PREFACE

Our understanding about the nature of creation of the universe and the dynamics which has set the cosmic objects in motions are mainly based on theoretical ideas. These theories have sprung from the era when the human beings had scanty information about the cosmic phenomena. The first successful theory is the gravitational theory of Newton, which gave us a mathematical model with which one could calculate the orbits of the planets around the sun. At that time the sole instrument to study the cosmos was the optical telescope, once invented by Galileo, and all information about the nature of the cosmos were solely confined to the planetary system. This success in explaining the motions of the planets changed our views about the cosmos as a mechanical system where the cosmic bodies were being turned in orbits by a gravitational force and not by any Divine hands.

The next big theoretical breakthrough came with the gravitational theory of Einstein, who explained the force gravity as caused by the curvature of space-time created by the masses moving in the cosmos. The motions of the planets were caused by the dents in space-time created by the sun in its surrounding. The planets were falling freely in this curved space-time and thus tracing the orbits. Einstein's theory could successfully explain the rotations of the perihelion of Mercury, the planet closest to the sun, which the Newtonian gravity could not do. The new theory, which could explain the motions of the cosmic objects even better than the Newtonian model gave a sophisticated mathematical foundation to understand the universe. At that time Einstein proposed his theory our knowledge of the cosmos was solely confined to the starry world of the Milky Way galaxy, where many nebulous spots, other than stars, were being discovered by the help of more powerful telescopes.

The big leap came when some of the nebulous spots turned out to be island universes, called galaxies, lying beyond the island of the stars where our sun was only one of the hundreds of billions of similar stars. Not only the planets around the sun, but also the stars were observed to be rotating along the arms of the galaxies. The galaxies themselves were observed to be moving. Theoretical analysis based on the equations of Einstein showed that the space-time in the universe started at a singular point, while everything in the universe were concentrated at that point. The space expanded with the beginning of time and became larger and larger as the expansion continued. After an expansion of many billions of years the universe has arrived at its present size.

Chapter 1

PREFACE

The observed motions of the galaxies receding from our Milky Way island, were considered to be the proof that the new theory of gravity was right. At this stage the knowledge of the cosmos, outside the Milky Way galaxy were still very scanty, and the information bout the cosmos were mostly gathered by the optical instruments and spectrometers, which detected the redshifts of the absorption lines from the stars in the galaxies. With the help of the spectrometers one could find out how fast the galaxies were moving away from us. The coincidence of the recessional motions of the galaxies with the expansion resulting from the solutions of the equations of Einstein brought new understanding about the nature of the cosmos. The big-bang theory, based on the idea of the curvature of space-time, came to dominate the rest of the twentieth century.

One of the consequences of the space-time theory of gravity is the existence of black-holes. Black-holes are objects so massive that space-time around them are so curved that no signal could ever get out from the realms confined by the curvatures caused by these massive objects. The black-holes are conceived as the invisible cosmic monsters which devour everything which may come near them and won't leave anything out of their bellies. The x-ray emissions observed from the centres of the galaxies are interpreted as the lights coming from the feast, when the black-holes are devouring the nearby stars. The infalling matter towards the black-holes are believed to generate synchrotron emissions in x-ray wavelengths.

The search for the black-holes have led to a new era in cosmology. Though upbeat by the x-ray emissions seen at the centre of the galaxies, this space-time cosmology, could not explain how the galaxies, and the larger structures like clusters of galaxies, and superclusters of galaxy clusters etc.could have come into existence following the primordial explosion. The solutions which predicted the expansion of the universe from an initially singular point was based on an assumption. It was assumed that the universe was homogeneous everywhere and isotropic in all directions. However, the structures observed in the universe all appear to be inhomogeneous clumps, even at the largest scale so far observed. How could an initially homogeneous universe create such inhomogeneous clumps?

It was hypothesized that the explosions in the beginning of time had created ripples in the space-time, which generated an initial fluctuations in the homogeneous soup of matter and radiation which was expanding. When the soup cooled down, the matter and radiation decoupled and followed their own individual destinies in the expanding universe. The expanding ball of radiation cooled more and more and after undergoing expansion for billions of years it turned into a very cold radiation ball. In 1965 a radiation coming from all directions of the sky was detected. It had a temperature of 3K. This observed radiation was interpreted as the relic of the primordial fire ball. In the 1990s it was observed that this cosmic radiation was not completely isotropic. There existed slight temperature fluctuations in the radiation ball. Once again the fluctuations were interpreted as the signature of the fluctuations which were generated in the beginning of time.

