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Human Universe -Quantum Mechanics, Manand Philosophy

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I. INTRODUCTION

Carl Sagan s famously said that we live in an infinitesimal dot in space and time in this vast Universe. This sums up a highly unlikely event, of man today, moving around on an ordinary planet of an average star, amongst the vast cosmos. Nature through its evolutionary processes created a creature that can contemplate on its own existence, in context of past, present and in future. Philosophy (a product of contemplation) therefore can only be meaningful when itemanates from understanding of the evolutionary processes that led to its occurrence. Critics can rightly point out, that this negates the entire glorious tradition of Metaphysics, Ethics, Epistemology, Aesthetics and logic, before Newton, before Darwin, before Einstein, before Hubble, before Watson and Crick et al before today as meaningless. With this criterion, at no time philosophy can be meaningful because tomorrow morning some truth about nature will be discovered and, in that light, everything said before is not meaningful. But the same story holds good for Science, Classical mechanics have been replaced by quantum mechanics and relativity. After all philosophy is a study of the fundamental nature of knowledge, reality and existence and therefore philosophy should not be bereft of the advances in our understanding of nature.

What is a human being? Particles of dust in an infinite arena, present for an instant in eternity. And yet human beings are necessary to raise such questions as Where are we; Who are we; Why are we here; and What is our future? Can we answer these questions, by understanding the laws of nature or should we allow our imaginations to float and discover the mystical hand of almighty? Hitherto when Science had not developed Philosophers had very little option but to invent their own Gods and that provided them a kind of assuredness, a purpose to live. It is another matter that different groups created their own Gods and fought amongst each other to establish the supremacy of their own Gods (respective Imaginations).

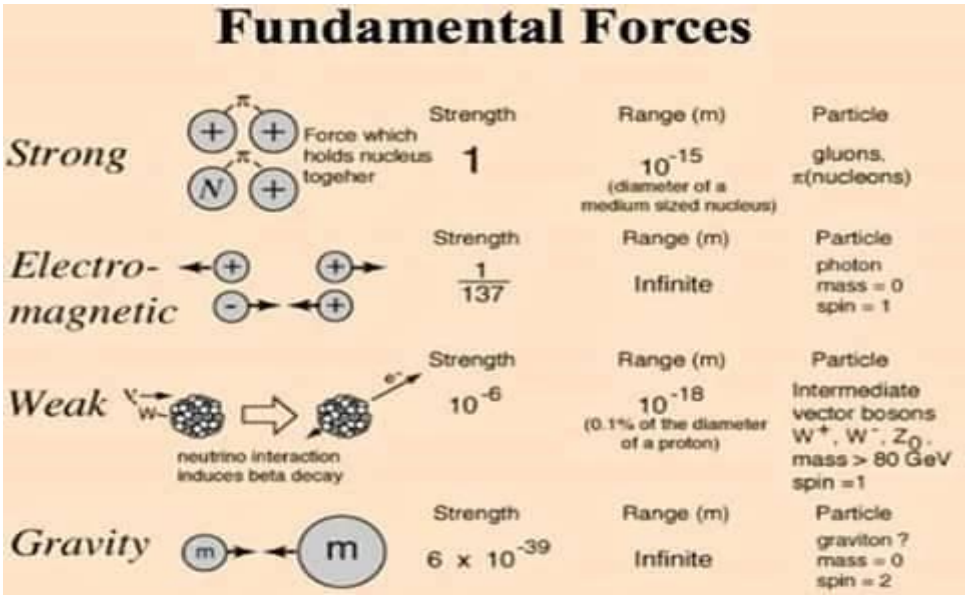
Modern Science as is understood today had its foundation from Newtonian mechanics in the seventeenth century. Sir Isaac Newton formulated two major laws, the laws of motion and the laws of gravitation. These laws come under the realm of classical mechanics and can explain motion of bodies including planetary motions. They are essentially deterministic in nature i.e. given the nature of forces and present state, a future state can be precisely determined. Mathematical tools to work out such solutions were also simultaneously developed. Macro objects like a train or a car moves at a velocity far less than speed of light and theoretical solutions matched reasonably well with experimental observations. In the eighteenth century another brilliant Physicist James Clark Maxwell worked out the laws of electromagnetism and together with Newtons laws it was felt that all that had to be learned was learnt.

