

Committee I
The Limits of Science?

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CHAOS BEYOND OUR COSMOLOGICAL QUEST

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Since we lighted the world with civilization, we have been enjoying our living style no matter how different were the nationalities or ideological concepts among men all over the global communities.

We were born equally bare handed many thousand years ago. However our eventual status nowadays shows unequal if we view ourselves by means of the wealth and power, which has been derived by the geographical, racial as well as ideological characteristics.

A break-through came into realization in 1989.

At last, persistent socialistic countries in the world gave their way in order to migrate with democratic freedom so that they could also take a share of success of what the free nations have been demonstrating.

It teaches us a fact that there would be no difficulty or impossibility if we comply with effort to resolve problems together.

On the other hand our history proves that we have established cooperative tradition in exhibiting their cultural activities. Physical science is one of the cultural fields which has decisively contributed in exploring the entity of the nature. Even though we are now able to extract a secret power of atomic nucleus or fly a sophisticated tool over any target planet billions kilometers away with bull's eye precision, we are still unable to solve a very honest yet basic question, "Where did we come from?" or "How was the universe created?"

Early Explorers of Cosmology

It took about three thousand years to reach a level of our current understanding of the universe.

We owe ancient Greek philosophers a great deal for initiating construction job of questions concerning the structure of our cosmic surroundings.

Pithagorus(BC 6-5) first pointed out that the earth might be spherical. Platon (BC 5-4) explained that the earth was positioned at a center of the universe having five planets revolving around it.

Eudoksos(BC 5-4) reached a notion that these planets were not following circular orbit and modified the Platonean model into an ashtonishing universe composed of 33 concentric shells with various stellar and planetary orbits, which were even increased later to 55 shells of them by Aristotels (BC 4). All of their concepts were based on the geocentric universe.

Nonetheless there appeared a man with a different idea about it. Aristarcus (BC4-3) introduced his belief that all the planets including our earth should revolve around the sun. It was the idea of heliocentric universe commented for the first time in our history. Thus, he is now often called as an ancient Copernicus.

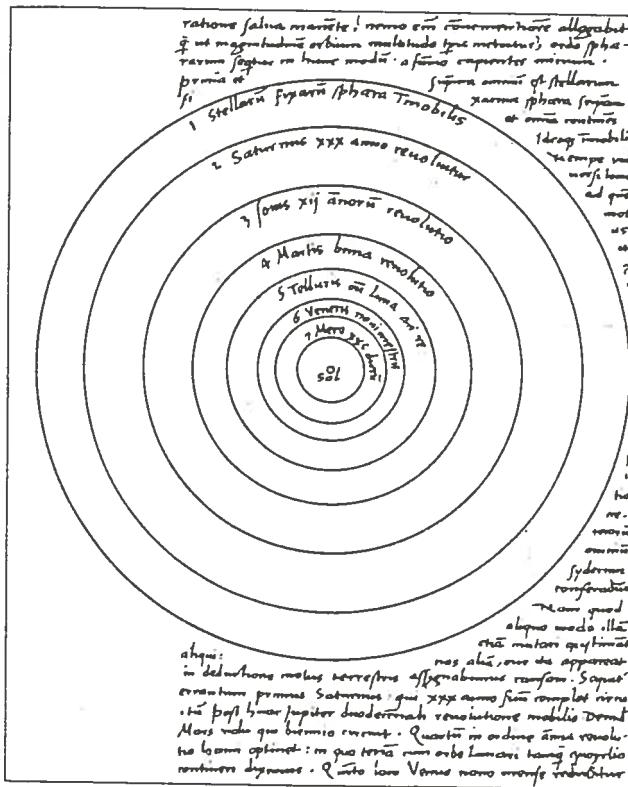
However those notions were results of deep philosophical speculation rather than factual statements derived from scientific observations.

Then, the history produced the first professional astronomer named Ptolemy, a half-breed of Greek and Egyptian, who wrote 13 volumes of astronomical books titled with "Megale Syntaxis" (AD 120) which were later translated into Arabic words under the title "Almagest." He investigated more than 600 years of Greek astronomy and concluded that the basic structure of the universe is geocentric. Since his works were regarded as the most authoritative by then even contex editors for the Bible

believed in them, which thus became the ruling concept for almost 1500 years since that time.

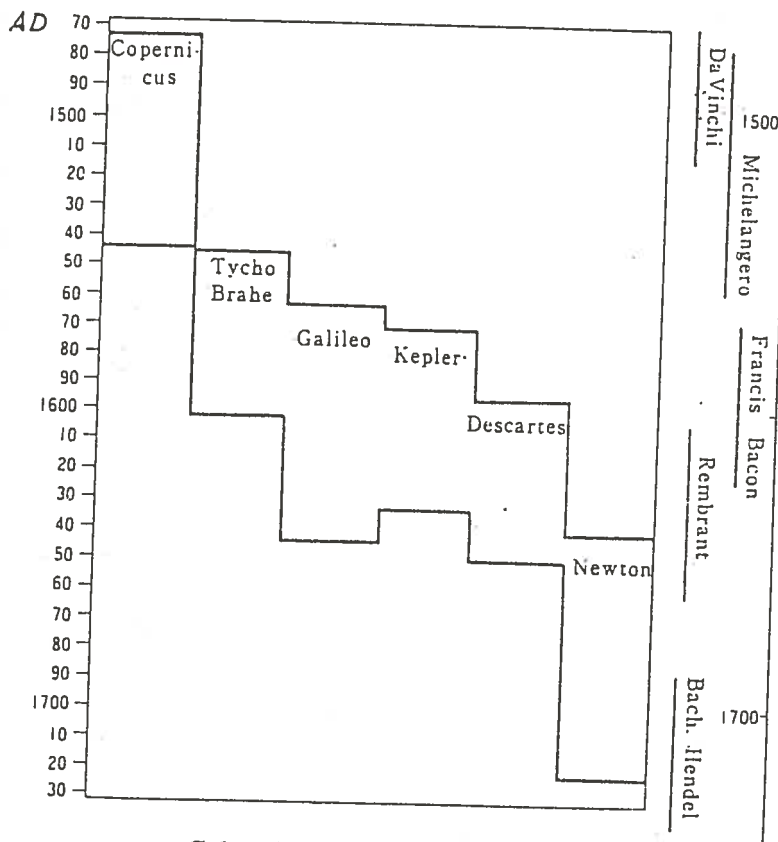
We call this period of 1500 years as the "Black or Dark Era", for no one could dare to think or express any constructive opposite opinion of any sort against Christian way of ethics in the Western world.

