Draft

Philosophy of Science (at the end of 20th Century)

"Science is like a boat, which we rebuild plank by plank while staying afloat in it"

Neurath

Introduction

The thinking man, the Homo Sapien Sapien, emerged on the earth about 40,000 years ago as a product of 3 billion years of evolution beginning as a single celled organism. Man acquired the facility of some kind of language communication not more than 10,000 years ago and started living in communities. Based on our daily experience and the type of questions that we ask ourselves or others, we can surmise what kind of questions should have bothered these early men and women who did not have the benefit of the cumulative knowledge that we possess to-day. Let us guess and list some of them.

Why do things change around us? Why day? Why night? Why seasons? Why rain? Why thunder and lightning? Who or what causes these changes?

Why disease? Why death? What happens after death? What is responsible for all the activity that characterise us when we are alive? What is the origin of man? of the earth? of the sun? of the stars? What is responsible for their motions?

As slowly ideas of space, time, causality emerged and concepts of mass, velocity, force etc became common usage and parlance, more fundamental questions must have occurred to them; like:

What is exactly space? What is time? When did time begin? How vast is space? How far are those objects in the sky? What is responsible for the regularity of the motion of planets? Who controls all these motions?

How old is the earth? the universe? What will happen in the future?

What is the difference between the waking state and the dreaming state? What happens to all this activity when we are in deep sleep? What is the connection between the mind with which we perceive and think and the external world of objects? What is responsible for our emotions – joy, sorrow, feeling of guilt, depression etc?

What is life? What is consciousness?

These types of questions must have occurred to people at different stages of their lives and to people in different parts of the world. There were some persons who had higher intellectual abilities who tried to find answers to such questions on the basis of their own thinking and by discussions with others around them. There must have been two kinds of motivations. One was to acquire knowledge and utilise it for meeting their daily necessities - food, water, shelter, protection from animals and natural disasters, rigorous of climate etc. The other must have been to satisfy their curiosity – an inborn trait that is especially strong in man.

Over a period of time these intellectual activities of man led to the development of various philosophies and religions in different parts of the world. About 400 years ago, modern science emerged branching off from the philosophical approaches and adopting a new methodology of investigation and has been eminently successful in meeting both the requirements of man – the utility aspect – which is science based technology and the curiosity aspect- the fundamental sciences. While science has answered many questions of the old kind, it has also raised many new ones which have a bearing on philosophical issues- particularly on the most outstanding issues.

Since this booklet is on "the Philosophy of Science at the end of the 20th century" and since practically most of modern science has come out of efforts in the west, the first three chapters of the book deal with the following topics: In the first chapter, the status of western philosophy before the dawn of modern science in the early 17th century is presented. The second chapter deals with the relevant developments in science till the end of the 19th century and their philosophical implications. The third chapter focusses on the far reaching developments that came about in the present century and the profound effects these have had on the philosophy of science. In the fourth chapter we

discuss the influence of Science on the Western Philosophical thought especially in the 19th and 20th Centuries. Some aspects of the philosophy of science as it stands today remind us of close parallelisms with ancient philosophical insights especially of the east. Bearing in mind the caution that modern science does not need the ancient insights for its furtherance and ancient philosophies do not need ratification of modern science, but philosophers of any hue at any time need to keep an open mind and should welcome inputs from ~~any~~ all quarters, in the fifth chapter some relevant aspects of ancient philosophies especially those that reflect a holistic view are presented. The quest behind philosophy and science is the same; what is the ultimate "Reality" behind all appearances? In the concluding chapter we examine the question as to where we stand with respect to these fundamental issues at the end of the 20th century.

Chapter1:

The very Early Western Philosophers

Thales of Miletus (640-546 BC) one of the earliest Greek philosophers set out to answer the question" of what and in what way the world is made?" and emphasised the importance of gaining substratum of facts to build a body of objective knowledge, facts that should be independent of the judgement of individuals. The famous Greek mathematician Pythagoras (570-501 BC) believed that everything whether physical properties or moral qualities are interpretable in terms of numbers. The structure of the physical Universe is deeply related to the Structure of the Mathematical Universe Pythagoras "considered number as the substance of all things". However, when he realised that the square root of number 2 is not expressible as a ratio of integers, he lost his confidence in the supremacy of numbers.

Leucippus and Democritus (470-400 BC) maintained that everything in this world consists of `atoms' and `void' – the emptiness between the atoms. Epicurus (341 BC) believed that the number of atoms was `infinite', and so also the `void'. As we shall see what appealed to Einstein most of all was Democritus' firm belief in the Omnipotency of Physical Causality.

Zeno, well known for the hare and tortoise paradox, (a tortoise given a little lead, would reach the destination earlier than a hare eventhough it moved much faster) was of the view that the world is moving towards a perfection designed by God. He believed that man could at least in part achieve the same capability.

The Mediaevalist Philosophers

Socrates (469-399 BC), Plato (429-347 BC) and Aristotle (384-322 BC) placed mental capabilities at a higher pedestal and firmly believed that mathematics provided a crucial key to the secrets of nature. They had no love for experimental knowledge. Theirs was essentially a holistic comprehensive approach, which was also characterized by the firm conviction that the universe proceeded as if it had a specific purpose to fulfil – a teleological outlook that was based on reason and revelations.

Aristotle, believed that all things great and small are exemplification of the existence of supreme order in nature that could be figured out by reasoning and the scriptures contained divine revelations on matters not accessible to reason. By

synthesizing these two kinds of information everything worth knowing could be learned. This synthesis was achieved by St. Thomas Aquinas (1225-1274). During the mediaeval period the emphasis was more on `Why things happened than on how things happen?

To understand Reality, Plato who was the first to establish an `academy' of the world, stated that we must make a clear distinction between Sensibilia and Intelligibilia - what the mind perceives through the senses and what it apprehends by thinking. According to Plato, reality is not to be found in the world of Sensibilia, the physical world but rather in the world of intelligibilia, which is where all mathematical entities and other non-physical objects of thought are housed. His ambition was to "poetize phenomena" and reduce the whole universe to a small set of abstract concepts and principles.

According to Plato non-physical objects like numbers, feelings of sameness, goodness, rightness etc reside in our brain and are a consequence of the judgements that the mind passes on sensations. Plato believed that the human mind is equipped from birth with a set of Forms or Ideas which exist independently of the external world. Each object is the meeting place of several such Forms. When we talk about a Red Square Brick, we have the confluence of three forms and a piece of matter, redness, squareness and brickness and a lump of the raw material of the external world. The only sure knowledge we have is of these forms and their relations only; we have no sure knowledge of the external world. These Forms of Plato, it should be emphasized were supposed to be inborn in each individual, as if they were memories from a past life. Only "Pure Reason" he thought would lead to truth. For Plato ordinary objects were changing and corruptible while the Forms were perfect, unchanging, eternal, `more real than real things'.

Plato also believed in a universal soul that was non-physical and immortal. He considered the body as a prison for the individual soul, and death was its liberation. The soul was considered to be the principle of `life' and of `motion'. Clearly there were two distinct substances, the mind-stuff and the material stuff, in Plato's theory, and therefore it is a dualist theory – Substance Dualism.

To emphasize the distinction between appearance and reality Plato resorted to the famous allegory – the citizens are confined within a cave and can watch only the shadow

play on the wall in front of them, without realizing that "the reality" is behind them in the world outside the cave – a two dimensional shadow play of a three dimensional world. The Philosopher among them turns his head and looks at the world outside "The real philosopher is the person who escapes from the cave into the light of truth - he is the one who acquires the real knowledge".

In the two thousand years that followed Plato, people were concerned more about Soul and God and not about the outer world. These concerns persisted in the west till the Renaissance Period when the emphasis shifted.

The Philosophers of the Renaissance Period.

Hobbes (1588-1679 AD) is regarded as the first modern philosopher, who defined philosophy as the study of effects from causes and of causes from effects. He was a pure materialist. He regarded the whole world as constituted of matter essentially in motion. For Hobbes, matter was the only reality. He regarded man as an animal with a material body; thoughts, emotions etc. being a consequence of the mechanical motions of the atoms in his body. Naturally in this kind of approach there is no scope for free-will and everything is predetermined.

Descartes (1596-1650 AD), the famous mathematician and founder of analytical geometry, after whom the well known Cartesian Co-ordinate System is named, was one of the founding fathers of modern science. How can any one doubt his own thinking for to doubt is to think? Descartes said "Cogito ergo Sum" which means "I think, therefore I am". But what is the connection between "Being" and "thought"? There can be no thought without "Being", but there can be "Being", existence, without thought. Being therefore is more extensive than thought. There could be an outside world.

He made a distinction between mind and matter. He contended that mind is to `think' and matter to occupy space. According to him the inner ideas, which have their origin in the vision of the intellect must be true. While Descartes believed that mind is made of subtle matter distinct from ordinary matter, he did not clarify the distinction and the connection between mind and matter. His followers said that "God had so ordained that activities of the mind and of matter corresponded exactly to one another in perfect synchronization".

Despite all the emphasis on matter and subtle matter, Descartes believed that the external world was inferential in nature and not one of direct perception. In this sense he is regarded as one of the founders of Idealism and it is said that it is his idealism that paved the way for Berkelian idealism, which we will come to later. Descartes believed that Soul was distinct from mind.

Leibniz (1646-1716 AD) was a German Mathematician, a contemporary of Isaac Newton, his professional rival claiming himself to be the discoverer of Calculus, (not without reason) echoed the ideas of Descartes on the duality of mind and matter. He said "In the beginning God created mind and matter in such a way that each can follow its own laws and yet the two move in perfect agreement as would prevail if God for ever was putting his hands to set them right". He was convinced that "so great a craftsman as God who could make Caesar's body and prearrange its atoms so that it should go to the senate house at such and such an hour on the Ides of March" could manage anything, and everything. According to Leibniz, the soul was a special type of "monad" an essential psychic unit. There were according to Leibniz an infinite number of monads – organismic units of psychic nature. Interestingly Leibniz described philosophy as the discipline in which you kick up lot of dust and then complain you can't see.

Benedictus Spinoza (1632-1677) has been characterized by his contemporaries as a God-intoxicated jew and a rare metaphysical genius. While Descartes believed in a duality of God and a real world created by God, Spinoza reduced his duality to a universal unity, which he called "the substance".

As Lewes in his History of Philosophy has put it, the doctrine of Spinoza (as outlined in his book "Ethics") is: "The great reality of all existence is substance. Not substance in the gross and popular sense of body or matter, but that which is substans – which is standing under all phenomena supporting and giving them reality. What is a phenomenon? - an appearance, a thing perceived, a state of the perceiving mind? But what originates this perception – what changes the mind from its prior to its present state? Something external and extrinsic changes it. What is this something? What it is in itself? This Spinoza called "Substance". This Substance was God for him – the only reality. He denied a cosmic purpose. According to him events in nature happened in accordance

with laws of cause and effect. He denied a personal God. According to him "the better one understands how the universe works, the closer he comes to God".

Kant (1724-1804) brought in an entirely new perspective. He maintained that the object and its mental picture are entirely different, since the frames through which we perceive are dependent on the mind. The "thing in itself" is not accessible to our senses. In the inborn mind there are a number of principles or facilities to discover truths about the universe. He went so far as to say that it should be possible to construct a pure science of nature which would be independent of all experiences of the world, thus stressing on the superiority of 'a priori' knowledge over "a posteriori". According to Kant the science of nature so constructed would be uncontaminated by errors and illusion of observations. Kant believed that our apprehension of the inner world is not any more privileged than our apprehension of the outer world.

Descartes, Leibniz, Spinoza and Kant were classified as rationalists since they maintained that true statements about material world can be made only through the power of reason without sense experience and that all knowledge must be obtained through contemplation. They firmly believed that knowledge obtained through direct observation of nature through the senses could be deceptive.

In contrast to the "rationalists", there was, around the same period, the school of "empiricists" who held that knowledge comes from experience alone and the only way to discover the facts about the universe is to go out into the world and search for them. However the prominent empiricists, none of whom had any scientific background, held different views on the role of mind in accessing reality of the external world.

According to Locke (1632-1704), the impressions produced by objects on the senses are vague in the first instance, but become definite and meaningful only by repition. At birth the human mind was a tabula rasa, a blank tablet. Locke says "In time the mind comes to reflect on its own operations about the ideas got by sensations and thereby stores itself with a new set of ideas which I call ideas of reflection. Thus the first capacity of the human intellect is that the mind is fitted to receive the impressions made on it through senses by outward objects or by its own operations which it reflects on them". According to Locke, all knowledge being of the nature of ideas, there can be no claim to anything beyond them even God or Nature.

According to Berkeley (1685-1753) "All that we know is only our own mind and its states and ideas. There is no doubt a law that regulates their concomittances and succession, a law for which we feel we are not responsible. In that case the only sensible view can be it proceeds from an omniscient mind – namely God…..

What we call "things" are but our ideas. They are real in so far as they are percepts. There is nothing in the `thing' which is not reducible to an idea;; or a bundle of ideas – a `thing' cannot transcend the nature of ideas, cannot become, by any kind of reasoning, other than what it is perceived to be. A something behind a percept has either qualities or not. In the former case it is akin to our percept and no more. In the latter it is unimaginable and therefore unreal., for what is imaginable is only what can be perceived or conceived as a sum of qualities or sensations". Berkeley, the arch enemy of materialism stated "All the choir of heaven and furniture of earth, in a word all those bodies which compose the mighty frame of the world, have not any substances without the mind……. So long as they are not actually perceived by me or do not exist in my mind or that of any other created spirit, they must either have no existence at all or else subsist in the mind of some Eternal Spirit".

Hume (1711-1776), on the other hand questioned the basis of the mind itself. He said "we are immediately made aware of feelings, sensations, volitions and cognitions – of pleasure and pain; of love and hatred, of sound and colour, but we can never come across the supposed substrate of feelings – the mind. It is as much a phantom haunting an unreflective man, as matter apart from sensation ….. there is neither mind nor matter, all is idea changing every moment. No substance, no reality ……. There is no permanent, immutable element in the world of our experience and there is no valid principle which can justify metaphysical speculation concerning the world beyond our experience". It is impossible to penetrate into the causality of observable phenomena" – an extreme skeptical attitude.

In his book "Physics and Philosophy" Sir James Jeans, a scientist well known for his books on popularizing science, pointed out more than fifty years ago that there has been a change in the view as to the proper aim of philosophy. "The ancient philosophers pursued their studies in the hope of finding a lantern which should guide their feet along

eighteenth centuries in a fixed determination to find evidence that this journey ended in a life to come. This humanistic tinge has taken a long time to disappear; but has almost done so in recent years; philosophy has become less concerned with ourselves and more concerned with the Universe outside. It is now recognized in Bertrand Russel's words "Man on his own account is not the true subject matter of philosophy. What concerns philosophy is the universe as a whole; man demands consideration solely as the instrument by means of which we acquire knowledge of the universe. .... We are not in a mood proper to philosophy so long as we are interested in the world as it affects human beings; the philosophic spirit demands an interest in the world for its own sake". This is precisely what happened in the 16th Century and during the following centuries. The emphasis shifted to the outer world.

Chapter 2

The Classical Mechanistic World View

Science undoubtedly began with a systematization of the observations of the sky, in particular the regularities of the motion of planets. The Egyptian astronomer Ptolemy (127-151 AD) had proposed the Geocentric system according to which the earth was the centre of the Universe. Almost one thousand five hundred later in 1540, Nicolaus Copernicus (1473-1543) came out with the Heliocentric theory according to which the sun and not the earth was the centre of the Planetary motions. The observations of Tycho Brahe (1546-1601) and of Galileo (1564-1642) supported the Copernican theory. Kepler (1574-1630) came out with the Planetary laws based on the painstaking observations of Tycho Brahe. Shifting the Centre of the Universe, as known at that time from the earth to the Sun was not liked by the Church, which had become politically very powerful by then. Consequently the famous book "De Revolutionibus Orbarium Coelestium" written by Copernicus was deliberately so much delayed in publication that the first copy of the book was brought to him, while suffering from apoplexy and brain hemorrhage and was in his last moments. A strong proponent of the Copernican theory, Giordano Bruno was burned at the stake because of the hostile Church. Strangely even in the 18th century, some of the American Universities like Yale and Harvard taught both Ptolemaic and Copernican theories. It was only in 1822 that the Roman Catholic Church gave permission for the Copernican system to be taught as the truth and not just a hypothesis.

In his earlier days Einstein, regarded Galileo (1564-1642) as the father of modern physics, because Galileo drummed it to the scientific world "Pure logical thinking cannot yield us any knowledge of the empirical world; all knowledge of reality starts from experience and ends in it". Surprisingly as we shall see, Einstein himself changed his views on this aspect of superiority of empirical knowledge over rational thinking.

Galileo held that mathematics, in addition to observation, is the true key to natural phenomena. He was of the view that the non-mathematical properties in nature are entirely subjective, and have no existence outside our senses. In this he included such properties as colours, sounds, odours. He thought all these are in our minds. In the

absence of mind, the universe would be just a drab collection of masses of various sizes, shapes, weights without colour, sound or odour.

This attitude had important philosophical consequences. The mediaeval philosophers had advocated the view that the purpose of everything was to reach to a higher state of being, culminating in the union with God. Time was the essential instrument that brought about this transformation. With all the important qualities being attributed to the power of the mind, stripping them from the external universe, the all important role of time was now being negated. The real world became a world of material particles moving in accordance with mathematical laws through space and time without a goal. Strangely enough God was no longer required for controlling the phenomena continuously, but was still required for starting the whole process.