Human curiosity is not quenched so easily. Scientists started working on extreme situations, i.e. when objects are at atomic level and when they start moving at or near the speed of light or when two frames of reference are not moving at uniform velocity with respect to each other. Physics had moved into an interesting world, the world of quantum mechanics and relativity. Einstein propounded the Special theory of relativity based on the invariance of speed of light setting the upper limit of velocity of any real objects. He also wrote a simple equation, based on his special theory of relativity which had a profound meaning, a connection between matter and energy and this explains the brightness of stars. Einstein built on the results of Michaelson Morley experiment that no physical objects can travel faster than light and this necessitated improvement on the Galilean transformation which were the pillars of newtons laws of motion. Similarly, non-invariance of Newtons laws in a circular frame of reference vis-a-vie stationary frame were also major limitations. Based on Lorentz transformation, Einstein came up with the concepts of invariance of “DISTANCE”, in four-dimensional space- time “, across different frames of reference, which resulted in time dilation and shortening of length in the moving frame of reference as viewed from a stationary frame. Absolute time and space concepts of Newtonian physics were discarded. Interestingly Maxwell s equations of Electromagnetism however were invariant across different frames of reference.

General theory of relativity was the next revolutionary concept which could explain the shift of Mercury s perihelion (where Newton's theory was inaccurate) using concepts like bending of light by gravity and space -time curvature caused by heavenly objects. While special theory of relativity was confined to transformations across uniform motion by the moving frame of reference, General theory worked out the transformations across accelerated frames of reference. There was another interesting development which General theory predicted but Einstein left the correct interpretation to others. A constant 'c', Cosmological constant, in his equation appeared which was later attributed to the inflationary nature of Universe. This essentially meant that the Universe had a beginning. An expanding Universe can only explain the dark sky we see in the night though there are billions of stars.

Meanwhile tremendous development took place in quantum mechanics with the foundation being led by Heisenberg, Schrodinger, Dirac, Pauli, Planck and host of others. Deterministic theory gave away to probabilistic theory of quantum mechanics. Heisenberg stated that atomic and subatomic particles do not follow deterministic laws and propounded his famous Uncertainty Principle stating that uncertainty is an intrinsic part of nature. Together with inflationary nature of universe, Heisenberg's theory could explain creation of universe and Big Bang. Another interesting thought process was the dual nature of subatomic particles in the form of wave and particles simultaneously like light ~~are~~ is electromagnetic waves as well as photons (particle) simultaneously. This led to the weird world of quantum mechanics when Schrodinger's cat could exist simultaneously in the two windows with a well-defined probability.

The world of particles soon got divided in two classes, one was the matter particles called Fermions, like proton, neutron, electron, quarks, neutrino etc. and the second were the force particle like photons, mesons, gluon, Higgs etc. Matter particles are the building blocks of matter and force particle are responsible for the interaction within matter. It may be mentioned here that an Indian Physicist Satyendra Nath Bose discovered the energy distribution of force particle and in his honour all force particles are called 'bosons'. Four types of forces were identified which were together as one unified force at the time of big bang and they separated soon after. Till date theoretical developments have taken place to unify, electromagnetic forces, weak nuclear forces which explains the radioactive decay of nucleus and strong nuclear forces which binds protons together in the nucleus. Unification of gravity has been tried in the String theory but it is still considered as work in progress. The Infographic below gives some of the properties of these forces; it is clear that gravity is the weakest force though along with electromagnetic it has the highest range. The strong and weak nuclear forces have a very limited range and therefore have their influence within the atomic nucleus