When 70 years old Nicolus Copernicus was near-death bed on May 24, 1543, a draft print of his book titled "De Revolutionibus Orbium Caelestium" arrived for his final inspection. His physical strength was so weak that he could not even pay a glance at it. its content stated that the sun should be placed at the center having even our earth revolving around the sun like other planets. It was a surprising blow to the ruling concept of geocentric universe designed by the Prime Hand.



Copernican Universe

Since then, Tycho Brahe, Galileo Galilei, Johannes Kepler and Isaac Newton had subsequently paved a way to establish the Copernican universe on a firm scientific foundation. Even the God's will could not win against the existing fact, which helped for the science to regain freedom to study. Such freedom had seeded new creative works in other cultural activities by various contributors namely the Renaissance artists; Da Vinci, Michelangelo, philosopher; Francis Bacon, light and shade painter; Rembrandt, founder of classic music; Bach and Handel and etc. during 16th to 18th centuries.



Cultural Giants in the Middle Ages

On the other hand, an operational aspect of the universe was pointed out by a French, R. Descartes in his book, "De La Methode", saying that "The

universe is mechanical, which has been evolved from the Chaos to Cosmos under the mechanical law commenced by our God".

Evolution From the Classical to the Relativistic View

No one would argue that Isaac Newton made the greatest contribution in exploring the mystery of the nature by means of analytical method. His discovery of the universal gravitational law introduced in his book "Principia" (1686) pulled a trigger decisively for organizing our physical world. Indeed, the birth of a new physical science by means of mathematical method should be entirely credited to his respectful ingenuity. A cluster of scientists dug in to see insight picture of both micro and macro-structure of the nature. Dynamic and quantitative aspects of analysis made by them helped a next generation to create new theories which again led to unveil hidden physical laws governing the natural world.

E. Rutherford had performed a successful experiment to sense an existence of atomic nucleus. N. Bohr thus reached an idea of hydrogen atomic model like a planetary orbit so as to explain spectral energy distribution and its size.

M. Planck drew a line separating physical world from the Newtonian physics by introducing revolutionary quantum theory of energy radiation. We also have to cite names of E. Schrödinger, D. de Broglie, W.K. Heisenberg, Pauli and P. Dirac who made distinctive contribution for the construction of quantum mechanics in order to depart from conceptual captivity drawn by the law of causality which was the entity of the Newtonian mechanics. A probable value is now regarded as more accurate than a visual measurement in the micro-world according to the quantum theory.

Such a break-through was made possible by a hand of Albert Einstein, one of the most respected scientific giants of our modern ages. His theory of relativity together with the quantum mechanics became two very dependable stems of knowledge, by which the cosmic structure as well as the micro-world's mechanism were seemingly well explained. Being encouraged by the above situation, Einstein had challenged a task to formulate a theory of unified field which was to induce in a common law applicable to conduct all of three universal forces in nature known by then. He failed unfortunately, for he did not realize one more universal force yet to be discovered.

Secret of Quarks

Fine structure of a heavier atom was not as simple as Bohr thought. Even if we are now capable of utilizing nuclear power from an atom, structural mystery of various elementary particles within the atomic world is still in veil.

In 1964, American physicists, Gell-Mann and Neéman suggested a concept of "Quark" after vehement pursuit of erratic behavior of these elementary particles.

Quark is thought to be a new sort of elementary particles within the elementary particle likewise proton or neutron and carries a fractional number of electrical charge so as to satisfy status of the proton, neutron or π particle.

Quark is of not a unique kind but of six various kinds. They all belong to Hadron family, which appear to be able to illustrate several characteristics of the Hadron particles.

However a problem still remains, for the concept of this quark is yet to be confirmed by means of either experimental or observational method. No matter how strongly let a proton be crushed by a ultra high energy particle

with a force of more than 10^4 times of binding energy of an atomic nucleus, even a single quark supposedly contained within the proton does not show up to our sight. Thus a question arises "Is quark a reality but unobservable?" or "Is our current technology still in infancy that it is incapable to dispose the quark from a proton?" Neither of the questions found an answer as yet.

Then what is the problem? Perhaps we are bound to be governed by a fate that the nature sets a certain limitation where men's interest can not dig in any further. Otherwise we might need another hundred years to develop our intellectuality.