The formations of the inhomogenous clumpy structures were explained as being the results of the fluctuations in the gas clouds which formed after the matter decoupled from the radiations and the ions combined into gases. The initial fluctuations were believed to have grown with the expansion. These increasing fluctuations caused gravitational instabilities in the initial homogeneous gas clouds. With it the bigger chunk disintegrated into pieces. These smaller pieces broke down into even smaller and smaller units and gave births to the cosmic structures observed in the present universe. This scenario of structure formation faced many problems. First, one needed dark matter to explain the nature of the expansion of the universe. Then one had to guess what could be the nature of such dark matter. If the dark matter were made of exotic elementary particles, the formation of structures as a process of breakdown from bigger chunks into smaller bodies could be modelled. However the breakdown would have gone so fast that the structures, which we observe at present, could not have survived such a long time that the universe has taken to expand to its present size. The other alternative was to assume that the dark matter existed in the form of cold dark matter. However, in the cold dark matter dominated universe the structures should be formed by merging of smaller structures. Moreover, all these models needed the knowledge about the spectrum of the initial fluctuation as an input parameter.

The theoretical modelling of the structure formation in the big-bang cosmology is in dolldrum. The cold dark matter models which also include the contribution of the vacuum energy, known as the cosmological constant, have gained popularity among the big-bang based theories. Einstein introduced the idea of the vacuum energy in order to stop the expansion of the universe. When the solutions of his equations generated an expanding scenario, he had corrected his equations with this vacuum energy term, known as the cosmological constant. Einstein did this because he preferred a steady non-expanding universe. However, when the recession of the galaxies were observed, he took away the cosmological constant term, so that his theory could fit with the expansion observed. Since then the role of the cosmological constant has remained a matter of speculation. By using different values of cosmological constant, different amounts of dark matter and varying the spectrum of the fluctuations the big-bang theorists are desperately trying to explain the formation of the structures like galaxies, clusters, superclusters and so on.

To worsen the situation the newest observations of the Cosmic Microwave Background Radiation indicate that something must be badly wrong with the standard theory. The WMAP observations, which started pouring in data since 2003, indicate that the large scale fluctuations, instead of carrying the signatures of the space-time fluctuations from the beginning of time, could in fact be coming from structures lying nearby our Milky Way Galaxy. The fluctuations are anisotropic, and aligned in a particular direction relative to the ecliptic plane.

The black-hole models of the galactic nuclei are also facing problems. The recent observations show violent winds and out-blow occurring at the centres of the galaxies, where the black-holes, instead of spewing out, should be devouring the material around

them. There are now theories which try to explain the ejections from the black-holes by some ingenious means. Even the most sacrosanct of all, the gravitational theory of Newton, is encountering trouble these days. The motions of the spacecrafts, which are sent to study the different planets in the solar system, indicate that something could be wrong as regards our understanding of the gravitational force. These suspicions first rose with the observed slowing down of the Pioneer 10 and Pioneer 11 spacecrafts. The Ulysses and Galileo spacecrafts too indicate that similar anomalies may exist.

It is now argued that not only dark matter, but dark energy should also exist in the universe. The invention of the dark energy was necessary to explain the accelerations of the universe. It has been an usual practice to find out the distance of cosmic objects from the speed at which the objects move. This relation is a result of the big-bang theory, which says that distance of the object is linearly proportional to the velocity. It is called as the Hubble Law. When a new method of distance measurement based on the universal characteristics of a class of supernovae, known as Type Ia, which is independent of the cosmological model is used, the universe turns out to be accelerating, instead of slowing down. This acceleration can only be understood with the existence of a repulsive force in the universe. The dark energy is hypothesized as the origin of the repulsion.