The universe was born with the Big Bang as an unimaginably hot, dense point. When the universe was just 10^{-34} of a second or so old — that is, a hundredth of a billionth of a trillionth of a trillionth of a second in age — it experienced an incredible burst of expansion known as inflation, in which space itself expanded faster than the speed of light. During this period, the universe doubled in size at least 90 times, going from subatomic-sized to golf-ball-sized almost instantaneously. After inflation the growth of the universe continued, at a slower rate. As space expanded, the universe cooled and matter formed. Quark-gluon plasma primordial stuff emerged. with temperatures, a billion times hotter than the surface of the sun. Quark, is a type of elementary particle and a fundamental constituent of matter. Quarks combine to form composite particles called hadrons, the most stable

of which are protons and neutrons, the components of atomic nuclei. Two up quarks with a charge of +2/3 e and a down quark with a charge of -1/3 e binds together to form proton and two down quarks with one up quark form neutron. Gluon is a strong Nuclear force particle and gluons interact with quarks as well as with itself binding the quarks. All quarks have the same quantum numbers for such properties as spin, size, parity, etc. Therefore, a new quantum number color with six manifestations had to be proposed to be consistent with Pauli's Exclusion Principle. The six manifestations are termed red, blue, green, antired, antiblue, and antigreen, the last three for antiquarks. Colored quarks attract one another by exchanging gluons, of which there are eight types. Gluons are massless, have spin 1, travel at the speed of light, and carry both a color and a different anticolor. The number of gluons is determined by the number of color-anticolor combinations. When a quark emits or absorbs a gluon, it changes color, a process that happens constantly. Therefore, a proton (uud and colorless), which must have all three colors, can have several different arrangements. Examples are $u_r u_g d_b$, $u_b u_r d_g$, $u_g u_b d_r$. Whereas the force between electrons decreases as distance increases, as the distance between two quarks increases, the strong nuclear force binding them together also increases. Due to the fact that the strong force increases with distance, there are no free quarks. The quarks of one proton become glued to the quarks of another proton and the attraction between the quarks is strong enough to overcome the electromagnetic repulsion. Quantum Chromodynamics is the theory explaining this strong force based on conservation of colorof quarks.

As the universe expanded temperatures dropped yet were high enough to trigger fusion reaction. Matter particles like electrons would annihilate anti particles creating photons. Thus, the Universe would mostly have protons, neutrons, neutrinos, electrons and large number of photons. About one hundred second after the big bang, protons and neutrons start combining together to form deuterium nuclei and then combine with more protons and neutrons to form helium nuclei. Radiation left over, from fusion reactions, which has cooled down to microwave level has been observed.

The weak nuclear force is carried by the W and Z bosons. These particles were predicted by Nobel laureates Steven Weinberg, Sheldon Salam and Abdus Glashow in the 1960s, and discovered in 1983 at CERN. W bosons are electrically charged and are designated by their symbols: W^+ (positively charged) and W^- (negatively charged). The z bosons are neutral. By emitting an electrically charged W boson, the weak force changes the flavor of a quark, i.e. up quark to down quark and vice versa which causes a proton to change into a neutron, or neutron to proton respectively. The energy to create W bosons have to drawn from vacuum and since W bosons are massive they survive for a short time in accordance with uncertainty principle and the probability of such an event happening is relatively low and so this force is called weak force and are described as Quantum flavor dynamics or QFD. In beta minus decay, a neutron decays into a proton, an electron and an antineutrino. In beta plus decay, a proton decays into a neutron, a positron and a neutrino. Weak force plays a major role in fusion causing stars to burn. When a proton converts to neutron it becomes a deuterium nucleus along with another proton. Two deuterium nuclei make a He nucleus. This is the fusion reaction creating Helium fromhydrogen. Since neutron is heavier than proton this change occur gradually explaining the long life of stars. The burningof stars also, creates heavier elements, which are eventually thrown into space in supernova explosions to become the building blocks for planets, along with plants, people and everything else on Earth. The Z boson is neutrally charged and carries a weak neutral current. Its interaction with particles is hard to detect. Experiments to find W and Z bosons led to a theory combining the electromagnetic force and the weak force into a unified "electroweak" force in the 1960s. However, the theory required the force-carrying particles to be massless, and scientists knew that the theoretical W boson had to be heavy to account for its short range. That led to the conceptualization and later discovery of Higgs Boson based on the fact that massless particle has infinite range like photon and gravitational force particle. Higgs boson is postulated to have created the baryon (three quark combinations i.e. proton and neutron) antisymmetry and is elaborated subsequently.