In other words, as far as the exploration of this micro-world is concerned, we are strongly shielded by a wall of the unknown or unconquerable which is still good enough to keep men bouncing in and out. Notwithstanding, we came this far with effort of our accumulated knowledge gained for thousands years to see if we have penetrated enough into this super-extreme micro-world.

Our strategy is to break through two apparent limitations of both unconquerable speed of light and uncatchable quarks. Someday we may be able to find super-speed particle, tachyon, faster than the light, which may open a door of new world where the Einstein physics would no longer be able to stand as an authoritative logics like what happened for the Newtonian physics 50 years ago.

Cosmic Models before Hubble

As the modern physics had been struggling her way in a rough jungle of unknowns to the truth, astronomy was right along with her by motivating all the acquired knowledges of new theories and discoveries on the way. Several concepts were suggested as follows as to possible visions of the truth we would reach eventually.

In 1919, a Dutch astronomer, Willen de Sitter studied Einstein's cosmic

equation which was given to explain our universe as a static one, then pointed out Einstein's calculational mistake. He came out with a different solution from the equation which contained gravitational field with a cosmic term of universal impulse. When it was applied to a space of no substances, a space characteristics of which particles within the space show mutually receding motion causing red-shift effect in spectra was appeared.

We called his idea as a de Sitter's Space. However he did not think that his calculational results, the red-shift and space particles' mutually receding motion, meant an expanding universe.

In any rate, this model of de Sitter's Space was the first attempt to picture our universe by means of the modern astronomical as well as physical theories.

If we look up the sky in a day or night our sight get encountered with various celestial objects like the sun, moon, planets or countless number of stars and others, which indicate the space is not empty but is full of heavenly bodies. Such a fact practically raises a doubt that our universe of reality is not in a form of the de Sitter's model which is based on an assumption, idealized imaginary space. In 1922, Russian mathematician named Alexander Friedman tried with a practical approach assuming that the space was not vacant but substantial.

He set up a gravitational equation without the cosmic term used by de Sitter. His solution showed that our space would expand permanently in case the space density is under a certain value. If the density is higher, our universe, according to his solution, would repeat expansion and contraction like an oscillating universe. Unfortunately, our observational wealth by then was so poor that his theory could not attract the attention of astronomers to become popularized. There was no way to measure the space density, besides we even did not know that famous Andromeda nebula was composed of billions of stars in those days.

We could find one more distinctive astronomer from Belgium. G. Le Maitre was the man who derived a model of expanding space theoretically based on the Einstein's general theory of relativity in 1927.

At his initial stage of thinking, he believed first in static and stable primitive mini-space which suddenly started expanding, but later changed

They assumed at a very beginning stage of this universe a "Cosmic Egg" composed of free neutrons of ultra high temperature and density. These were quite different from ordinary neutrons in an atomic nucleus. Then, a big cosmic explosion took place! The free neutrons were decayed into protons after 20 minutes of life by emitting electrons and neutrinos.

As the universe kept expanding with enormous velocity, temperature of it got cooled down accordingly.

By the time of which the cosmic temperature reached around 10^5 - 10^6 electron volts, the number of protons transformed from the free neutron became comparable to the still existing neutrons.

A mixture of this state was called by Gamow as "Ylem" which meant a primitive space matter of all origin.

The protons in the Ylem captured the neutrons, which transformed into nucleuses of deuterium (α particles) and in the same time reaction of radiating γ -ray also had been taken place. Then, the deuterium started to capture the neutrons but were so unstable that they soon became helium 3 by throwing electrons out (β -decay). Again the helium 3 went after to capture a neutron in order to become helium 4. Such chain reaction had called for a helium 4 to do the same procedure of that neutron capturing works.

By repeating these reactions, some nucleuses became fatter and by causing β -decay actions their unstable problems were solved, which eventually changed some atoms to heavier elements up to uranium.

Let us review the story once more. At the very first stage of the Big Bang, it started with the protons, which had gone through more than 270 stages of neutron-capture works to become up to the uranium.

According Gamow, creation work to produce all of the natural elements in the universe needed only a half of an hour to finish the job. What a magnificent job it was!

Weakness of the adjusted Big Bang Theory

Though the $\alpha\beta\gamma$ theory seemingly advocated well of creating all of the existing elements by means of modern physics, its contradiction was pointed out by Enrico Fermi of University of Chicago that the elements heavier than the helium could not be produced in space by neutron-capture but by thermonuclear reaction within stars.

Thus the theory had to be corrected accordingly by adding several patches to holes drilled by the modern physics' news discoveries. Nonetheless, its main concept was conserved, number and time elapsed for creating elements explained in the theory were amended saying that not all of the elements but two of them, hydrogen and helium could have been synthesized in a few minutes after the Big Bang.

Table 1. Chronological Events Since Big Bang

SpaceTime	Red Shift	Event
0	∞	Big Bang
⁻⁴⁴ 10 sec	³² 10	Birth of elementary particles
⁻⁶ 10 sec	¹³ 10	Proton-antiproton reaction
1 sec	¹⁰ 10	Electron-positron reaction
3 min.	⁹ 10	Helium and Deuterium formed
1 week	⁷ 10	Radiation cooled down
10,000 yrs.	⁴ 10	Substance superior than Radiation
⁵ 3 x 10 yrs	³ 10	Space became transparent
3 bill. yrs.	5	Galactic Cluster formed
4.1 bill. yrs	4	Stars were born
15.2 bill. yrs		Interstellar nebulae formed
15.4 bill. yrs		Planets were born
17.0 bill. yrs		Micro Life appeared on the earth
20.0 bill. yrs.		Men appeared on the earth

When the cosmic explosion took place with temperature in order of 10^{12} K°, it was the time the nuclear reaction could have started. By the time the helium synthesis was about to be finished, its temperature went down to about 10^{10} K°. Table 1 shows a chronological illustration of our universe since the Big Bang.