When many uncomfortable omens against the standard cosmology like the anisotropy of the Microwave Background Radiation, acceleration of the universe, outflows from the black-holes etc. are showing up from the traditional corner, evidences against the big-bang theory are also emerging from untraditional corners. The most notable among them are the claims that the universe could be a fractal. By rejecting the hypothesis that the matter in the universe is homogeneously distributed, and studying the data in the galaxy surveys by using different methods than the methods used by the big-bang supporters, Pietronero and Labini have arrived at the conclusion that the universe is a fractal. The other developments include the claim by Halton Arp. According to his observational findings the high redshift quasars are not cosmic objects lying at the edge of the universe. He argues that the quasars are objects ejected from large seyfert galaxies existing in the nearby universe. Third, there is an increasing evidence that the activities in the galaxies can be explained from the magnetic field structures of the galaxies. It has given rise to the idea of a plasma universe, where gravity plays a minor role only.

While evidences against the standard theory are increasing in rapid pace, the big-bang theorists, who have monopolized modern cosmology, are digging in to their old faith, and trying to defend their views by using all possible means. Their best defense is, of course, their power to influence the majority opinion in the world. They act as referees of the established journals, and by the sheer power and prestige which their scientific institutions enjoy, they can easily array the governments, who finance their research activities, and the media, who knows little about science except the names of those who are famous, on their side. If one is in disagreement with this respectable group one may risk the fate of being frozen out from this academic milieu who enjoy grants, honours and fame. Once a Russian

professor, working at the Astrophysics Institute in Copenhagen told me that science is like a religion. He would like to be on the side where there are more adherents. It is too risky to promote a new theory without being excommunicated by the powerful clergies of science.

By writing this book, I know that I am taking such a risk. But, if science has to progress, one may need to take such risks. This new theory does not suffer from the defects of the standard cosmology. It can not only provide alternative explanations of the experimental facts on which the standard theory is based, but also can explain most of the observations which the standard theory fail to explain. The most important of all, the new theory provides a unified model for cosmic structure formation in all scales - starting from the comets and the planets in the solar system to the superclusters and super-superclusters of galaxies. At the foundation of this structure formations lies a fractal design. Beside being consistent with the observation which claim that the universe as a fractal, and the observations of Halton Arp about the nature of quasars, the plasma cosmology too has a natural place in this theory.

One may wonder, why those clever people, who fill the most prestigious chairs of the most prestigious institutions in the world have failed to discover it. Reasons could be many.First, once one is a part of a prestigious group of scientists one bears the pressure of not stepping into ideas which may prove wrong, and thus jeopardize the power of authority, which his or her institution may command. So they become conservative, and skeptical to everything new. The second, the new theory could not have come forth before the satellite data at different wavelengths, as they have poured during the last couple of decades, were available. Third, it lies in the conservative way of processing the available data, which only picks a small amount of information from the rich data set. Fourth, the lack of academic communications between the theoretical astrophysicists and other branches of science - for example the biological and polymer science, and the science of geodynamic, and fluid dynamics. Instead, the research regarding the structure formation in the cosmos have derived inspirations from the elite theoretical elementary particle physicists, who are attempting to build a unified field theory of all forces in nature. Fifth, the theoreticians dealing with the cosmos, may have lost grounds in the physical reality and become more experts in refining old mathematical technics where newer mathematical areas like fractal geometry, for example, have not gained much footing. Chaos theory and fractal geometry are not the usual areas where the theoretical physicists trod. Instead, they are deeply sunk in field theories. Once, before I gave a lecture I was warned by the organizer that my audience were mathematically oriented “technical” people, who wants to see equations and how you get results by churning those equations. This mainly meant that they wanted to see a set of differential equations as the premise for a good science. Probably, this extreme emphasis on equations, based on the limited mathematical methods at the disposal of the human beings, has caused the modern cosmology to slide into an area where it has become more a fiction than a science.

