A More Coherent Big Bang Model

G. H. Mickey Thompson
Independent Researcher
2111 E. North Crescent Ave
Spokane WA 99207 USA
e-mail: mickeythompson112@msn.com

ABSTRACT

Upon examining thousands of astrophysics papers and journal articles, one can't help noticing the many researchers who are expressing a frustration that their well confirmed findings are not consistent with the Inflationary, Lambda Cold Dark Matter (ΛCDM) cosmic model. Their plea is for a simpler model that better explains these findings. This paper introduces such a model. It's based on evidence that back in the 1930s Georges Lemaître erred when he made the unprovable assumption the big bang created the entire universe. Simply negating that assumption supports a new paradigm in which our big bang overlays part of a grander universe; one that's perpetually consolidating residues of old big bangs and growing singularities that spark new ones. It's this background litter that generates the anomalous behaviors observed by researchers. The paper shows how a dozen such popular complaints can easily be demystified. In addition to placing this unexamined model in the discussion, the paper also questions popular assumptions about dark matter and gravity, positing more logical magnetohydrodynamic (MHD) explanations.

Keywords: black holes, cosmology theory, dark energy, dark matter, galactic super clusters, large-scale structure of the universe, missing antimatter, quasars, singularities, stars

INTRODUCTION

While much of the evidence tracks closely with General Relativity and the ΛCDM model, there is a large and growing number of exceptions. These have left researchers hungry for a simpler and more compliant model of the universe.

Georges Lemaître published the original big bang theory in 1927 and later said the universe originated from a "primeval atom" or "cosmic egg" whose expansion marked the beginning of time and space[1]. His point of origin is now called the "big bang singularity". To most of his colleagues, his assumptions must have seemed plausible, as bigger telescopes and advancements in spectroscopy were beginning to reveal a trillion times more matter than had been identified prior to 1920, and it looked as though the big bang could have created all of it.

The case has more clearly been made that big bang nucleosynthesis created the subatomic particles composing light elements[2]. However, this does not mean *all* of the universe's matter was created by this one big bang.

Most of the discrepancies between theory and data seem to stem from Lemaître's unproveable assumption the big bang created the whole universe. Yet, current theory is still founded on this assumption. This puts big bang theory in a box. Looking outside that box we find a world of new possibilities. What follows is an unexamined model that's simple to imagine when we explore beyond the confines of the creation assumption.

Most scientists accept that a big bang created our expanding sphere of galaxies. If it were clear that this sphere is the whole universe, we could say the big bang created the universe. However, such is not the case.

In the late 1940s, Fred Hoyle and associates disagreed with the notion a big bang created the universe. They proposed a steady state model that had no big bang[3]. Since the 1960s, however, there's been a growing body of cosmic microwave background (CMB) evidence that a big bang really did occur. What I'll be describing is a steady state model of the universe that continuously produces big bangs.

Neither Lemaître, Einstein, nor any of their contemporaries ever actually attempted to prove our big bang is the whole universe. To prove it, we'd need to be able to examine the whole universe. Disproving it is much easier. This only requires evidence that *some* of the universe was not created by our big bang. That evidence has been before us for years, but our dedication to Lemaître's assumption hampered our ability to see it.

The first step in replacing an established theory with a new one is to describe the flaws in the old one. In looking through the relevant research papers, I find many in which the authors are not satisfied that their mathematical conclusions are consistent with both General Relativity and big bang theory. This results in fine tuning of the inputs and occasionally brings the results closer to theory. While these quantitative discrepancies merit more investigation, I'm not mathematically astute enough to participate in those projects. Instead, I focused on a dozen or so well-accepted big bang problems that can be dealt with in a puzzle solving analysis.

The challenge that stimulated my research stems from the list of anomalies for which the standard model either has no answer or provides dubious answers that are not disprovable. Here are some questions these mysteries pose:

- How can big bang structures be larger than the cosmological principle allows?
- Why are there so many anisotropies within our big bang?
- What causes dark energy behavior?
- What causes big bangs?
- Where are all the missing monopoles?
- Why is there vastly more matter than antimatter?
- What gave the cosmic microwave background its uniform temperature?
- What gave the CMB its rough texture?
- How did galaxies and stars form so soon after the big bang?
- What will ultimately become of our expanding big bang?
- How did we get so many quasars, back when stars were just beginning to form?
- What is dark matter?
- How did improbable anthropic conditions evolve, in just 13.8 billion years?

The following analysis treats these mysteries as compatible puzzle pieces that fit together nicely in a less constrained picture of the universe. Numerous researchers have analyzed each piece individually, but I've never seen an analysis that treats them all as part of the same puzzle.

I'll describe each puzzle piece in more detail as we broach its topic. Combined, they form the image of a grander universe, whose mechanics are logical and easy to visualize. My sense is that each of these mysteries has a straightforward solution if our big bang took place in an old universe. One whose general characteristics look like multiple layers of past big bangs.

We'll start by contrasting the difference between the assumption the big bang created the universe, and a big bang that's not constrained by that assumption. Here's a first principles overview of these two alternatives:

The "creation" model is based on an explosion that created the universe from a hot mass that burst forth from a singularity that appeared out of nowhere and was surrounded by nothing but emptiness. The most logical way to explain its formation from nothing is to assume half of its mass is matter and the other half antimatter. That way if you add it back together, it annihilates itself and you end up where you started.

In the absence of outside influences, its hot matter should expand smoothly, with no means for texturizing it and only its internal gravitational force to slow or contain it. One way to give it texture would be to throw in a brief hiccup at the beginning of its expansion; one that amplifies the texture of the hot quantum froth. This "inflation" preamble can also hold all matter in contact for an instant, to give the big bang a uniform temperature in all directions. The big bang is bathed in electromagnetic energies, but there's no reason to expect them to behave non-uniformly.

That's it! Nothing else existed. So, theoreticians need to be veerrrry creative to explain all the weirdness seen in the big bang's expansion.

In contrast: If an older, vaster, and far more massive universe creates big bangs, it would have the background necessary to explain everything researchers are finding, with no need for unproven physics. And it would do so in the confines of a natural and preexisting 3D space.

FINDINGS DISMISSED WITH TOO LITTLE PRESS

The cosmological principle says that on a sufficiently large scale the universe is homogeneous and isotropic; meaning its mass should be distributed fairly uniformly throughout its volume. It has been determined that a universe, created by our big bang, can produce structures no larger than 1.2 billion light years across[4]. Surprisingly, researchers are finding structures a lot bigger than that[5].

Wikipedia maintains a "List of largest cosmic structures"[6]. As of early 2017, there were six that are more than 1.2 billion light years across. The Hercules–Corona Borealis Great Wall is 10 billion light years across, 7.2 billion light years wide, and 900 million light years thick[7]. It was the largest structure recorded at the time, but the search for massive structures is just beginning and better instrumentation will likely reveal many more of these monstrous anomalies.

Scientists had earlier determined that even smaller structures take longer to form than the age of the big bang; concluding it takes more than 100 billion years for galaxies to lose outflowing momentum, reverse directions, and gravitationally form such huge structures[8].

