The Cosmic Evolution of Autobiogenesis

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I have recently redefined the scientific term 'autobiogenesis' to mean the consistent and widespread development of life on small, water covered terrestrial planets, within the habitable zones of stable yellow metal rich stars, as opposed to 'abiogenesis', which I now define as the singular, one time only development of life on this planet. Formerly, this rarely used term referred to the highly improbable development of life by way of randomly reacting biomolecules within our terrestrial planet's ocean.[1]

Recent developments in stochastic thermodynamics,[2] verified experimentally via colloidal dynamics,[3] indicates that this highly improbable development of life within a biological soup is not the appropriate approach to the evolution of life. A superior alternative to the origin of cellular metabolism has recently emerged, involving the energy gradients in the vicinity of seafloor alkaline hydrothermal vents,[4] where inorganic clays contain a variety of mineral catalyst surfaces within microporous containment vesicles.[5] Although the existence of a highly enriched biological soup composed of many protobiological decay products can also serve as a secondary pathway to the evolution of free floating biological replicators, the hypothesis of random chemical reactions within a biological soup doesn't adequately represent any modern thinking about plausible theories on the origin of life, which necessitates (r)evolutionary ideas.

Evidence for autobiogenesis on suitably stable terrestrial planets is persuasive. Besides the unforgiving spectroscopic evidence that radioactive atomic nuclides formed by nucleosynthesis in stellar processes are identical across the observable universe,[6] it also appears that the development of life on this planet was particularly rapid, and survived multiple periods of intense post formation planetoid and asteroid bombardment events, many of which were undoubtedly easily capable of planet wide life sterilization.[7] Furthermore, large planetoid, asteroid and volatile cometary surface impacts are now thought to enrich the environment and the energy gradients under which autobiogenesis is now thought to readily occur.[8]

Given the widespread and now nearly indisputable evidence for autobiogenesis on terrestrial planets as I have defined the term, the time has now come to discuss the evolutionary history of its development, from both cosmological perspectives and through condensed matter physics theories and experiments. From condensed matter physics perspectives recent breakthroughs in quantum topological physics have made the simulation of these concepts possible in tabletop experiments, yet there remains glaring gaps of knowledge in quantum cosmology and high energy particle physics, such as relationships between quantum field theories of the standard model and the equations of general relativity. Large fractions of the mass and energy of the universe remain missing from theory almost entirely while the observational demonstration of its existence is irrefutable. Thus we are confronted with yet another crisis in physics. In this essay I will discuss and analyze what is known, and not known, and outline a path to discovery. I will focus on what can be experimentally observed, measured, calculated, simulated and predicted.

The existence of biological life on the planet Earth is the result of a long sequence of evolutionary steps extending back through time, to an era of cosmic history that is hidden from direct observations by the cosmic microwave background emissions at roughly 2.72548 ± 0.00057 K which peaks at ~160.2 GHz.

Besides invoking mathematical theories, numerical computations and direct experimental simulations, the only other observational means of accessing this early era of cosmic evolution, is via high energy physics experiments, using large electron, proton and ion particle accelerators,[9, 10] and through indirect observations of black holes and their event horizons, through their electromagnetic spectral emissions, and now more recently through their gravitational wave emissions, using large laser interferometers.[11] Space based cosmic ray detectors and underground neutrino observatories will provide additional data.

Recent LIGO detection of a pair of merging black holes seems to indicate that spacetime has a deeper topological structure, in addition to the ordinary globally flat to slightly curved geometry – pushed to the extreme as one approaches the event horizon of a black hole. That broken geometry of spacetime is hidden by the event horizon much like a quantum critical point is hidden by a superconducting dome.[12] Topological phase transitions are required for two rotating and revolving black holes to merge into one.

Deeper topological structures of spacetime can only be simulated in modern condensed matter systems. Axion electrodynamics, Chern Simons physics, Kitaev hierarchies, transport anomalies, gravitational couplings to bulk - boundary correspondences, Dirac, Weyl and Majorana fermions and other exotic excitations, as well as a wide variety of new composite bosons and quasiparticle excitations, are now all accessible in a consistent framework, requiring at most liquid helium temperatures for examination. Ultra cold atomic system manipulations in laser trapping experiments have already revolutionized our understanding of ambient condensed matter systems and will continue to contribute heavily to the field, providing the alternative perspectives and techniques necessary to cross check and verify any results.[13] Condensed matter simulations of gravitational physics and quantum field theories[14] will be the primary engines of scientific progress moving forward, for this current theoretical impasse to be fully resolved.

The cosmic microwave background radiation has been perhaps the most informative limit in regards to our knowledge of the larger cosmic universe. Besides its predicted existence and discovery, it has been the subject of intense high resolution study by ground based observations, and lately via satellites.[15, 16, 17] Although the Lambda cold dark matter concordance model of cosmic evolution is the widely accepted version of cosmic expansion, further analysis of the observational data for the cosmological parameters indicates that new dynamical running vacuum models may be favored over a rigid Lambda term.[18] This result has profound implications for gravitation, and the prospects for gravitational manipulations, since the unknowns now are the observed and calculated mass fractions of the dark matter particles and dark energy and their possible implications in future unified theories of gravitation and quantum field theory.

