

Quantum Cosmology and Buddhist Emptiness

An adequate cosmology will be written only when an adequate philosophy
of mind has appeared.

—E.A. Burtt

Disquieting Quiescence: Tales From the Dark Side. For recent quantum cosmology the totemic idol of atomic baryonic matter—our beloved protons and neutrons that comprise an unnatural whopping 5 percent of the observable universe—is usually presumed to have arisen *ex nihilo*, *observer-independently* from nothing, the “empty space” random “virtual” *quantum fluctuations* of the vacuum ground state—zero point quantum foam vacuum energy (probably dark energy) field (ZPE)—*quidditas* of the total energy density of space ($\Omega_{\text{tot}} \approx 0$). How is it that all of this energy sums to zero?

Astoundingly, positive universal mass/energy, minus negative universal gravitational energy, equals a sum total universe energy of zero! Quantum emptiness. Some Hindu's and some Buddhist's were right. Thus, for cosmic inflation theory this zero point energy universe arising from nothing is “eternal inflation” guru Alan Guth's “ultimate free lunch”.

While nothingness must be applauded in principle for its simplicity, this oracular zero point “empty space”, Dirac's “zero womb” energy quantum vacuum cannot be nothingness. Far from it. This spooky ZPE is pervaded by Wheeler's “it from bit”—real stuff arising from the near nothingness of proto-physical “quantum foam” vacuum energy—virtual particle information qbits popping into and out of more or less physical reality endlessly from the cosmic plenum of quasi-quiescent quantum emptiness; just as Quantum Electrodynamics (QED), and Buddhist Mahayana philosophy predict.

This proto-mystical ZPE energy of empty space is roughly 10^{-29} grams of stuff per cc of space. Nearly nothing. Why isn't it zero? We saw in Chapter 3 that something cannot arise from nothing. How is this so? Because there has always been a bit of virtual something that grounds and becomes all the rest. For ZPE theory it's a gram or so of something that is not nothing.

In 1998 the competing Perlmutter and Schmidt teams discovered, while observing type 1A supernovae in an attempt to prove how is it that gravity will eventually halt the expansion of the universe ending in a Big Crunch, and to the great surprise of both teams, demonstrated that Hubble's 1929 expanding universe was actually accelerating! (Carroll 2010; Smolin 2006.) Bad news for the Big Crunch hypothesis of a merely expanding universe.

In the early 1930's, after Edwin Hubble's discovery that the universe is actually expanding, the major players seemed to agree that the abductive argument to the best explanation for such cosmic conjuring was to resuscitate Einstein's “greatest mistake”, his 1917 “cosmological constant” lambda (Λ). Lambda, now generally understood as the value of the ZPE quantum vacuum energy field density of nearly empty space was first formulated by Einstein to comply with what his astronomer pals were certain was a static, closed universe; but as well to fit his own procrustean ideology of this “Steady State Universe”.

In 1917 Einstein inserted Λ into his lovely 1915 GRT field equations “to hold back gravity”, preserve Fred Hoyle's current Steady State Universe, and prevent it from collapsing into what was later to be called the Big Crunch, possibly the cosmic seed of a "Big Bounce" new universe.

Einstein's lambda (Λ) is a constant that is a continuous uniform energy density that pervades all of his and his old math professor Minkowski's 4D spacetime continuum. This ideologically motivated, badly behaved *ad hoc* equation contorted the original elegant "Big G" (Newton's gravity geometry of spacetime) by adding $G + \Lambda g$, (g being the metric tensor) which he thought would counter the contraction force of gravity with a repulsive force and thereby bestow the requisite non-expanding, static, proto-theistic closed biblical firmament, the prevailing view of early 20th century cosmology of which Einstein was an ardent believer. Indeed this static, closed ancient cosmology of “the fixed stars” has been the conspicuous Western cosmology since the final polishing of Greek Materialism by Aristotle (384-322 BCE), arguably the greatest intellect of our Western cognitive efflorescence.

In 1929 Edwin Hubble's red-shift calculations (Hubble's Constant H_0 which became the Hubble Parameter H , which changes in time)—the discovery that the universe was actually dynamic and expanding—seemed definitive. A duly chastened Einstein, in 1931, was thus empirically compelled to formally retract, as "my greatest mistake", his anti-gravity cosmological constant lambda ($\Lambda > 0$) that *ex post facto* obviated the need "to hold back gravity". If only he could have known that by the end of the century (1998) his Λ was actually *accelerating* Hubble's expanding universe through mysterious vacuum energy/ dark energy.

