pitch is lower. A departing train results in the distance between the crests of the sound waves issued by its whistle to become larger. A larger wavelength indicates a lower frequency or pitch. Likewise, red light (650 nm) has longer wavelengths than blue light (475 nm) – thus a redshift indicates a departing object and a blueshift an approaching object.

[4] MAGUEIJO, J., *Faster Than the Speed of Light: The Story of a Scientific Speculation*, Perseus Publishing, Cambridge, Mass., 2003, p78.

[5] Martin Rees Royal Society Research Professor at Cambridge University. He holds the title of Astronomer Royal.

[6] REES, M. J., Piecing Together the Biggest Puzzle of All, *Science*, 290(5498), p 1919, 2000.

1.2. Six unproved assumptions deflate the Big Bang theory

We enumerate below six unverified assumptions with big bang cosmology. These assumptions are numbered (a) to (f).

a) A fundamental cornerstone of the Friedmann-Lemaitre space-time solution is the Cosmological Principle. However, this cornerstone is a totally unproven *assumption*. The Nobel Laureate Steven Weinberg wrote:

> "Nevertheless, there *is* one great uncertainty that hangs like a dark cloud over the standard model. Underlying all the calculations described in this chapter is the Cosmological Principle, the assumption that the universe is homogenous and isotropic. (By homogenous we mean that the universe looks the same to any observer who is carried along by the general expansion of the universe, wherever that observer may be located; by "isotropic" we mean that the universe looks the same in all directions to such an observer.) … However, we have no evidence that the Cosmological Principle was valid at earlier times."[7]

In fact, we cannot have any such experimental evidence for homogeneity because nobody has yet been to the distant galaxies to verify its correctness! No wonder the resulting uncertainty "hangs like a dark cloud" over the theory.

b) Another fundamental cornerstone of the Friedmann-Lemaitre space-time solution is the *assumption* that relates the expansion factor (a) of the universe to observed redshifts (z)[8]. This relation describes the basic assumption that the redshift is not a normal Doppler effect (of galaxies receding within a static space) but rather a space-time expansion redshift (i.e. the expansion of space itself as illustrated by the dots on an expanding balloon). The venerable MTW monograph *Gravity* lets us in on a good secret:

> "Recognize that present measurements have not yet provided a good, direct handle on the absolute dimension $a(t)$ of the universe"[9].

No procedure is provided in MTW for measuring the expansion factor a – the expansion relation is thus a sheer assumption of big bang cosmology.

Hubble was aware that the redshift could be interpreted as a Doppler effect rather than as a space expansion effect. A Doppler effect would mean that we on earth inhabit a special position near the center of the universe from which the galaxies are receding within a static space. Hubble wrote in 1937 that his commitment to the Cosmological Principle is a "sheer assumption" – he felt forced to accept it to avoid the "horror" of a special position for planet earth – "the unwelcome supposition of a favoured position must be avoided at all costs" [10]. The famous cosmologist Stephen Hawking[11] wrote as follows in 1988:

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[7] WEINBERG, S., *The First Three Minutes: A Modern View of the Origin of the Universe*, Basic Books, New York, 1993. page 119-120.

[8] The space expansion factor $a(t)$ is also interpreted as the radius of the universe in MISNER, C. W., K. S. THORNE and J. A. WHEELER, *Gravitation*, W. H. Freeman, San Francisco, 1973, p733. The assumption is written on page 744, equation (27.73) as: $a0/a = 1 + z$. The symbol a_0 is the expansion factor now when we observe the photons of light, a is the expansion factor at the time the photons were emitted at an earlier time, and z is the redshift, i.e. the change in wavelength observed to the normal emission wavelength.

[9] Ibid., p744.

[10] I have seen this quoted from E. P. Hubble, *The Observational Approach to Cosmology*, Clarendon Press, 1937; see page 54 and page 59.

> In particular, it might seem that if we observe all other galaxies to be moving away from us, then we must be at the center of the universe. There is, however, an alternate explanation: the universe might look the same in every direction as seen from any other galaxy, too. This, as we have seen, was Friedmann's second assumption. We have no scientific evidence for, or against this assumption. We believe it only on grounds of modesty: it would be most remarkable if the universe looked the same in every direction around us, but not around other points in the universe, but not around other points in the universe![12]

Eminent cosmologists describe these foundational and untested assumptions as "sheer assumptions", as being under "a dark cloud", and that they should be accepted "only on grounds of modesty" or out of "horror" against the alternative of the earth as near the center of the universe – this indicates how speculative big bang cosmology really is.

How did the theory get such wide acceptance without any direct experimental evidence for its basic assumptions over the 70 years since it was first formulated? The existence of sheer assumptions is cause for a very big deflation in this expanding balloon theory[13].