In a global concern about mismatches in the cosmological principle and actual findings, Wen Zhao and Larissa Santos recently summarized the discrepancies[9]. They say, "several directional anomalies have been reported in various observations: the polarization distribution of the quasars, the velocity flow, the handedness of the spiral galaxies, the anisotropy of the acceleration, the anisotropic evolution of the fine-structure constant, including anomalies in the CMB low multipoles, such as the CMB parity asymmetry. Although the confidence level for each individual anomaly is not too high, the directional alignment of all these anomalies is quite significant, which strongly suggests a common origin of these anomalies.

If these anomalies are due to cosmological effects, e.g. the alternative theory of gravity or geometry, the non-trivial topology of the universe, the anisotropic dark energy or the particular large-scale fluctuation modes, they indicate the violation of the cosmological principal. So, one should consider to build a new cosmological model to explain the large-scale data."

Throughout 21st Century archives we find researchers telling us the creation model fails its homogeneity and its isotropy tests. These unevenly distributed findings don't mean the universe is not homogeneous and isotropic. It means our big bang sphere seems to be filled with stuff our big bang could not have created. Big bangs, themselves, may represent the universe's upper granularity limit.

It wasn't unreasonable for 20th-Century physicists to think the big bang created the universe, as they had no knowledge it doesn't obey the cosmological principle. If we stop ignoring this data, it suggests our big bang is but a local event in a much grander universe. Other standard model anomalies also support this argument.

There are tests we can do to determine if these structures are older than our big bang. Older matter is colder and denser than big bang matter. It also has more metallicity and contains more black holes, many of which will be more massive than our big bang has had time to create. This ancient matter will have been overlaid by dense new gasses, bringing old white dwarfs back to life and quickly spawning supernovas; further increasing the metallicity and number of black holes. Old supermassive black holes become quasars when overrun by clouds of new gasses. Their active age would tell how long it took our big bang to overrun them. Massive structures are the homogenization of old and new big bangs.

If it's difficult to perceive an infinite universe, then be practical. The universe became a trillion times larger when astronomers discovered our solar system is but a speck in the Milky Way. It grew another trillion-fold when we discovered the big bang and all the other galaxies. The model, hypothesized here, only *needs* to expand the universe another trillion times. That's sufficient to accommodate the evidence, for now. While huge, a 10^{36} solar mass universe doesn't begin to approach infinity. On the other hand, maybe the universe *is* infinite.

Picture an ancient universe littered with prior big bangs. Their expanding spheres overrun one another, creating domains wherein we find the structures that are too big to have been created by our big bang (Fig. 1).

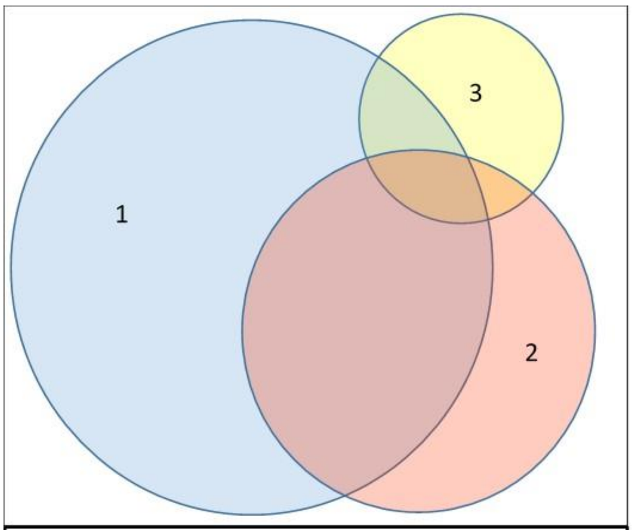

Figure 1: Three overlapping big bangs in a common universe

Sphere 3 represents our big bang. It overlaps two progressively older and larger big bangs, creating unique environmental domains.

Recent big bangs are hotter, smaller, and more uniform. Older ones are colder, larger, and lumpier—due to having overrun a lot of other ancient matter. The oldest and coldest structures are like heat sinks, gravitationally attracting and cooling the hot gasses of more recent bangs; forming CMB cold spots.

Each new big bang behaves much like those that preceded it, with the most notable differences being their initial masses and energies. This simple model provides a means for explaining the many anomalous structures and processes we find in the bounds of our own big bang.

It's not surprising that most local evidence supports the standard model, since our big bang is a subset of this grander paradigm. But elements tailored to conform with the creation assumption need to be revisited; e.g. the creation of space—as space was already in place. This suggests the big bang's outer boundary is nearer than current theory posits. The standard model's puzzling list of anomalies tend to substantiate this grander paradigm. This simple model fits those anomalies together nicely, to form a more cohesive picture.

DARK ENERGY?

The 2011 Nobel Prize in Physics went to Saul Perlmutter, Adam Riess, and Brian Schmidt for their discovery that the big bang's expansion is accelerating[10]. More accurately, the prize was awarded for discovering that the *universe's* expansion is accelerating; as the standard model assumes the big bang *is* the universe.

The force accelerating this expansion is called dark energy. From our perspective dark energy behaves like negative gravity[11]. So when dark energy modulates the expansion, we find an early decelerating expansion caused by the big bang's gravitational mass; then, several billion years later, the dark energy caused a gradual reacceleration[12]. From appearances, the universe's three spatial dimensions are becoming infinite—if they weren't already infinite.

In 2016, Adam Riess et al were still refining the dark energy parameters accelerating this expansion[13]. They ponder the possibility of "gravitational physics beyond General Relativity, additional relativistic particles, or non-zero curvature. Indeed, none of these features has been excluded by anything more compelling than a theoretical preference for simplicity over complexity. In the case of dark energy, there is no simple explanation at present …".

What natural force could possibly cause this behavior? Actually, this decelerating and reaccelerating velocity profile is a common ballistics behavior. Here's a simple example:

If we shoot a projectile to earth from our moon, the moon's gravity decelerates it until earth's gravity becomes dominant; then the missile reaccelerates as it approaches the earth. The big bang's expansion has the velocity profile we'd expect if our big bang is surrounded by huge masses, sharing its 3D space. Its reacceleration in all directions means the expanding mass is receding from its own dispersing center and getting closer to surrounding masses. There may be more mass in any given direction beyond our big bang than there is within it. Thus, in an all-natural 3D world, dark energy behavior supports the view our big bang took place in an older and grander universe. Instead of our big bang spawning a new universe, it seems our old universe spawns big bangs.

We know how massive stars form black holes[14,15]. Once they form, there's no way to stop their growth by accretion and merging with other black holes. Matter at the center of each black hole becomes a singularity. We already have accepted theories wherein exploding singularities create big bangs[16,17]. So, in a vastly larger universe, it's just a matter of time before singularities grow massive enough to spark big bangs. And a steady state universe never runs out of time.

Now, let's examine how a mature universe might cycle through its perpetual renewal.

HOW COULD SINGULARITIES CREATE BIG BANGS?

Black holes crush particles until they collapse and can no longer move. This squeezes out all their heat. Stephen Hawking says the more massive a black hole gets the lower its temperature gets[18]. "A black hole with a mass a few times that of the sun would have a temperature of only one ten millionth of a degree above absolute zero." (He also says black holes continue to absorb more mass than they emit until the background temperature falls below the temperature of the black hole. Then the black hole begins its virtual eternity (10^{60} years) of slow evaporation. I'll revisit this in my summary.) Now, if we had a hundred billion trillion solar mass black hole—on the order of the mass of our big bang—at absolute zero, it would be the most stable mass imaginable. How could it possibly blow itself to smithereens?