Believe it or not, this is the best currently available list of what the most of scientists think that it is close to the reality except a moment of truth before Planck time, duration of 10^{-44} second, and question concerning a pre-assumed existing "Cosmic Egg" of enormously high temperature. If it is so, its history of 20 billion years of expansion must have meant a scale of the universe itself and radius of it should also be around 20 billion light years accordingly. If a point source with an order of 10^{12} K° gets expanded into a space with 20 billion light years of radius, its temperature would be cooled down to a mere order of about 3K°, for such high temperature gets dissipated into an enormously large volume of the space as mentioned here.

In 1965, Arno Allan Penzias and Robert Wilson of the Bell Telephone Laboratory discovered that the cosmic background radiation to be 2.7K°, which was regarded as a decisive proof of the expanding universe by the Big Bang theory.

Thus the theory showed a great success in crushing a rival theory of Stationary Universe suggested by Cambridge group of Hoyle, Gold and Bondi in 1948. Its success story obtained another credit that it could meld cosmology and high energy physics together in a crucible of the theory.

However, the theory revealed some weakness also.

It's first problem was that the theory could not answer the question, "Why was the cosmic background radiation uniformly distributed within the space?" This is called as a problem of uniformity.

The second difficulty is so called difficulty of flatness. The shape of the universe depends on the density of the space. If the density becomes larger

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than 10^{-29} gram/cm³ the space shows closed. If it gets smaller, the space would keep open which means expanding permanently. Its boundary density is called as a critical density. When the universe is of a value of this critical density, it balances with expansion and contraction to become flat. Current universe seems to be in the state of balance. However, we see that the situation with such critical density is a case of very limited yet special incidence. Actual observed density of the universe is found out to be about 1/1000 of the critical density. Since we suspect that there exists some matter in the space unobservable with our current level of observational technology, our space density lies between the value of 1/1000 to 100 times of the critical density.

Therefore our suspicion is that "Why is the space density is so close to the critical density in order to make the universe to be flat?"

The third weakness is that the theory has to start with a unquestionable assumption of a primary point in which infinite temperature and density are contained.

The fourth and the last one is a kind of the philosophical. "Why is our universe of a four dimensional space?" The Big Bang could certainly not answer this very basic question either.

New Discoveries and Philosophy of Science

As we went over a divide of the 20th century, we have encountered with various new impressive discoveries. Introduction of the quarks mentioned earlier opened a way to grasp a new force called strong force which is believed to be binding force of the quarks within nucleon. By carefully following the prediction, physicists were finally able to cope all four forces of the nature namely the strong, electromagnetic, weak and gravitational forces. Table 2 shows characteristics of these forces.

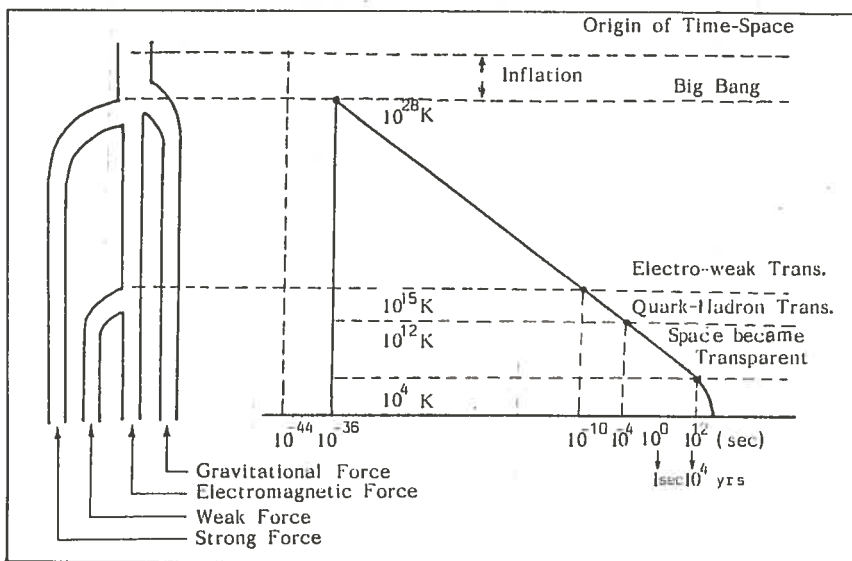
Table 2. Fundamental Forces of Nature

Force	Intensity	Range	Mediating Particle
Gravitational	10^{-39}	∞	Graviton
Weak	10^{-5}	10^{-18}	Weak Meson
Electromagnetic	10^2	∞	Photon
Strong	0.2	10^{-15}	Gluon

Right after the Big Bang explosion, 10^{-44} second later, a stem of force began to split as new forms of the cosmic components were created into the gravitational and a composite force. When 10^{-36} second had been passed, the composite force was split into the strong and a subcomposite forces by a phase-transition.

10^{-10} second later, another phase-transition took place and that subcomposite force became split again into the electromagnetic and weak forces. During these splitting processes, energy at each stage was 10^{-19} Gev, 10^{-15} Gev and 10^2 Gev respectively.

If our translation of the force history is correct, the currently exhibiting



History of Four Forces

four forces are of the same root, which should be able to interpreted by means of an unified theory.