Big bang cosmology relies on deep theory i.e. on the existence of a variety of hypothetical entities for which no direct experimental evidence exists. Without these hypothetical entities there would be fatal contradictions between experimental evidence and the theory. Currently, some of these hypothetical entities include:

c) the *assumption* of an inflation field;
d) the *assumption* of dark matter;
e) the *assumption* of dark energy.

A recent letter in *New Scientists* (May 22nd, 2004) describes the severity of the problem. The letter was signed by 33 scientists including Hermann Bondi, (Cambridge), Thomas

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[11] Stephen W. Hawking holds Newton's chair as Lucasian Professor of Mathematics at Cambridge University.

[12] HAWKING, S. W., *A Brief History of Time: From the Big Bang to Black Holes*, New York: Bantam Press, London, 1988, p42.

[13] Budding cosmology students are often confronted with a very disturbing contradiction associated with spacetime expansion: "*where are the spacetime equations that would justify galaxies to separate into greater and greater distances, without causing stars within galaxies to separate at the same time*?" In MTW (see footnote 8), in an Orwellian fashion, such questions are labelled as "bad" (page 744). MTW advises students that the universe expands but "*only distances between clusters of galaxies and greater distances are subject to the expansion. No model more quickly illustrates the actual situation than a rubber balloon with pennies affixed to it, each by a drop of glue. As the balloon is inflated the pennies increase their separation one from another but not a single one of them expands!*" (p. 719). But, the pennies-on-an-expanding-balloon illustration is merely an intuitive description – a scientific explanation of galaxy formation appears to be missing. I have heard others pose the problem in the following words: clearly, if it were admitted that expansion works to enlarge the physical size of galaxies, as well as to expand the separation between them, then logic would say there should be no galaxies at all, for such expansion would long ago have equally separated stars to very great distances from each other, just as the galaxies themselves are now separated very great distances. Thus, ever since its inception, there has been hidden within the balloon illustration the requirement that expansion must have been exceedingly selective. But this requirement is easily shown to be contradictory because, if expansion existed at all, then by its very definition [in the FL equations] it must have acted impartially on all celestial entities, regardless of their masses. How is it that spacetime expansion (in the expanding balloon illustration) overcomes the huge gravitational force between galaxies allowing them to separate, yet fails to cause the separation of the far more weakly gravitationally bound stars within the galaxies. Trefil (*The Dark Side of the Universe*, Charles Scribner's Sons, 1988) has a popular presentation titled "Five reasons why galaxies cannot exist" (p55-66). His optimistic solution is the existence of undetectable dark matter within galaxies. The putative dark matter, despite making up more than 90% of the matter in the universe, is undetectable because it does not emit photons. Hoyle *et. al.* (footnote 18) state: "So far it appears that [from the point of view of standard big bang cosmology] a satisfactory structure [using dark matter] has not been achieved despite the existence of a large industry trying to cover as much of the parameter space. The infinite patience, unbounded human hours and grant money spent on gigantic computer simulations are matched by the firm **faith** [emphasis added] that the approach is correct" (p293-294). See also the critique in the Lerner letter (referenced in footnote 15). The fact that galaxies exist is a contradiction to big bang cosmology as described by the expanding balloon illustration, and budding cosmology students should continue to ask politically incorrect questions.

Gold (Cornell) and Halton Arp (Max-Planck-Institute Fur Astrophysik). Part of the letter is reproduced below:

> The big bang today relies on a growing number of hypothetical entities, things that we have never observed – inflation, dark matter and dark energy are the most prominent examples. Without them, there would be a fatal contradiction between the observations made by astronomers and the predictions of the big bang theory. In no other field of physics would this continual recourse to new hypothetical objects be accepted as a way of bridging the gap between theory and observation. It would, at the least, raise serious questions about the validity of the underlying theory.
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> But the big bang theory can't survive without these fudge factors. Without the hypothetical inflation field, the big bang does not predict the smooth, isotropic cosmic background radiation that is observed, because there would be no way for parts of the universe that are now more than a few degrees away in the sky to come to the same temperature and thus emit the same amount of microwave radiation.
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> Without some kind of dark matter, unlike any that we have observed on Earth despite 20 years of experiments, big-bang theory makes contradictory predictions for the density of matter in the universe. Inflation requires a density 20 times larger than that implied by big bang nucleosynthesis, the theory's explanation of the origin of the light elements. And without dark energy, the theory predicts that the universe is only about 8 billion years old, which is billions of years younger than the age of many stars in our galaxy[14].
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> What is more, the big bang theory can boast of no quantitative predictions that have subsequently been validated by observation. The successes claimed by the theory's supporters consist of its ability to retrospectively fit observations with a steadily increasing array of adjustable parameters, just as the old Earth-centered cosmology of Ptolemy needed layer upon layer of epicycles.
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> Yet the big bang is not the only framework available for understanding the history of the universe. Plasma cosmology and the steady-state model both hypothesize an evolving universe without beginning or end. These and other alternative approaches can also explain the basic phenomena of the cosmos, including the abundances of light elements, the generation of large-scale structure, the cosmic background radiation, and how the redshift of far-away galaxies increases with distance. They have even predicted new phenomena that were subsequently observed, something the big bang has failed to do.[15]