Isaac Newton (1642-1727) was born on Christmas Day in the year that Galileo died. Newton's contributions to science were truly multidimensional. Newton formulated the solid framework of classical physics. While Galileo believed in the necessity of mathematics for explaining natural phenomena it was Newton who was the first to bring about a fusion of mathematics with the empirical outlook, the formation of the scientific methodology. About experimental methodology Newton writes in his "Principia":

"…….. This analysis (methodology) consists in making experiments and observations and in drawing general conclusions from them by induction and of admitting of no objections against the conclusions, but such as are taken from experiments or other certain truths. For hypotheses are not to be regarded in experimental philosophy…… But if at anytime afterwards any exception shall occur from experiments, it may then be pronounced with such exceptions as occur. By this way of analysis we may proceed from compounds to ingredients and from motions to the forces producing them: and in general from effects to causes, from particular to general….."

Clearly for Newton, experiment was the final test. He dispensed with final causes as driving the present; preceeding physical events determined the future. He had no need for concepts like purpose. Newton agreed with the Galileo's view of the subjectivity of secondary qualities like colour, sound, etc. He said: "…… For the rays, to speak

properly, are not coloured. In them there is nothing else than the power and disposition to stir up a sensation of this or that colour. For as sound in a bell or in a musical string or other sounding body, is nothing but a trembling motion, and in air nothing but that motion propagated from the object, and in the sensorium `tis' a sense of that motion under the form of sound ....."

Newton's ideas on space, time, matter and motion were extremely important for the progress of classical physics.

Newton believed in the existence of absolute space and absolute time. According to him, material particles that constitute the external world moved in absolute space and absolute time. His dictum was that absolute space exists in its own nature without regard to anything external and is always similar and is innovable. All changes are described in terms of absolute time which is the same everywhere in the Universe and has no connection with the material world and flows smoothly from the past to the present and will flow to the future without regard to anything. All matter is made of solid and indestructable particles - mass points.

Though there are some similarities with the old Greek model of Democritus to which we have referred earlier, in the Newtonian model the concept of Force is introduced. This force of gravity, Newton assumed was proportional to the product of the two masses between which it is acting decreasing as the square of the distance between them – the famous inverse square law of Gravitation. Newton assumed that the force acts instantaneously irrespective of the distance. To the question "how does the action at a distance take place?" Newton's answer `was: "God only knows". Newton also believed that God, not only designed nature initially but also every now and then made the necessary adjustments with the mathematical machine that kept the world going. Newton is his book "Opticks", writes

"It seems probable to me that God in the beginning formed matter in solid, massy, hard, impenetrable moving particles of such sizes and figures and with such other properties and in such proportions to space as most conduced to the end for which he formed them and that these primitive particles being solids are incomparably harder than any porous bodies composed of them, even so very hard as never to wear or break into

pieces; no ordinary power being able to divide what God made himself in the first creation".

"By existing always and everywhere He constitutes duration and space. In him all things are contained and moved". For Newton, space was sort of emanation or "tamquam effectus emnativus" from God.

Essentially all physical events reduced in Newtonian mechanics to the motion of these particles caused by the gravitational force between them. For describing the details of this motion, Newton discovered the Differential Calculus.

Since the universe ran according to these pre-determined forces, Newton's was a rigorous deterministic theory, though Newton supposed that the intervention of God was necessary to keep the Universe going. According to Newton: "The Goal of Science is to fathom how God made the World".

Laplace (1749-1827), the great mathematician produced a 5-volume book entitled "Mecanique Celeste" explaining the motion of all planets according to Newton's formulations. Laplace presented the first edition of his book to Napolean. The story goes that Napolean remarked "Monsier Laplace, they tell me that you have written this large book on the system of the Universe, and have never even mentioned its creator". To this Laplace is reported to have replied "I had no need for that hypothesis".

The contrast between Newton who needed God to create and sustain the universe and Laplace who did not need God is quite amazing. Newton despite the remarkable successes of his dynamic theory was too deeply sold on the necessity of God.

Newton's dynamics also explained many aspects of the vibrations of the classical bodies, the phenomena of heat – as motion of molecules. This led to the whole field of thermodynamics, hydrodynamics, and to an understanding of phase transformations which change solids to liquids to vapour on the application of heat.

In parallel with these developments during the 16^{th}, 17^{th} and 18^{th} centuries, a large number of physical instruments which enhanced the power and range of observation and more precise acquisition of data, came to be designed and fabricated. Among these we must mention specially, the microscope, the telescope and the pendulum clock.

Also considerable progress was made in understanding the nature and structure of matter. Chemistry which began with alchemy, had come of age.

Robert Boyle (1627-1691) the outstanding early chemist, introduced the concept of elements. In 1744 Priestly (1733-1804) discovered "oxygen" and studied systematically nitric and nitrous oxides. Hydrogen was discovered as the inflammable gas by Cavendish (1731-1810). Lavoisier (1743-1794) studied the chemical composites of many substances. Proust (1754-1826) proposed the famous hypothesis that goes by his name, Proust's hypothesis, which states – "All matter might consist of Hydrogen atoms". Dalton (1766-1844) came out with the atomic hypothesis: "Gases must exist in the form of minute particles – the atoms". The application of Newtonian mechanics to the study of thermal phenomena led to the formulation of thermodynamics and to the enunciation of important laws of nature – (I) the law of conservation of energy, (ii) the law of entropy - isolated physical systems proceed spontaneously in the direction of increasing disorder (entropy being a measure of this order) - this became an extremely important way of defining the arrow of time (as time moves forward, the entropy of the world as a whole increases). This statement has the very significant implication that as we go backwards in time, the universe must have been in a state of high order. How did this happen? Who or what was responsible for this high order at the earlier times?

In the 19th century, in some of the other fields like electricity and magnetism, thoroughly unexpected, but very welcome developments took place which had major consequences on the living conditions and life styles of Man in the coming centuries.

Michael Faraday (1791-1867) discovered the effects of magnetic induction resulting in the generation of electricity. This led to the ideas of electric dynamos as generators of electric power and to the design of electric motors for industrial purposes. Further the concept of electric and magnetic fields or lines of force introduced by Faraday led to the development of the electromagnetic theory by Maxwell (1831-1879) and to the unification of electricity and magnetism into a single concept. While Faraday showed that a changing magnetic field produced an electric current in a conductor, Maxwell deduced that a changing magnetic field would produce an electric effect even in space and similarly a change in electric field would produce a magnetic effect too in space, the combined acts in succession resulting in the generation of an electromagnetic

wave. Maxwell's equations concerning these effects showed that there would be a finite time required for the waves to travel. Surprisingly it turned out that the speed with which these electro-magnetic waves would travel in space is the same as the speed of light. This extraordinary coincidence of velocities led to the realization that light is an electromagnetic wave. Further, Maxwell pointed out that these electromagnetic waves could extend over a wide band of wave lengths and exhibit properties of heat (infrared), light, ultraviolet, x-rays, ϒ-rays To explain the mode of transmission of the EM waves in space, Maxwell tried to build several models of ether –inter-locking spheres and cylinders of ether material that could simulate some kind of a mechanical model of transmission. These just did not work.

A remarkable thing happened next. Hertz (1857-1894) produced electromagnetic waves of long wave length (microwaves) in the laboratory in 1875 and Marconi transmitted the radiowaves across the Atlantic in the early part of this centry. Maxwell's theory had implied that light must travel with a finite speed with respect to the ether. This brought up the question whether the `ether' is stationary with respect to the earth or whether it moves along with the earth.

A famous experiment conducted by Michelson-Morley in 1880, gave the result that there was no relative motion between the earth and the ether. The same experiment also led to the result that velocity of light is the same whether the earth is moving towards a source of light or away from it. This was a startling result since it contradicted the normal laws of addition of velocities, laws that had been so firmly established in all mechanical motions.

Chapter 3

20th Century Developments in Physical and Life Sciences

As the 20th century dawned Einstein came on the scene of physics. He said "we can do away with the ether; the velocity of light may be considered as a constant of nature independent of the motion of the source or receiver as Michelson - Morley experiment dictated. But, we have to give up our conventional ideas of space and time".

Einstein emphasized that "Laws of Science" should be the same for all freely moving observers no matter what their speed is. Einstein formulated his Special Theory of Relativity by stating that: (1) There is no absolute space; no absolute time; space and time have to be fused into a four dimensional space-time continuum. (ii) Space contracts and time dilates in a moving medium – the extent depends on the velocity. (iii) The idea of simultaneity, that two events take place at the same time, has no longer any meaning. What is simultaneous in one frame of reference may not be so in another moving frame of reference, revolutionary ideas throwing out Conventional ideas on Space and Time.

Einstein's special theory of relativity led to another very important result that had tremendous consequences to humanity apart from supreme importance to science itself. Einstein showed that Mass and Energy are equivalent. $E = mc^2$ – the famous Atom Bomb equation. [1 kg of Gold = 25 Billion kilowatts of Electrical Energy if all the mass is converted to energy]. He also showed that the mass of a body increases with velocity. A stationary mass of 1 kg becomes equivalent of 2 kg when it moves with 90% of the velocity of light. Einstein's theory also meant that the velocity of light is the top most velocity. Nothing physical can move faster than light since even a tiny mass would become infinitely heavy as it reaches the velocity of light.

Thus the special theory brought about major revisions not only in our ideas of space, time, and simultaneity but also on mass, energy and limitation to maximum velocities that objects could acquire..

The special theory of relativity was published in 1905. The theory was developed taking into consideration frames of reference in uniform motion with respect to each other. Einstein then went further to develop the General Theory of Relativity by

considering accelerated frames of reference. This led to even more startling results and even more radical views on space, time, gravitational force and mass and their inter-relatedness.

The space-time continuum which Einstein introduced in the Special Theory of Relativity, was shown in General Relativity as not Euclidean in nature. For example the three angles of a triangle do not add to 180^0. The space-time becomes increasingly curved by the presence of mass and energy. In contrast to Newtonian theory in which gravitation is a force, in Einstein's theory it is not. Einstein's gravitational laws describe the relation between the mass of a gravitating body and the structure of the field around it. The earth going round the sun in an elliptic orbit is not looked upon as due to the action of the gravitational force, but as a consequence of the structure of the gravitational field around the sun determined by its mass., and the mass of the earth.

Another phenomenon predicted by General Relativity was the bending of light in the gravitation field. This effect was very beautifully verified during the solar eclipse of 29th May, 1919. The light from a star behind the sun did show the amount of bending predicted by Einstein. There are other interesting consequences too. In the neighbourhood of a dense body (like a neutron star or a black hole) time will slow down appreciably.

A major consequence of the equations of the general theory of relativity is that the universe as a whole is expanding. Einstein however introduced a constraining factor called the Cosmological constant to ensure that this did not happen since he thought that the universe as a whole was static. But Einstein was mistaken. Observations showed, that the universe is expanding. In the general theory, the Universal space itself serves as the material medium that interacts with gravitating bodies. The field became the primary reality than a consequence of some other reality.

Just before the dawn of the 20th century, major new experimental discoveries and theoretical formulations took place. In 1895 the German scientist Roentgen discovered "x-rays" and in 1896 the French scientist Becquerel discovered "Radioactivity" and in the following year 1897, the British scientist J.J. Thomson discovered "the electron". These

discoveries may be regarded as the parting gifts of the 19th century. They had tremendous scientific and technological implications. But more importantly, for the purpose here, they had profound philosophical implications essentially because they opened up in course of time the microworld of atoms, nuclei and elementary particles, the investigations on which led to the recognition of deeper subtleties in our every day concepts of space, time, matter, causality, determinism and so on, which already had quite radical transformation because of the relativity theories. This parallel transformation began with the introduction of the quantum hypothesis in 1900 by Max Planck (1858-1947) to explain an anomaly that had been observed experimentally in the relative intensities of light of various wavelengths emitted by any source. The theory that was prevalent at that time predicted that the intensity would increase at shorter wave lengths disastrously and lead to what was known as ultra-violet catastrophy. The experiments on the other hand showed that such was not the case. Depending on the temperature of the source, the intensity increased at shorter at shorter wavelengths, but reached a maximum and then decreased. Max Planck showed that by making the hypothesis that light energy would be emitted in discrete chunks, in the form of Quanta, this difficulty regarding UV catastrophy would be avoided and the theoretical distribution would agree with the experimental one. Plank postulated that the relation between the energy of the quantum (E) and the frequency of the emitted radiation (∂) is given by $E = h\partial$ where h is a very small quantity ` 10^{-27} ergs. seconds is now known as the Planck Constant. Einstein went one step further of Planck and said that not only light is emitted as quanta, but light energy exists only as quanta. With this hypothesis, Einstein was able to explain the photo-electric effect in which an electron is emitted when light is incident on certain types of surfaces like clean metal plates. This implied that light was a particle with an energy $h\partial$.

We have seen earlier that Maxwell's theory established light as an electro-magnetic wave. The wave theory of light developed by Huygens (1629- ?) in the 17th century had scored over the Corpuscular theory of light championed by Newton in providing explanation for some of the intricate phenomena of light like intereference, diffraction and polarization. With the new quantum hypothesis of light which was

essentially a restoration of the corpuscular theory, suitable explanations had to be found for those features which could more easily be explained by the wave theory. This wave/particle duality which shows itself in some experiments as wave and in others as particle, highlights the importance of making a distinction between appearance and reality even in physical sciences, an issue of prime significance in all systems of philosophy. Experimentally this duality aspect which was thought to be unique to phenomenon of light, was beautifully demonstrated to be present in the case of material particles like the electrons also, by Davisson and Germer. Beams of electrons passed through crystallized nickel plates showed preferred directions of scattering. G.P. Thomson, using faster electrons recorded distinct diffraction pattern in the scattered electrons. It is interesting to note that J.J. Thomson, the father proved the electrons to be particles. Decades later the son G.P. Thomson proved that electrons behave like waves. Quantum mechanics, which succeeded classical mechanics had to grapple with dual behaviour of both light and electrons.

In 1895, Rutherford came to Cambridge, U.K., all the way from Australia as a student of J.J. Thomson. Referring to the pioneering work that Rutherford had begun, Thomson is stated to have remarked "we have got the rabbit here from the antipodes and he is burrowing mighty deep". In 1906, Rutherford moved to McGill University in Canada and was conducting experiments with α -particles from radioactive sources. He noticed that in passing through a thin mica sheet the α-particle was deflected by a large angle occasionally. Such large deviation of the massive α-particle required an intense electric field inside the atom. Rutherford came back to Manchester in UK in 1909. Marsden and Rutherford continued the α-particle scattering experiment and to their great surprise found occasionally the α-particle bounced back! This was like firing a bullet at a thin sheet of paper and finding that the bullet turns back after hitting the paper. This could happen only if the mass of the atom was concentrated in a volume orders of magnitude smaller than the atom. Rutherford called this central portion "the nucleus". Later it was established that the nucleus consists of Protons and Neutrons. Bohr's theory of the atom as corresponding to a miniplanetary system with the nucleus at the centre and electrons orbiting in fixed orbits around the nucleus became the most acceptable

model of the atom. The difference between one chemical element and another was soon established as due to the number of protons (and neutrons) in the nucleus and the number of electrons in the different orbits adding to the number of protons, so that the atom as a whole was electrically neutral. Bohr made the bold hypothesis that any atom could exist only in discrete energy states ensured by the discreteness of the electronic orbits. Further according to Bohr, the emission of light from any atom was caused by the jumping of electrons from one orbit to another where there was a vacancy, due to the absence of an electron belonging to that orbit. Such emissions accounted for the discrete spectral lines seen in spectrographs against a continuous background emission. Thus Bohr's theory was formulated to be in complete confirmity with the quantum hypothesis.

Some new unsatisfactory features emerged which had to be accounted for. Neither in the case of α-particle emission from radioactive atoms, nor in the case of emission of light from excited atoms, the theory could predict in what direction the α-particle or light would be emitted, when exactly the next emission will take place and what would be the energy of the emitted particle or of the light photon, which particular atom would emit the particle or light next. The α-particle as such did not exist within the nucleus. It had to formed out of the protons and neutrons. Calculations showed even when formed it did not have sufficient energy to come out of the nucleus. To explain emission, the α-particle had to be treated as a wave. Using an equation that Erwin Schrolinger had developed for such situations on the basis of the quantum ideas, the probability of finding the particle outside the nucleus could be calculated. However, no definite path by which the α-particle came out could be specified. What however was most interesting was that the half-life of the radioactive source, by which one meant the time in which half of the atoms will disintegrate due to the emission of the α-particles could be determined and this quantity i.e. the half-life had a very precise value characteristic of the element of which the source was made. While in individual cases there was so much of uncertainty, collectively there was high order and precision. There was no way in which classical physics could account for these features of radioactivity and light emission. It should not be mistaken that this precise nature of half-life is connected with any collective action. This is borne out by the example of the way half-life is determined in the case of many

unstable particles – the μ-meson, the pi-meson etc. In these cases the lifetime is measured for each individual case and only when the measured data is combined for analysis does one see the precise value of the half-life.

Further it was realised that contrary to the macroscopic domain in the atomic domain the parameters like position, momentum, energy, time etc. had serious restrictions in exact evaluations because of the disturbances caused in the very act of measurements, which came to be known as Observer's interference. What came as a bigger surprise, but of paramount importance, was the realization that not only precise measurements are not possible, but these quantities do not have intrinsically precise values for any measurable length of time. The values fluctuate about a mean value. This is an inherent characteristic of nature at these levels. However, even though the fluctuations are uncaused and are spontaneous, the extent of deviations is rigorously controlled by relations of the type $\Delta P.\Delta X \sim \hbar$ and $\Delta E.\Delta t \sim \hbar$ where $\hbar$ is the Planck's constant divided by 2π. These are known as Heisenberg's uncertainty relations. They have both practical and philosophical implications.

