

Fundamental: Light, the Way

Fundamental & Existence

That which is fundamentalⁱ is absolutely necessary for existence, whether real, imagined, animate or inanimate. Nothing fundamental exists without its subject or the conscious being investigating it. Furthermore, its subject and our grasp of concepts evolve with study and knowledge. Einstein, the conscious being, and his new concept of gravity are a case in point.

Fundamental and existence are intrinsically tied together, and light is the discovery agent.

Accordingly, the investigation of the fundamental is brought to light by a sentient being through discovery. What is basic to all studies is the existence of the subject, which might constitute an assembly of atoms or a theory held by sentient beings conducting the study.

Fundamental then is irrelevant if a conscious being does not exist to point out that which is fundamental. And that sentient being would not exist if those essential inanimate atoms never assembled into patterns that gave them functional animas. Indeed, American physicist, Nick Herbert, believes that the mind is as fundamental a componentⁱⁱ of the universe as elementary particles and forces.

Elementary particles are basic building blocks, but the way they assemble into living and non-living things brings character and color into the many assemblages which absorb/emit photons of light.

Light gives entities expression in their various states and basically guides us to discovery of fundamental truth and existence, whether in the classical or the quantum world.

Word & Quanta

The basic symbol the sentient being uses to analyze and describe the fundamental world is the word. The word gives identity and expression to the concept and the subject, especially large objects of study in the classical world, including their motions and the forces influencing them.

This essential unit of language expression even gives substance to the foundations of philosophy and religion: “The word was made flesh and dwelt among us,”ⁱⁱⁱ suggesting that God and Jesus are identical but with a human connection and existence.

Then the quantum world of science brought our focus to Planck size. The quanta became physics’ fundamental unit of a physical magnitude. Light illustrates that which exists in our world and is sent out in quanta called photons. The quantum sheds probabilistic light on the classic world.

With this shift in perspective, there is almost a religiosity attached to the fundamental transformation from inanimate matter to animate matter when fundamental elements assemble in

sentience. The study of such existence or *being* encompasses disciplines that examine the material and sentient worlds that exist around us, the real and even the hypothesized.

What exists and our fundamental understanding of it radically changed a century ago from knowable attributes of large objects' location and speed to the quantum energy level view of atoms and subatomic particles, where attributes are uncertain. It gradually arose with studies like Max Planck's solution in 1900 to the black-body radiation problem^{iv}.

The Fundamental evolves with discovery

Humankind's ability to grasp the essentials of existence grows and evolves almost daily with discovery, encompassing all disciplines, but especially science. "[Discovery science](#)" emphasizes this goal of finding new patterns and concepts.

For example, fundamental to the ancients was an Earth-centered solar system which was their universe. By the fifteenth century, it was a Sun-centered world. In the last few decades, science revealed that the existence of our universe depends on black holes, dark matter, and dark energy, all mysteries that defy the fundamentals of current scientific theories.

Samples of discoveries^v last year alone range from creating a new element state, to breakthroughs in human biology to discoveries in space. Scientists successfully edited the first human embryo, successfully created metallic hydrogen, perfected methods to grow human organs, recycled rockets, and found alien planets that are good candidates for life. For many disciplines fundamental truths changed.

A focus on a few disciplines of study help clarify how concepts of existence change.

The biggest sphere of existence is the universe. In that realm, cosmology studies the origin, evolution and structure; physics, its basic properties, materials and forces; astronomy, the sun, moon, stars, planets, and other material bodies in that universe.

For example, a varied team of scientists working on NASA's Juno probe of Jupiter found fundamental changes to earlier concepts: they were wrong about Jupiter's interior structure, wrong about the atmosphere and even wrong about the magnetosphere.^{vi}

You might say that all scientific studies have an overarching goal of discovering, even rediscovering what is fundamental, looking to investigate, then prove and advance that which is necessary for existence.

Look at cosmology, for example. Its scope of existence is vast. With the advent of new telescope technology and techniques, two trillion galaxies,^{vii} each with some 100 billion stars, are objects of deeper probes. Science is constantly seeking the fundamentals of origin, evolution and structure. Such are fed into supercomputers, humankind's means of building a universe.

The modeled universe is an entity that helps to fill in the unknowns of the existence our senses have discovered, and our brains hypothesize. It is like building a living thing with the capability for growth, reproduction, respiration, metabolism and movement. It and its family of stars live and die like other living things. We seek fundamental accuracy as a model's creator, to breathe life into its existence.