A cornerstone of big bang theory is the Hubble relation – the further away astronomical objects are from us, the older they are, and the greater is the velocity at which they are receding from us. According to this, two objects that are attached to each other at approximately the same distance from us should have the same age. However, Arp has catalogued an increasing number of stubborn anomalies. A recent journal article provides an example of an anomaly that turns out to be even greater than what was originally thought over 15 years ago:

[14] See also footnote 13.
[15] LERNER, E., An Open Letter to the Scientific Community, *New Scientist*, 182(2448), p 20, 2004.

> There are 4 objects [associated with galaxy NGC7603] with very different redshifts [z = 0.057, 0.243, 0.391, and .029] apparently connected by a filament associated with the lower redshift galaxy. This system is at present the most *spectacular* case that we know among the candidates for *anomalous redshift*. Future studies of this system are clearly warranted [emphasis added[16]].

The anomaly is absolutely startling! By the Hubble relation, objects 4 and 3 should be about the same age – yet, from their redshift, object 4 is (very approximately) 0.03 billion years old, and object 3 is over 4 billion years old (a contradiction involving an order of magnitude). Berlinski quotes some rather severe problems raised by the mathematician I.E. Segal.

> The [late] American mathematician I.E. Segal and his associates have studied the evidence for galactic recessional velocity over the course of twenty years, with results that are sharply at odds with predictions of Big Bang cosmology. Segal is a distinguished, indeed a great mathematician, one of the creators of modern function theory and a member of the National Academy of Sciences. He has incurred the indignation of the astrophysical community by suggesting broadly that their standards of statistical rigor would shame a sociologist. Big Bang cosmology, he writes "owes its acceptance as a physical principle primarily to the uncritical and premature representation of [the redshift-distance relationship] as an empirical fact.... Observed discrepancies … have been resolved by a pyramid of exculpatory assumptions, which are inherently incapable of noncircular substantiation."[17]

The experimental redshift data contradicts big bang cosmology even with the postulated hypothetical entities needed to fudge the data. A recent Cambridge University Press monograph states:

> Among all the observational discoveries of the last few years, it has been those which involve the measured redshifts which cause the most problems. They are so difficult to understand and so unexpected, that discussion of them has been completely left out of other books on cosmology … there are some phenomena that we have not so far described since we have not been able to understand or explain them.[18]

f) For the big bang age of the universe to be established we need to *assume* that all the stubborn redshift anomalies (which contradict Hubble's Law) can be resolved and that Hubble's Law can be experimentally confirmed.

1.3. Extrapolation, Deep Theory and Anomalies

Even one small anomaly may spell the death of an otherwise elegant and deeply held theory. The discrepancy in Mercury's path ultimately revealed a flaw in Newton's theory of gravitation. Likewise, current cosmological dates are speculations at the end of a long sequence of untested inferences based on unverified core assumptions, extrapolations

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[16] LÓPEZ-CORREDOIRA, M. and C. M. GUTIÉRREZ, Two Emission Line Objects with in the Optical Filament Apparently Connecting the Seyfert Galaxy Ngc 7603 to Its Companion, *Astronomy & Astrophysics*, 390(L15-18), 2002.

[17] BERLINSKI, D., Was There a Big Bang? *Commentary*, February,p28-38, 1998.

[18] HOYLE, F., G. BURNBRIDGE and J. V. NARLIKAR, *A Different Approach to Cosmology*, Cambridge University Press, 2000, p325.

from a small snapshot to vast eons of time, deep theory involving hypothetical entities, and stubborn anomalies in the experimental evidence.

The *sina qua non* of a scientific theory is that its core assumptions are carefully checked by experiment. Many deeply held theories have failed because they involved untested assumptions and extrapolations. Newton's theories were supposedly verified in numerous careful experiments. Nobel Prize winners declared the end of physics at the turn of the previous century[19]. Yet Newton's theories of absolute time, space and reference frames were invalidated by Einstein. Bohr (in his Copenhagen interpretation of Quantum Mechanics) invalidated the carefully constructed Newtonian determinism of Laplace and allowed for the possibility of free-will. Hubble and Friedmann invalidated the eternally old universe of deeply held scientific thinking from Aristotle to Einstein – suddenly the age of the universe changed from an eternal static universe with a confirmed age of $t = -\infty$, to a dynamic created universe with an age of $t = 14$ billion years. Creation *ex nihilo*, which had a moment earlier been considered unscientific because it violated conservation of energy and matter laws validated in numerous careful experiments, suddenly became respectable. Copernicus invalidated Ptolemaic astronomy, and the General Theory of Relativity invalidated the Copernican Principle.