One of CERN's missions is to simulate big bangs by bashing heavy particles together[19]. Singularities *are* heavy particles and gravity bashes them far more forcefully than man-made colliders bash heavy elements. This process requires *two* singularities.

While there have been several computer simulations of black hole collisions, I've not yet found one that simulates the collision of singularities massive enough to create big bangs.

An awesome force

Gravity's accelerating force equation is: $F = G(m1m2)/d^2$, where G is Newton's gravitational constant, $m1$ and $m2$ are the masses of our two singularities, and d is their ever-closing distance. Singularity radii are said to be zero; so, when two singularities collide, d becomes zero and gravity's force becomes infinite. This not only means gravity is powerful enough to generate big bangs, it seems to overthrow the notion that gravity couldn't possibly be the strong nuclear force. Both gravity and the strong force fall off abruptly at distances greater than .8 femtometers[20]. Uniting gravity and the nuclear forces may be just a quark stacking and elasticity problem. We'll explore this later.

Einstein's enhancement of Newton's formula increases collision forces even more—if that's possible—by growing the inertial masses as the singularity speeds approach the speed of light.

When the singularities reach their collision point—at the speed of light—they'll splatter, transforming their inert masses into an expanding plasma cloud and sparking the big bang's nucleosynthesis[21]. For simplicity, assume our singularities had equal masses and—being at absolute zero—each had a rest energy of zero. As gravity draws them together their kinetic energies are each $½\ mv^2$ and at their collision speed, c, each has a kinetic energy of $½\ mc^2$. Summing their energies yields: $E=mc^2$, the big bang's total system energy. This implies that the inertial force of gravity gets transformed into all other energy forms.

This Big Bash model uses colliding singularities as entropy's rechargeable batteries and thus supports the viability of a perpetually animated, steady state universe.

Gravity sparks all the heat, pressure, electrostatic and electrodynamic energy forms, when it bashes singularities together. It later quiesces those energies by squeezing heat out of the atoms in stars; where smaller atoms are fused into ever more massive, but cooler and less energetic, elements. The less stable radioactive elements are formed by ultra-high pressures, like those in supernova implosions. This creates a compressed super-cooling of particles that gives them a temporary stability. As they absorb radiated energy and begin to warm up, the particles expand and begin their various rates of decay.

Gravity eventually halts all particle motion and quenches their heat by crushing them back into black hole singularities. The collision inflates the singularity masses and its friction charges the electrons, muons, quarks, and any other particles that trap charges. Heat becomes the electromagnetic background, existing as photons and other defined energy packets.

While a big bang begins its life as a sphere of pure energy, it quickly begins to cool and form ionized gasses. As the plasma ball overruns old black holes, its smooth periphery becomes pockmarked as each black hole rips off blobs of gas to form protogalaxies.

In contrast to big bang/big crunch models, whose expansion and contraction takes place around one center point; this model's big bangs disperse their energies into many older big bang domains. The oldest and coldest regions grow the singularities that will generate new big bashes.

MONOPOLES?

Physicists have long searched for magnetic monopoles, but have had difficulty finding them[22]. Our big bang *is* a monopole. The explosion's electromagnetic pulse forms a sphere whose extremity has a single magnetic polarity. It's an expanding electric field stretching radially outward from the point of impact, creating a ball of radially flowing heat and electricity.

Black holes are its counterpart. Their heat flows from their exteriors to their cold interiors. Big bangs are scatterers and black holes are gatherers. Black holes are nature's only effective gatherers of neutrinos.

In both kinds of monopoles, heat and electricity flow from hot to cold. Every radial of these monopoles is a dipole, with opposing poles at the center and on the periphery. Stars are also fuzzy monopoles, but big bangs and black holes are the alpha and omega of energy flow.

Heat behaves as antigravity, so it tends to repel gravitational objects. Cold is a gravity concentrator. When you add heat to electrons, they move to higher orbits; when you cool them they move back down. It seems to be the heat that keeps electrons from crashing into their positively charged nucleons. Hot double stars resist collisions, so they orbit one another until they dump enough heat to merge. Black hole growth is limited by the rate at which they can dump heat, the Eddington Limit. That limit causes a pushback that acts as a growth rate governor and causes heat dumping black holes to orbit and gently merge, rather than collide head-on.

Gravity adheres to the rules of thermodynamics. In thermonuclear reactions, pressure is a gauge for heat and heat is a gauge for gravity's pressure. It's easier for me to visualize pressure as the driver of nuclear fusion.

The problem with harnessing thermonuclear energy is the difficulty of making a vessel to contain it. Even when enclosed in a magnetic field, the Eddington limit of the reaction will radiate pressure and heat to the walls of its container and its cryogenically cooled magnets.

MATTER/ANTIMATTER DISPARITY

One unanswered standard model question is: why isn't the big bang 50% antimatter[23]? The belief it should be, stems from Lemaître's assumption the big bang formed out of nothingness.

Singularities we see growing are not 50% antimatter. Bashing two of them together may form some positrons and antiprotons, but they'd be as rare and fleeting as they are today. Lemaître's creation assumption seems to have sent theoreticians on yet another wild goose chase.

HORIZON AND TEXTURE PROBLEMS

Opposite sides of the big bang recede from one another faster than the speed of light. This "horizon problem" prevents the most distant masses from mixing with each other. Yet, researchers find average temperatures across the sky are uniform within few parts in a hundred thousand[24]. What created such a uniform temperature?

Another question is: How did the CMB get its patchy texture? If all matter originated in a uniform ball of heat, what broke it up into galactic clouds? If it hadn't broken up, it would be a monolithic mass that condenses uniformly, forming a star that becomes a black hole in one galaxy that collapses on itself in a big crunch.

The Inflationary Universe model solves the horizon problem by briefly holding all matter in intimate contact at the instant of the big bang, causing it to begin at a uniform temperature[25]. Then, about 10^{-34} seconds later, it solves the texture problem by quickly doubling the big bang's radius some 10^{50} times in the next 10^{-32} seconds, while the quantum froth has just the right texture to amplify and lock in. This expansionary halt and abrupt acceleration beyond the speed of light doesn't abide by Relativity's rules, but this process is thought to have occurred at the instant time began and the laws of physics had not yet jelled.

By contrast, our Big Bash model's colliding singularities were each at absolute zero when they contacted, dispersing ejecta from a uniform temperature. The texturizing was caused by the explosion's overrunning and mixing with ancient matter.

THE BIG BANG MACHINE

What we see in structures too big have been created by our big bang is a more massive version of what we see everywhere, just more webs of galaxies. Ancient structures were overlaid by a veneer of big bang gasses and warmed a bit, but remain colder than the new matter. This underlying structural mesh is representative of matter throughout the universe.

The big picture is one of intertwining galactic streams whose intersections form clusters, like knots binding the strings of fishnets[26]. Their masses are gravitationally compacting and reeling in the strings, forming more massive clusters. The oldest, coldest, and densest regions pull hardest on the strings. The thinning strings of galaxies—pulled in opposite directions by opposing masses—eventually break, ripping the cosmic fabric and forming vast islands of web segments.

Space surrounding the islands becomes mostly empty as matter is compacted. Black holes merge, forming ever more massive singularities. Within a trillion years the islands merge and are rendered down to stringy balls of dense matter, rotating around massive singularities that are drifting toward one another.