Any force can not be influential unless there exists no object to be acted on. In other words, the force is a kind of fundamental interaction. Therefore when the force acts, it needs a stage to perform.

Physicists call such stage as a field, and the unification of these forces is often referred as the unification of the fields.

Let us take an electromagnetic interaction, and it gets mediated by electromagnetic field, which has been very rigorously defined by Maxwell equation.

However the equation would find itself unable to handle when it has to attack a problem of the field caused by micro-particles such as proton, electron or quarks. The micro world is certainly a domain of quantum mechanics as well as the theory of relativity called as quantum electrodynamics (QED) or field quantum theory, which has been developed by Heisenberg and Pauli since 1929.

According to them, the field could be replaced by a certain imaginary quantum. They also indicated that light is represented as particles of the electromagnetic field and its interaction exerted between two electric charges can be produced in exchanging light by these two charges.

Next, Let us think of the weak interaction force. It first appeared as an acting force within a nucleus when it went through a β -decay process, which was discovered later in cases of decaying elementary particles together with capture reaction of the particles. We owe a great deal to Fermi for his active theoretical research works made since 1934. Yet his works were based on phenomenal study not on analysis of the true models. Very precise understanding of this weak force was in fact made during the past 15 years.

Efforts for Unification

As a counterpart of the Hadron family, Lepton family is known to be of point source without mass but charges. Electron, μ^- particle and π^+ particles belong to this family.

It is believed nowadays that the quarks and leptons are the most fundamental particles which are materials of constituent for atomic substance. The strong force does not act between the leptons but the quarks.

As we mentioned before, four forces acting between these fundamental particles are from a same origin.

In a middle of 1970s, theory of these four forces are found to be expressed by a "Gage theory". Therefore, these force particles are often called as "Gage particles".

Two scientists named S.Weinberg of Harvard and A. Salam of Trieste (ITPC) tried successfully to unify the weak and electromagnetic forces in 1976.

They discovered a common field for these two forces and their success story is now called as "Weinberg-Salam Theory" or "Electro-Weak Unification Theory".

Another important result of their theory is that it could assign mass to weak-boson, leptons and quarks which were believed to be of no mass till then.

However the theory has its own weakness also. Though it appears to be a successful theory in unifying two forces, it is in fact not a real theory of unification, for the theory does not fulfill a condition that the unified interaction should be expressed by one parameter. The Weinberg-Salam theory carries two parameters instead.

On the other hand S.L.Glashow's group of Harvard thought of even more ambitious challenge for unifying three forces namely the strong, weak and

electromagnetic forces. Their attempt was called as "Grand Unification Theory". Contrary to the Electro-Weak theory which tried to put two forces together, the GUT's effort was to fuse these forces by reorganizing fields of the three interactions.

One has to note that the theory must satisfy the generalized Gage principle.

The Gage theory states that when two or more forces are unified, a respective proper yet very heavy particle would be produced. In case of the W-S theory it predicted a birth of meson with mass of 100 times heavier than a proton, which was eventually discovered experimentally, and thus confirmed the W-S theory.

What if the GUT is applied? It predicts a particle 10^{15} times heavier than a mass of proton!

We call this as X-particle. If we want to discover the X-particle by an experiment with a particle accelerator, its scale should be as big as a size of our solar system! Even with this a kind of unrealistic theory, we can still trace back up to 10^{-36} second after the Big Bang. The reason being that we have neglected the remaining gravitational force. If we wish to advance further to the moment of truth of the Big Bang, we need to have the unified theory of the four forces including the gravitational.

It can be called as "Super Grand Unified Theory". In this case, predicted size of a particle produced will become infinity! This is impossible.

Let us change our thinking point of view, a case that the universe itself becomes ultra high density and the gravitational force is comparable against the rest of three forces. The condition which satisfies a state of the universe is expressed by a series of physical quantities called as "Planck Units". The units are so called that mass, energy length and time are expressed in terms of combination of three constants namely G; gravitational constant, c; velocity of light which characterizes the special theory of relativity and h ; Planck constant which is the specific constant of

quantum mechanics. 6.6×10^{-34} joule · sec.

Table 3 shows a list of these Plank units.

Table 3. Planck Units

Name	Formula	Quantity
Planck Mass	$(ch/G)^{1/2}$	10^{-5} gr
Planck Energy	$(c^5h/G)^{1/2}$	10^{28} ev
Planck Length	$(Gh/c^3)^{1/2}$	10^{-33} cm
Planck Time	$(Gh/c^5)^{1/2}$	10^{-44} sec

G: Universal Gravitational Const.
c: Velocity of Light
h: Planck Const.

The Planck time means the instance when the gravitational force was split to be branched out after the Big Bang. How about the size of the universe which satisfies the Planckean condition? That space has to be in order of 1/10000 cm by a length! According to our calculation, number of substantial quantity in the whole universe is 10^{80} in terms of number of protons. Besides, number of photons and neutrinos are amounted to be a billion times more than that of protons. How could we imagine that these enormous amount of matters be squeezed in a space of 1/10000 cm scale volume which is much smaller than a size of a pin-hole?

How can our astrophysics solve this problem?

Are we stranded because the method of analysis developed in the last hundred years has misleded us? Or, would God not permit men to infiltrate the domain of sanctity?

String Theory as a miracle Theory

There is another theory which has been trying to unify the forces in the nature. It is called as "Super String Theory". Because it possesses the most probable possibility of unifying these forces, which is sometimes regarded as the ultimate theory or a miracle theory, for it throws a spot light of hope at our dismayed situation confronted by the other unification theories.