Not enough mass with known matter, so we build dark matter, adding six times the known matter. Not enough cause for the universe's expansion, so we add dark energy. We want to see back in time to microseconds after the theorized Big Bang (BB), so we search for long wave lengths stretched by billions of years of travel. Concepts are updated with new data, sometimes redefining established concepts we model, then tools of discovery are constructed.

New telescopes are built in the desert where manmade interference is minimal. Some 280 long-wave-length arrays in the Owens Valley see through the Dark Age hydrogen fog. The heavy ion collider depicts the early universe, gold nuclei colliding, trying to see how matter first formed. A new radio telescope is launched in a 300-foot-high hot air balloon into New Mexico skies. Twenty-three miles into the air at the edge of space, it will try to penetrate the early hydrogen fog and confirm inflation theory, proving our nascent universe expanded by a trillion trillion times immediately after the BB.

Open minds acknowledge that these studies could prove the BB didn't happen and that the inflationary epoch didn't occur between 10^{-36} and 10^{-33} seconds after the BB, and that fundamental does change – belief systems, truths and theories.

First Light

Beyond just an intellectual focus on truth, the Hubble telescope peers for some 44 days on one spot in the sky to help find the youngest star in the universe, perhaps as early as 100 million years after the Big Bang. The James Webb telescope will soon follow in a more advantageous orbit with more resolution yet and look farther back in time. Evidence shows that the first star would have been a giant some 100 times the mass of our Sun. Its color reveals no iron in its composition, an almost pure hydrogen composition from first matter.

Like a stubbornly born existence, the universe's protracted dawn came over millions of years. Each star was a short-lived addition to star clusters, born in a veil of fog, shining with one million times the light of our Sun, but with its radiation only piercing the fog gradually.

The fundamentals of religion are infused with the image that we are seeking to discover. There is the biblical phrase at the beginning of Genesis: "Let there be light."^{viii} Christians call Jesus the "light of the world." In Hinduism, light triumphs over darkness during Diwali. Religious figures are represented with halos of light, like the Buddha and Jesus. In the same sense, scientists are looking for a cosmic dawn in the Dark Ages, the first star to pierce the darkness of the universe.

Light is the advent of consciousness, the proof of our existence, a kind of a first cause. It is fundamental in that it is necessary for the existence of the universe and all in it.

Even more pointedly, the Sun's energy is the source of life on Earth,^{ix} the driver of our very existence. What is fundamental to the existence of the Sun in our solar system are the basics of physics, including its formation, properties of fusion and basic forces of nature.

For cognizant creatures, a basic mission of scientific discovery is to explain our existence. In doing so, we are drawn to the source of life and being. First cause of existence draws us to the origin of the cosmic dawn. Each day from the Earth, we see dawn coming from the light of our own star, the Sun.

In our discoveries, we are constantly confronted with what is often called the miracle of life or existence, explained in many shades of religious and non-religious perspectives. For example, in investigating the source of Earth's energy, we discover rules of physics which make life possible.

If not for the heat of the Sun in the radiation zone and its thick ionized plasma, that photon of light produced in the core by fusion would race through some half million miles of the Sun's radius in 2 seconds and then eight minutes later tear apart Earthly human cells with gamma rays.

Instead, it takes perhaps from a hundred thousand to a million years before that photon reaches the surface of the Sun and then it is infrared light or visible light, which can safely touch our skin and grow our plants through the process of photosynthesis.

Knowledge gives understanding to how natural processes like photosynthesis can be used to store the energy from sunlight in the chemical bonds of a fuel, thus utilizing natural energy for our livelihood. Such things are necessary for sustaining existence.

The actual source of energy was produced in the Sun a million years ago. Curiously with this seemingly ancient energy, our telescopes can take us back to primordial time, to the dawn of creation. That knowledge is part of a fundamental infrastructure.

But our fragility keeps beckoning us. The realizations of our fragile existence keep cropping up as we add to our knowledge. In Earth's billions of years of existence, have close supernovas ripped apart Earth's atmosphere with deadly gamma rays?

What is too close^x? If Earth is occupied, a bright Type II or a normal Type I supernova would possibly remove our ozone layer and eventually us if we are closer than 30 light years^{xi}. So being far enough away from a giant dying star is fundamental to our existence. That doesn't necessarily remove the non-animate things, but who would be around to record the fundamentals of existence?

Would other sentient creatures record the fundamentals of existence if we falter? Do we share existence with other sentient creatures? We know that that photon of light from our Sun which reaches Earth in 8 minutes travels to distant worlds over billions of years.