What is different

In *our* fresh new big bang, the mass of central black holes is outweighed by the mass of their host galaxies, which are mostly empty space. When these galaxies collide and merge, they do so in slow motion and their central black holes are carried along in the gravitational current. The galaxies pass through one another, oscillating for millions of years while forming a new galaxy. Their central black holes, having warmed while accreting new matter, radiate sufficient heat to resist a head-on collision, so they orbit one another and eventually merge smoothly, without any destructive explosion.

By contrast, the isolated islands of ancient matter are being rendered down to dense super galaxies. Their mass is concentrated in central singularities so cold that they radiate too little energy to resist head-on collisions. These gravitational focal points attract the singularities to bash one another, head-on.

Black holes have Schwarzschild radii from which neither light nor matter escapes[27]. Their radius is proportional to the black hole's mass, M, and its formula is $r=2GM/c^2$ where G is the gravitational constant and c is the speed of light[28]. For simplicity, each solar mass adds 2.95 kilometers to a black hole's Schwarzschild radius.

If our two big bash singularities each had 10^{22} solar masses, their Schwarzschild radii would be 2.95×10^{22} km or about 2.8 billion light years. This ballpark figure lends scale to the size of the rips in the cosmic fabric and the islands of matter surrounding each singularity. Two such singularities would be locked in one another's grasp while still 5.6 billion light years apart.

They'll still be drawing in strings of matter when they collided. The concentrations of mass in the singularities are adequate to draw them together head-on, even with trillions of solar masses still orbiting them. It's this orbiting litter that dices and texturizes the new big bang.

A big bang begins its life as a sphere of energy that quickly cools to form ionized gasses. In contrast to big bang/big crunch models, whose expansion takes place around one center point; this model's big bangs disperse their energies into several older big bang domains. The oldest and coldest regions grow the singularities that will generate new big bashes.

What's different between the collision of big bang singularities and the merger of solar mass singularities; is the orbiting of merging singularities versus the head on collision of big bangs. Even when supermassive black holes are not considered to be brilliant and active, they're continuously accreting gasses and neutrinos at their Schwarzschild radii. This provides an Eddington heat that pushes the converging black holes off course, causing them to orbit one another, rather than collide directly. As they spin down they merge relatively gently. Even then, they give off enormous quantities of energy.

By contrast, colliding big bang black holes have Schwarzschild radii that are billions of light years from their singularities and their event horizons merge billions of years before the two singularities come into close proximity. That places all the radiating heat at the exterior of their Schwarzschild radii, leaving no Eddington radiation between the singularities and allowing them to collide head-on. The singularities are each essentially at absolute zero and contain virtually no rest energy. The sum of their kinetic energies, however, is $E=MC^2$. At the instant of collision, this kinetic energy becomes all the system energies and forces that constitute a big bang.

EARLY FORMATION OF STARS & GALAXIES

In their analysis of galaxy makeup, Peebles and Nusser say, "the relativistic Big Bang theory is a good description of our expanding Universe. However, the properties of nearby galaxies that can be observed in greatest detail suggest that a better theory would describe a mechanism by which matter is more rapidly gathered into galaxies and groups of galaxies[29]."

If the Schwarzschild radii of our colliding black holes were billions of light years across, inflowing matter would take billions of years to arrive at their central singularities. This means much matter could still be orbiting the singularities at the time of impact. When the singularities bash and explode, even before the radiation cloud becomes transparent its radial outflow starts to overrun the trillions of black holes orbiting perpendicular to the outflow. As the cloud blows past this matter, pressure and the passing gravitational mass causes the orbiting chunks to spiral outward, shredding the expanding cloud and creating swirls that form rotating protogalaxies. Old debris creates cold spots in the primordial radiation[30]. This mixing of old and new matter breathes life into our big bang's smoothly expanding dullness and randomly texturizes it.

Heat from the collision expands the event horizon as it spreads outward at the speed of light. This inverts the singularity monopoles and creates a big bang monopole. Chunks of old matter seed the early formation of stars and black holes become quasars.

On a grand scale, we'd see an exploding cloud orbited by strings of cold, dense residue. Beyond it lies a sparsely populated void the expansion will cross before encountering walls of ancient galaxies. The increasing gravitational pull of this old dense matter reaffirms why our big bang's expansion is reaccelerating.

WHERE ARE WE GOING?

Researchers have spent decades trying to predict the outcome of our big bang's expansion. They ask: will the big bang expand and thin forever; will it slow, but never quite stop; or will it collapse in a big crunch[31,32]?

This Big Bash model's answer is simply "none of the above". It's being reabsorbed by the same universe that created it. Wherever we're located in that expanding sphere, we'll always be able to see much of the big bang's matter, which can't completely escape our horizon as it merges with the ancient universe. We'll just need more sophisticated telescopes to track it.

As we focus enhanced instruments on windows like the Hubble Ultra Deep Field, it should be as interesting to study incoming blue shifted objects as those that are red shifted.

QUASARS, THE SMOKING GUN!

Quasars are active black holes, millions to billions of times more massive than the sun. They devour any gas or stars that come in their grasp, squeezing the heat out of all they consume. Expelled heat makes them extremely bright, often outshining a thousand galaxies[33]. Most are found in early galaxies, within a few billion years after the big bang. Scientists are puzzled by how they formed so quickly[34].

In 2013, researchers published an analysis of an ancient proto-galaxy whose redshift dates it at 772 million years after the big bang[35]. It's illuminated either within or from behind by quasar ULAS J1120+0641. They found no evidence of star formation. The question it begs is: where could early quasars come from if their galaxies were not yet making stars? These black holes were already old when new gas clouds overran them. Our big bang was born with enough black holes to light up the sky and reionize its cooling new gasses.

More than a million quasars are cataloged[36]. Their quantity peaked within a few billion years after the big bang. There's been a steady decline in their population during the past 10 billion years[37]. In 2015, researchers reported a 12 billion solar mass quasar that existed just 900 million years after the big bang[38].

In 2010, Hilton Ratcliffe summarized his research and that of several colleagues, concerned about the reliability of redshift for measuring distance[39]. Much focus was on quasars having a different redshift than their associated galaxies. On statistical distribution they found aspects of quasar distribution that were anomalous: The 2-D density distribution of quasars showed an unusual prevalence of quasars paired in close angular proximity across Active Galactic Nuclei; objects close in space had different redshifts; and the quasars were moving away from their galactic centers, suggesting they were being ejected[40–46].

J.C. Jackson found an effect in galaxy distribution that made clusters of galaxies appear elongated when expressed in redshift space, resembling fingers pointing toward earth[47].

I'd venture that quasars don't necessarily co-move with their galaxies because they are preexisting black holes being overrun by new galactic clouds. When black holes are overrun by dense clouds; instead of orbiting the black holes the gas plows directly into them and matter accretes prodigiously. Intense radiation forms as the black holes become quasars. This radiation holds back the inflowing gas, stretching the galaxies and creating the fingers that point toward earth.

A quasar's velocity relative to its galactic cloud may either propel it through the cloud and on to other clouds, leaving a trail of cosmic debris; or it may slowly oscillate through a cloud's gravitational center and settle in as its central black hole. Once a quasar comes to rest at its galactic center its accretion slows, causing the quasar to dim and behave like an ordinary central black hole. The NGC 1600 galaxy, 200 million light years from earth, contains such an inactive 17 billion solar mass black hole[48].