A few years earlier, great Russian cosmologist Alexander Friedmann with his elegant 1922 Friedman Field Equation, which predicted an expanding universe well before Hubble's Constant of 1929, along with original Big Bang inventor and cosmologist, Belgian priest Georges Lemaitre, and British cosmologist Arthur Eddington all criticized Einstein's arbitrary addition of his Cosmological Constant (Λ) into the General Relativity field equations. They all agreed that Λ would render the cosmos highly unstable, negating the possibility of large scale galactic structure, and thus sentient cosmologists to ponder the matter. Einstein didn't listen.

No one publishing at the time understood that the expanding cosmos was actually accelerating! Anthropically speaking (the Strong Anthropic Principle of Barrow and Tipler)—since we are all more or less consciously here in spacetime to ask such ontologically impudent questions—an altogether new explanation for the existence of the physical basis of this appearing universe of ours was urgently required.

Then, in 1932, quite unbelievably, Einstein brazenly co-authored a paper with brilliant Dutch astronomer and mathematician Willem de Sitter proposing an exponentially expanding universe with $A = \pi r^2$, a tiny, nearly zero *positive* Λ value moving us toward a perspicuous new non-zero cosmological constant lambda (Λ), hitherto given by Einstein in his GRT field equations to be about zero ($\Lambda > 0$). This new nearly non-zero Λ erupted into late century post-Standard Model astrophysical orthodoxy with a vengeance as the utterly *fantasque* dark energy—fully 70 percent of the matter-energy density of this observable universe! (Ch. 9). The disquieting result was Concordance Standard Model Λ -CDM (lambda cold dark matter) quantum nonlocality/entanglement—"spooky" subjective cosmological cognitive chaos that has still to conceptually disentangle and integrate itself into post-WMAP, post-Concordance Λ -CDM Standard Model cosmology.

Ultimately construed, quantum nonlocal entanglement is proto-mystical, super spooky, super-luminal or trans-luminal (faster than light speed c) interconnectedness of all particle/field systems in the vast interdependent "implicate order of the unbroken whole", to use Bohm's metaphor.

What is now mainstream "cosmic eternal inflation" with its requisite multiverse, has rendered quantum nonlocal entanglement/interconnectedness mainstream physics. This all reads like a page from the hoary Vedas, or Buddhist *Dzogchen*. Curiously good news for our emerging noetic paradigm (body, mind, spirit unity) in science, spirituality and culture. *We are indeed on the cusp of a Kuhnian scientific and cultural noetic revolution.*

Einstein's confusion about lambda (Λ)—its insertion into GRT in 1917, its retraction in 1931, then its resurrection in his 1932 paper with de Sitter—that is to say, Einstein's second guessing of his prodigious original 1915 GRT field equations cost him the opportunity to predict spooky dark energy, probable cause of the expanding, accelerating universe, 83 years before it was actually discovered in 1998 by Perlmutter and Schmidt. As Nobel laureate Steven Weinberg told, "Einstein did not take his (GRT) mathematics seriously enough". Mathematics will trump ideology every time. If, that is that one is aware of one's ideological cognitive biases. Indeed, a big "If".

Albert Einstein, the greatest "badass physicist" (Neil De Grass Tyson) since Newton, called, on the accord of Nobel laureate George "Big Bang" Gamow, his 1917 failure of intellectual nerve as "my greatest blunder".

The fate of our good old paradigm proto-theistic closed Steady State Universe? Francis Bacon's ideological "idols of the tribe" writ large—now but a footnote to Western astrophysical and philosophical history; which is itself, as luminous 20th century mathematician and philosopher Alfred North Whitehead told, "but a footnote to Plato".

So, until the mid-1990's Einstein's cosmological constant Λ was presumed to be ≈ 0 . But a *positive* value for lambda Λ matter-energy density, as proposed by Einstein and de Sitter in their unabashed 1932 paper resulted in a *negative* pressure/tension acting as the dark energy driving force for the observed outward *accelerating* cosmic expansion of a purely physical cosmos.

Thus do quantum vacuum "virtual" ZPE particles, with their anti-particle siblings—Wheeler's trans-physical "quantum foam"—create a repulsive vacuum pressure that counters Big Crunch gravitational attraction/contraction and *accelerates* an observable universe, perhaps forever.

This is bad news for sentient beings three trillion years hence—give or take a trillion, whose fate has now become, as matter-energy peters out entirely, a rather brisk "Big Chill" or "heat death". Or worse, if badly behaving accelerating dark energy/vacuum energy speeds up, perhaps exponentially, we end in a "Big Rip" ripping asunder what matter remains, right down to the nakedness of its quarks and leptons. Bad for any residual embodied, or even disembodied consciousness (Ch. 9).

What remains at the end of spacetime being in form? It is this: innate nondual *kosmic* primordial awareness-consciousness itself, boundless whole forever embracing this *kosmos*, infinite primordial ground that is reflexively already the beginning of all eternal cycles of

existence and nonexistence, by whatever name or concept. It is That (*tat, sat*) that forever pervades this boundless process of all origins and ends.