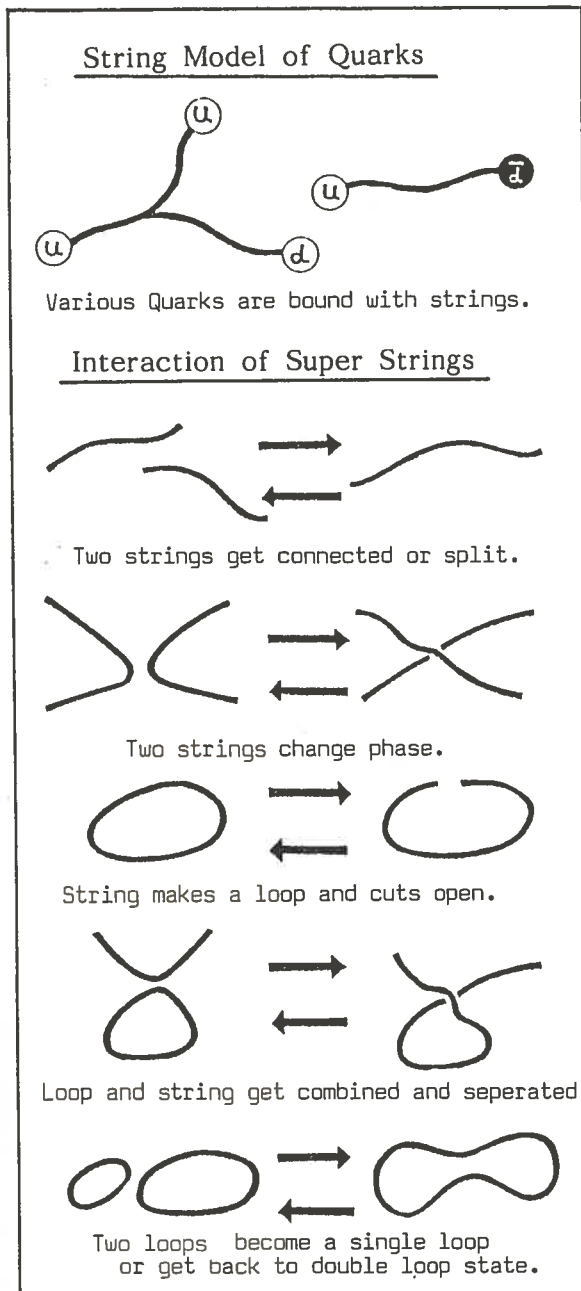
An advantage of this theory is based on a fact that all of the particles which constitute the matter and forces can be translated as being born naturally from a string of the Planck length, 10^{-33} cm, in a state of ten dimensional time-space. This is why we call this as a super string. The theory was first inaugurated by a British M. Green of Queen-Mary University and others in 1984. They started with a problem that why couldn't the quantum theory of 1970s find an answer about an impossible situation of distracting free quarks from Hadron particles. They came up with an idea that because there existed a mediating particle yet to be discovered. The particle was named as "gluon" and it was regarded as a sort of string which is a strongly binding medium between quarks. The super spring is elastic and its elasticity coefficient is 10^{39} tons/cm, which can act each other, and at the same time it can also act on itself.

Though the Gage particle and Fermion are interpreted as due to the strings' interaction and vibration respectively, the interactions are limited to types in the following illustration given in the next page.

The Super String theory can advocate the fundamental interaction using such models of the strings as follows.

The Gage particles mediating the electromagnetic, weak and strong interactions are due to vibrations from open super string's both ends. On the other hand, the gravitational interaction is due to a vibration from a closed ring form of the string.

Existence of the Fermion can also be explained by a multiple sound Wave of the fundamental vibration of the string.



Thus we may encounter with a situation that since the closed super string should be made of an open string, the former theory must be contained within the latter theory. The answer is clear. The gravitational interaction born from a form of the ring is a result of these interactions (Gage interaction) of three electromagnetic, weak and strong fields produced by the super string. This is a surprising consequence.

The Super String theory did the job of the Grand Unification which most of the physicists could not do since the era of Einstein even with the GUT.

There was one more problem of quantum mechanical extra-ordinary term which could not be solved by either theory of general relativity or Gage theory that particles' probability of existence often became negative(-). However the super string theory also conquered the problem by introducing some kind of Gage symmetry. This is why theory is often called as a "Miracle Theory".

Sometime later a group of four men led by D. Gross of Princeton listened to a concert of the String Band of Green and Schwarz. They composed better music of the Super Spring quartet than the Duet group. Though the nick-named Princeton String Quartet played superior music we should not forget to pay a proper respect to those who had played a pioneering String Duet.

Current Vision of the Galaxies

The cosmos has been busy in revealing her true picture one by one during the last 50 years. Baade extended its scale to a radius of 20 billion light years.

A rise of radio astronomy extended our knowledge up to the edge of the universe. A detailed spiral structure of our own Galaxy was vividly pictured by 21cm radio wave observations. A accidental discovery of a

pulsar opened a new world of astronomy and it led us to develop theories of condensed matter and objects like neutron stars. Quasars near the cosmic horizon were caught, which furnished us an enormous amount of new information concerning an evolutionary aspect of galaxies and even the universe itself.

A concept of a "Black Hole" suggested by Oppenheimer of Princeton in 1936 became unconfirmed reality.