When multiple black holes arrive at a galactic center, being cold, they're able to merge with one another without creating the light show quasars provide.

A GALACTIC CHRONOMETER

The radially expanding gasses of a big bash and the black holes orbiting orthogonally within the collision's Schwarzschild radius, represent two distinct inertial systems that ultimately merge to form galaxies. Since the gasses were part of our big bang's monolithic cloud, and the cloud is becoming less dense at a uniform rate, the density of any given cloud at the time it captures its central black hole provides a timestamp indicating how soon after the big bang the galaxy formed. Our Milky Way Galaxy and some of its stars seem to have formed soon after the big bang[49]. This suggests the galaxy was created from a dense gas cloud and it formed near the big bang's center.

DARK MATTER'S VISCOCITY

The rotational behavior of large structures, like galaxies and clusters of galaxies, suggest they have more mass than they appear to. In 1937, Fritz Zwicky said, "The essential feature is a central core whose internal viscosity due to the gravitational interactions of its component masses is so high as to cause it to rotate like a solid body[50]." A lot more mass would let galactic extremities rotate around their centers nearly as fast as central matter does, without flying off in space. But if there *is* extra mass it doesn't emit or absorb radiation, so it's called "dark matter". The problem is: we can't find any dark matter, even down at quantum levels[51].

While the Big Bash model deposits old heavy matter in galaxies that would otherwise be lighter, I believe dark matter is not matter at all. More likely, it's a magnetohydrodynamic (MHD) force behavior that's manifest when radiation ionizes galactic gasses. This plasma provides the "internal viscosity" Zwicky described.

In 1970, Hannes Alfvén won a Nobel Prize "for pioneering the study of galactic magnetic fields generated by the electrically conducting plasma that pervades the universe: such magnetohydrodynamic waves are now known as Alfvén waves." Alfven's paper, *Electricity In Space,* describes two experiments that demonstrate these waves[52].

"If you tap the side of a vessel containing a pool of mercury, the surface quakes and ripples as if it were alive. We found that when we placed such a pool in a strong magnetic field of 10,000 gauss, its behavior instantly changed. It did not respond to jarring of the vessel; its surface stiffened, so to speak. The magnetic field gave a curious kind of viscosity to the mercury."

His second experiment used a tank where the bottom had vanes that could be moved like the agitator in a washing machine. "In the absence of a magnetic field, the slow oscillation of this agitator, stirring the mercury at the bottom of the tank, will not disturb the surface of the mercury at the top of the tank; the mercury molecules slide past one another so that the motion dies out before it proceeds very far up the tank." … "When a strong vertical magnetic field is applied to the tank, however, the motion at the bottom is quickly communicated to the top." …

"To be sure, the magnetic fields in the stars are very much weaker than the 10,000 gauss of our experiment (the sun's general field is estimated at between 1 and 25 gauss). But our theory tells us if we made the vessel larger, we could produce the magneto-hydrodynamic effects with a smaller magnetic field; the magnetic force required would decline in proportion to the increase in size of the vessel. Hence in a star, which is, say, 10 billion times as large as our experimental vessel, the magnetic field need be only one 10-billionth of the laboratory field. The stars' fields are much stronger than this." "Furthermore, there are good arguments for assuming that a weak magnetic field (some millionths of a gauss) pervades all of space."

In this reference Alfvén describes how the principle applies to the interior of the sun, but doesn't scale it up to apply to galaxies. Galaxies have a trillion times the sun's diameter.

Recent research confirms galactic field strengths are about 10^{-6} gauss[54]. From Alfvén's perspective this would generate dark matter behavior, given timescales available to build momentum and gel in the behavior. We might even find a magnetic meniscus around galaxies that reduces the number of stars being flung out.

At a 1986 NASA conference, Alfvén illustrated how plasma generates intergalactic currents a billion times greater than those flowing in the sun[53]. These would create MHD fields that stiffen the viscosity of galactic gasses. The Square Kilometer Array project will provide an excellent means for mapping the cosmos' magnetic character[55]. This may substantiate dark matter's magnetic character and shed light on gravitational forces.

A DIFFERENT GRAVITY PARADIGM

Einstein received a Nobel Prize for his 1905 photoelectric theory[56]. He concluded his acceptance speech saying his new passion was to unify general relativity (gravity) with electromagnetism and possibly even with quantum mechanics[57]. He may have been closer to his objective than he realized. He, like others, saw gravity as a force originating in matter. Perhaps all he missed was gravity's source. In our well-lit universe, all matter resides in a field of electromagnetic radiation that seems ample for *inducing* gravity's weak characteristics. An *induced magnetic gravity* may be all it takes to provide Einstein's unification.

Magnetism has long been compared to gravity. Invariably the conclusion has been that gravity can't possibly be magnetic. Nonetheless, I'll revisit that subject. The first characteristic we'll deal with is that gravity is always attractive, while magnetism is both attractive and repulsive. But there *are* situations in which magnetic forces are always attractive.

When we sprinkle iron filings near a magnet, its field aligns their magnetic domains and makes the filings mutually attractive. This is scalable. It seems that galaxies sprinkled in a huge magnetic field would also feel an induced magnetism and behave like powdered iron's clusters and strings. A magnetic field draws electrons into coherent alignments.

In a reed switch, a solenoid draws electrical contacts in its magnetic field together, connecting one or more electrical circuits. Current flowing in the solenoid provides mutual attraction to the material enclosed in the coil's field.

Scaling-up a reed switch's solenoid to a half-meter diameter would provide a good magnetic cavity for testing the characteristics of an induced magnetic gravity. There, one could check out induced field strengths; field concentrations representing the curvature of space; gravitational lensing; and the slowing of time. Of course, these field strengths will be many orders greater than the force of gravity.

While these simple examples support the point that induced magnetism can provide mutual attraction, without exhibiting repulsion, they don't support Newton's observation that gravity's force is proportional to the mass of objects attracted to one another. My examples depend on the coherent alignments of electrons in magnetic metals, but won't work in non-magnetic materials and the induced force is not proportional to the masses of everything. The characteristic we need is an attractive force that's proportional to mass and independent of material types.

Mass is determined by the quantity and types of particles in atomic nuclei. An induced magnetic gravity would need to coherently align the nucleons to create a force that's proportional to mass. With nucleons aligned in attractive orientations, atoms would remain attractive—whether the elements involved are magnetic, nonmagnetic, antimagnetic, or surrounded by Faraday cages. Nucleons drag their electrons along, even when the electrons are aligned with other atoms.

How could the warping of spacetime be caused by electromagnetism? Quarks and electrons have a much higher permittivity and permeability than the vacuum of space, and electricity and magnetism seek the path of least resistance. Matter provides a much lower impedance path than a vacuum. This low impedance would concentrate the magnetic energies of space around matter in proportion to its mass, creating gravitational wells that curve spacetime. What makes an induced magnetic gravity unique from other induced magnetic fields, is the fact that the cosmos provides omnidirectional radiation that impinges on matter from all directions.

Singularities are the most concentrated of masses. While these cold points of mass are devoid of energy; they're surrounded by Schwarzschild radii that focus powerful spheres of background radiation on them. These concentrated fields crush all incoming matter and induce extreme gravitational forces, like the Z-Pinch forces fusion energy teams are developing[58].