In classical physics, the conservation principles of energy, momentum, angular momentum etc. could never be violated. In quantum physics these violations are permitted subject to conformity with Heisenberg's uncertainty relations. In fact this gave the clue regarding the spontaneous generation of particles and radiations in vacuum.

The original concept of vacuum was that it is empty space devoid of all matter and radiation. However, in quantum theory, vacuum is not the absence of everything, but in a specialised sense the repository of all the fundamental particles of nature – particles like the protons, neutrons, electrons, mesons etc. and all the radiations – light, uv, x-rays, ϒ-rays etc. which are the building blocks of all matter and forces. In pure vacuum, we do not normally encounter these particles and interact with them. However under special conditions, like depositing a lot of energy in a extremely small volume of space in a short time like during the collisions of particles accelerated to high energies in accelerators, or due to spontaneous fluctuation of the type discussed above, these

particles (hidden particles in the vacuum) can be mined out as particles and anti-particles. Those that are due to spontaneous fluctuation have the peculiar feature that they can combine together and disappear if the energy is just sufficient for creation and not enough for them to fly away. Such pairs of particles created for a short while are called "virtual particles" since they do not last long enough to be recorded by instruments. Their creation however is confirmed by indirect experiments which record other effects of their creation.

In very high energy collisions of the elementary particles, entirely new types of particles called mesons and hyperons are created. Here an enormous amount of energy of collision is deposited in a very small volume and all these created particles spring out with sufficient energy to be recorded by special instruments like nuclear emulsions, cloud chambers, bubble chambers etc. That is how they were detected in the collisions of the high energy cosmic ray particles coming from depths of space with air nuclei.

How did such a space (vacuum) with all these wonderful properties get created? From where did all the energy required for the creation of all the particles that constitute the universe come from?

The present thinking is that all this is connected with the "Big Bang" creation.

The Big Bang Creation

There is astronomical evidence that the universe comprising stars, galaxies, clusters of galaxies etc., some 10^{22} celestial objects and various types of radiations is continuously expanding – the space between galaxies is increasing continuously which is clearly noticed in the increased separation between galaxies as time goes by. There is also evidence that the rate of expansion is faster when the distances are larger. From the velocities of recession which have been measured by astronomers, it is found that about 15-20 billion years ago the entire universe would have been together at one point. Obviously density would be infinite at this stage. So in principle the entire universe could be the result of an explosion of this infinitely dense object. Such an explosion termed "Big Bang" by Hoyle, as the starting point of the Universe was proposed by

Hoyle

Lemaitre in 1927. Though initially ignored it has become the most acceptable theory for the creation of the Universe.

Several recent experimental results have given considerable credibility for the Big Bang Creation Theory of the Universe. Among them, the most significant is the detection of the presence of a background isotropic microwave radiation known as the remnant of the Big Bang, corresponding to a temperature of 2.7^0 K through out the universe. The possible existence of such a radiation corresponding roughly to about 5^0 K had been predicted by Gamow in 1948 and a Princeton University astronomer Dicke had set up an antenna system in the early 60's for detecting this primordial universal radiation. However, as it happens in major scientific discoveries, the evidence came from an entirely unexpected quarters. Penzias and Wilson two radio engineers from the Bell Laboratories were trying to identify the source of a persistent radio noise in their antenna in the microwave band and stumbled in 1965 into the detection of the universal radiation of tremendous importance to astronomy, cosmology and philosophy of science.

Another supporting evidence for the Big Bang theory was the determination of the ratio of primordial Helium to Hydrogen in the Universe. The calculated figure of ~25% agrees well with the observations.

What is most exciting is that on the basis of the present temperature of the Universe (2.7^0 K) and the rate of expansion at different space separations, it has been possible to work out the size, density and temperature profiles of the universe at different times in the past; further, making use of the knowledge obtained at high energy accelerators on the creation of various types of particles at different threshold energies, it has been possible to figure out the detailed features regarding the composition of matter and radiation right down to a very very small fraction (10^{-43}) of a second from the time of the so called zero of the Big Bang explosion. A most interesting feature that is expected at these very tiny intervals immediately after the explosion is for the differences between the four forces that dominate and control the universe all to vanish and reduce to just one type of unified force. This very early universe is the scenario in which such a Grand Unification could have occurred, only to break up into the four distinct forces that

dominate the universe today. Such a break up is expected to have happened with in an extremely short time of the Big Bang Creation. Further, if scientists have to understand all the workings of nature in the manner they have figured out in the last hundred years or so, the following assumptions regarding the happenings immediately after creation have to be made:

(1) The four dimensional space-time continuum (the Quantum Mechanical Vacuum) which humans experience as three dimensions of space and one dimension of forward moving time has to be created, and should start expanding. There are special features of this expansion itself which we will not go into here.

(2) This space-time has to be vested with all the properties for the creation of various types of particles that constitute matter, and radiations that mediate forces,

(3) The Laws of Physics (or their correlates) should somehow start operating in the desired manner with the constants of nature like the charge of the electron, the masses of various fundamental particles, the velocity of light, the Plank's constant etc. having the precise values determined now by experiments. Even very small deviations are not permitted, since they will lead to an entirely different pattern of evolution or no evolution at all.

(4) As the space expands, the new space that is created should have the same properties as the earlier, without borrowing anything from the already created space.

There are many other constraints which we will not list. The essential thing to note is that these features have somehow to be initially there for any scientific formulation of the evolution of the Universe, in the Big Bang framework. Questions regarding the nature and status of space and time before the Big Bang do not arise in this formalism. The nature of the exploding object of infinite density and infinite energy also is not specifiable. The Big Bang event is considered to be a spontaneous fluctuation of something and therefore the question of what caused the explosion does not arise.As remarked by Dyson "The Big Bang explains things other than the explosion

itself "There are several other theories like the `Steady State Theory', multiple mini bang theories which we have not discussed here essentially because they are not able to account for all the aspects of the Universe.

The history of Life Sciences:-

Illness and death of loved ones must have been the concern of men and women of all ages. In the very early days it must have been thought these are due to the displeasure of Gods or the work of evil spirits. Offerings to Gods and Spirits were thought to be the only option.

The Greek Physician Hypocrates (~460 BC) was perhaps the first physician in the western world. He emphasized the importance of the study of anatomy from the point of view of curing diseases. He is credited with 70 medical texts. Systematic anatomical studies of humans and apes was the work of Galen (129 AD-) of Asia Minor (modern Turkey). Galen had come very close to the modern ideas of blood circulation and to the importance of the nervous system in motor functions like breathing. He had even figured out the connection between pulse rate and emotional stresses. Galen's treatises were the unquestioned authority in medical practice till Vesalius (1514-1564) of Belgium established more authentic work on anatomy pointing out some serious errors in the treatises of Galen. A real breakthrough in anatomical studies came with the work of William Harvey (1578- 1657) of England. In his famous book "Anatomical Dissertation" concerning the motion of heart blood in animals, Harvey established that the heart is a muscular pump and blood is circulated through the body.

In 1683, Van Leenwenhoock (1632-1723) of Holland, who had made his own microscope and was peering through it at rain drops, discovered" "little animals swimming, playing, a thousand times smaller than you can see with the eye alone". The world of bacteria was laid open by this Dutch scientist, and the theory that life came out of decaying matter was disproved. Life begets life was the lesson that was learnt. Today the electron microscope which can magnify by a factor of hundred thousand (10^5) and more has revealed the even smaller entities, the viruses, responsible for a variety of diseases.

During the period 1700-1800 more than 60 million Europeans died of smallpox. More than half the population of the city of Boston in USA had been affected by smallpox in the epidemic of 1721 and nearly 10% of the victims died. Thanks to the pioneering work of Edward Jenner (1749-1823) of England, and subsequent efforts small pox has been essentially wiped out of the globe. Jenner's finding that those afflicted with cowpox did not contract small pox, led to the idea of vaccination which was the turning point in the conquest of not only this dreaded disease, but many others in the years to come. Louis Pasteur (1822-1895) developed the `germ theory' of fermentation and showed that the performance of the microorganisms could be controlled by heat. This led to the pasteurization of milk and making it absolutely safe for consumption. The entire wine industry was indebted to him since wine is produced by fermentation. Alexander Fleming (1881-1955) of Scotland is the scientist who discovered Pencillin, the drug that destroys bacteria and opened up a whole new field of antibiotics - Streptomycin, Aureomycin, Terramycin etc. which have become the wonder drugs of modern medicine that control and cure virus induced diseases. These developments along with the surgical interventions wherever called for, have changed totally the average life expectancy of a human being all over the world especially in the developed countries, and this naturally has resulted in a transformation on the philosophical outlook of man from being a helpless animal at the mercy of uncontrollable natural diseases to one who can combat many of them.

Biological Evolution

While developments in the fields of medicine and surgery provided succour to millions of people and animals all over the globe, the fundamental questions – What is life? How and when it originated? What is the relation between man and animal? Why are there so many species of animals? Do animals have mind and consciousness like Man? These and a host of similar questions have been the concern of the life sciences over the past several hundred years. Darwin's theory of evolution proposed in 1858 has been a major landmark in this area of investigation.

One of the fundamental questions that bothered Charles Darwin (1809-1882) of England when he was on his South American Trip on HMS Beagle collecting plants,

rocks, insects, animals and fossils, was "If all creation had taken place at the same time, why were there so many organisms with slight differences?" By examining fossils that resembled organisms still living, he concluded that some species were replaced by closely related ones. How did this change come about? The answer came to him after reading Thomas Malthus's Essay on Population. Increasing population gave rise to a increasing need of food and hence struggle for existence. This led to the idea of the "survival of the fittest". Darwin postulated that in this struggle for existence "favourable variations would tend to be preserved and unfavourable ones destroyed. The result of this would be the survival of best adapted species". Another biologist of the time, Alfred Wallace had similar ideas and the work of both was presented to Linnean Society of London in July 1858 – the first public announcement of the theory of evolution.

Darwin's theory of evolution did not go down well with the Church. Man's ancestry traced to animals was anathema to the biblical tradition. Darwin paid a glorious tribute to Nature by stating: "The more I study nature, the more I become impressed that the contrivances and beautiful adaptations, slowly acquired through each part occasionally varying in a slight degree .... transcend in an incomparable manner the contrivance and adaptations which the most fertile imagination of man could invent". Darwin had also foreseen the ultimate fate of his theory, which underwent radical modifications in later years. He had said "I look at it absolutely certain that very much in the "origin" (the book "Origin of species") will be proved rubbish; but I expect and hope that the framework will stand". That is precisely what has happened.

The foundation for the heredity aspect of organic evolution was laid by Gregor Mendel (1822-1884)of Czechoslovakia, a monk in an Austrian monastery through a series of beautiful simple experiments in his garden. He studied the heredity in garden pea plants. He noticed that some were short and some tall; some pale yellow and some bright yellow. He had identified seven different traits in his pea plants. By cross pollination he was able to produce different traits in different generation of plants and established the laws of inheritance which as we shall see have important consequences in molecular genetics since they are applicable not only in peas but to all creatures including man..

Reflex actions are an important and necessary aspect of our living. These do not need any prior thinking. We are born with this ability for reflex action. The Russian Scientist Ivan Pavalov's (1849-1936) studies on conditioned reflexes in dogs set psychologists to understand the behavioural aspects of human beings, and had a great impact on learning theories. The behaviourist school thrived for sometime on the thesis that complex behaviour patterns were the result of a vareity of conditioned responses.

Darwin's theory of evolution propounded in his two famous books "Origin of Species" (1859) and "Descent of Man" (1871) highlighted the concepts of chance variations in the species and natural selection as defining the course of evolution leading finally to the emergence of man. Mendel's discovery of the units of heredity which were later identified as chromosomes and genes gave a boost to Darwin's evolutionary theory and laid the foundation of the most important branch of biology, Genetics in the early part of this century. An aspect that was ignored in the early years of Genetics was the fact that any organism is a multilevelled system and not controlled only by the genes. The genes are within the chromosomes, the chromosomes are in the nuclei of the cells and the cells are within the tissues and so on. There are subtle and vital interactions at the various levels which determine how the organism as a whole develops. These influences do transform considerably the `genetic blue print' that is inherited in the first instance.

A major triumph of the biological sciences of this century which launched Molecular Biology as the most important and most promising field of advancement in the area of life sciences was the determination of the double helix structure of the DNA molecule by Crick and Watson. This gave considerable hope that biological phenomena could come well within the fold of physical sciences – in terms of molecular structures and their interactions. The unravelling of the complex structures of the biomolecules which contained thousands of atoms became a major activity during the second half of this century. An important development was the recognition of the connection between the genes and the synthesis of enzymes on an almost one to one basis. This was followed by the discernment of the identity of enzymes and proteins, the mechanisms of protein synthesis in the cells, the gene replication and the processes by which gene

mutation is accomplished. The role of DNA in self-replication and protein synthesis was unfolded. A certain length of the long chain DNA molecule had the property of synthesizing a particular enzyme and this length of the molecule was identified as the gene. Each gene or combinations of several genes controlled specific aspects of the organism. A longer length of DNA molecule with several genes in a linear chain constituted the chromosome. From single celled organisms like bacteria to the multicelled man, all contained the same genetic molecules, but arranged in different orders and with widely different numbers of molecules.

A fundamental question in molecular biology was the one relating to differentiation. If each cell in any multicelled organism had the same genetic code then how does it happen that in the different parts of the body it performs different functions, commensurate with the specific functions of that organ? How are the relevant cells transported to the right locations where they grow and multiply? There are also the related problems of growth and control – when exactly a particular function should start and when it should stop? These spatio temporal aspects still remain to be understood in a satisfactory manner. It is in this context that Paul Weiss has stated : "there is no phenomenon in a living system that is not molecular and there is none that is molecular only"; clearly the importance of an approach to the field of life sciences which is both reductionistic and holistic is implied in such statements. Another renowned biologist Sydney Brenner says" ..... And here there is a grave problem of levels. It may be wrong to believe that all the logic is at the molecular level. We may need to get beyond clock mechanism". This essentially leads to a systems approach in which the wholes cannot be just reduced to functions of the smaller units, but an integrated organizational collaborative and coherent mechanism in addition to the individual functions is essential. This particular aspect is becoming apparent not only in biological systems, but in many physical phenomena too. Reductionism and holism become not contradictory, but complementary aspects.

The organisms consists of a large number of cells. Each cell is not passive. There is a vast amount of chemical activity going on continuously in each cell. As part of the self-organizing programme of the organism, there is a continuous activity of break

down of cells, building of structures, tissues and replacement of cells by new ones. For example in the case of Pancreas in the human body, most of the cells are replaced within a span of 24 hours. In fact all the cells in our body excepting the brain cells are renewed in a matter of several years. However despite this continual transformation the overall pattern and functioning remains the same. This portrays a state of dynamic transactional balance of the system as a whole. There is adaptability to the environmental changes that will necessarily be the same. This involves a feedback mechanism which is also manifest in the highly regulated functions like maintenance of body temperature, blood pressure, breathing rate, pulse rate etc.

Modern version of the Darwinian type of adaptation of the species leading to newer species is through the process of genetic mutation. What had remained as a mystery was the clear tendency for increasing complexity in the course of evolution that had started with a simple single celled organism in the beginning, and the highly creative aspects of the human brain. The existence of a purpose or goal in evolution was not something that most scientists concede. Struggle for survival against the environment, adaptation for this to be achieved and reproduction and multiplication was all that they could concede.

From the progress made in the 19th century and the first decades of the 20th, in the areas of Physics, Chemistry and Astronomy it became clear that all matter in the universe is made essentially of combinations of ~~just~~ 92 elements, hydrogen to uranium. All these elements are constituted of just three elementary particles the protons, neutrons and electrons. The differences in the properties of the elements and compounds were primarily due to the spatial structures of these constituents dictated by the electromagnetic and nuclear forces in the case of stable matter and in addition the dominance of weak forces in the case of the heavy elements and their compounds that suffered radioactive decay.

What about animate matter – the constitutents of the organisms? The most important chemical is called the Protein which is made of five well known elements carbon, hydrogen, oxygen, nitrogen and sulphur. The protein molecules are hundreds of

thousand times bigger than the normal molecules we are familiar like say water. All proteins are made of twenty different units called amino-acids which are strung together linearly. Different sequences of the amino-acids give rise to different proteins. One type of proteins called enzymes play an extremely important role in body chemistry. These enzyme molecules have the unique property of hastening chemical reactions without anything happening to themselves.

The cell is the unit of life. The human body which starts as a single fertilized cell multiplies into ten million billion (10^{16}) cells. There are about 260 cell types in a man or woman and 100,000 different genes. Each gene codes a protein. What is amazing is that each cell has the same DNA molecule in its nucleus. The cells differ in their functions, (like blood cells which constitute blood, and bone cells bones, liver cells the liver functions etc,) because different sets of genes control the production of different enzymes and other proteins. A single drop of blood contains about forty billion cells.

The living matter inside the cell has been given the name protoplasm. The protoplasm has two parts – the nucleus and cytoplasm. The cells multiply by division into two parts each of which became additional cells. Before each division the DNA in the nucleus makes a full replica of itself so that the newly created cells have identical DNA's. Around 1880, a German biologist, Walther Flemming noticed that during cell division certain lengths of the nucleus could pick up the colour of a red dye that was made available. These thread like lengths of the nucleus that picked up colour were given the name chromosomes. Later studies revealed that it is these chromosomes that carry the genetic information that is unique to each individual and to each species. In the case of man for example there are 23 pairs of chromosomes half contributed by the father and half by the mother. Each chromosome consists of a large number of genes and each gene or combinations of them determine the various characteristic of each individual. It is estimated that roughly there are about 3000 genes in each chromosome.