Among others, the developments in the studies of the complex systems critically balanced between order and chaos, which can self-regularize, and the ideas of the fractal knots, which

have been subject of investigation in polymer science and DNA studies, have inspired me to conceive the new theory which cut across the old thinking of the traditional physicists habituated to analytically solving linear equations, or running computer simulation of a set of non-linear equations. The theory involves the turbulent dynamics, which can be best understood as a multifractal system, where the quantum mechanical aspects hide in the classical domain. A hidden order seems to lie at the foundation behind apparent chaos. This order manifests through a fractal geometric network, which possesses a property where the global and local dynamics are inseparably tied together. Thus the predictable and the unpredictable domains have a common frontier. Not only there exists a common frontier between the micro and the macro worlds, but also the non-living world may be working in a similar way as the biological world of life.

The main departure of this theory from the standard cosmology arises from different assumptions about the dynamics behind the working of the universe. The standard theory assumes that the gravitational dynamics, which drive the planets in their orbits around the sun, is the sole dynamics responsible for building and driving all cosmic structures. The universe owes its existence to the gravitational force, which has set it to expand starting from an initially singular point, where all masses of the universe were once concentrated. The expansion has brought forth the creation of the gas clouds, which in turn have fragmented as results of gravitational instabilities. From these fragmented chunks the observed cosmic structures have appeared.

Only very recently, the importance of other forces have been realized as vital in understanding the structure formations in the universe. The main new elements are the roles which turbulence and magnetic fields play in the formation of structures. The roles of turbulence and magnetic fields in the formation of especially planets and stars are found to be very important in the newer studies. Even in the scales of the galaxies and clusters of galaxies the magnetic field and turbulence are emerging as crucial players. The ejections observed from the centres of galaxies too, can only be explained with the help of turbulence and magnetic fields.

The foundation of the new theory, proposed in this book, lies in turning our thinking in a dramatically different direction. According to the new view, there exists no such beginning of time, when the process of creation has started. The universe exists for ever. It possesses a dynamics where an eternal turbulence rage everywhere in all scales. With this turbulent churning, the gases and dusts get ionized and magnetic fields are generated. The turbulence and the magnetic fields then become the main dynamical players in an ever lasting cosmos, which regenerates itself from its own decay. It is the turbulence first, then the magnetic field, and then the gravity, which come to play their respective roles when the universe creates and destroys objects in different scales. In the scales of planetary systems, like our sun, where the turbulence have subsided and the magnetic fields have cleared up chaos in the surrounding of the star by using the mechanisms of accretion and ejections, the gravity may take over the planetary dynamics. As long as the turbulence rage, and the effects of the

magnetic fields are much stronger than the gravitational force, the universe can not be modelled by the way the theorists have done so far.

If one holds to the view that the universe embodies an eternal vortex, which self-regulates inflows and outflows at all scales, and thus bring birth and death of the cosmic objects at different dimensions, the fractal nature of the universe follows (turbulence embodies fractal characteristics). At the same time one gets rid of the assumptions of the homogeneous and the isotropic universe. Instead, it is made of filaments of gases of different sizes and densities, which generate an inhomogeneous pattern of void (less space filling) and matter (more space filling). This pattern entangles knots of different sizes and strengths. Every knot, in turn, embodies smaller knots in descending scales, as fractal structures do when they are built by assembling self-similar structures at smaller and smaller dimensions. The dynamics of turbulence can be seen as the dynamics of coiling, braiding, splitting and merging of fractal filaments, as well as the growth and breakdown of the knot structures. The knots are the places where the cosmic objects are born and destroyed.

This turbulent dynamics, assisted mainly by the magnetic fields repeat the same process of building structures whether they are stars, or galaxies, or clusters and so on. Ejections follow during the birth of structures, their evolutions and break up. The ways the structures assemble, grow, break and eject structures, from which new structures are built, involve a universal mechanism. Apart from the formation of knots, the universal characteristics also include duality and spiral hierarchy. The central knot are flanked by dual-lobed structures. These lobes, formed from the ejected material emerging from the centre, are moulded by the magnetic fields, which also cause the formation of “double-bubbles” which are seen to be ejected in the polar directions. Fractal embedding of self-similar structures is the other universal mechanism. Most structures begin to form as spirals by winding their arms around the central knot. More the arms wrap tightly, and more the core evolves by the methods of accretion, the ejections from the core become more and more vigorous. During this process of evolution of the spiral structure the system generates a hierarchically embedded structure, where smaller spirals remain enwombed inside larger spirals, which in turn are enwombed within even larger spirals and so on.