Quantum electro dynamics describes the interaction of light with matter. Electromagnetic field as visualized in classical sense is quantized into individualized discrete quanta's called photons and interaction between particles takes place through exchange of photons with conservation of charge. Dirac came up with relativistic equations describing the interaction and Feynman explained the interaction with simplistic diagrams incorporating probabilities of going from state A to state B through numerous paths, the total probability being the sum total of all the paths.

Atom formation could only start after millions of years (after the formation of -nucleus) when electromagnetic energy was strong enough so that the nuclei could capture electrons. Universe also had its heterogeneity and denser areas started collapsing under gravity and this explains the formation of galaxies and stars. S Chandrasekhar an Indian physicist propounded the birth and death of ~~galaxies and~~ stars. Stars convert hydrogen into Helium as explained earlier and once all the hydrogen atoms are burnt out the star collapses due to its own gravity resulting in an explosion which results in the formation of heavier elements besides star dust. Depending on the original size, stars collapse as white dwarf or neutron stars or even black hole but ultimately, they all explode. We human beings as well as our earth are products of this star dust. New stars again get

formed and this cycle continues. It is simply amazing that billions of stars in billions of galaxies have formed through such processes. As per researchers our Universe is 13.8 billion years old. Our sun is a third-generation star with an age of 4.6 billion years while the earth is around 4.5 billion years.

The strength of the force particles and the parameters that define the matter particles rather their proportions are in a delicate balance and even minor variations would result in a catastrophe. Similarly, the size of our sun and its age and the distance of the earth from the sun has been such that water could exist on earth in liquid form. This is a prerequisite for life. Another interesting mystery is that roughly 68 % of the universe is dark energy. Dark matter makes up about 27%. The rest - everything on Earth, everything ever observed with all of our instruments, all normal matter - adds up to less than 5% of the universe. It is the dark energy that is responsible for expansion of Universe. Dark matter does not interact with electromagnetic waves but contributes to the formation of stars and their presence was discovered through gravitational effects. Creation of our Universe, our solar system, our unique planet Earth are all highly improbable. Yet they have happened. The total energy of our Universe is zero for gravitational forces have negative energy and matter particles have positive energy. On this premise, it is presumed that the shape of the Universe is flat i.e. the Universe was created out of nothing simply due to quantum fluctuation and inflationary theory. Science does not rule out improbable situation, except that the chance of their occurrence is infinitesimally small. After all we cannot have any data on failed universes. If we work out what the Universe was like one billionth of a second after it began, it turns out that for every billion particle-antiparticle pairs there was just one extra particle. To that particle we and stars owe our existence and this is a result of a violation of symmetric principles in the electro -weak theory. The weak symmetry breaks but the electromagnetic symmetry survives. Because electromagnetic symmetry survives, the photon is massless, and electromagnetic forces carry over large distances. In contrast, because weak symmetry breaks, the W and Z are massive, and weak interactions act only over a very short range. What breaks the electroweak symmetry is still a topic of research. The simplest explanation is that there is a field called the Higgs which, is analogous to a ferromagnet (which breaks symmetry of iron fillings which are scattered by magnetizing them), breaks symmetry when it falls into its state of lowest energy giving mass to the W, Z, and all other massive particles