While the cell division with replication ensures the perpetuation of identical cells, occasionally there could be changes introduced either by errors in the duplication or by external influence of radiation. These are called mutations and are responsible for

changes that gradually come about in the different generations of the same species. This is what is responsible for the varieties in the species and for evolution through the mechanism of survival of the fittest.

All this points to the possibility that common physical and chemical principles operate in the non-living and living environments as well. The question arises whether life arose out of purely physical and chemical processes and if so when and how did it happen.

From radioactive dating it is fairly well established that the oldest rocks are 3.8 billion years old. Fossil evidence has revealed that the earliest forms of life could be 3 billion years old which shows that the planet earth did not have to wait for too long (about 700-800 million years) for life to emerge. The Russian biochemist Oparin made the suggestion that life might have arisen in the primal soup of various chemicals that were part of the ancient oceans. A similar suggestion was made by Haldane. The energy required for the chemical reactors could have come from ultraviolet radiation or by some type of discharges or other types of extraterrestrial radiations. It was believed that the atmosphere in those early epochs was rich with hydrogen, ammonia and methane and there was no oxygen. In the 1950's Stanley Miller simulated these conditions in the laboratory passing electrical discharges through a mixture of vapour of ammonia, methane and hydrogen in the presence of boiling water. The analysis of the resultant soup did show the formation of some amino acids imino acids and hydroxyl acids. While the early experiments have been followed with modifications, it is fair to say that in none of them has there been evidence of the emergence of even the simplest forms of life. Clearly the emergence of life might not have been a one step process.

The current belief is that single celled organisms appeared on the earth about 4 billion years ago. These are called Prokaryotes. They have no nucleus inside and survive without oxygen. For almost two billion years the prokaryotes produced enough oxygen on the earth by Photosynthesis for the organisms that required oxygen for their survival to appear. These were first the single celled eukaryotes that had a nucleus in them which contained genetic material and it is these that gave rise to multicellular organisms.

George Wald, a famous biologist raises the question: "How could it be that a collection of molecules come together, in just the right way to form a living cell?" and answers it by saying "with very many trials – the unthinkably improbable becomes virtually assured. Time is the hero of the plot. Two billion years (the present estimate is 4 billion) – given so much time the impossible becomes possible, the possible becomes probable and the probable virtually certain.

Not all share this optimistic view. Robert Shapiro for example estimates that to create an organism like E-coli even, the odds are 1 against 2×10^{51}. Hoyle and Vikram Singhe who are great enthusiasts regarding the extraterrestrial origin of life point out that to make a bacterial enzyme with 200 amino acids the probability is as low as 1 in 20^{200}. Since one aminoacid sequence may be able to catalyze a given reaction, the authors concede a probability of 1 in 10^{20} and even this leads to a probability of 1 in $10^{40,000}$ for synthesis of 200 functioning enzymes. As Kauffmann says this probability is like a Boeing 747 being assembled by a Tornado sweeping a material junk yard. It looks very very unlikely that life could have originated purely on the basis of random assembly of the constituents.

The Systemic approach : Reductionism to Holism:

While there is no doubt that the reductionistic approach has paid rich dividends in the understanding of some of the aspects of both inanimate and animate matter, it is becoming increasingly apparent that for the resolution of some of the key issues one has to take a "systemic" approach in which there is a radical shift from the reductionistic to a holistic approach. One looks for organizational principles whose applications lead to the emergence of wholly new properties which are not just there in the constituents. In fact the emergent properties are destroyed when the system is broken up into its constituents. As P.N. Anderson, the Nobel Laureate has said "I believe that at each level of organization on scale, types of behaviour open up which are entirely new and basically unpredictable from a concentration on the more and more detailed analysis of the entities which make up the objects of these higher level studies".

It had become a practice in science to assume that most of the systems in nature operate under equilibrium conditions which could be described by linear equations. (Linear Systems imply cause and effect are related in a simple proportionate fashion). This was essentially because of the simplicity of mathematics of solving linear equations. With the advent of computers this limitation on the solution of non-linear equations has disappeared. It has become increasing apparent that most systems in nature do operate non-linearly and equilibrium conditions are an exception than a rule. What came as a big surprise however was the finding that spontaneous self-organization occurs in far from equilibrium open non-linear systems with a degree of high feed back. These open systems have access to reservoir of energy. The importance of feed back in amplification and oscillation was known and had been exploited fully in the field of electronics. Yet another feature that came to be known with the advent of computer simulations, was that the motion of even simple dynamical systems that obeyed deterministic laws could not be predicted far into the future. They are extremely sensitive to initial conditions. These are known as "chaotic" systems. In them errors grow in an escalating rate. Although the word `chaos' normally implies negative and destructive consequence, what is most interesting is that chaotic system have a creative aspect. The random element in a chaotic system allows it to explore a vast range of behaviour patterns. This results in the emergence of entirely unexpected new forms.

According to Kauffman "when a system of chemicals reach a certain level of complexity, it undergoes a dramatic transition, akin to phase changes when liquid freezes. The molecules begin spontaneously combining to create larger molecules of increasing complexity and catalytic capability. This process of self-organization or autocatalysis rather than fortuitous formation of molecules with ability to replicate and evolve led to life. .... Complex arrays of interacting genes subject to random mutations do not evolve randomly. Instead they tend to converge to a relatively small number of patterns or attractors to use the term favoured by "chaos theorists", Because of these possibilities, Kauffman says that "we are not incredibly improbable events" Thus order of Biology in this approach arises not out of "opportunistic tinkering" but through principles of self-organization and complexity. This may also give an explanation for the Permion extinction (some 250 millions years ago) of 96% of the species that ever existed ~~are now extinct~~. It is interesting to note that 99 to 99.99% of all species that ever existed

are now extinct. Today there are about 10-1000 million species alive, implying that 10-100 billion species have come and gone since evolution of life began on the earth.

The next question that is of interest to both scientists and philosophers is the one relating to mind and consciousness. There have been dualistic schools of thought from the beginning, but they got highlighted by Descartes who believed that mind stuff is different from that of body. In western philosophies no distinction has been made between mind and consciousness.

The current scientific approach to the problem of the mind (consciousness) has been that it is essentially a consequence of the physico-chemical processes that go on in the brain and the associated nerve system connected to all organs of the body. It has been recognised that billions of neurons carry information in the form of milliseconds duration electrical pulses generated by the various sensors like the eyes, the ears, the nose, the skin etc. The information is coded in the form of bursts of signals, simultaneous firings of multiple signals etc. Each neuron has to pass through on the average about a thousand synapses and in these synapses the information is carried further or aborted by the release of special types of chemicals known as neurotransmitters. The release of the chemicals is dependent not only on the input pulses but also those in the neighbouring neurons and the interconnecting dendrites. The signals from different sensors terminate in specific regions of the brain – the visual cortex in the case of eyes, the auditory cortex in the case of ears etc. It is conjectured that the synapses hold the key to the question of long term memory and for this purpose additional synapses may grow as and when required.

The whole exercise in the field of unearthing the modalities of brain functions has been to establish "neuronal correlates" of specific events and happenings either in the outside world or within the brain itself. This exercise is proceeding vigorously in recent years with the use of the new type of non-invasive recording instruments like fNMR, the PET, Laser etc., in addition to Computer Coupled Electro Encephalographs. While it is generally recognised that these physico chemical happenings in the brain and the associated neuronal system are necessary for the functioning of the mind, it is still not clear whether they are sufficient to explain all its intricate aspects of brain funtioning and consciousness.

An extremely significant development that has taken place over the last few decades has been the search for a "homonculus" or "Little man" in the brain where all the information is centrally received and processed for action. It has been established that there is no such central processing unit in the brain.

A famous neurosurgeon says "I can dissect and analyse any part of the brain I want to and can do so even in more detail and sophisticated way. Yet it is frustrating to think that however hard I probe, I cannot find where some one's consciousness is or his sense of humour".

An impressionist painting is not composed of impressionist atoms and molecules. It is virtually inconceivable that any one (even in principle) can state the rules stipulating whether a painting ~~was~~ is or ~~was~~ is not impressionist in terms of the individual molecules".

This brings us to the same question that we discussed earlier in connection with "life", whether the systems approach is relevant in the context of understanding the functioning of the brain. System theorists have emphasised that the organizational properties of a system are determined by the overall relations among the subcomponents and not on the behaviour of individual parts. It has been demonstrated by neuroscientists that while single cells in a particular brain region respond with great deal of variability in responding to external stimuli, large assemblies of neurons behave in a much more invariant and predictable fashion and "consciousness" may be viewed as a systemic property of large neuronal assemblies acting in concert. In systems approach the laws of the structures cannot be traced to or deduced from the laws of the constituents which invariably follow normal laws of physics and chemistry.

Among scientists, diverse opinions persist on these questions. There is the view expressed by the Nobel Laureate Francis Crick that "your joys, your sorrows, your memories, your ambitions, your personal identity and your free will are in fact no more than the behaviour of the vast assembly of nerve cells and their associated molecules". On the other hand Marvin Minsky, expert on Artificial Intelligence says "Many scientists look on Chemistry and Physics as ideal models of what psychology should be like. After all, atoms in the brain are subject to the same inclusive laws that govern other forms of matter. Then can we explain what our brains actually do entirely in terms

of these basic principles? The answer is "No" simply because even if we understand how our billions of brain cells work separately, this would not tell us how the brain works as an agency. The laws of thought depend not only on particles of the brain cells, but also on how they are connected. All these connections are established not only by the basic general laws of physics, but by the particular arrangement of millions of bits of information in our inherited genes".

Neuroscientists have generally treated the entire system of the sensory organs, the neuronal channels, the synapses, and the cortices of the brain as operating essentially according to the laws of classical physics. Recently it has been realised especially by physicists who have started looking into the problems of consciousness and the associated brain processes, that there may be considerable advantage in treating the system as a quantum mechanical system since it opens up the possibilities of "superposed states", "non-local causes", "coherent operational modes over wide distance ranges", etc. which are also in some sense features of the information processing aspects of the brain. In fact each neuron which comprises of a large number of "microtubules" behaves like a microcomputer and generates electromagnetic oscillations that are linked to quantum processes inside. Also the emission of neurotransmitters in the synapses has also been considered by the Nobel Laureate Eccles as a quantum process.

The famous astrophysicist Penrose in his book "Emperor's New Mind" says: "Quantum Mechanics involves many highly intriguing and mysterious kinds of behaviour. Not the least of these are "Quantum Correlations" which can occur over widely separated distances. It seems to me to be a definite possibility that such things could be playing an operative role over large regions of the brain. Might there be any relation between a "state of awareness" and a highly "coherent quantum state" in the brain? Is `the oneness' or "globality" that seems to be a feature of Consciousness connected with this? It is somewhat tempting to believe so".

Chapter 4

Post Kantian Western Philosophy and the influence of Science on Philosophy

We saw in Chapter one that the British Philosopher John Locke maintained that "all knowledge of the world must rest finally on Sensory experience". This followed by inner reflection is what gives rise to ideas. According to him the mind is at first a blank tablet upon which experience writes. The mind possesses innate powers, but not ideas. This was quite in contrast with Descartes, Spinoza and Leibnz who had held that mind alone through its recognition of self-evident truths achieved knowledge and sensory impressions and the delineation of the nature of the external world. For this purpose, following Galileo and Descartes, he introduced the ideas of primary and secondary qualities, the primary ones being those that characterized external material objects like weight, shape, motion etc and the secondary qualities being taste, odour, colour etc that are subjective experiences of the humans. Locke maintained that the primary qualities produce ideas that genuinely represent the characteristics of the external objects and the secondary qualities produce ideas that are a consequence of the subjects' perceptual apparatus. But Berkeley who followed Locke, emphasized that a rigorous analysis clearly points out that all qualities that humans register whether primary or secondary are ultimately experienced as "ideas" in the mind". There is no definite way of knowing the precise nature of the external world. All human experience, according to Berkeley, is phenomenal, limited to appearances in the mind. "To be" is to "to be perceived by mind" (esse est percepi).

To account for the similarity of perception of different individuals, Berkeley had to bring in the idea of a "universal mind" – "mind of God". The Universal mind had the role to produce sensory ideas in individual minds according to certain patterns which are recognized by individuals as "laws of nature".

David Hume, who followed Berkeley, did not agree with either Locke's contention on representative perception nor Berkeley's identification of external objects with internal ideas as finally rooted in the mind of God. Causal relation is never directly experienced by the mind, except as experiences of coexistence or in time sequence. Even space and time according to him are not objective. These notions are abstracted by the

mind. Hume's questionings undermined even logical deductions since causality itself was questioned. This became a source of discomfort even for the scientist. For Hume, the human mind could never claim access to the world's happenings. The mind was a bundle of incohert perceptions and no objective knowledge could thus be obtained. Hume's extreme skepticism meant no God, no order, no causality, no substantial world. The order that man perceived was due to psychological habit and instinctual needs.

Kant who came on the scene in the latter half of the eighteenth century, had the task of resolving these highly contradictory view points and at the same time take cognisance of the scientific developments that had taken place. Kant was fully aware that Newton and his successors in the field of science had obtained real and definite knowledge of a kind of the external world, despite Hume's criticisms.

Another aspect of science was the success of mathematical formulations. If laws of mathematics and logic had their origin in the human mind, what is the basis for saying that the actual world should conform to these laws? It is this correspondence that science had vindicated. Kant turned the tables around and said that the world that Science explicated was the one that mind's own cognitive apparatus had created. For Kant, the mind was not just a passive receiver of sense data. The mind actively "digests" and "structures" the sense data. Thus the world that is available to the human mind is the one that is already organized by it in accordance with its own processing of the sensing data. The data gets sorted out into the mind's "categories" and "framework" of cognition. In short it is not the mind that conforms to things, on the contrary things conform to mind.

According to Kant, space and time are not drawn from experience, but are presupposed in experience. They constitute the invariable context in which events are observed. He was categorical that space and time were not characteristic of the world itself, but they came into effect in the act of human observation and therefore grounded in the mind. Space and time, as well as causation are a priori. Other categories like substance, quality, relation etc were also a priori.

Experience, according to Kant, is the construction of the mind imposed on sensation and the world exists only to the extent that man constructs it. Reality for man is necessarily one's own making. The reality of the external world is therefore something that one can never be certain of.

Kant emphasised the necessity of the combined operations of sensing and thinking to know something about the world. The important aspect is that these have to be simultaneous for interpretation. Man's knowledge of the external reality was essentially a product of his own cognitive apparatus. The laws of nature were not independent, but depended on the internal organization carried out by man's mind in interaction with external inputs. The necessity for a full understanding of the formal structure of the mind and its modes of operation was the highlight of Kant's philosophical endeavour.

Kant's successors in Germany, Fichte, Schelling and Hegel (1770-1831) to obviate the problem caused by the inaccessibility of the Noumenon or the-thing-in itself, brought in the idea of a "universal mind", "an absolute ego" – a transcendental and supra-individual principle that spontaneously manifests itself in the world and knows itself through the mind of man. They identified the cognitive categories of Kant with ontological categories of the universe. According to them both the content and the form were determined by the Universal Mind.

Schelling transformed the idea of God to that of the Absolute", while Fichte insisted on "divine Absolute". The idea of dialectics was introduced by Hegel, each entity carrying its own negative or opposite and the combination of the two leading to a higher entity. Being contained Non-Being and the combination leads to a higher category. The highest category according to Hegel was the "Absolute Idea" from which "Nature" was deduced. A synthesis of "nature" and "Absolute Idea" led to the "Absolute spirit in the end.

Hegel sought to relate and unify of man and nature, spirit and matter, human and divine, time and eternity. For him through the dialectic process everything about reality

could be comprehended. Hegel saw human reason as an expression of God's mind. Nietzsche (1844-1900) the German Romanticist talked of the self creating power of the "will" of man and how "God who had long been projected to the beyond could be born within the human soul". The psychologists Freud (1956-1939) and Jung (1875-1961) were influenced to a great extent by the German romanticism that began with Goethe and flowed through Nietzsche. Freud introduced the idea of the unconscious to explain memories of traumatic experiences in hysterical cases. He was of the opinion that analysis of dreams could lead to an understanding of the unconscious. Jung on the other-hand claimed evidence for the collective unconscious structured into archetypes that had cultural roots. Jung was emphatic however that psychology can reveal nothing with certainty about the universe and reality as such.

Schopenhauer (1788-1840) introduced the doctrine of "the will" – the most dynamic element known to us as volition, as the first principle. According to him every phenomenon of the universe, wherever we may look is resolved into will. It is nothing but will which as physical, chemical and organic force intrudes into space, time and causality, thereby appearing in all changes of bodies and in bodies themselves. According to Schopenhauer: All is will. He was against the idea that the complete knowledge of the world and the purpose of the world is to be found in reason alone. "Reason can only systematize the material brought to it by experience so that full meaning of reality can be known only by experience and not in the abstractions of mere thought".

According to Duhem (1861-1916), the French Philosopher and Theoretical Physicist, metaphysics is concerned with explanation of "Being" – to stop reality of appearances covering it like a veil in order to see the bear reality itself. A physical theory does not explain the laws though it coordinates them systematically, nor do the laws explain reality. What we know are relations between sensations. The connection of these to reality is a matter of faith.

In Europe despite the general progress in living conditions and material benefits due to the scientific revolution which began in the 18th century and the industrial

revolution in the 19th century, the early part of the 20th century was characterized by downward trend in intellectual and cultural life brought about by the distressing fall in moral values, the incidence of cruel world wars and science not providing any definitive evidence for the presence of a God. All this resulted in the birth of a new kind of philosophy termed "postmodernism" that reflected itself in pragmatism, existentialism, Marxim etc. in all of which the focus had shifted to, above all a priority for concrete experience by individuals. Truth became a subjective experience connected with human inner feelings, images, sensations, memories and these had to be meaningful to be true. Objective essences or things-in-themselves are not directly accessible. Reality is not a solid self-contained given, but a fluid unfolding process and its ramification depends on one's own actions and beliefs. There is a continual interaction between the knowing subject who is never separated from his own body and the external world.