Our technology can now detect other planets that might sustain life. We are nearing the capability of detecting atmospheres that might sustain life and dispel those nasty gamma rays on these planets. Some day we might see if ET is in that fundamental equation: fundamental = existence.

Earthly living bodies emit an infrared light that our eyes cannot see. Cells within those bodies emit biophotons as ultraweak visible light which we cannot see as well. We see living and non-living things through mostly reflected light. Curiously, human beings, who contain light emitted by some 37 trillion cells in our bodies, are the discovery agent of light. Thus, light represents a basic *force*.

Electromagnetic forces riddle our universe, illuminating existence at all levels. Through our tools of discovery, such an electromagnetic force has drawn us and taken us near the fundamental edge of the universe's discovery.

But it only takes us to the edge of the Dark Age, not able to pierce the opaque fog of mostly hydrogen clouds, when few if any stars existed. Discovering light in the dark is fundamental.

Light Discovers Darkness

But there is thought to be a dark existence that doesn't emit light. Its original detection came from studies of light in the radio wave range, first by astronomer, Vera Cooper Rubin.^{xii} Decades of study showed that the rotational velocity of clouds of ionized hydrogen in spiral galaxies like the Milky Way, were too fast. Its cause is speculated to be Dark Matter (DM). Newer studies measure gamma ray emissions by the Fermi Large Area Telescope, looking for DM annihilations^{xiii} in the theoretical rest mass range of the DM particle.

Meanwhile, further studies by a UCI physicist^{xiv}, who, building on Hungarian physicists' detection of an unknown particles, is looking for a "dark photon" or what could be a "protophobic X boson." In effect, it could be a new fifth force of nature. Obviously, it would not be accounted for in the Standard Model. If confirmed, it would be a fundamental update.

Dark Energy was hypothesized when cosmic candles,^{xv} Type 1a supernovas, whose absolute brightness is known, were used to show an accelerated expansion of space. Those effects and others signaled their existence, providing fundamental evidence of two separate forces not conventionally explained. Dark Energy too poses a mysterious break in the Standard Model.

The fundamental truth of the universe's expansion rate is in flux.^{xvi} Is it 73 Km/s/Mpc with an uncertainty of 2.4% or 67 Km/s/Mpc with an uncertainty of 1% based on the BB afterglow? There is even uncertainty about the uncertainty rate.

Can scientists even expect the existence of a visible universe to study in the future to examine what is fundamental? The effect of the universe's accelerated expansion could be no visible universe to study beyond our own galactic group, pertinent for a civilization with a star more long-lived than the Sun. Future scientists from these civilizations could lose sight of at least distant galaxies where space-time expansion is faster than the speed of light.

Radiant light provided the evidence of Dark Matter and Dark Energy, which represent yet another alteration in a fundamental existence we can't otherwise explain. We can't see gravity either, but we know it is there and we can measure it. It too is a study whose fundamental signature and existence we seek to update.

ToE is the ultimate Fundamental

The ultimate theory, the theory of everything (ToE) is thought to be tied up in the first few seconds of the Big Bang (BB) when the four fundamental forces – the weak, the strong, electromagnetic, and gravitational – were thought to be united into one force at high energies, the ultimate beginning of existence, when the universe was Planck size.

There is a touch of irony in the fact that the two forces thought separated at the BB are united, perhaps ultimately to discover the fundamental beginning.

In August, multiple instruments around the world detected the collision of two neutron stars some 130 million light-years from Earth. The Laser Interferometer Gravitational-Wave Observatory (LIGO) utilized lasers to detect gravity waves and telescopes, EM waves, including radio waves, X-rays and gamma rays.

The first observed neutron star merger has helped bring together scientific truths and studies that greatly advance humankind's inquiries into theories fundamental to our very existence. "Researchers call this coordinated approach 'multimessenger' astronomy, in which the messengers can be electromagnetic radiation, gravitational waves or subatomic particles."^{xvii}

It seems like déjà vu, two forces, one producing no light and the other producing photons across the whole EM spectrum. They have been long separated but come together again, this time in discovery.

With much greater sensitivities, it is theorized that such instruments can track back to the BB, measuring the greatest disturbance in space time.

The BB is a time when the whole universe was thought to [expand](#)^{xviii} from a Planck size to macro size, forces of equal strength differentiating into four forces, two in the Planck range and two, long-range.

Even if the BB is the key to our beginning and to the ToE, humankind – and any other sentient being who might be discovered – most likely will continue to redefine the meaning of

fundamental, knowing that scientific knowledge and what we deem the fundamental evolve, requiring constant editing, revision and refinement.

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