The more recent theoretical bad news? As dark energy and the ZPE vacuum energy of so called empty space are both energy fields that fill space completely, perhaps vacuum energy is the source or cause of dark energy. Indeed, Einstein's Cosmological Constant Λ is the prime candidate to be dark energy. Now the energy of quantum fluctuating ZPE virtual particles can be observed and calculated. Well and good. What is the result of these calculations?

The really bad news? This purported estimated outward expansive Cosmological Constant— Λ vacuum energy density—is 10^{120} times greater than that calculated for dark energy! Quantum Electrodynamics (QED) ostensibly shows that this quantum vacuum energy exists, and is more or less physically "real". But dark energy density is very small. Yet, this quantum foam vacuum energy density is preposterously greater than what is actually measured for dark energy! If actual dark energy were any greater, then cosmic expansion would have been so great that large scale structure, and thus speculating cosmologists could not have evolved to be now chagrined over this inanity.

This absurd result is known as the *Cosmological Constant Problem*, or the Vacuum Catastrophe, clearly a devastating discovery which casts an intellectual pall over our understanding of the entire physics dark sector, especially dark energy, whether it be the unchanging constant Λ , or a dynamically declining Quintessence (or something else), and thus of the entire enterprise known as the Concordance Λ -CDM Standard Model Cosmology (Carroll 2010). Hence, for this and other reasons, the venerable Standard Model is woefully incomplete; and nearly everyone knows it. What to do?

Recall that our prodigious Standard Model of particle interactions and forces embraces the Quantum Theory (QFT, QED), but not the gravity of Einstein's General Relativity Theory (GRT). Thus, as we shall soon see, a new post-Standard Model theory that quantizes gravity—to wit, a logically consistent Quantum Gravity Theory (QGT) is urgently required to unify currently mathematically incommensurable QED and GRT. As is often the case in such matters, things get much worse before unifying clarity finally outshines. This is the present state of confusion in which theoretical physics now abides.

The Blessing and the Curse of Logical Undecidability. An undecidable proposition or theorem is one that cannot logically be proved or disproved.

In 1931 Mathematical Platonist (mathematical truth is purely realistic, descriptive and objective) Kurt Gödel ironically thickened our objective certainty plot with two astonishingly radical Incompleteness Theorems. *Theorem 1*): there exist mathematical statements that are undecidable (cannot be proven true nor false) in basic arithmetic (Peano's arithmetic), or in other formal logical systems. In any consistent formal logical system there are propositions which cannot be proved or disproved. *Theorem 2*): the logical consistency of arithmetic cannot be found within the system of arithmetic itself, or within the logical system itself. A formal logical system cannot prove the consistency of the system itself (if it is indeed consistent). The much improved 1936 Gödel-Rosser Theorem is even more destructive to ideological objective certainty. Here be undecidable dragons!

Formal axiomatic logic has severe limits of provability.

Gödel's discovery devastated Einstein's GRT competitor and pal, the great David Hilbert's grail quest for a mathematically formalist absolute logically consistent foundation for mathematics. "Hilbert's Program" was perhaps the last hope for the intellectually forbidden fruit that forever precludes even a hint of cognitively distressing logical "undecidability" (Ch. 10 "Idols of the Tribe").

At about the same time Heisenberg's quantum uncertainty piled on more objective uncertainty to the cognitive chaos of mid-century mathematical physics. Is there any positivist program that can save absolute objective certainty from the incipient jaws of an ignoble undecidable death?

Fortunately, or not, depending upon your bias, the grail quest for the false idol of absolutely logically decidable objective certainty has suffered a 21st century insult that is even more decisive than Gödel's great uncertainty discovery. It is the 2015 emergence of the Spectral Gap Problem, as we shall soon see.

Hence, it is beginning to appear that the tribal grail quest of Greek Platonic Realism and Aristotelian Materialism, arising through its Modernist European Enlightenment incarnation as 20th Scientific Local Realism and Scientific Materialism/Physicalism with its ideological pursuit for absolute objective, even logical certainty, has fallen on hard times.

Well, what about this most recent insult to our perennial positivist crusade to recover an instance of absolute conceptual objective certainty? The challenge has assumed a new cloak of Gödelian undecidability known to mathematical physicists (functional analysis spectral theory) as the *Spectral Gap Problem* ("Undecidability of the Spectral Gap": Cubitt, Perez-Garcia, Wolf in *Nature*, Vol. 528, December 10, 2015).