For the Existentialists, beginning with the German Philosophers Husserl (1859-1938), Heidegger (1889-1976) followed by the French Philosophers Sartre (1905-1980) and Merleu Ponty (1908-1961), the world exists before the study begins – Existence before Essence. In the earlier theistic philosophies, Descartes, Leibnitz etc., God the creator had the concept of man and other creation in his mind. In the later philosophies of Diderot, Voltaire and Kant, each man was a particular example of a universal concept man. Essence of man preceeded the creation or existence.

In the atheistic existentialism of Heidegger and Sartre man exists first, turns up and appears on the scene and then defines himself. Existence is before essence. Thus man is nothing else than what he makes of himself. Each man is responsible not only for himself, but also for other men.

The British Philosopher Herbert Spencer (1820-1903), a positivist of the 19th Century, believed that reliable knowledge is to be found only in the sciences, was to be a great extent a Lamarkian. He did not subscribe to the idea that species evolved through chance mutation, but only through adaptation to environment. He held that there is one absolute reality of which the subject and object are mere signs.

Bertrand Russel (1872-1970) another highly influential British Philosopher, who even as an Idealist held that scientific knowledge was the best available and that philosophy should be built around it. He is one of the few western modern philosophers who maintained that "Philosophy bakes no bread" or arrives at any definitive conclusions about reality, but has an effect on the life of those who pursue it. He emphasised on the need for food for the mind which was what philosophy provided. He talks of the union of the universe and the mind". "Philosophy is to be studied, not for the sake of definite answers to its questions, since no definite answers can as a rule, be known to be true, but rather for the sake of the questions themselves, because these questions enlarge our conception of what is possible, enrich our intellectual imagination and diminish the dogmatic assurance which closes the mind against speculation; but above all because, through the greatness of the universe which philosophy contemplates, mind also is rendered great, and becomes capable of that union with the universe which constitutes its higher good".

In the last two hundred years after Kant's death, with the remarkable development in the field of science, there has been considerable change, as pointed out in the previous chapter, in our understanding of the external world and the process that go on there, in addition to much greater and deeper understanding of the human brain and the processes that go on there. First of all the Universe is orders of magnitude larger and very much more complicated in terms of its constituents and processes. Our concepts of space, time, causality, determinism have, radically changed. Even the concepts of force, field, vacuum have changed. Mass and Energy have been unified. Many more laws of nature have been discovered and the importance of the breakdown of these laws under certain circumstances, but subject to certain restrictions have become evident and these are connected with such prime questions like creation of matter, creation of the universe etc. Scientific explanations require a reductionistic as well as a holistic, individual as well as statistical interpretations.

The most significant development of the 20th century has been the discovery of fundamental particles which are the ultimate constituents of matter and radiation and carriers of electromagnetic, weak and strong forces as we discussed in the previous

chapter. Despite the discovery of these particles and forces and elucidation of their properties, some of the leading theoretical physicists of the 20th century have in no uncertain terms favoured an Idealist philosophy akin to that put forward by Plato in the fourth century BC. Werner Heisenberg, who played a major role in the development of Quantum Mechanics, says "…. In spite of the tremendous success that concept of the atom has achieved in modern science, Plato was very much nearer to the truth about the structure of matter than Leucippus or Democritus".

While behaviour of the elementary constituents can be described only in terms of quantum theory, the problem is that quantum theory itself can be described only in a mathematical language and the ordinary intuitive concepts we use to describe physical objects and phenomena like position, velocity, colour, size and so on, when applied to individual particles lose their validity in the classical sense. Heisenberg states "The smallest units of matter are, in fact, not physical objects, in the ordinary sense of the word; they are "forms", "structures" or in Plato's sense – Ideas which can be unambiguously spoken of only in the language of mathematics. Democritus and Plato both had hoped that in the smallest units of matter they would be approaching the "one" the unitary principle that governs the course of the world. Plato was convinced that this principle can be expressed and understood in mathematical form. The central problem of theoretical physics nowadays is the mathematical formulation of the natural laws underlying the behaviour of elementary particles.

According to Plato, "material things are the copies, the shadow images of ideal shapes in reality. This pure ideal "being" is apprehended not by senses, but through acts of mind. The ideal being is not in anyway in need of man's thought in order to be brought forth by him. On the contrary, it is the true being of which the corporeal world and human thinking are reproductions".

The famous astronomer Kepler also talks about innate archetypes that bring about recognition of forms. Wolfgang Pauli (1900-1958) another eminent quantum physicist says "The process of understanding in nature, i.e., in becoming acquainted with new knowledge, seems therefore to rest upon a correspondence, a coming into congruence of

the pre-existent internal images of human psyche with external objects and their behaviour. Kepler in fact speaks of Ideas which preexist in the mind of God and imparted accordingly upon the soul as the image of God. These primal images, Kepler calls archetypes". In Phaedrus, Plato says "The soul remembers as if it were something it had unconsciously possessed all along ..... The soul is awe-stricken and shudders at the sight of beautiful for it feels something is evoked in it that was not imparted to it from without senses, but has always been already laid down in a deeply unconscious region".

Another founding father of quantum mechanics, Erwin Schrodinger (1887-1961) also subscribed strongly to the idea of "oneness" says: "The same elements compose my mind and the world. This situation is the same in every mind and its world, in spite of the unfathomable abundance of "cross-references" between them. The world is given to me only once, not one existing and one perceived. Subject and object are only one. The barrier between these cannot be said to have broken down as a result of recent experiments in the physical sciences, for this barrier does not exist".

Schrodinger identifies this one with the `ego', the "I" and "Consciousness". According to him "the reason why our sentient, percipient and thinking ego is met no where in the scientific world picture is" – it is itself the world picture. It is identical with the whole and therefore cannot be contained as part of it". He emphasises "I" am the person, if any, who controls the motion of atoms according to laws of nature. This "I" in the Christian faith is God Almighty and in Vedantha it is Atman = Brahman = Consciousness. I is the ground stuff upon which all experiences and memories are collected. "Hence this life of yours which you are living is not merely a piece of entire existence, but is in a certain sense the whole".

Sir James Jeans (1877-1946) an eminent physicist of the early part of the century, who later became famous as science writer and the author of the books "Philosophy of Physics", "The Mysterious Universe" etc, is quite categorical in his views: "To my mind, the laws that Nature obeys are less suggestive of those which a machine obeys in its motion than those which a musician obeys in writing a fugue, or a poet in composing a sonnet. The motion of electrons and atoms do not resemble those of the parts of a

locomotive so much as those of the dances in a cotillion. And if "the true essences of substances" are forever unknowable, it does not matter whether the cotillion is danced at a ball in real life or on a cinematography screen or in a story of Boccasio. If all this is so, then the universe can be best pictured, although still very imperfectly and inadequately as consisting of pure thought, the thought of what, for want of a wider word, we must describe as a mathematical thinker". Streams of knowledge are heading towards a non-mechanical reality. Substantial matter resolves itself into a creation and manifestation of mind. "Mind has to be hailed as the creator and governor of the realms of matter – not of course our individual minds, but the mind in which atoms out of which our individual minds have grown and exist as thoughts".

Arthur Eddington, (1882-1944) the famous British astronomer, astrophysicist, and author of several popular books on science was also quite categorical in his assessment of what the ultimate reality is. "..... the stuff of the world is mind-stuff. The mind stuff of the world is of course, something general than our individual conscious minds, but we may think of its nature as not altogether foreign to the feelings in our consciousness". Eddington goes on to say "the realistic matter and fields of force of the former physical theory (prior to quantum theory) are altogether irrelevant – except in so far as the mind stuff itself has spun these imagings. The symbolic matter and fields of force of the present day theory are more relevant, but they bear to it the same relation that the bursar's account bears to the activity of the college". Our bodies are more mysterious than our minds which we know by direct self-knowledge.

John Wheeler, a student of Niels Bohr, and a renowned astrophysicist, while emphasizing the participatory role of man in deciphering the universe and reality behind says "Man is not a mere spectator to some vast cosmic clock work nor trivial cog in a machine whose every action is preordained. Man might be an active and vital player in determining what is real .... Conscious mind is crucially involved in establishing what is real. That which reaches our sense is at best a confusion of phantasmal energies – not sights, sounds or any coherent qualities that we project on to the physical world until mental construction takes place, reality must wait in the wings".

According to quantum physics the wave function of a particle, a purely mathematical thing is the only reality that is there until observation takes place.

The Austrian born, British Philosopher Karl Popper (1902-1994) agreed with Kant that Science can never produce knowledge that is certain. Any theory can never be viewed as final. New facts have several times upset old theories which were thought to be final. According to popper, falsiability is the most important criterion for acceptability and rejection of scientific truths rather than just verifiability. Proof against falsiability is most important. Science is therefore tentative in its conclusions. Reinterpretation in a new framework is always a possibility. In that sense human ignorance is infinite.

Thomas Kuhn (1922-) analysing the history of science doubted the prevalence of adequate self-criticism among scientists and in arriving at unbiased and valid conclusions from the data. He was particularly upset by the tendency to interpret the data to validate pet theories and paradigms of their choice and liking. Some of the relevant data was even ignored or delected for this purpose. He pointed out that major developments in science have taken place not by continuous accumalation of data, but by sudden flashes of genius, and serendipiitous discoveries. A significant point that he made which was of special relevance to philosphy is that science is not a linear progress, but is one characterized by radical shifts of vision in which non-rational and non-empirical factors play a crucial role. The knowledge that one acquires through science is tentative, contextual, relative and based on prevalent theories and expectations. It also depends on belief systems and the cultural milieu. According to him the post-Newtonian world order is neither intuitive nor internally consistent and coherent.

Peter Medawar (1915- 1967) in his book "The Limits of Science" argues that we must look to literature, religion and philosophy, not science for answers to questions about the first and last of things.

Chapter 5

Insights from Oriental Philosophies:

When Plato established the first academy of the World he said "Here scholars, researchers, of every stripe come together to fathom the plan of the world and to comprehend under a single edifice the overall scheme of things – poetize phenomena, to reduce the whole visible universe to a small set of abstract concepts and principles". We have seen in the last few chapters how western philosophy over several millennia and modern science over the past few hundred years have made tremendous progress in the attempts to understand the complex phenomena of the universe. Modern science has unravelled through the power of technology many more aspects of the universe than what Plato had envisaged in his reference to visible universe. The extension has been both in time and space and in the nature of contents. From a philosophical point of view however, the emphasis has remained on the discernment of the nature and relations between matter, mind, space, time and spirit (God).

In this chapter, we shall consider what the oriental views have been on these issues. Needless to say that some of the oriental philosophies go back to a time much earlier than those of the earliest western philosophies.

Among the ancient Indian philosophers too we have radical materialists, pure spiritualists, some who require both spirit and matter. It all boils down to discerning what is primary – spirit or matter? And what is real? And what is illusory?

A distinctive aspect of Indian philosophy has been not only to discover the "truth" but also to "realize" it in one's own experience. Philosophy is not only a way of thought, but also a way of life. Therefore Philosophy has necessarily a close relation to religion – the code of ethics and conduct in daily life. Among Indian Philosophies there are two broad categories, those that owe either partial or full allegiance to the scriptures – "the Vedas" and those that are independent of any scriptures. Among the former the differences arise essentially on the interpretation of the vedic utterances and also on the extent of dependence on post vedic texts. We shall not go into the historical, developmental details of these various schools of philosophy, but consider only the main

insights from the point of view of comparing and contrasting them with the insights from Western Philosophies and of modern science.

Among the six schools of Indian philosophy that depend on the authority of the vedas, the Vedantha and Patanjali's yoga philosophies are theistic and the nyaya, vaisheshika, sankhya and purva mimamsa are atheistic. Among those that are independent of the authority of the vedas are the Jain, Buddhist and Charuvaka philosophies.

The materialistic philosophers of ancient India date back to 3-7th Century BC. Among them the Charuvakas – Lokayitakas of Brihaspathi – who restricted themselves to the world of common experience – 7th-6th Century BC, the Sankhyas (Kapila, 6-5th Century BC) Nyaya (Gautama – 3rd Century BC) and Vaiseshikas (Kanada, 3rd century BC) held views which are very similar to the modern materialists. They believed in atomic nature of matter, the cause and effect links for all phenomena, the manifestations of the external world attributable to physical actions rather than linking them up with ideas, magic, prayer etc. They did not believe in supernatural powers. They believed in conservation of matter and emergence as a transformation of matter without destruction. The development of the world was attributed to spontaneity without any outside interference.

The Carvaka philosophy is perhaps the earliest, atheistic material philosophy dating back to a period earlier than 600 BC. It totally denounces the authority of the Vedas. Perception (Pratyaksha) is the only means of knowledge that is accepted. What is not perceived, does not exist. Inference is totally rejected. Matter is the only reality. The basic constitutent elements of the world are earth, water, fire and air. Even Space or Akasa is not there because it is not directly perceived. It is only inferred. Intelligence is a modification of the four elements. Consciousness arises from a mixture of these, so also thought. There is no Soul since it is not directly experienced, but inferred. Intelligence is a modification of the four elements. Consciousness arises from a mixture of these, so also throught. ~~There is no soul since it is not directly experienced, but inferred~~. The Lokayata, the other name for Carvaka, does not deny a spiritual principle, but maintains that it is a property of the physical aggregate of body and disappears when the body disintegrates. Consciousness or Soul is not external to the body. The Carvakas

have no belief in supernatural, no transcendental being, no God that controls. According to them, no life after death, no deeper reality. Pleasure in the individual's life should be the sole aim. (Hedonism). Pain is an inevitable feature of life, should be endured. The over all philosophy is "make the best of the bad bargain and enjoy yourself".

Though there are some differences between Nyaya and Vaisesika Systems of Philosophy founded by Gautama and Kanada respectively in the 3rd century BC, for our purpose here we can treat them together. In this Nyaya-Vaisesika system, diversity and not unity is at the root of the universe. Experience reveals nine entities which make up the universe. These are called `dravyas'. Not all the dravyas are material. The four materials are earth, water, fire and air all of which are actually composed of "atoms" which are indivisible and have specific properties. Akasa which is other constituent of the universe is partless and infinite and does not produce anything like the combinations of the dravyas do. Space and Time are conceived as objective realities. They are infinite and partless like Akasa. In this scheme Akasa stands for what fills the space – some ethereal substance which supports `Shabda' or Sound.

There are infinite number of souls. Each soul, the object of the notion "I", is omni-present and eternal. Though present everywhere feelings, thoughts, volitions of a soul are confined to the physical organism with which it is associated at any given time. Soul by itself is unconscious but consciousness is produced by the reaction of the individual soul and the organic nature. The soul is present even after the body is lost. The original Nyaya and Vaisesika philosophies are not theistic though there have been later attempts to fit them into a theistic mould.

The Sankhya philosophy founded by Kapila (6th-5th Century BC) is based on the concepts of Purusha and Prakriti, Purusha being pure consciousness without quality or character and is formless. The World of objects is a transformation of Prikriti. Prikriti has three qualities or Gunas, Satva (virtue), Rajas (passion) and Tamas (darkness). Combinations and proportions of these decide the variety of objects in nature, including man. Prakriti is the ground condition for all creation in the universe. The three Gunas may also be equated with essence (Satva), energy (Rajas) and mass (Tamas). According to Sankhya, Mahat which is Satva prominent evolves first from Prakriti from which the

world, mental and physical is manifest. In Sankhya there is one purusha for each soul. Patanjali's yoga system is grafted on the Sankhya metaphysics. Purusha is the transcendental principle underlying all being and knowing. Purusha cannot be perceived. It may be realized by personal development and practice of certain disciplines. Intellectually the presence of purusha can be inferred from the manifest purposiveness of the universe. Thoughts and images of the world are physical, but more subtle. Like gross physical objects, images of objects are non-conscious unless they are felt as experience – made conscious by purusha. Purusha is the light which illumines the mind. Patanjali emphasised the importance of controlling the breath (pranayama) for cleansing the body and achieving control of the mind, and practising meditation. There is no concept of God as Creator. Mind is subtle matter.

The Vedantha philosophy is based not only on the Upanishads, the last part of the vedas, but also on the non-vedic texts like the Brahma Sutras of Vyasa and the Bhagavad Gita which is part of the epic Mahabharata. According to Vedantha, the ultimate and only reality is Brahman. Reality is described as "that which persists – remains the same in the past, present and future; both manifest and unmanifest; substratum and structure. Reality is like an Ocean and Creation like Waves".

What is Brahman?

> "that from which all things are born, that in which, when born they live and into which when departing enter; that which we seek to know – that is Brahman".

There are many versions of the Vedantha, philosophy, the three main schools being the Advaita philosophy of Shankara (788-820 AD), – the Visistadvaita philosophy of Ramanuja (1027-) and the Dvaita Philosophy of Madhwa (1199-1278) the essential difference being in the relation between Brahman, God and Reality.

Shankara addresses the problem from two distinct stand points or reference frames. One is the Vyavaharika (Transactional) stand point – that of everyday experience and of common man, the other is the Pramarthika (Transcendental) – the Absolute truth – which is the view point of those who are much more advanced in their mental abilities. In the latter case, Shankara takes into account not only the experiences

of the waking state, but also of the dreaming and deep sleep states and also the experiences of those who are able to reach higher mental states through practice of Yoga and Meditation, giving relevant importance to the revelations from the scriptures. From a transcendental point of view (Adhyatmika Dristi), according to Shankara there is only ONE REALITY – that is BRAHMAN - and there is NOTHING ELSE. (Ekameva Advayam Brahma).