The purpose of thermonuclear Z-Pinch devices is to magnetically implode a 1 to 6 mm metallic sphere or cylinder filled with deuterium and tritium. The implosions fuse the enclosed nucleons to form helium and generate heat, in the hope they'll eventually produce more energy than the process consumes[59]. One Z-Pinch model uses ten radially and symmetrically arranged lasers to shine 10^{14} watts of power on the capsule being imploded[60]. The principle here is that laser radiation creates MHD forces that crush the fuel pellet.

Black holes are impinged on by radiation focused on their mass. This curves space so much that singularities have no volume. Earth's gravity is a weak manifestation of this phenomenon. Internally the force is compressive; externally it's attractive. Radiation forms Z-Pinches around all masses. So, it seems that gravity is a re-radiated attractive force that's induced by a pervasive and omnidirectional magnetic field. Mapping the flux of the cosmos may help us visualize the scale and character of gravity.

LIGO's detection of gravitational waves is consistent with the idea gravitational forces are magnetically induced by cosmic fields[61]. What's been detected is magnetic vibrations caused by merging black holes. They're *induced* into the detectors—substantiating the reinducibility of gravity from external sources.

An electromagnetic gravity's induced force would be attractive clear down to quark levels. This unexamined concept provides a means to unify gravity and nuclear forces. With that in mind, I'll share some observations and speculations:

Physicists say electromagnetism exhibits 10^{38} to 10^{40} times more force than gravity[62,63]. That doesn't hold up when we note that singularity gravities have enough force to completely crush particles. The perception that magnetism is stronger than gravity stems from comparing the strong forces between quarks to weaker forces between atoms, molecules, stars, and galaxies.

Atoms are mostly empty space. Objects composed of this fluffy matter will feel a weak aspect of gravity. Quarks, however, are squeezed close together and the inverse square law gives them a strongly bound gravitational force. Electromagnetism and an induced force of gravity both approach infinity as the distance between masses closes. Gravity's force equals that of the strong force when the distance between quarks approaches zero. If gravity seems 10^{40} times weaker on earth than the attractive force between quarks, I'd venture earth's atoms are 10^{20} times farther apart than their nuclear quarks are.

Scientists continue their quest to measure Newton's big G to ever greater precision[64]. It's embarrassing that we can't improve the accuracy of this basic reference beyond 4 decimal places. Well, if background radiation creates gravity, what would that say about the constancy of gravity? NASA says CMBR temperature is uniform to better than one part in a thousand[65]. If CMBR temperature varies by a few parts in 10,000, and its radiation generates gravity, then G would not *be* steady beyond four significant digits.

Magnetic fields and gravitational fields may be interchangeable in areas Einstein describes as time dilation. He says, "An atom absorbs or emits light of a frequency which is dependent on the potential of the gravitational field in which it is situated. The frequency of an atom situated on the surface of a heavenly body will be somewhat less than the frequency of an atom of the same element which is situated in free space (or on the surface of a smaller celestial body)[66]."

Gravitational forces around cosmic bodies are caused by the curvature of space, a Z-pinch whose strength is determined by the concentration of mass. Atoms situated in omnidirectional magnetic fields may behave like those Einstein describes in gravitational fields, with magnetic viscosity slowing atoms and shifting their frequencies toward the red. Einstein's field equations may apply equally to omnidirectional magnetic fields and gravity. He partially derived them from Maxwell's work.

CONNECTING GRAVITY TO QUANTUM MECHANICS

The separability of mass and energy at cosmic levels means it's also separable at particle levels. So, charged particles should be separable from their electric charges.

Paul Dirac's 1962 paper, "An extensible model of the electron", submits that electrons may have a spherical bubble membrane[67]. Quarks had not yet been discovered and he never updated his paper to include them. Dirac may have been correct, and perhaps *all* stable charged particles have membranes. While Dirac's model places charges outside the membranes, it seems more reasonable to enclose them within. This variance is based on the observation that quark charges don't neutralize one another even when neutron stars squeeze them together under extreme pressure. And when electrons collide with protons they neither annihilate nor neutralize one another; they just exchange a short wavelength photon and bounce[68]. Strong elastic membranes would both isolate charges and impart mass to particles. When neutron stars get massive enough to become black holes; particle membranes burst, neutralizing their charges and inert membrane residue becomes the cold dense mass of singularities.

Gerard 't Hooft described strong force bonds, saying, "The quarks in a hadron therefore act somewhat as if they were connected by rubber bands at very close range: where the bands are slack, the quarks move almost independently, but at a greater distance, where the bands are stretched taught, the quarks are tightly bound[69]."

If elastic quark membranes are bound together by the strong force—an induced magnetic force—the stretch of the membranes would exhibit such behavior. We can model this by placing magnets in two balloons and bringing them together. Pulling the balloons apart would simulate the force behavior 't Hooft described.

Induced magnetism acts as both the strong and weak forces. Gravity's force between quarks is limited only by distance. When externally magnetized quark membranes get squeezed together, their elastic contact areas enlarge, making the holding force adequate to overcome the repulsion of excessive positive charges. When the pulling force between a pair of quarks stretches their centers to about .8 femtometers apart, the magnetic bond holding them together (the strong force) is overcome and the quarks come apart at proton or neutron boundaries. It's gravity's weakness beyond .8 femtometers that gives nuclear forces their short range.

RADIOACTIVE DECAY

Having particle charges enclosed in elastic membranes would explain the behavior of radioactive decay. When supernovae explode, they create implosive pressures on the atoms in their cores. More nucleons get rammed into their nuclei than the atoms can retain under normal pressures. Extreme pressure super-cools the quarks the way black holes squeeze out their heat. When the pressure subsides, most unsustainable nucleons fall away from their up-quark overloaded nuclei, but many are temporarily retained. These oversaturated atoms are radioactive. Pressure has squeezed the quark membranes into oblate spheroids, increasing their contact surface and allowing them to bind more nucleons than they hold under normal temperatures and pressures.

As the distorted membranes absorb radiation, their pressures build and they become more nearly spherical, reducing their magnetic contact areas. This lets the supersaturated nuclei shed excess nucleons as radioactive decay, often exhibiting alpha, beta, or gamma decay, or they may emit protons, electrons or positrons. Some heavier elements even fission down to two or three lighter elements. Different radioactive elements have differently shaped nuclei. The less stable shapes have shorter half-lives.

An experiment that may substantiate this model would be to expose radioactive elements to a spectrum of high energy radiation, to see if it shortens their half-lives. If such is the case, it suggests we may be able to extend the lives of heavy manmade elements by routing them to an ultra-cold environment.

In this membrane model, the strong and weak forces are the same force. The strong force is manifest when atomic nuclei are not overstressed by up-quark overload and are difficult to pull apart. The weak force is pronounced when induced magnetism is marginally adequate to bind the nucleons of radioactive elements and the pressure-chilled nucleons are heating up.

Particle colliders have detected a family of force carriers referred to as gauge bosons. Most common among these massless particles are the gluons, photons, W bosons, and Z bosons, that are viewed as energy fields[62]. About quantum electrodynamics and quantum chromodynamics, Richard Feynman said, "It's very clear that the photon and the three W's are interconnected somehow, but at the present level of understanding, the connection is difficult to see clearly—you can still see the 'seams' in the theories; they have not yet been smoothed out so that the connection becomes more beautiful and, therefore, probably more correct."