The other intriguing mystery is Man and its evolution. Earth in its formative years was intensely hot with volcanic eruptions and were hit by comets, asteroids and possibly other planets (at least once) resulting in the formation of moon and 23.5 deg tilt in its axis. Existence of moon has also stabilized wobbling of the Earth's axis resulting in gradual temperature fluctuations. Earth became blue and the first form of life appeared around 3.5 billion years ago. Indirect evidence through carbon isotope studies shows that first living things even appeared earlier possibly 3.7 billion years ago. The LAST UNIVERSAL COMMON ANCESTOR (LUCA), may not even be cellular but may be a product of biochemical reactions involving proteins and self-replicating molecules and possibly contained inside rocky chambers around deep sea hydrothermal vents. Yet all living things on this planet are descendants of LUCA, sharing the same basic biochemistry including DNA, i.e. shared common origin.

Interestingly evolution of LUCA into complex multi cellular animals took over 3 billion years. An oxygen atmosphere is the precursor to this evolution and could take place through photosynthesis, by which green plants and certain other organisms captures Sunlight and is used to convert water, carbon dioxide, and minerals into oxygen and energy-rich organic compounds. Primitive photo synthesis knocked of electrons from hydrogen sulphide while modern plants use water thus oxygenating the atmosphere. The process started 2.5 billion years ago and this change from sulphide to water is an intriguing story of a cyanobacterium being swallowed by another and was coopted to the complex task of releasing oxygen from water. The other reason for this long period of 3 billion years is the evolution of prokaryotes, (unicells without nucleus)into eukaryotes with nucleus which contains most of its DNA. How did this happen? Was it also through ingesting? Cambrian life explosion took place around 550 million years ago with prokaryotes and oxygen environment in place.

Perhaps the world's most famous early human ancestor, the 3.2-million-year-old ape "Lucy" was the first Australopithecus afarensis skeleton ever found, discovered in 1974 by paleontologist Donald C. Johanson in Hadar, Ethiopia, with a mixture of ape and human features—including long dangling arms but pelvic, spine, foot, and leg bones suited to walking upright—slender Lucy stood three and a half feet (107 centimeters) tall.Recreations based on another Australopithecus. afarensis skulls later found nearby reveal an apelike head with a low and heavy forehead, widely curving cheekbones, and a jutting jaw—as well as a brain about the size of a chimpanzee's. The present Scientific belief is that the Hominid biped evolution began 7 to 8 million years ago with the separation from Chimpanzees and they spent more time on ground rather than on trees. Around 1.8 million years ago there was a step change in the brain size and different hominin species, homo-erectus emerged, all in the active rift valley of East Africa. A riftvalley is a lowland region that forms where Earth's tectonic plates move apart, orrift. Perhaps high geothermal gradient in rift valley, triggering climate change helped in the evolutionary process. Homo -erectus only survived 1.4 million

years ago with a brain size of 1000 cc. 800,000 years ago homo Heidelbergenesis appeared with a brain size of 1400cc and they are considered as immediate ancestors of Neanderthals and Homo sapiens.

Neanderthals were our closest evolutionary relatives and evolved in Africa around 300,000 years ago. Neanderthals were shorter than modern humans, and had barrel chests, stocky limbs, and large noses. Their ancestors left Africa before modern humans, venturing into Europe as far back as 200,000 years ago, and were still there when our ancestors embarked on the same journey about 60,000 years ago. Some even ventured into Asia, traveling as far east as Siberia. Neanderthals and modern humans actually lived alongside each other in Europe for several thousand years before Neanderthals vanished some 30,000 years ago. Most humans have 1 to 3 percent Neanderthal DNA. This could be due to the two species sharing a common ancestor and /or hybridization.

Homo sapiens based on fossil study emerged around 200000 years ago in the Rift valley in central Africa. They migrated to Europe around 60000 years ago and were hunter gatherers. Homo sapiens started agriculture and settling down as late as just 12000 years ago. As per Harari prehistoric Sapiens were a key cause of the extinction of other human species such as the Neanderthals along with numerous other fauna. He further argues that the ability of Sapiens to cooperate in large numbers arises from its unique capacity to believe insymbolic things such as Gods, Nations, money and human rights. Harari claims that all large-scale human cooperation systems including religions, political structures, trade, network, legal institutions owe their existence to Sapiens' distinctive cognitive capacity for fiction. Possibly larynx of grown up homo sapiens being close to the neck rather than throat have given the modern human beings the language skill which gave them the distinct advantage.