Brahma is spelled out in the four vedas as follows:

• Pragyanam Brahma (Consciousness is Brahman)	Rig Veda	Atreya Upanishad
• Aham Brahmasmi (I am Brahman)	Yajur veda	Brihadaranyaka Upanishad
• Ayam Atma Brahma (The Self is Brahman)	Atharva Veda	Mandukya Upanishad
• Tat Tvam Asi (That thou art)	Sama Veda	Chandogya Upanishad

By linking terms and ideas with which we are familiar like I, Self, That, Consciousness, the active principles in the individual and the Universe with Brahman, a glimpse of the ultimate reality is given to us. Brahman is beyond space, time and causation and the only property if it may be so called, is that of Being or existence. Brahman is something that can be realised, not something that can be taught. ["Sweetness" is something that can be known only by tasting; you cannot describe it in words]. Those that have realised cannot take you there, can only show the way. When objectively considered the supreme reality is Brahman and when subjectivity considered it is Atman. Brahman has a creative power that is termed Maya. The World is a Superimposition (Adhyasa) on Brahman of his own power Maya. Man can see either the world or Brahman and not both. Seeing Brahman, as pointed out earlier, is only by experiencing. It is through Maya, the ONE becomes MANY. Man does not normally recognise the state of ONENESS – THE REALITY because of the other power of Maya

namely to suppress and conceal (Avarana Shakti). Illusion in Shankara's advaita is in not recognizing the other state of ONENESS.

From the Vyavaharika or Worldly point of view, the advaita does not deny the existence of the world. It does not treat it as a dream or a fantasy. It is objective. Its experience is public. There is no way this experience can be denied. The world is negated only for those who have overcome the veiling power of Maya and seen the truth behind the worldly appearances – those who realize that the self, the universe and Brahman are all ONE. As ultimate reality it is ONE, but as souls and the world it is many. The variety is implicit in Brahman and becomes explicit on creation.

While talking of absolute and relative realities, Shankara gives the example of the serpent that appears while there is only a rope. According to him the serpent is neither existent nor non-existent. (Sad-Asad Vilakshana). [Is a Mirage real or unreal? From the point of view of bending of light it is real. But from the point of view of interpreting it in terms of reflection of light in water it is unreal]. What this emphases is that more knowledge and information is necessary to interpret correctly. Shankara considers the blend of Brahman and Maya as Qualified Brahman (Saguna Brahma) – this combination becomes the Iswara or God of advaita. From a Vyavyharika stand point, there is a world and there is a God who is regarded as the creator, preserver and destroyer of the World. From a transcendental point of view – for one who has realised the truth, - there is only Brahman and even Maya is not there, and the empirical God with all the attributes is not there. Some esoteric scholars maintain that it is not even ONE since even number does not inhere to it.

According to another version of Vedantha, known as Vishistadvaita of Ramanuja Brahman (identified with God), Soul and the World are all different, but inseparable. There exists a synchronised unity between the three. The whole of the physical world in its infinite variety evolves out of nature (prakriti) under the guidance of God. The individual soul (Jiva) is different from God but an accessary to Him (Prakara), coeval with God, but not identical. The soul remains unchanged in its nature through all processes of birth and death. It is born many times in the world and departs. At the time of pralaya or destruction of the world, the particular forms of the soul are destroyed; But Souls themselves are indestructible. In Visistadvaita, personal theism is united with the

philosophy of the absolute (Ubhaya Vedanta) The ultimate reality comprises of three factors matter (achit), soul (chit) and God (Iswara). The first two in Ramanuja's philosophy are dependent on the third, the dependence being conceived as similar to that of the body upon the soul. The entire world is treated as the body of God and He is not only the soul of inorganic nature but also of jivas. The inseparable unity of matter, soul and God is Brahman – the Absolute. The complex whole (vishista) is the unity. Hence the name Visitadvaita.

The third vedantic school of thought is that of Madhwa who expounded a theistic and dualistic interpretation of vedantha. According to Madhwa, God and Soul, Soul and Soul and Soul and the World are all different, though they depend on each other like body and soul. God is the supreme personality, devoid of all defects, all powerful and nothing is impossible for him. Out of his own choice he creates, saves and sustains the world. He is the efficient cause, but not the material cause of the world. The souls which are infinite in number are of three categories (Satva, Rajas, Tamas) and only Satva Souls can attain liberation (Moksha). Everything on earth is a living organism. Every atom of space is filled with jivas. Souls are atomic in dimension. Man is separate from God and never becomes God. God is looked upon as the exponent of vedas, but not as its creator.

Jainism, (6th Century BC) while not denying the existence of Gods, gives no special place to them since the world functions, according to Jains, on the basis of universal laws. The Universe is eternal following an infinite number of cycles. In each cycle there is improvement and decline. The soul is life (Jiva) and is finite and each soul is eternal. There is no concept of a universal soul into which individual souls merge. The categories of souls depend on the number of sense organs they possess. Even stones, rocks, water etc have souls. The Jain philosophy stresses that the absolute and whole truth can be known only by perfect souls. The ordinary souls can grasp only a relative many sided truth – which naturally is a fragmented one and limited in many respects. The soul is very small when it starts in the womb, expands gradually with the body and again contracts into the seed of next birth. The soul has no parts. Nirvana or deliverance is an escape from the body but not from existence.

Buddhism, in contrast to Vedantha and Jainism, did not have any necessity for either individual souls or a universal soul, but retained the concepts of rebirth and karma. But in Buddhism, Karma depended not so much on what one did (action), but more on motivation or intention. Like in Vedantha the process of rebirth can be stopped by achieving Nirvana, which is essentially destruction of all attachment and ego. Buddha himself (6th Century B.C. – contemporary of Pythogoras, Confucius, Lao Tzu, Zoraster, and Heraclitus) was not interested in questions like the origin of the world, nature of the Divine etc. What concerned him most were the problems of the individuals in their day to day living – suffering, frustration etc. He pointed out how relief from these could be obtained by developing a suitable mental attitude, through the eight-fold path – Right views, Right resolve, Right Speech, Right conduct, Right livelihood, Right effort, Right recollection and Right meditation. Though he did not specifically deny the existence of God, Buddha had no role for Him in human affairs and the phenomenal world which was the concern of man himself.

Later several different versions of Buddhism emerged. In Mahayana Buddhism founded by Asvaghosha and elaborated by Nagarjuna (1-2nd Century AD), also called the Madhyamika School, the phenomenal World had only a qualified reality. The actual reality is emptiness (Shunyata) or Void, while ordinary human beings perceived things all over – essentially an illusion. It is however possible to attain, to reach a mental state of awakening – to go beyond opposites and reach the status of "achintya" – where the world will appear to be undivided, and undifferentiated – "suchness" or Thathata which status Buddha had reached. Emptiness or Void in this context is not a state of "mere nothingness" but the very source of everthing – of life and forms.

In Mahayana, the term "Dharmakaya" (Body of Being) is used to denote the all pervading reality - that pervades the body and mind, a concept similar to Brahman in the Vedantha Philosophy. The Chinese philosophers called this one all pervasive thing - the substratum – "Tao". In this philosphy the world is seen as a continuous flow and change resulting in the emergence of new patterns - cyclic patterns of coming and going or expansion and contraction, of Yin and Yang – the primardial pair of opposites which projects the thought – "this is that and that is this". The cyclic change is not controlled by any external face, but by spontaneous characteristics of nature and life. "Zen" which

arose as a result of the interaction of Chinese, Japanese and Indian thoughts (~ 1200 AD) provides a methodology by which "enlightenment manifests itself in everyday affairs themselves" by training the mind.

Aurobindo (1872- 1950) based on his own experiences, has the following to say regarding higher mental states: "..... All things begin to change their nature and appearance. One begins to know things by different kinds of experience, more direct, not depending on external mind and senses. It is not that the possibility of error disappears, for that cannot be so as long as the mind of any kind is one's instrument for transcribing knowledge, but there is a new, vast and deep way of experiencing, seeing, knowing, contacting things; and the confines of knowledge can be rolled back to an almost unmeasureable degree".

Aurobindo goes further to say "True knowledge is not attained by thinking; it is what you are; it is what you have become ....." Without this secret identity, this underlying absolute oneness, we would be able to know nothing of the world of beings .... The naturalness is not separation, not differentiation, but oneness of all things".

Chapter 6

Epilogue

In this concluding Chapter, we will focus our attention on some of the quintessential questions of philosophy and examine to what extent the developments of science in the last four hundred years have provided satisfactory answers to these questions. We will also consider to what extent the various streams of philosophical thoughts extending over several millenia both in the East and West are relevant and meaningful and whether they supplement or complement the scientific explanations or entirely contradict them. The objective, as emphasised in the Introduction is not to put one at a higher pedestal than the other or indicate any priorities of thoughts and ideas, but to let winds of knowledge flow from all directions.

Lets us begin with one of the most fundamental questions – the origin of the universe, of life, of consciousness – the universe of which we are all part of and the one that we all cognize. How and when did the universe originate – how did the various constituents – matter, radiation, forces, space, time etc. come into being?

One school of thought, both among scientists and philosophers, is that the universe has been like this from times stretching back to infinity in the past and will continue in the same strain for ever. Some have modified this by introducing the ideas of a cyclic universe which gives the impression of a beginning and an end and accommodates continuity and changes seen over fairly long periods of time.

In science today, an infinite past is not favoured because of the many observed astronomical and biological features which all fit into an elegant model of creation and evolution at a specified time.. The expanding nature of the universe with the rate of expansion increasing with distance of separation and the discovery of a universal microwave radiation and the measured relative abundance of hydrogen and helium in the universe, all strongly support the Big Bang theory of creation according to which the universe that we are all part of came into existence about twenty thousand million years (20 billion year) ago as a result of a gigantic explosion. The first entity to be created was the space-time continuum which we perceive as three dimensional space and one dimensional forward moving time. It is this space that is continuously expanding. When

this space was created it was endowed with certain very special and specific properties that have been inferred from the experiments carried out at the highest energy accelerators. These experiments together with a variety of cosmic ray and nuclear physics experiments in the past, have given us an incisive knowledge of the microworld of elementary particles and the forces of interactions which determine the course of evolution of matter and life – in short all the activities in the universe.

A synthesis of astronomical and high energy experimental results have made it possible to figure out the precise time sequence of the creation of the various particles, nuclei, atoms, molecules, stars, clusters of stars, galaxies etc. While it does appear to be a long success story, there are aspects which have opened up many new questions that have no answers yet. What is it that exploded? And why? How did the space-time continuum acquire the very specific properties and how did the laws of nature and the values of natural constants that are so critical for the success of the theory get formulated? What the Big Bang theory has done is to push all the mystery to the first moment of creation. Given the initial conditions (whose origin is a mystery) the subsequent happenings in the inanimate part of the universe can be explained on the basis of this framework.

What about the origin of life and the animate part of the universe? At the moment there is no concrete evidence for existence of life outside the planet earth. While the physical and chemical evolutions have been figured out in considerable detail in the framework of well established laws of physics and chemistry, it has not been possible to extend the same frame work into the biological evolution which has many distinct features of its own. It has not been possible to define at what stage and in what precise physiico-chemical manner, the inanimate becomes animate. A very much more advanced question is at what stage the mind or consciousness with all its powerful features becomes manifest in the animal evolution.

In partial answer to such questions, there have been some new developments over the last few decades in what has come to be known as systemic approach which relies on the self-organizing capabilities of complex systems. A novel feature of these systems is the emergence of new properties that could not be envisaged or predicted on the basis of the properties of the constituents of the system. A classic example is the case of the three elements carbon, hydrogen and oxygen combining into innumerable

compounds with widely different characteristics like alcohols, fatty acids, sugar etc. One cannot from a study of the properties of carbon, hydrogen and oxygen predict all the properties of their compounds. It is surmised that something similar – emergence – may be happening in the case of biological systems. There is another feature noticed in some physical systems, like lasers, holograms, superconductors etc, which may be happening in biosystems as well. This is the phenomenon known as "downward causation" in which higher level laws control those at lower level – the group influencing and controlling the behaviour of individuals. In the case of biosystems yet another control is exercised by the millions of bits of information that is inherited in the genes. The study of complex chemical systems in which the chemical reactions are taking place far away from equilibrium conditions with free access to energy and in which there could be feed back from output to input systems, is a fertile field of research that is going on in many laboratories and may throw considerable light on biological systems.

These approaches bring us to the question of the supremacy of laws of nature at various levels in various systems that operate on the constituents and give rise to all the variety in nature. Einstein has said: "Scientific research is based on the assumption that all events including actions of mankind are determined by laws of nature. Therefore a research scientist will hardly be inclined to believe that events could be influenced by prayer, that is by a wish addressed to a supernatural being. However, we have to admit that our knowledge of these laws is only an incomplete piece of work, so that ultimately the belief in the existence of fundamental all embracing laws rest on a sort of faith. All the same, this faith has largely been justified by the success of science.On the other hand, however every one who is seriously engaged in pursuit of science becomes convinced that the laws of nature manifest the existence of a spirit vastly superior to that of men and one in the face of which we with our modest powers feel humble. The pursuit of science leads therefore to a religious feeling of a special kind which differs from religiosity of more naïve people".

This vastly superior spirit Einstein identifies with his Concept of God.

Like the philosopher Spinoza, Einstein denied the existence of a personal God who rewards and punishes. It is exceedingly educative and thought provoking to become familiar with Einstein's Concept of God: "I am not an atheist and I don't think I can call myself a pantheist. We are in the position of a child entering a huge library filled

with books in many languages in which they are written. The child known that someone must have written those books. It does not know how. It does not understand the languages in which they are written. The child dimly suspects a mysterious order in the arrangement of the books, but does not know what it is. That seems to me the attitude of even the most intelligent human being towards God. We see the universe marvellously arranged and obeying certain laws, but only dimly understand these laws. Our limited mind grasps the mysterious force that moves constellations . I am fascinated by Sponoza's Pantheism, but I admire even more his contribution to modern thought because he is the first philosopher to deal with Soul and Body as one and not two separate things".

This idea of oneness of Soul and Body that attracted Einstein, is contrary to the idea of Rene Descartes, one of the pioneers of modern science, who had proposed that mind (soul, consciousness) is some kind of thinking substance, not describable in terms of matter that composed the body. This philosophy known as Cartesianism was proposed four hundred years ago, at a time, when very little was known about the structure of matter and much less about the structure of the brain and the physico-chemical processes in the brain and in its accessories and the correlations between mental processes and the brain activities. Therefore, it is relevant to ask the question whether all the reductionist developments that have taken place in the last four hundred years in the analysis of matter and all the developments that have taken place in neurosciences that have enabled very detailed and minute mapping of the physico-chemical processes in the complex neural networks associated with the brain, have led to any clearer understanding of the mind-body identity or distinction. As one progressively went into the discernment of the structure of matter at deeper and deeper levels - molecules, atoms, nuclei, elementary particles, quarks and gluons and photons, it became clear that these entities could no longer be thought of as miniature and subminiature versions of the types of objects we are familiar with at gross levels. Even concepts like position, momentum, localization of charge, energy, causality etc. would just not be applicable in the way we are familiar with. In short they became very abstract entities which somehow in conglomeration give rise to the pieces of matter like dust grains or sand particles that we see with our eyes. In this sense, matter itself, in the final analysis has became very mysterious. In fact there are aspects of those fundamental particles which are baffling. The same entity behaves once like a localized particle and another time as an extended

wave. By a spontaneous fluctuation particles and anti-particles can suddenly pop up. Determinism and exact predictability which were held as sine qua non of science no longer hold and many things depend on the observer and the equipment with which he makes observation.

Is there then no objective reality? "What is the thing-in-itself?", as Kant would ask.

Bohr and Wheeler talked of the "Participatory Universe"; science cannot tell us "what is"; can only tell "what will happen when we observe". Reality gets tied down to observation!

According to Wheeler, "reality may not be entirely physical. Our cosmos is a participatory phenomenon requiring act of observation. Truth in some sense is imagined rather than apprehended. Erwin Schrodinger wrote "The world is a construct of our sensations, perceptions and memories. It is convenient to regard it as existing objectively on its own. But certainly does not become manifest by itself by mere existence".

In the same strain, Wolfgang Pauli has said " .... The only acceptable point of view appears to be the one that recognises both sides of reality, the quantitative and the qualitative, the physical and the psychic as comparable with each other and can embrace them simultaneously ..... It would be more satisfactory if all of physics and psyche (matter and mind) can be seen as complementary aspects of the same reality". This trend of oneness is reflected by many scientists hailing from different disciplines. The Noble Laureate Prigogine says: "Biological life instead of being a pack of strangeness gazing at a cold and sterile universe is embedded in a living universe".

How far down can we carry this concept of oneness?

The reductionistic method of science which progressed over the last few hundred years by discovering more and more fundamental particles as the basis of matter and interactions between these matter particles, finally came up with the recognition that all these are manifestations of one substratum – vacuum - which for technical reasons has been called quantum mechanical vacuum, which is also identical to the four dimensional space-time continuum. It is best to quote the two masters Paul Dirac, the physicist who

was the first to recognise the significance and content of this quantum mechanical vacuum and the other Einstein who introduced the space-time continuum idea and spelled out the connection between this continuum and matter and established the identity of matter and energy ($E=mc^2$).

Dirac: "All matter is created out of some imperceptible substratum – Nothingness. Unimaginable and undetectable. But it is a peculiar nothingness out of which matter is created.

Einstein : Matter when we perceive is merely nothing but a great concentration of energy in very small regions. We may therefore regard matter as being constituted of space in which the field is extremely intense. Field is the only reality.