How it is that science is so successful in providing technological breakthroughs if it can also make such huge errors? The answer, it appears, is rather simple. Not all the "facts" of science are equally credible. From higher to lower credibility we have:

1. Facts established by *repeatable observable experiments*[20];
2. *Interpolation*;
3. *Extrapolation* (especially huge backward extrapolations from a small subset of observations to huge eons of time).
4. *Deep theory* (hypothetical objects and fields which have no direct experimental verification).

Newtonian mechanics is deeply flawed when applied outside its scope (e.g. at speeds approaching that of light), yet it is accurate enough to be used to build bridges and send rockets to the moon. It fails only when extrapolated outside of its proper domain of repeatable observable experiments.

Consider the starlight problem for a young universe. Supernova SN1987A is approximately 168,000 light years away. Given that the speed of light in a vacuum is just under 300,000 km/s this apparently means that the universe is at least 168,000 years old. No detectable drift in the speed of light has been observed since it was first measured hundreds of years ago. Science confidently asserted that "the speed of light is one of the most sacrosanct of the universal physical constants"[21]. We can safely extrapolate backwards for billions of years and state with confidence that it was constant into the distant past as well. It would be "heresy" to question such an extrapolation.

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[19] In 1894, Nobel Prize winner Albert Michelson (of Michelson-Morley fame) had just (prematurely) announced the end of physics at a conference of scientists in that year. He stated: "It seems probable that most of the grand underlying principles have been firmly established . . . the future truths of physics are to be looked for in the sixth place of decimals." At the turn of the century the chair of physics at Harvard University advised his students to look elsewhere for employment.

[20] See footnote 2.

[21] REICH, E. S., If the Speed of Light Can Change, *New Scientist*, 183(2454), 2004.

The constancy of the speed of light was an obvious "fact" – until 1998. Since 1999[22], multiple groups of researchers have started to actively investigate variable speed of light theories with a variety of cosmologists looking at theories in which the speed of light might have been 60 orders of magnitude faster than the current value in the early history of the universe[23]. For a young universe, a more conservative 12 orders of magnitude would suffice! Variable speed of light theories are reported to be provoking a "simmering debate" between cosmologists especially as such theories may require fundamental changes to Einstein's theory of relativity[24].

1.4. Maimonides' argument against Aristotle's eternal universe

> It is usually assumed that the laws of nature have always been the same as they are now. There is no justification for this. The laws may be changing, and in particular quantities which are considered to be constants of nature may be varying with cosmological time. Such variations would completely upset the model makers. (Nobel Prize winner, Paul Dirac, *On methods in theoretical physics*, June 1968, Trieste.)
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> This weakness of the observational method shows itself most acutely when we come to consider the past or the future of the universe as a whole. Observation, of itself, simply cannot tell us what an observer living five thousand million years ago would have seen, nor can it tell us what an observer living five thousand million years ago hence might see. … Of necessity, any statements that we make about the past history of future of the whole universe lies at the frontiers of our knowledge, and must today be considered uncertain and tentative. (Sir Fred Hoyle, *Astronomy*, Macdonald & Co, London, 1962, page 298.)

Scientists such as Dirac and Hoyle came close to an argument made by the great 12th century sage Maimonides when he provided a detailed critique of Aristotle's eternal universe. Maimonides wrote as follows in the *Guide to the Perplexed* (II: 17):

> No inference can be drawn in any respect from the nature of a thing after it has been generated, has attained its final state, and has achieved stability in its most perfect state, to the state of that thing while it is moved towards being generated. … Whenever you err in this and draw an inference from the nature of a thing that has achieved actuality to its nature when it was only in potential, grave doubts are aroused in you.

Maimonides devoted much of the 2nd part of his *Guide to the Perplexed* to show that what we observe now is not a reliable guide to how things come into being – a point he proves with an "argument that comes close to a demonstration".

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[22] Barrow, J.D. Cosmologies with Varying Light Speed. *Physical Review D*, 59(4), 1999.

[23] ALBRECHT, A. and J. MAGUEIJO, A Time Varying Speed of Light as a Solution to Cosmological Puzzles, *Physical Review D*, 59(4), 1999. DAVIES, P. C. W., T. M. DAVIS and C. H. LINEWEAVER, Black Holes Constrain Varying Constants, *Nature*, 418(8), 2002. MAGUEIJO, J., Plan B for the Cosmos, *Scientific American*, 248(1), p 58-59, 2001. MAGUEIJO, *Faster Than the Speed of Light: The Story of a Scientific Speculation*.

[24] Reich, If the Speed of Light Can Change, *New Scientist*, 183(2454), 2004