Summarizing, it follows that the greatest mystery has been the creation of the Universe, the mother Earth on our solar system and above all the creation of modern man. Sun is already in its mid -life, and will becomea red star, around 4 billion years from now and then will gobble the Earth. Man will possibly be long extinct through natural causes like periodic ice ages, asteroids hitting the Earth, or major climate fluctuations. Natural causes are beyond our control but anthropogenic changes can be regulated. Our philosophy today should actually follow from our much better understanding of "What" and "How", we are here. It is really remarkable that a naturalist and biologist Charles Darwin in the early nineteenth century, could conceive the process of Natural selection and survival of fittest which could explain the evolution of Man in this planet. Surely, he will rank as one of the greatest Philosophers. After all Philosophy is the study of the fundamental nature of knowledge, reality, and existence. The ability of human beings to contemplate reality has to transcend instinctive egotism and Science has progressed only when Copernicusdiscarded the geocentric theory. Galileo also confirmed that Copernicus was right, but he was condemned, convicted of heresy and put under house arrest.

"Why" i.e. the "purpose", is what philosophers can ponder about it but surely there is no definitive answer, baring the absurdity and the ephemeral nature of our situation. Possibly it is much more relevant to ponder on much more pressing issues like preserving this planet with its biodiversity and preserving mankind. That takes us to the realm of social sciences where philosophers have often said that the greatest service is the service to mankind. Possibly an objective analysis by NASA astronaut Ron Garan explains this incredible feeling in his book; The orbital Perspective ". Quote

As I approached the top of this arc, it was as if time stood still, and I was flooded with both emotion and awareness. But as I looked down at the Earth - this stunning, fragile oasis, this island that has been given to us, and that has protected all life from the harshness of space - a sadness came over me, and I was hit in the gut with an undeniable, sobering contradiction. In spite of the overwhelming beauty of this scene, serious inequity exists on the apparent paradise we have been given. I couldn't help thinking of the nearly one billion people who don't have clean water to drink, the countless number who go to bed hungry every night, the social injustice, conflicts, and poverty that remain pervasive across the planet. Unquote

Homo Sapiens, with all their intelligence have essentially failed and today on one hand we are draining the Earth's resources at a rate beyond its capability, as if there is no tomorrow, yet on the other hand we have this sad spectacle of seeing the wealth distribution being more and more unequal. We fail to realize that greed beyond a point is actually counterproductive and ultimately leads to wastefulness of natural resources. Irreversible climate change with CO2 concentration beyond 400 ppm is a consequence of it, signs of which is as clear as day. Rise of authoritarianism in different parts of the world, curbing of free speech, intolerance to contrarian thoughts, building walls and spreading xenophobia are very distressing. It seems the world has forgotten the lessons of second world war. Similarly rise of fundamentalism, terrorism has no place in a civilized society and needs to be unequivocally condemned by one and all. The greatest philosophy to my mind is the one that promotes happiness, progress, peace, perpetuation and above all Universality of Mankind and human development.

Philosophy emanates from the newest parts of the Human Brain (the thinking contemplating and imaginative brain) The process of thinking evolves moment to moment with acquisition and acceptance of scientific knowledge and is required to result in shift of attitude from competitive survival (function of the primitive brain) to thriving through inclusion and collaboration. The Human form weakens and wilts in isolation and energizes with connection, trust, understanding and purpose. Transcendence to a level above self to create collective purpose is a state of mind that generates pure joy though natural design of physiology. Taking a cue from Nature's design, we can design aspirations to embrace the diversity of our home planet Earth if not beyond.

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