In Science, the chief advantage of this concept of all pervading oneness is the removal of the barrier between different entities that enters in our attempts to understand the mechanism by which they interact with each other. For example, right from the time of Newton himself, we had the problem of action at a distance. The challenging question was – How is the gravitational force between the sun and the earth negotiated? What is exactly happening in the intervening space? Now with the grand idea that the sun and the earth and the space in between are all one and the same, the sun being a location of a higher curvature of space than that of the earth, with the space in between having the property of transmitting the gravitational force carrying "gravitons" between the two sites the barrier difficulty is removed. The "gravitons" (gravitational warm) have not yet been detected experimentally yet. Major effort is going on this direction. Large number of `gravitons' are expected to be released during the explosion of stars – supernovae explosions. These rare celestial events are monitored for recording "gravitons".

To summarise, the quantum mechanical vacuum (the four dimensional space-time continuum) is the ultimate substratum which is the reservoir of all fundamental particles which exist in a state normally non-detectable. Spontaneous fluctuations of this substratum does give rise to virtual pairs of particles and anti-particles. Very occasional violent fluctuations can give rise to detectable particles. This space with all the special properties was created at the time of Big Bang and is continuously expanding since the

last 20 billion years. Over the last fifty years, increasing number of fundamental particles have been discovered at accelerators and to accommodate these the properties of the vacuum are correspondingly redefined. It is perhaps true to say that not all the properties of the vacuum have been uniquely and finally determined.

This concept of oneness – existence of a substratum which is responsible for everything – all creation, all action in the universe, pervades many philosophies both in the West and in the East. Naturally the detailed specifications, contents and mode of action of the substratum is different in the different systems.

In an exhilarating article entitled "The Debate between Plato and Democritus", the Nobel Laureate Heisenberg, discusses the concepts of matter in ancient philosophy and according to modern science.

Heisenberg emphasises: "I think that on this point (Democritus or Plato) modern physics has definitely decided for Plato. For the smallest units of matter are, in fact, not physical objects of the ordinary sense of the word; they are forms, structures or – in Plato's sense – Ideas, which can be unambiguously spoken of only in the language of mathematics. Democritus and Plato had both hoped that in the smallest units of matter they would be approaching the "one", the unitary principle that governs the course of the world. Plato was convinced that this principle can be expressed and understood in mathematical form. ..... Plato's symmetries were not yet the correct ones, but he was right in believing that ultimately at the heart of nature, among the smallest units of matter, we find mathematical symmetries. It was an unbelievable achievement of the ancient philosophers to have asked the right questions . But lacking all knowledge of empirical details, we could not have expected them to find answers that were correct in detail as well".

The above remarks of Heisenberg are true of many of the philosophical approaches of the Orient.

In Mahayana Buddhism, which is one of the later versions of Buddhism that spread to Tibet, China and Japan the concept of Sunyata (void, emptiness) was introduced to represent "not a state of nothingness", but as the "very source of all life and activity and essence of all forms". The Avatamsaka Sutra of this School of thought emphasises the unity and interaction of all things. Lao Tzu, a Chinese philosopher and

contemporary of Buddha and the founder of Taoism in China spoke of the Tao, as the ultimate reality – a unity of opposites Yin and Yang whose dynamic cyclic interplay generates all the activities of the world. It is a philosophy of continuous change and harmony.

In the Vedanta Philosophy, this all pervasive oneness is identified with Brahman which is everything (Sarvam Khalu Idam Brahma). In the advaita philosophy of Sankara, the Brahman is also identified with Aatman (the individual soul i.e. self) and consciousness.

The self is looked upon as pure consciousness itself and it is when this consciousness interacts with the mind, which in advaita is treated as material (the sixth sense), that consciousness of something arises.

We all have the experience of three states – the waking, the dreaming and the deep sleep states and make experiential statements like "I" ran, "I: dreamt, "I" slept implying that the "I" – "the self", "the experiencer" is common to all of them. This we do despite the very different space-time frames in the waking and dreaming states and the absence of space-time in the deep sleep state. The experiencer, the witness that is common to all the states and provides the continuity, is the absolute consciousness since as glimpsed in the deep sleep state it has transcended space-time. In the deep sleep state there is nothing other than a unique experience of oneness. Therefore it is justifiable to equate absolute consciousness with Brahman and Atman.

While we all get a glimpse of this oneness in the deep sleep state, there are the siddha purushas (the realized souls) who can reach this state of unification through yoga, meditation, zen etc.

There is a confusion that is often created by some who say that according to sankara's advaita philosophy the world is not real but is an illusion. How can the world that is experienced by all of us day in and day out be an illusion? What needs to be emphasized is that sankara makes a clear distinction between the transactional state (vyavaharika state) and the transcendental state (paramarthika state) of human beings. In the transactional state, which is the normal state of all of us in everyday life, the world is real and not an illusion. However in the transcendental state we become aware of the supreme reality that is behind all the worldly activities and in that state we recognise the unification of all the multiplicity that we see around us. In that sense the illusion –

namely the world – disappears for the one who has realized the truth, namely the oneness. Until then the illusion persists. Sankara illustrates this with the most beautiful and yet very simple example of the "rope and snake" – what is in reality a rope is mistaken in darkness to be a snake and the illusion persists until true knowledge is obtained by the shining of a light. As long as one is in darkness the "snakeness" persists and the attendent fears. The "illusion" is not that the world does not exist, but the non-recognition of the oneness of the substratum that really constitutes the world.

The explanation of the causal connections between this substratum and the multifarious entities and activities of the universe has posed serious difficulty in all the different standpoints that we have discussed above – be it in science, be it in western philosophies, be it in Buddhism or in Advaita. The reason is that when we seek explanation of anything from the transactional point of view, it has necessarily to be in terms of what is known, what is familiar. The process by which something that is indescribable in terms of what is known is transformed into something concrete like the world, cannot just be described. It has been termed Anirvachaniya (cannot be explained by words). As we have seen in science too the same thing is true for example of the very first moment of the Big Bang and the creation of the space-time continuum with all its properties.

The question naturally arises whether this incomprehensibility, this abject helplessness is a limitation of the human mind at its present stage of evolution. Will a new type of comprehension become possible after, say another million years of evolution? Or can the human mind be trained even now by special methods and practices to achieve this comprehension? Wheeler has said, "As the island of knowledge grows so does the shore of our ignorance". This certainly is true of scientific knowledge. In Science, the more we know the more we realize that there is far more to be known. We have to search for that type of knowledge which conquers all ignorance. The fact that science creates new knowledge and also new ignorance does not detract the merit of science, nor does it warrant the abandonment of science. It only highlights its limitations.

Acknowledgements:-

Philosophy of Science (at the end of 20th Century)

Introduction

The thinking man, the Homo Sapien Sapien, emerged on the earth about 40,000 years as a product of 3 billion years of evolution beginning as a single celled organism. ~~He/She~~ Man acquired the facility of some kind of language communication not more than 10,000 years ago and started living in communities. Based on our daily experience and the type of questions that we ask ourselves or others, we can surmise what kind of questions should have bothered these early men and women who did not have the benefit of the cumulative knowledge that we possess to-day. Let us list some of them.

Why do things change around us? Why day? Why night? Why seasons? Why rain? Why thunder and lighting? Who are what causes these changes?

Why disease? Why death? What happens after death? What is responsible for all the activity when we are alive? What is the origin of man? of the earth? of the sun? of the starts? What is responsible for ~~these~~ their motions?

As slowly ideas of space, time, causality emerged and concepts of mass, velocity, force etc because of common usage and parlance, more fundamental questions must have occurred to them. What is exactly space? What is time? When did time begin? How vast is space? How far are those objects in the sky? What is responsible for the regularity of the motion of planets? Who controls all these motions?

How old is the earth? the universe? What will happen in the future?

What is the difference between the waking state and the dreaming state? What happens to all this activity when we are in deep sleep? What is the connection between the mind with which we perceive and think and the external world of objects? What is responsible for our emotions – joy, sorrow, feeling of guilt, depression etc?

What is life? What is consciousness?

These types of questions most have occurred to people at different stages of their lives and to people in different parts of the world. There were some persons who had higher intellectual abilities who tried to find answers to such questions on the basis of their own thinking and by discussions with others around them. There must have been two kinds of motivations. One was to acquire the knowledge and utilise it for improvement of their daily necessities - food, water, shelter, protection from animals and natural disasters, rigours of climate etc. The other must have been to satisfy their curiousity – an inborn trait that is especially strong in man. Over a period of time these intellectual activities of man led to the development of various philosophies and religions in different parts of the world. About 500 years ago, modern science emerged branching off from the philosophical approaches and adopting a new methodology of investigation and has been eminently successful in meeting both the requirements of man – the utility aspect – which is science based technology and the curiosity aspect- the fundamental sciences. While science has answered many questions of the old kind, it has also raised many new ones which have a bearing on philosophical issues- particularly on the most outstanding issues.

Since this booklet is on the Philosophy of Science at the end of the century and since practically all of modern science has been carried out in the west where it had its origin, the first three chapters of the book deal with the following topics: In the first chapter the status of philosophy before the dawn of modern science in the early 17th century is presented. The second chapter deals with the relevant developments in science till the end of the 19th century and their philosophical implications. The third chapter focusses on the far reaching developments that came about in the present century and the profound effects these have had on the philosophy of science. Some aspects of the philosophy of science remind us of the close parallelisms with ancient philosophical insights especially of the east. Bearing in mind the fact that modern science does not need the ancient insights for its furtherance and ancient philosophies do not need ratification of modern science, but philosophers of any hue need to keep an open mind and should welcome inputs from any quarters, in the last chapter some relevant aspects of ancient philosophies especially those that reflect a holistic view are presented.

Chapter1:

The very Early Western Philosophers

Thales of Miletus (640-546 BC) emphasised the importance of gaining substratum of facts independent of the judgement of individuals. He set out to answer the question"of what and in what way the world is made?" This shows that there were individuals even in those early days who were bothered by fundamental aspects of nature and were interested in acquiring knowledge for the sake of knowledge without worrying about practical fall-outs. The famous greek mathematician Pythagoras (570-501 BC) believed that everything whether physical properties or moral qualities are interpretable in terms of numbers. However, when he realised that the square root of number 2 is not expressible as a ratio of integers, he lost his confidence in the supremacy of numbers.

Leucippus ( ) and Democritus (470-400 BC) maintained that everything in this world consists of `atoms' and `void' – the emptiness between the atoms. Epicurus (341 BC) believed that the number of atoms were `infinite' as well as the `void'.

Zeno, well known for the hare and tortoise paradox, was of the view that the world is moving towards a perfection designed by God. He believed that man could atleast in part achieve the same capacity .

The Mediaevalist Philosophers

Socrates (469-399 BC), Plato (429-347 BC) and Aristotle (322 BC) All the three had no love for what we now call experimental knowledge. They placed mental capabilities at a higher pedestal and firmly believed that mathematics provided a crucial key to the secrets of nature. Theirs was essentially a holistic comprehensive approach, which was also characterized by the firm conviction that the universe proceeded as if it had a specific purpose to fulfil – a teleological outlook. Their outlook was determined by reason and revelations.

According to Aristotle, the scriptures contained divine revelations on matters not accessible to reason. By synthesizing these two kinds of information everything worth knowing could be learned. This synthesis was achieved by St. Thomas Aquinas (~~Limitations of Science P~~[14]).

Medieval

During this ~~medieval~~ period the emphasis was more on `Why things happened than on how things happen?

~~Plato:~~

The Greeks were quite concerned about the `origins' of the things they perceived near and far. Plato reflects:

"The Philosophers say that the earth and air, fire and water all exist by nature and chance and none of them by art, and the bodies which come next in order – the earth, the moon, the sun, the stars – have been created by means of these absolutely inanimate existences. The various elements are moved by chance and also by inherent forces according to certain affinities amongst them – of hot with cold, dry with moist, soft with hard and according to all the other accidental mixtures of the opposites which have of necessity happened. After this fashion has been created the whole of heaven and all that there is in, as well as all animals, plants and all the seasons. These come from these elements not by any action of mind or of any God or from art, but by Nature and chance only".

Close

How ~~else~~ they were to the modern ideas of creation in terms of constituents, forces and chance!

To understand Reality,

~~On the philosophical front~~, Plato stated that we must make a clear distinction between Sensibilia and Intelligibilia - what the mind perceives through the senses and what it apprehends by thinking. According to Plato, reality is not to be found in the world of Sensibilia, (the physical word) but rather in the world of intelligibilia, which is where all mathematical entities and other non-physical objects of thought are housed.

According to Plato non-physical objects like numbers, feelings of sameness, goodness, rightness etc reside in our brain and are a consequence of the judgements that the mind passes on sensations. Plato believed that the human mind is equipped from birth with a set of Forms or Ideas which exist independently of the external world. Each object is the meeting place of several forms. When we talk about a Red Square Brick, we have the confluence of three forms - redness, squareness and brickness. The only sure knowledge we have is of these forms and their relations. These Forms of Plato, it should be emphasized were supposed to be inborn in each individual, as if they were memories from a past life.

Plato also believed in a soul that was immortal. He considered the body as a prison for the Soul., and death was the liberation. The soul was considered to be the principle of 'life' and motion'.

To emphasize the distinction between appearance and reality Plato resorted to the famous allegory – the philosopher is confined within a cave and can watch only the shadow play on the wall in front of him, without realizing that the reality is behind him in the world outside the cave – a two dimensional shadow play of a three dimensional world. Plato remarks "The real philosopher is the person who has escaped from the cave into the light of truth - he is the one who posesses the real knowledge".

In the two thousand years that followed Plato, ~~the immediate connection with truth – God in the Christian era is what occupied the human mind.~~ People were concerned more about Soul and God and not about the outer world. These concerns prevailed in the west till the Renaissance Period.

The Philosophers of the Renaissance Period.

Hobbes (1586-1679 AD) is regarded as the first modern philosopher, who defined philosophy as the study of effects from causes and of causes from effects. He was a pure materialist. He regarded the whole World as constituted of matter essentially in motion. For Hobbes, matter was the only reality. He regarded man as an animal with a

material body; thoughts, emotions etc. being a consequence of the mechanical motions of the atoms in his body. Naturally in this kind of approach there is no scope for free-will and everything is predetermined.

Descartes (1596-1650 AD), the famous mathematician and founder of analytical geometry and after whom the well ~~know~~ known Cartesian Co-ordinate System is named, was one of the founding fathers of modern science. He made a distinction between mind and matter. He contended that mind is to 'think' and matter to 'occupy space'. According to him the inner ideas, which have their origin in the vision of the intellect must be true. While Descartes believed that mind is made of subtle matter distinct from ordinary matter, he did not clarify the distinction and the connection between mind and matter. His followers said that "God had so ordained that activities of the mind and of matter corresponded exactly to one another in perfect synchronization".

Despite all the emphasis on matter and subtle matter, Descartes believed that the external world was inferential in nature and not one of direct perception. In this sense he is regarded as one of the founders of Idealism and it is said that it is his idealism that paved the way for Berkelian idealism, ~~which we will come to later~~.

Leibniz (1646-1716 AD) was a German Mathematician, a ~~C~~c ontemporary of Isaac Newton, his professional rival claiming himself as the discover of Calculus, echoed the ideas of Descartes on the duality of mind and matter. He said "In the beginning God created mind and matter in such a way that each can follow its own laws and yet the two move in perfect agreement as would prevail if God for ever was putting his hands to set them right". He was convinced that "so great a craftsman as God who could make Caesar's body and prearrange its atoms so that it should go to the senate house at such and such an hour on the ideas of march" could manage anything, and everything.

Spinoza (1632-1677) has been characterized as a God-intoxicated jew and a rare metaphysical genius. Descartes believed in a duality of God and a real world created by God. Spinoza reduced his duality to a universal unity, which he called "the substance".

As Lewis in his History of Philosophy ~~(p421)~~ has put it, the doctrine of Spinoza is "The greater reality of all existence is substance. Not substance in the gross and popular sense of body or matter, but that which is substans – which is standing under all phenomena supporting and giving them reality. What is a phenomenon- an appearance, a thing perceived, a state of the perceiving mind. But what originates this perception – what changes the mind the mind from its prior to its present state? Something external and extrinsic changes it. What is this something? What it is in itself. ~~We can never know because to know it would bring it under the forms and conditions of the mind i.e. would constitute a phenomenon – unknown therefore, but not denied – this ens – this something is; and Kant calls it noumenon~~. This Spinoza called "Substances".

Kant (1724-1804) brought in an entirely new perspective. He maintained that the object and its mental picture are entirely different, since the Frames through which we perceive are dependent on the mind. The "thing in itself" is not accessible to our senses. In the inborn mind there are a number of principles or facilities to discover truths about the universe. He went so far as to say that it should be possible to construct a pure science of nature which would be independent of all experiences of the world, thus stressing on the superiority of 'a priori' knowledge over "a posteriori". According to Kant the science of nature so constructed would be uncontaminated by errors and illusion of observations. These views of Kant were rather startling since he had familiarity with the science of those days. Kant believed that our apprehension of the inner world is not any more privileged than our apprehension of the outer world.

Descartes, Leibniz, Spinoza and Kant ~~have been~~ were classified as rationalists ~~who~~ Since they maintained ~~that~~ that all knowledge must be obtained through contemplation. True statements about material world can be made only through the power of reason without sense experience. and that They firmly believed that knowledge obtained through direct observation of nature through the senses could be deceptive.

The surprising aspect is that Descartes, Leibniz ~~and Kant~~ and who subscribed to this rationalist view point were ~~all~~ in a sense pioneers of modern science and mathematics, which could never subscribe to such a view.