Space astronomy and bioastronomy became favorable fields of front-runners to study in 1980s. These investigations and research activities have been carried out on the accepted assumption of the cosmic uniform density distribution attributed by the Big Bang Theory.

Recently one tried to plot 58500 known galaxies on a two dimensional celestial plane with the help of a computer. It clearly showed that these distribution pattern was not uniform in density. Apparently they were of galactic groups and local galactic groups. A typical galactic group is such that about 5 galaxies are gathered within a region of 1.5 million light years in diameter. Their relative velocities come up to be 100 km/sec in average.

We also find cluster of galaxies in which 50 - 1000 galaxies are crowded within a volume of a side length 10 million light years. About 4000 such galactic clusters are now catalogued. Each galaxy of the members show relative velocity of 1000 km/sec.

In 1978, we learnt that two galactic clusters of Coma Berenices and its nearby A1367 are over-lapped as if the former is placing a bridge over the latter, from which a super galactic cluster together with a galactic void were discovered.

In 1981 the galactic void of 300 million light years was also discovered in Ophiuchus.

These continuous yet very surprising new discoveries stimulated the Harvard-Smithsonian group led by R. Davis. They organized a project "CfA Survey" and investigated red shifts of 1942 galaxies brighter than the

apparent magnitude, 14.5. Their first survey report was made in 1982, and they showed us that the super composite structure of the galactic cluster and voids are popular in all over the cosmic space.

Their second survey work was extended to the galactic objects of up to 15.5 apparent magnitude.

The number of the galaxies were amounted to be more than 30,000.

In 1986, M. Geller of Harverd-smithsonean who had been engaged in this survey works for ten years made a public announcement that the galaxies are in fact distributed over surface of bubble-like void, 60~150 million light years in diameter and they apper to be occupying the cosmic space likewise a sink-full of bubbles of detergent in a kitchen.

Accordingly we found a boundary wall of our Galaxy's bubble structure, which is now named as the "Great Wall". Such walls are immensely inter-related to form "Picket Structures" in the cosmic space.

Such uneven super structure of the galactic clusters would cause corresponding gravitational density distribution. Since we are still in a foggy situation for digging ore of "Dark Matter" out from the space mine, any confident study of this intensity distribution of the space gravity seems to be impossible.

However there were so called "Seven Professionals" led by A. Dresser who had dared to make a challenge at the problem. They investigated peculiar motions of 400 elliptical galaxies up to 400 million light years away from us in 1980s and what they found was that all of galaxies located within a range of 300 million light years from our Galaxy are moving together in the direction of Centaurus and their everage velocity measured by our Galactic position comes out be 500 km/sec.

In other words there might be a mysterious object located in the direction of Centaurus and is attracting the galaxies mentioned above. They called it as a "Great Attractor." According to their calulation, the attracter is located at a distance of 150 million light years from us and its mass is estimated to

be equivalent to those of 100,000 galaxies or 10 super galactic clusters. Then, a question arises "What is the entity of it? So far, we could not find an answer as yet.

The Seeding of Life by Comets

We see this wonderful earthfull of lives, men, herd, fishes, insects and herbs as the result of cosmic evolution. No one is possible to prove decisively where they came from. This is why science and religion are still standing apart persisting opposite views concerning the origin of life. As far as we can see, the mystery of life is still unexplorable domain of either molecular biology or biophysics even though we have come so close to it. That's where theologians would come in to infer as due to the Prime Hand.

However, very recently an interesting work was reported in 1990 by J. M. Greeberg of Leiden University that lives on the earth were seeded by comets!

According to his statement we read that the chemical prebiotic evolution on the earth might had been initiated by the earth-bombarded fragments of the comets.

With what we have learnt from the space missions it has become clear that the comets' chemical composition showed a large fraction of quite complex organic molecules. In addition to it, we found that the comets are consisted of very fluffy aggregates of interstellar dust whose chemistry derives from photoprocessing of simple ice mixture in space.

Therefore, Greenberg believes that the ultimate source of organism in comets comes from the chemical evolution of interstellar dust. Thus, he insists that an important and critical justification for assuming that interstellar dust is the ultimate source of prebiotic molecular insertion on

the earth is the proof that comets are very fluffy aggregates, which have been shattered in fragments when the comet impacts the earth's atmosphere.

His observational together with laboratory experiments so as to reproduce the cometary according to the concept of the interstellar dust are quite convincing as a matter of fact.

If his theory is true, there must be lives on many other heavenly bodies since the interstellar dusts are the most commonly existing media among stars.

In order to find a clue to this honest question, a research committee was organized as the Number 51 Commission of International Astronomical Union in 1982. During the past ten years three symposia meetings were held at Boston, Balatonfüred in Hungary and Val Conis in France, at where many encouraging papers were presented ranging from searching another planetary system like our solar system to a possible contact with signal from extraterrestrial intellectuls. We hope a next place for such symposium would be held in Seoul as we are eager to support the meeting.

What Ignited the Cosmic Explosion?

Let us again go back from the present to the cosmic beginning of 20 billion years ago. As we have examined the Big Bang theory in this paper already, it has to start from an assumption of an existing cosmic egg of some sort which contains unimaginable super high temperature with ultra high density.

Then, how was the fire ball created? Until about five years ago, it was still within a palm of the Prime Hand.