Moving forward, an opportunity unfolds to explore TeV physics at the CERN Large Hadron Collider. There are generally considered to be few possible outcomes of these high energy physics explorations. In a circular representation of the fundamental forces and coupling strengths, between the strong force and gravitation, there will either be a hierarchy of strong force extensions in the strong sector, yielding a plethora of novel new particles and resonances and new physics, possibly never achieving unification with general relativity, or there may appear resonances and particles associated with supersymmetry, and possibly even string theory, as is often predicted. Alternatively there may appear new particles and effects that indicate a low energy coupling with gravitational physics, leaving a large gap between low energy electroweak physics and the Planck scale, absent of any physics at all. At that point Kaluza type geometries and its related physics might be expected. Or, unfortunately, nothing might be found at all. It's quite possible in all of this, that string theory and its various extensions might be pinned up at the Planck scale, far from all that we know down at the Higgs scale, and only accessible by new condensed matter experimental methods and techniques. What I will do is outline a series of thought experiments, in order to classify and narrow down the most probable outcomes of these scientific explorations and their anticipated near term discoveries, which respect to new physics, the dark matter and dark energy.

Modern condensed matter physics theories and experiments have been quite honestly shocking in what they have revealed about new topological physics since the discovery of the topological insulators and the pnictide superconductors in 2008. Another spectroscopic and theoretical impasse was broken, long after the initial discovery of high temperature superconductors in 1986 (now 30 years ago), and indeed, since the first emergence of mathematical superstring theories in roughly that same time frame. It had also been anticipated as far back as 1994, at about the time of the discovery of high-T_c superconducting pseudogap, that a decades long interim period was in store for theorists, as spectroscopic resolution was improved to the point where the electronic structure of matter could be aligned with these new theories, and particularly, with the more precise atomic and molecular simulations and numerical computations.

We are now enjoying a regime of scientific discovery in condensed matter physics where mathematical predictions are immediately translated into experimental demonstration and spectroscopic verification. This has resulted in rapid adoption of geometric and topological descriptions of electromagnetism and the electronic structure and behavior of matter under extreme high pressure and high field conditions, where the atomic lattice has been highly tuned to unusual states dictated by mathematical descriptions. Coincident with this time frame in the field of statistical mechanics, the new subdomain of stochastic thermodynamics also emerged, and in the last few years it has also reached a level of sophistication of development, where significantly useful results have been obtained. The energetics of simple machines and heat engines have been translated into the quantum regime in explicit terms of energy, entropy and efficiency, leading to ever more remarkable results equally applicable to the real world of soft forces.

Baryogenesis and nucleosynthesis produced an exact quantized sequence of structured charged species in great multitudes - elements and their radioactive isotopes and decay products. Through gravitational aggregation into dense, high pressure and high temperature states or bodies – stellar or star formation, further aggregation of these composite nuclei into convecting water rich terrestrial planets created an environment rich in soft forces and low energy physics immersed in polar cryogenic solvents. Volatile elements of low atomic weight with varying dynamic charge availability are absolutely unique. There is no reason to believe that the use and function of these elements will vary across the cosmos, within the present stellar and terrestrial planet forming era of expanding galaxy formation, collision and evolution.

The uniqueness of the coulomb force and molecular energetics of low atomic weight volatile elements guarantees that any well formed experiments in organic chemistry will yield similar results everywhere. Although the varying gravitational, structural, environmental compositions and evolutionary histories of each stellar and terrestrial planetary system will modify the final organic and biological products in ways that will be difficult to imagine – fundamental electromagnetism, combined with principles of quantum and statistical mechanics, stochastic thermodynamics and quantum chemistry, along with the weaker and softer forces resulting from dissipating optical and thermal transport processes, are latched by thermodynamic irreversibility and the breaking of time reversal symmetry. This allows information about the physical and chemical environment to be stored into rapidly polymerizing molecular bonding.

Autobiogenesis, as I have now defined it, refers to the ability of the force of gravity to create conditions where the force of electromagnetism, along with a multitude of weaker and softer forces, demands that organic chemistry self organize, self assemble, and ultimately to self replicate into the polymerized and structured molecular machinery required to efficiently dissipate the energy of charge transfer gradients available in the micro-environments existing at the surface of impact rich, convecting terrestrial bodies. Implicit to this argument is the ability of the strong and weak nuclear forces to create and then disperse into the environments of space, via nucleosynthesis, and under the force of gravitational aggregation, the point charges necessary for cosmic evolution to proceed. What is missing is a unification of the force of gravitation and its continuum representation with electromagnetism, with both of the strong

forces. What condensed matter physics is now revealing is that the path to unification lies in quantum topological physics, now readily accessible in simple tabletop laboratory experiments at liquid helium temperatures, with clear replication and verification routes available through cold atom laser trapping.

The simplest possible explanation of the results now obtained from condensed matter theories would be the QCD axions coupled to gravitons just above the electroweak – TeV scale, with cosmic axions being the light bosonic topological defect remnants (nodes, lines and domain walls) of the cosmic inflation. The excitation of these bosonic QCD axions would then be responsible for the clear running vacuum variations from a rigid ΛCDM. Identification of the missing dark matter component of the mass of the universe is therefore crucial to any modern synthesis between gravitational and quantum field theories. Stochastic energetics will be a vital component of these theoretical unifications, since in our universe, time has a direction, and life exists. A path forward to the unification of quantum gravity is now open.

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