Well, if nuclear bonds are induced by an electromagnetic field, it seems that breaking those bonds would spark flux transitions resembling gauge bosons. One might expect similar energy blips when two electromagnets are pulled apart.

While this gravity bridge between relativity and quantum physics may seem far-fetched, it does provide a plausible placeholder that matches many of the observations. It would be great, however, if those more knowledgeable in quantum mechanics could either enhance or replace this membrane model.

QUANTUM PHYSICS AND ANTHROPIC ENVIRONMENTS

If, indeed, our big bang is the explosive byproduct of two different singularities and this yielded only one family of elements; it suggests every big bang yields that same table of elements. This could be due to all singularities being at the same temperature and density and getting bashed at maximum speed and force. All quantities are up against their stops.

In that case, the merging of multiple big bangs would be seamless as far as their chemistry is concerned, making life adaptable among multiple big bangs. Stray comets are ubiquitous and great transporters for delivering complex molecules to every planet. Once the accident of RNA and DNA got a foothold, its machinery could propagate forever.

SUMMARY

Evidence suggests our big bang did not create either the universe or space. This would limit the big bang's radius to the speed of light times the age of the big bang. Beyond this distance, we should see objects that were never part of our big bang and are as likely to be approaching us as receding from us. Out there, temperatures should be colder, but still above absolute zero.
If background temperatures don't get down to Stephen Hawking's nanokelvin range, black holes will never evaporate.

Inside our big bang's expanding periphery, we should find many objects that were not created by our big bang and are not co-moving with its outflowing matter. We'll see large structures moving at all different velocities. Some will be much older than the other matter in their regions of space. The quasars are a case in point; as are the underlying masses of great wall structures.

If the archaic creation assumption is to be retained, we'll need to see some rigor to support it. Otherwise, we'll need a new cosmic paradigm. Its development will undoubtedly require much iteration. I'd prescribe this Big Bash model only as a starting point. Its design is quite flexible.

There is a movement afoot to assess the science community's support for unproven string theories and multiverses[70]. The primary argument favoring string theory is the alleged lack of alternatives when it comes to explaining observed standard model behaviors. To get my oar in the water, I'd pose the following axiom:

Given sufficient mass, energy, and time; every valid permutation and combination of mass and energy is possible within the realm of a single, unbounded, three-dimensional space.

It seems to me that Mother Nature has no need for supernatural spatial dimensions.

ACKNOWLEDGEMENTS AND AUTHOR CONTRIBUTIONS

My self-taught cosmology was mentored by a 55-year subscription to *Scientific American*, plus numerous other tech journals and books. Wikipedia and arXiv.org are my primary research libraries. Since adolescence, I've been integrating the international community's cosmic findings into a mental model of the universe and am solely responsible for having documented it.

References

1. Lemaitre, C. G. *The Primeval Atom: A Hypothesis of the Origin of the Universe*. (D. Van Nostrand Company, 1950).
2. Fields, B. D. & Sakar, S. Big-Bang Nucleosynthesis. (2011). Available at: http://pdg.lbl.gov/2011/reviews/rpp2011-rev-bbang-nucleosynthesis.pdf. (Accessed: 21st January 2014)
3. Hoyle, F. R. *The Nature of the Universe*. (New American Library, 1955).
4. Yadav, J. K., Bagla, J. S. & Khandai, N. Fractal dimension as a measure of the scale of homogeneity. *Mon. Not. R. Astron. Soc.* **405,** 2009–2015 (2010).

5. Clowes, R. G. *et al.* A structure in the early universe at z ~ 1.3 that exceeds the homogeneity scale of the R-W concordance cosmology. *ArXiv12116256 Astro-Ph* (2012).
6. List of largest cosmic structures. *Wikipedia, the free encyclopedia* (2016).
7. Horvath, I., Bagoly, Z., Hakkila, J. & Toth, L. V. New data support the existence of the Hercules-Corona Borealis Great Wall. *Astron. Astrophys.* **584,** A48 (2015).
8. Lerner, E. *The Big Bang Never Happened: A Startling Refutation of the Dominant Theory of the Origin of the Universe*. (Vintage, 1992).
9. Zhao, W. & Santos, L. Preferred axis in cosmology. *ArXiv160405484 Astro-Ph Physicsgr-Qc* (2016).
10. Reiss, A. G. et al. Observational Evidence from Supernovae for an Accelerating Universe and a Cosmological Constant. (1998). Available at: http://arxiv.org/abs/astro-ph/9805201. (Accessed: 13th December 2013)
11. Peebles, P. J. E. & Ratra, B. The Cosmological Constant and Dark Energy. *Rev. Mod. Phys.* **75,** 559–606 (2003).
12. Overbye, D. A ‘Cosmic Jerk’ That Reversed the Universe. *The New York Times* (2003).
13. Riess, A. G. *et al.* A 2.4% Determination of the Local Value of the Hubble Constant. *ArXiv160401424 Astro-Ph* (2016).
14. Hughes, S. A. Trust but verify: The case for astrophysical black holes. *ArXivhep-Ph0511217* (2005).
15. Natario, J. Relativity and Singularities - A Short Introduction for Mathematicians. *arXiv:math/0603190* (2006).
16. Guth, A. H. & Kaiser, D. I. Inflationary Cosmology: Exploring the Universe from the Smallest to the Largest Scales. *Science* **307,** 884–890 (2005).
17. Lemaitre, A. G. Homogeneous Universe of Constant Mass. (1931). Available at: http://articles.adsabs.harvard.edu/cgi-bin/nph-iarticle_query?1931MNRAS..91..483L&data_type=PDF_HIGH&whole_paper=YES&type=PRINTER&filetype=.pdf. (Accessed: 16th January 2014)
18. Hawking, S. *The Illustrated A Brief History of Time / The Universe in a Nutshell - Two Books in One*. (Bantam Books, 2007).
19. CERN. ALICE. (2014). Available at: http://home.web.cern.ch/about/experiments/alice. (Accessed: 20th October 2014)
20. Wiringa, R. B., Stoks, V. G. J. & Schiavilla, R. An accurate nucleon-nucleon potential with charge-independence breaking. *Phys. Rev. C* **51,** 38–51 (1995).
21. Penrose, R. *The Road to Reality: A complete guide to the laws of the universe*. (Vintage Books, 2007).
22. Ray, M. W., Ruokokoski, E., Kandel, S., Möttönen, M. & Hall, D. S. Observation of Dirac monopoles in a synthetic magnetic field. *Nature* **505,** 657–660 (2014).
23. Peskin, M. High-energy physics: The matter with antimatter. *Nature* **419,** 24–27 (2002).
24. Guth, A. H. & Steinhardt, P. J. The Inflationary Universe - Scientific American. (1984). Available at: http://www.scientificamerican.com/article/the-inflationary-universe/. (Accessed: 24th February 2014)
25. Guth, A. H. Inflationary Universe: A possible solution to the horizon and flatness problem. (1980). Available at: http://www.astro.rug.nl/~weygaert/tim1publication/cosmo2007/literature/inflationary.universe.guth.physrevd-1981.pdf. (Accessed: 21st January 2014)