In Contrast to the "Rationalists" in parallel there was the School of "empiricists" who held that knowledge comes from experience alone and the only way to discover the facts about the universe is to go out into the world and search for them. However the prominent empiricists, none of whom had any scientific background held different views on the role of mind in accessing Reality of the external world.

According to Locke (1632-1704), the impressions produced by objects on the senses are vague in the first instance, but become definite and meaningful only by Repition. Locke says

" In time the Mind comes to reflect on its own operations about the ideas got by Sensations and thereby stores itself with a new set of ideas which I call ideas of Reflection. Thus the first capacity of the human intellect is that the mind is fitted to receive the impressions made on it through senses by outward objects or by its own operations when it reflects on them.

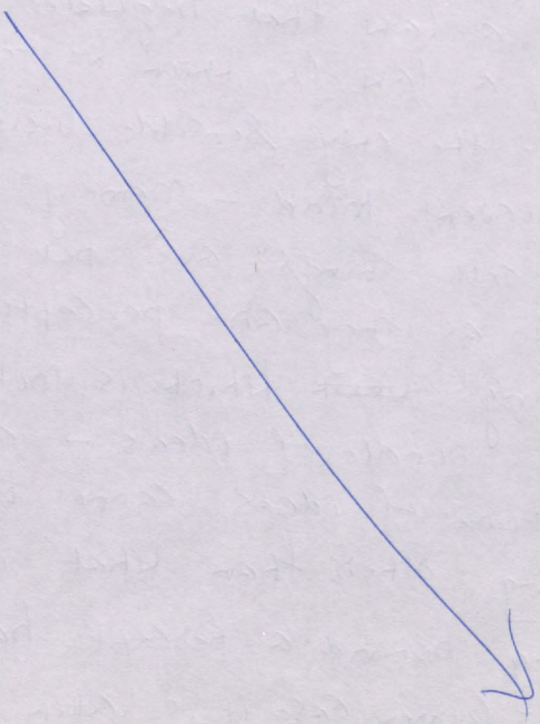
According to Berkeley (1685-1753) " All that we know is only our own mind ~~or~~ and its States or ideas. There is no doubt a law that regulates their concomittances and succession, a law for which we feel we are not responsible. In that case the only sensible view can be it proceeds from an omnicient mind - namely God. ----

What we call "things" are but our ideas. They are real in so far as they are percepts. There is nothing in the 'thing' ~~that~~ which is not reducible to an idea; and a bundle of ideas. - a 'thing' cannot transcend the nature of ideas. cannot by become, by any kind of reasoning, other than what it is perceived to be. A something behind a percept has either qualities or not. on the former case it is akin to our percept and no more.

PTO

In the latter it is unimaginable and therefore unreal.; for what is imaginable is only that can be perceived or conceived as a sum of qualities or sensations."

Hume (1711-1776) questioned the basis of the mind itself. He said "We are immediately made aware of feelings, sensations, volitions and cognitions - of pleasure and pain; of love and hatred, of sound and colour, but we can never come across the supposed Substrate of feelings - the mind. It is as much a phantom haunting an unreflective man, as matter apart from sensation. ..... there is neither mind, nor matter all is idea changing every moment. No substance, no reality. --- There is no permanent, immutable element in the world of our experience and there is no valid principle which can justify metaphysical speculation concerning the world beyond our experience" - an extreme skeptical attitude.



In contrast, Francis Bacon, Locke, Berkeley and Hume and much later philosophers Whitehead and Russel are classified as empiricists who believed that the only way to discover facts about the universe is to go into the external world and search for them. The only concession that was made is with regard to mathematics, truths of which could be known by intuition. This is essentially the modern scientific view point.

In his book "Physics and Philosophy" Sir James Jeans, a scientist well known for his books on popularization of science, pointed out more than fifty years ago that there has been a change in the view as to the proper aim of philosophy. "The ancient philosophers pursued their studies in the hope of finding a lantern which should guide their feet along the best path in their journey through life., the philosophers of the seventeenth and eighteenth centuries in a fixed determination to find evidence that this journey ended in a life to come. This humanistic tinge has taken a long time to disappear; but has almost done so in recent years; philosophy has become less concerned with ourselves and more concerned with the Universe outside. It is now recognized in Bertrand Russel's words "Man on his own account is not the true subject matter of philosophy. What concerns philosophy is the universe as a whole; man demands consideration solely as the instrument by means of which we acquire knowledge of the universe. .... We are not in a mood proper to philosophy so long as we are interested in the world as it affects human beings; the philosophic spirit demands an interest in the world for its own sake".

The Classical Mechanistic World View

Science undoubtedly began with a systematization of the observations of the sky, in particular the regularities of the motion of plantes. The Egyptian astronomer Ptolemy (127-151 AD) had proposed the Geocentric system according to which the earth was the centre of the Universe. Almost five hundred later in 1540 Nicolaus Copernicus (1473-1543) came out with the heliocentric theory according to which the sun and not the earth was the centre of the Planetary motions. The observations of Tycho Brahe (1546-1601)

and of Galileo (1564-1642) supported the Copernican theory. Kepler (1574-1630) came out with the Planetary laws based on the painstaking observations of Tycho Brahe. Shifting the Centre of the Universe, as known at that time from the earth to the Sun was not liked by the church, which had become politely politically very powerful by them. Consequently the famous book "DeRevolutionbus Orbarium Coelestium" written by Copernicus was so much delayed in publication that the first copy of the book was brought to him on his death bed, Copernicus was suffering from apoplexy and brain hemorrhage. and was in his last moments. A strong proponent of the Copernican theory, Giordano Bruno was burned at the stake because of the hostile church. Even in the 18th century, some of the American Universities like Yale and Harvard taught both Ptolemaic and Copernican theories. It is only in 1822 that the Roman Catholic Church gave permission for the Copernican system to be taught as the truth and not just a hypothesis.

De Revolutionibus

In his earlier days Einstein regarded because

Einstein regards Galileo (1564-1642) as the father of modern physics, Galileo drummed it to the scientific world "Pure logical thinking cannot yield us any knowledge of the empirical world; all knowledge of reality starts from experience and ends in it". Surprisingly as we shall see Einstein himself changed his views on this aspect.

in addition to observation

Galileo held that mathematics is the true key to natural phenomena. He was of the view that the non-mathematical properties in nature are entirely subjective, and have no existence outside our senses. In this he included such properties as colours, sounds, odours. He thought all these are in our minds. In the absence of mind, the universe would be just a drab collection of masses of various sizes, shapes, weights without colour, sound or odour.

This attitude had important philosophical consequences. The medieval philosophers had advocated the view that the purpose of everything was to reach to a higher state of being, culminating in the union with God. Time was the essential instrument that brought about this transformation. With all the important qualities being attributed to the power of the mind, stripping them from the external universe, the all important role of time was now being negated. The real world became a world of material particles moving in

without a goal.
accordance with mathematical laws through space and time ~~that had no arrow towards the final goal~~. Strangely enough ~~though~~ God was no longer required for controling the phenomena continuously, ~~he~~ but was still required for starting the whole process. ~~Let us see what Newton had to say on this whole matter~~.

Isaac Newton (1642-1727) was born on Christmas Day in the year that Galileo died. Newton's contributions to science were truly multidimensional. Newton formulated the solid framework of classical physics. He was the first to bring about a fusion of mathematics with the empirical outlook, the formation of the scientific methodology. About methodology Newton writes in ~~this~~ his "Principia":

(methodology)

"..... This analysis consists in making experiments and observations and in drawing general conclusions from them by induction and of admitting of no objections against the conclusions, but such as are taken from experiments or other certain truths. For hypothesis are not to be regarded in experimental philosophy..... But if anytime afterwards any exception shall occur from experiments, it may then be pronounced with such exceptions as occur. By this way of analysis we may proceed from compounds to ingredients and from motions to the forces producing them: and in general from effects to causes, from particular to general....."

as driving the present.

~~as driving the present~~ Clearly for Newton, experiment was the final test. He dispensed with final causes; proceeding physical events determined the future. He had no need for concepts like purpose. Newton agreed with the Galileon's view of the subjectivity of secondary qualities like colour, sound, etc. He said: "..... For the rays, to speak properly, are not coloured. In them there is nothing else than the power and disposition to stir up a sensation of this or that colour. For as ~~in~~ sound in a bell or a in a musical string or other sounding body, is nothing but a trembling motion and in air nothing but that motion propagated from the object, and in the sensorium 'tis' a sense of that motion under the form of sound ....."

Galileo's

~~It is important to get familiar with~~ Newton's ideas on space, time, matter and motion, were extremely important for the progress of classical physics.

Newton believed in the existence of absolute space and absolute time. According to him, material particles that constitute the external world moved in absolute space and absolute time. Absolute space exists in its own nature without regard to anything external and is always similar and is innovable. All changes are described in terms of Absolute time which has no connection with the material world and flows smoothly from the past to the present and will flow to the future without regard to anything. All matter is made of solid and indestructable particles - mass points.

Though there are similarities with the old Greek model of Democritus to which we have referred earlier, in the Newtonian model the concept of Force is introduced. This force of gravity, Newton assumed was proportional to the product of the two masses between which it is acting decreasing as the square of the distance between them – the famous inv..... square law of Gravitation. Newton assumed that the force ~~gets~~ instantaneously irrespective of the distance. ~~Newton believed that nature was designed by God~~. To the question "how does the action at a distance take place?" Newton's answer 'was: God only knows'. Newton also believed that God, every now and then made the necessary adjustments with the mathematical machine that kept the world going. Newton is his book "opticks", writes

"It seems probable to me that God in the beginning formed matter in solid, massy, hard, impenetrable moving particles of such sizes and figures and with such other properties and in such proportions to space as most conduced to the end for which he formed them and that these primitive particles being solids are incomparably harder than any porous bodies composed of them, even so very hard as never to wear or break into pieces; no ordinary power being able to divide what God made himself in the first creation".

Essentially all physical events reduced in Newtonian mechanics to the motion of these particles caused by the gravitational force between them. For describing the details of this motion, Newton discovered the Differential calculus.

Since the universe ran according to those pre-determined forces, Newton's was a rigorous deterministic theory, though Newton supposed that the intervention of God was necessary to keep the Universe going.

Laplace (1749-1827), the great mathematician produced a 5-volume book entitled "Mecanique Celeste" explaining the motion of all planets according to Newton's formulations. Laplace presented the first edition of his book to Napolean. The story goes that Napolean remarked "Monsier Laplace, they tell me that you have written this large book on the system of the Universe, and have never even mentioned its creator". To his Laplace is reported to have replied "I had no need for that hypothesis".

The contrast between Newton who needed a God to create and sustain the universe ~~the~~ and Laplace who did not need a God is quite amazing. Newton despite the remarkable successes of his dynamic theory was too deeply sold on the ~~idea~~ necessity of God.

Newton's dynamics also explained many aspects of the vibrations of the classical bodies, the phenomena of heat – as motion of molecules which led to the whole field of thermodynamics, the hydraulic motion of fluids, ~~the~~ phase transformations which changed solids to liquids to vapour on the application of heat.

In parallel with these developments during the 16th, 17th and 18th centuries, a large number of physical instruments which had enhanced the power and range of observation and more precise acquisition of data ~~had been~~ came to be designed and fabricated. Among these we must mention specially, the microscope, the telescope and the pendulum clock. Also considerable progress had been made in understanding the structure of matter.

The outstanding very early chemist Robert Boy~~ce~~le (1627-1691) ~~had~~ introduced the concept of elements. In 1744 Priestly (1733-1804) ~~had~~ discovered "oxygen" and ~~had~~ studied systematically nitric and nitrous oxides. Hydrogen was discovered as the inflammable gas by Cavendish (1731-1810). Lavoisier (1743-1794) ~~had~~ studied the chemical composites of many substances. Proust (1754-1826) proposed the famous

Proust's hypothesis Dalton States

hypothesis that goes by his name – "All matter might consist of Hydrogen atoms." Dalton (1766-1844) came out with the atomic hypothesis: "Gases must exist in the form of minute particles – the atoms". The application of Newtonian mechanics to the study of thermal phenomena ~~had~~ led to the formulation of thermodynamics and to the enunciation of important laws of nature – (I) the law of conservation of energy, (ii) the law of entropy - isolated physical systems proceed spontaneously in the direction of increasing disorder (entropy being a measure of this order) - this became an extremely important way of defining the arrow of time (as time moves forward, the entropy of the world as a whole increases). This statement has the very significant implication that as we go backwards in time, the universe must have been in a state of high order. How did this happen? ~~God~~?
Who or What was Responsible for this high order at the earlier times?

In the 19th century some thoroughly unexpected, but very welcome developments took place which had major consequences on the life styles of Man in the coming centuries.

Michael Faraday (1791-1867) discovered the effects of magnetic induction resulting in the generation of electricity. This led to the ideas of electric dynamos as generators of electric power and to the design of electric motors for industrial purposes. The concept of electric and magnetic fields or lines of force introduced by Faraday led to the development of the electromagnetic theory by Maxwell (1831-1879) and to the unification of electricity and magnetism into a single concept. While Faraday showed that a changing magnetic field produced an electric current in a conductor, Maxwell deduced that a changing magnetic field would produce an electric effect in space and similarly a change in electric field could produce a magnetic effect too in space. Maxwell's equation concerning these effects showed that there would be a finite time required for the waves to travel. Surprisingly it turned out that the speed with which these magnetic and electric effect would travel in space is the same as the speed of light. This led to the realization that electromagnetic waves extend over a wide band of wave lengths and exhibit properties of heat (infrared), light, ultraviolet, x-rays, r-rays all travelling with the same velocity of light. In connection with the transmission of the EM waves in space, Maxwell tried to build several ~~a~~ models of the ether comprising of spheres and cylinders, to simulate some kind of a mechanical model of transmission. This just did not work.

resulting in an electro-magnetic wave.

Light is an electro-magnetic wave

Hertz (1857-1894) produced electromagnetic waves of long wave length (microwaves) in the laboratory in 1875 and Marconi transmitted the radiowaves across the Atlantic in the early part of this centry. Maxwell's theory ~~had~~ implied that light must travel with a finite speed with respect to the ether. This brought up the question whether the `ether' is stationary with respect to the earth or whether it moves along with the earth.

Conducted in 1880

~~In 1880~~, the famous Michelson-Morley experiment gave the result that there was no relative motion between the earth and the ether. The same experiment also led to the result that the velocity of light is the same whether the earth ~~was~~ is moving towards a source of light or away from it. This was a startling result which contradicted the normal laws of addition of velocities which had been so firmly established in all mechanical motions.

The dawn of 20th century Physics:

As the 20th century dawned Einstein came on the scene of physics. He said "we can do away with the ether; the velocity of light may be considered as a constant of nature independent of the motion of the source or receiver as on Michelson-Morley experiment dictated. But, ~~this is a big but~~, we have to <u>give up our conventional ideas of space and time.</u>"

Einstein enunciated that "Laws of Science should be the same for all freely moving observers no matter what their speed is. ~~For this to happen the ideas of Absolute Space and Absolute Time must be given up~~. Einstein formulated his special theory of Relativity by stating that: (1) There is no absolute space; no absolute time; space and time have to be fused into a <u>four dimensional space-time continuum.</u> (ii) Space contracts and time dilates in a moving medium – the extent depends on the velocity. (iii) The idea of <u>simultaneity</u>, that two events take place at the same time, has no longer any meaning. What is simultaneous in one frame of reference may not be so in another moving frame of reference.

Einstein's special theory of relativity led to another very important result that had tremendous consequences to humanity. It showed that Mass and Energy are equivalent. $E = mc^2$ – the famous Atom Bomb equation. [1 kg of Gold = 25 Billion kilowatts of Electrical Energy} He also showed that the mass of a body increases with velocity. A stationary mass of 1 kg becomes a ~~body~~ equivalent of 2 kg when it moves with 90% of the velocity of light.

Einstein's theory also meant that the velocity of light is the top most velocity. Nothing physical can move faster than light. ~~A 1 kg~~ Since even a tiny mass would become infinitely heavy as it reaches the velocity of light.

Thus the special theory brought about major revisions in our ideas of space, time, mass, and simultaneity. The special theory of relativity was published in 1905. The theory was developed taking into consideration frames of reference in uniform motion with respect to each other. ~~He~~ Einstein then went ~~on~~ further to develop the General Theory of Relativity by considering accelerated frames of reference. This led to even more startling results and even more radical views on space, time, gravitational force, and mass and their inter-relatedness.

The space-time continuum which Einstein introduced in the Special Theory of Relativity, was shown in General Relativity as not Euclidean in nature. ~~As a consequence~~ The space-time becomes increasingly curved by the presence of mass and energy. In contrast to Newtonian theory in which gravitation is a force, in Einstein's theory it is not. Einstein's gravitational laws describe ~~the field properties of space-time continuum. One set of laws describe~~ the relation between the mass of a gravitating body and the structure of the field around it. The earth going round the sun in an elliptic orbit is not looked upon as due to the action of the gravitational force, but as a consequence of the structure of the gravitational field around the sun, determined by its mass, and the mass of the earth.

For example the three angles of a triangle does not add to 180°.

Another phenomenon predicted by General Relativity was the bending of light in the gravitation field. This ~~– an~~ effect ~~which~~ was very beautifully verified during the solar eclipse on 29th May, 1919. The light from a star behind the sun did show the amount of

bending predicted by Einstein. There are other interesting consequences too. In the neighbourhood of a dense body (like a neutron star or black hole) time will slow down.

appreciably.

A major consequence of the equations of the general theory of relativity ~~was~~ is that the universe as a whole ~~would be~~ is expanding. Einstein however introduced a constraining factor called the Cosmological constant to ensure that this did not happen, since he thought that the universe was static. But Einstein was mistaken. Observations showed, ~~as we will see later~~, that the universe ~~was~~ is expanding.