Broadly construed, in spectral theory the basal energy state of matter is known as its ground state, the primal phenomenal state at which solid matter is utterly absent heat/motion—absolute zero. The *gap/schnitt* between this ground state and the next phenomenal strata of complexity is the *spectral gap*, the space or difference in energy between this utterly quiescent zero ground state, and the phase transition to the first atomically excited state of energy or motion of material substance. It is this transition wherein matter ascends in a cataclysmic leap to its first excited "physically real" state. In atomic theory electrons are presumed to execute "quantum leaps" between such orbital energy levels. There is thus a quantum "spectral gap" between such energy orbits. Spectral Gap Theory parallels quantum uncertainty.

However, in more complex matter strata of formation there may or may not be such a spectral gap. That is to say, some physical processes are "gapless". The "undecidability of the spectral gap" demonstrates that it is not logically possible to decide whether a given state of matter possesses such a gap, or not. In quantum phase transitions we must determine when matter at the fundamental level of quarks is "gapless", so the "gap problem" is most critical. This presents the inherently perplexed "Yang-Mills Mass Gap Problem".

The vexing problem of logical undecidability and of quantum spectral undecidability augers badly for a mathematically consistent Quantum Gravity Theory; and for the disentanglement of the present absurd state of the Cosmological Constant Problem; and as one

might suspect, for the very future of an objective, empirical science as we transition to a new paradigmatic "post-empirical", post-Standard Model physics and cosmology.

Yet mathematics, while it possesses no meta-mathematical absolute formal logical foundation, as Hilbert, Russell and Whitehead (*Principia Mathematica*) might have liked, shall continue to provide the quantitative backbone to physics and cosmology. Mathematical logic is here to stay in this relative world of space and time. Though admittedly, it may fall a qbit short in the trans-conceptual dimension of nondual contemplative praxis.

We shall here dodge the tedium of the spectral theory proofs, but the inherent logical/mathematical undecidability of the Spectral Gap appears to be as definitive as Gödel's (1931) and the Gödel-Rosser Incompleteness Theorems (1936). The noble discipline of mathematical logic offers no support for our ideological presuppositions that the world of stuff is conceptually, objectively knowable beyond the flaky subjectivity of our deep background scientific and cultural "global web of belief", as Quine (1969) so aptly called it. Much more on such impudent cosmic conjecture in Chapter 7.

No one knows what to do next. Newton's gravity Big G devastated 16th century physics. Einstein, Bohr, Heisenberg and Gödel have done the same for 21st century mathematical physics. Yet we go on.

Back to Einstein. What if Einstein's venerable, but clearly incomplete (at Planck scale microphysics and Big Bang and black hole singularities) General Relativity Theory only describes great gravity on relatively local scales, say within our own Milky Way galaxy, but is incorrect at vast intergalactic scales? If GRT must be modified to accommodate Planck Scale and intergalactic scale motion, then the spooky dark sector becomes a discomfiting *fait accompli*. It's a good bet that our effort to quantify gravity in a consistent Quantum Gravity Theory (QGT) shall not only reveal incompleteness in both conceptual planks of physical theory, namely, the quantum and the gravitational. It may well reveal that the grail of a mathematically consistent QGT is not logically possible. Yet, quantitative life shall go on. Time, if there is any, will tell.

In short, we have not a conceptual theoretical clue as to the nature of the *relative* physical dimension, the domain of relative truth, let alone the ultimate nature, by whatever name or concept, of this eternally emerging physical reality stuff arising through it.

Once again, the two theoretical pillars of physics and cosmology are: classical, objective *observer-independent* General Relativity Theory (GRT) with its proto-physical spooky action-at-a-distance gravity, on the one hand, and the mostly subjective *observer-dependent* Quantum Field Theory (QFT, QED) of the Standard Model on the other.

And we have seen that these two conceptual totems of Modern physics are hopelessly mathematically incommensurable. Indeed, we shall see in Chapter 8 that quantum nonlocality, along with its parallel Eastern analogue Buddhist nonlocal emptiness/boundlessness require the surrender of our conceptual space and time altogether, the very physical ground of all this arising stuff. Now that's spooky!

Well, does this all portend the collapse of objective spacetime reality itself? What's left of 2500 years of valorized Western Metaphysical Realism and its ontic consort, Metaphysical Scientific Materialism? Read on.

Perhaps then, it would behoove those of us who care to conceptually, and even contemplatively understand that bane of modern physics, namely, philosophical ontology, “what there is that exists”. In other words we must confront, at long last and in fear and trembling, the odious Western objective science taboo against the not altogether subjective wisdom of Eastern ontology and epistemology (Yikes! There goes the tenure track.)

Has not the inherent *observer-dependent* subjectivity of quantum reality with its Quantum Field Theory (QFT, QED) demonstrated, in at least some of its several interpretative cloaks, that our understanding of arising physical and mental spacetime reality requires something more cognitively subtle than mere old classical scientific paradigm obsessively objective, *observer-independent*, physicalist knowledge strategies? Much more on this in Chapter 8.