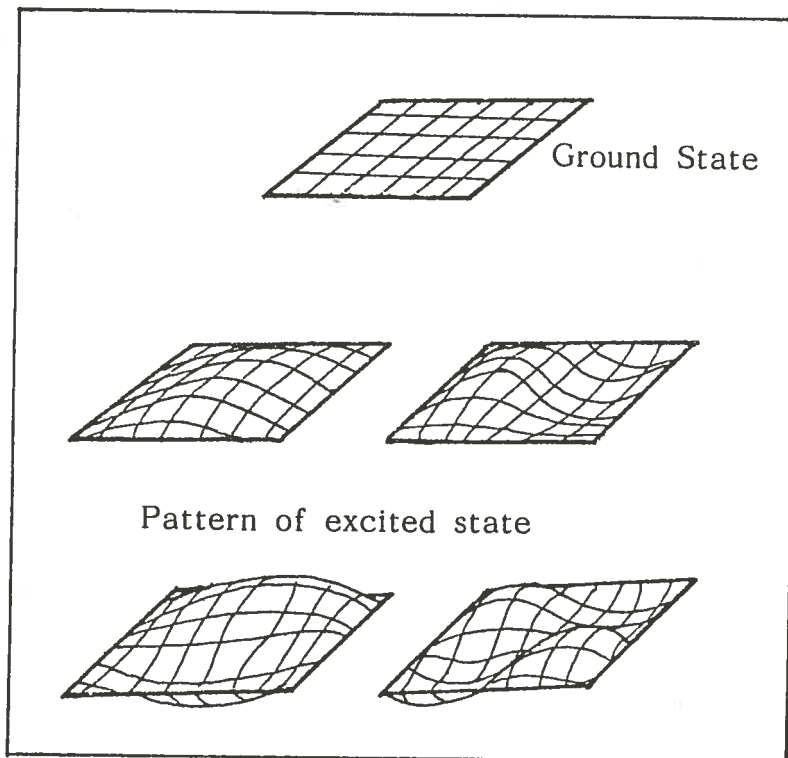
But the quantum mechanics finally constructed a theory that the assumed fire ball could be created from a state of nothing, the vacuum!

According to our common sense, the vacuum should mean "nothing" or

absolutely vacant state. If we have to prove nothing, then we have to know everything in the universe, otherwise we can not say that there is nothing we know of, because it is absolutely impossible to prove ourselves that we know everything.

In other words, a state of vacuum must mean that it is not a nothing but a state where no particles or substance we know of are contained within.

Therefore if we define a substance as a form of collective particles like what an energy is expressed as countable particles, the vacuum can be interpreted as a state of where not a single particle is in an excited level. A ground energy level of the vacuum is expressed as a lattice formation of medium composed of phonons by the quantum mechanics. Existence of any elementary particles is thus explained by a degree of excitation of the lattice of vacuum.



Ground and Excited state of Vacuum

The vacuum energy before a birth of the fire ball had higher energy level than the current vacuum. Since the prevacuum state was rather unstable it called eventually for a phase-transition that the energy difference was liberate by means of inflation to become innumerable cosmic bubbles, from which one of them became a seed of the Big Bang. This is an essence of the "Inflation Theory" which is believed to be igniting the cosmic fire ball for the historic explosion.

Chaos in Theories But in the Universe

Cosmologic discussion we have reviewed here has been mainly focused on a point of view, "when" or "how" was the universe was created. But in 1937 Dirac thought of it by a different angle to ask "why".

He first payed an attention to the weakest force, gravitation, among the fundamental forces. Its magnitude, if we neglect fractional difference, came to be 10^{40} times weaker than the strongest force, the electromagnetic.

Next he compared atomic unit which is the time needed for the light to cross a radius of a proton against Hubble age of the universe. The age of the universe came out to be 10^{40} time of an atomic unit.

Total number of nucleons (protons and neutrons) are estimated to be $(10^{40})^2$.

When we compare its nucleon number against the super galactic cluster's substantial density it also came out to be 10^{40} !

In other words, there must be a hidden factor or law of mutual relation among these age, gravitation, electromagnetic force and number of the elementary particles which can be expressed by an order of 10^{40} .

This is called as Dirac's "Great Number Hypothesis", which has been remained to be unsolved so far.

In 1986, E. Fishback of Purdue University announced that there might be one more force, the "fifth interacting force", besides the four forces we

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have been discussing here. He made the report from his analysis of old observational data made during the 19th century.

But in the following year, 1987, D. Ekhart of the American Air Force made another surprising report at the Autumn meeting of the American Geophysics Union that there may exist even the "sixth force"!

He obtained a clue from his experiment of measuring the gravitational differences as he changed altitude along a 600m television tower. He compared the observational against the theoretical values and found a systematic deviation between them which may have been caused by the sixth force.

If these are true, currently accepted standard theories of high energy physics or the unified force theories must face a new problem or difficulties.

Besides B.Tully from University of Hawaii declared in 1987 that he discovered a composite structure of super galactic clusters whose size is of a billion light years in length and 150 million light years in width. There are 1000 galaxies in that structure. We may call it as another unique structure, "Ultra Super Galactic Cluster".

He added a comment that the structure was formed right after the cosmic formation, it may cause another challenge to the existing theory which has been regarded as the theory which can explain everything. John Ellis of CERN reported in an issue of October 8, 1987, Nature that a few theoretical attempts have been made in order to describe the Super String directly by the four dimensional coordinate systems instead of 10 dimensional treatment. If this so called compactization is successfully done, a new hope will be lighted so as to guide us to reach closer to the entity of the true story about the creation of our universe.

As we learn more about the cosmological theories, we feel that we are in a state of more confused chaos from which we can't swim out even though we are living in a beautiful pool of the universe.