26. Bond, J. R., Kofman, L. & Pogosyan, D. How filaments of galaxies are woven into the cosmic web. *Nature* **380,** 603–606 (1996).
27. Penrose, R. *Cycles of time: an extraordinary new view of the universe*. (Alfred A. Knopf, 2011).
28. Gribbin, J. *Q Is for Quantum : An Encyclopedia of Particle Physics*. (Free Press, 1999).
29. Peebles, P. J. E. & Nusser, A. Nearby galaxies as pointers to a better theory of cosmic evolution : Nature : Nature Publishing Group. (2010). Available at: http://www.nature.com/nature/journal/v465/n7298/full/nature09101.html. (Accessed: 27th February 2014)
30. Bernui, A., Mota, B., Reboucas, M. J. & Tavakol, R. Mapping the large-scale anisotropy in the WMAP data. *Astron. Astrophys.* **464,** 479–485 (2007).
31. Vardanyan, M., Trotta, R. & Silk, J. Applications of Bayesian model averaging to the curvature and size of the Universe. *Mon. Not. R. Astron. Soc. Lett.* **413,** L91–L95 (2011).
32. Steinhardt, P. J. & Turok, N. *Endless Universe: Beyond the Big Bang*. (Doubleday, 2007).
33. Graham, S. Quasars' Humble Roots Revealed - Scientific American. (2004). Available at: http://www.scientificamerican.com/article/quasars-humble-roots-reve/. (Accessed: 18th February 2014)
34. Alexander, T. & Natarajan, P. Rapid growth of seed black holes in the early universe by supra-exponential accretion. *Science* **345,** 1330–1333 (2014).
35. Simcoe, R. A. *et al.* Extremely metal-poor gas at a redshift of 7. *Nature* **492,** 79–82 (2012).
36. Flesch, E. Milliquas million quasars catalogue. (2014). Available at: http://quasars.org/milliquas.htm. (Accessed: 18th October 2014)
37. Mortlock, D. Astronomy: The age of the quasars. *Nature* **514,** 43–44 (2014).
38. Wu, X.-B. *et al.* An ultraluminous quasar with a twelve-billion-solar-mass black hole at redshift 6.30. *Nature* **518,** 512–515 (2015).
39. Ratcliffe, H. Anomalous Redshift Data and the Myth of Cosmological Distance. *Journal of Cosmology* (2010). Available at: http://cosmology.com/Multiverse10.html. (Accessed: 9th October 2014)
40. Arp, H. C. *Quasars, Redshifts and Controversies*. (Cambridge University Press, 1988).
41. Arp, H. *Seeing Red: Redshifts, Cosmology and Academic Science*. (Apeiron, 1998).
42. Arp, H. Redshifts of New Galaxies. *ArXivastro-Ph9812144* (1998).
43. Arp, H. C. *Catalogue of Discordant Redshift Associations*. (Apeiron, 2003).
44. Arp, H. & Fulton, C. A Cluster of High Redshift Quasars with Apparent Diameter 2.3 Degrees. *ArXiv08021587 Astro-Ph* (2008).
45. Arp, H. & Fulton, C. The 2dF Redshift Survey II: UGC 8584 - Redshift Periodicity and Rings. *ArXiv08032591 Astro-Ph* (2008).
46. Arp, H., Burbidge, E. M. & Burbidge, G. The double radio source 3C343.1: A galaxy-QSO pair with very different redshifts. *Astron. Astrophys.* **414,** L37–L40 (2004).
47. Jackson, J. C. A critique of Rees's theory of primordial gravitational radiation. *Mon. Not. R. Astron. Soc. Vol 156 P 1P* (1972).
48. Thomas, J. *et al.* A 17-billion-solar-mass black hole in a group galaxy with a diffuse core. *Nature* **532,** 340–342 (2016).
49. Frebel, A. *et al.* Discovery of HE 1523-0901, a Strongly r-Process Enhanced Metal-Poor Star with Detected Uranium. *Astrophys. J.* **660,** L117–L120 (2007).
50. Zwicky, F. On the Masses of Nebulae and of Clusters of Nebulae, Astrophysical Journal 86. 217. (1937). Available at: http://articles.adsabs.harvard.edu/cgi-bin/nph-

iarticle_query?1937ApJ....86..217Z&defaultprint=YES&page_ind=0&filetype=.pdf. (Accessed: 14th March 2014)
51. Livio, M. & Silk, J. Broaden the search for dark matter. *Nature* **507,** 29–31 (2014).
52. Alfvén, H. in *The New Astronomy* 74 (1966).
53. Alfven, H. Double layers and circuits in astrophysics. in (1986).
54. Kahniashvili, T., Tevzadze, A. G., Brandenburg, A. & Neronov, A. Evolution of Primordial Magnetic Fields from Phase Transitions. *ArXiv12120596 Astro-Ph Physicshep-Ph* (2012). doi:10.1103/PhysRevD.87.083007
55. Akahori, T. *et al.* Resolving 4-D Nature of Magnetism with Depolarization and Faraday Tomography: Japanese SKA Cosmic Magnetism Science. *ArXiv160301974 Astro-Ph* (2016).
56. Einstein, A. Concerning an heuristic point of view toward the emission and transformation of light. (1905). Available at: http://scholar.google.com/scholar?start=20&hl=en&as_sdt=0,48&cluster=2793416974452212602. (Accessed: 28th February 2014)
57. Isaacson, W. *Einstein: his life and universe*. (Simon & Schuster Paperbacks, 2008).
58. Hammer, D. A. & Kusse, B. R. *Dense Z-pinches 7th International Conference on Dense Z-Pinches, Alexandria, Virginia, 12-21 August 2008*. (American Institute of Physics, 2009).
59. Gibbs, W. W. Triple-threat method sparks hope for fusion. *Nature* **505,** 9–10 (2013).
60. Kirshner, R. P. The Earth's Elements. *Sci. Am.* **271,** 65 (1994).
61. The LIGO Scientific Collaboration *et al.* GW150914: First results from the search for binary black hole coalescence with Advanced LIGO. *ArXiv160203839 Astro-Ph Physicsgr-Qc* (2016).
62. Feynman, R. P. & Zee, A. *QED: the strange theory of light and matter*. (2006).
63. Gamow, G. *Gravity: [classic and modern views]*. (Anchor Books, 1962).
64. Quinn, T. Don't stop the quest to measure Big G : Nature News & Comment. (2014). Available at: http://www.nature.com/news/don-t-stop-the-quest-to-measure-big-g-1.14566. (Accessed: 21st February 2014)
65. WMAP Big Bang CMB Test. *NASA* (2014). Available at: http://map.gsfc.nasa.gov/universe/bb_tests_cmb.html. (Accessed: 2nd February 2014)
66. Einstein, A. *The Meaning of Relativity: Fifth Edition: Including the Relativistic Theory of the Non-Symmetric Field*. (Princeton University Press, 1956).
67. Dirac, P. A. M. An Extensible Model of the Electron. (1962). Available at: http://rspa.royalsocietypublishing.org/content/268/1332/57. (Accessed: 27th February 2014)
68. Bernauer, J. C. & Pohl, R. The Proton Radius Problem. *Scientific American.* **310, Number 2,** 32–39 (2014).
69. 't Hooft, G. Gauge Theories of the Forces between Elementary Particles. *Scientific American* (1980).
70. Castelvecchi, D. Feuding physicists turn to philosophy for help. *Nature* **528,** 446–447 (2015).

2/3/2016