The question remains: How to create a mathematical model of such a theory. It will need a mathematical apparatus which can deal with knot dynamics in a fractal space. Moreover such a knot is not any simple knot but a fractal, where smaller and smaller fractal knots are embedded inside larger and larger knots. The spiral hierarchy is an equally complicated mathematical task.

The aim of this book is not to try to provide a mathematical model for this theory, because I have no ability to deal with such a complex problem. Though the conclusions, I have presented in this book, are not based on any computer simulation by using a mathematical model, I have been guided in my understanding by the results of the simulations run by different groups of researchers working on the questions of structure formation - especially

the star and planet formations. My understanding about the roles of turbulence and magnetic fields in structure formation are based on their studies.

One should read this book as one would read a book on experimental astronomy. I have gone through a very large amount of data from different experimental groups working with the questions of structure formation, which are available in the internet. It covers the areas like the formation of planets to the formation of the super-clusters. I have analyzed these data, taken at different wavelengths, by using advanced methods of image enhancement techniques, that come with some of the best image processing softwares available today. My analysis have revealed the universal characteristics which lie behind the structure formation. In order to understand the dynamics, which may give birth to such universal characteristics, I have studied turbulence and come to realize that the turbulence may embody the dynamics, which may lie at the foundation of the structure formation in the universe.

My approach has been to first find out how the universe may look like in reality and then find out the dynamics, which may explain the structures. It is very different from the way the standard research about the structure formation has been done. In the framework of the presently accepted understanding of the universe, the theory comes first and the gravitation theory of Einstein forms its backbone. Then one proceeds to simulate the formation of structures by running the equations in very powerful computers. If things go wild, one adds many known, or unknown parameters and factors of pure speculative nature in order to close up the gap with the observational data. However, as I have mentioned earlier, most of the simulations done so far have not been able to throw any clear understanding about the ways the structures in the universe may have come into existence. If there has been any success in any area of studies of structure formation, it would be field related to the formation of stars, where magnetic field and turbulence are the most vital players.

The book is divided into ten chapters. In the first Chapter “How Big is the Universe?” I have introduced the ideas of the fractal. In the second Chapter “How are the Cosmic Structures Distributed and Organized?” I have presented the nature of the cosmic structures by extracting greater information from the available digital data. In the third chapter “Formation and Evolution of Cosmic Structures” the universal way the cosmic structures grow and evolve- whether they are stars, or galaxies, or clusters, or superclusters - are described. In chapter 4 the nature of the fractal network, which lies at the foundation of all structure formation in the universe, is presented together with the discussions about the hierarchical spiral and the knots. In chapter 5 “Our Galaxy and the Question of the Existence of Black-hole at its Center”, the mechanism of the cosmic structure formation in our own Milky Way galaxy, and the dynamics which may operate at the galactic centre, are explained. In chapter 6 “Planetary Nebulae, Supernovae, Quasars and Gamma-ray Bursts”, the mechanisms by which the cosmic structures die after reaching the critical stage of growth are demonstrated by using factual data. In chapter 7 “Vortex Dynamics Behind the Creation of the Universe”, the way vortices grow and decay are described, and examples of the vortices in the laboratories as well as in the atmosphere are studied. In chapter 8

“Cosmic Structure Formation and the Vortex Model” the cosmic structures are compared with the structures seen in the vortices as they grow, evolve and decay. In chapter 9 “Planet Formation”, the question about the role of gravity is touched upon, while the formation and motions of planets caught in turbulence and the magnetic fields are discussed. In chapter 10 “Summary, Comparison and Conclusion” the basic ideas of the theory are summarized and the answers given by this new theory and the old theory in explaining some of the crucial observations are compared. In the conclusion I have hinted at the connection which may exist between the way universe builds its structures and the biological world of life.

In some way it had been a lonely journey, which has lasted for more than ten years. However, without the immense data available in the internet from different academic institutions and Space Agencies it would not have been possible for me to embark on this journey. I have also been extremely benefitted by the preprint libraries of Harvard and Los Alamos, which are available in the net. I remain immensely grateful to the computer specialists who have developed the software which have imparted a new vision to see beyond the visible world into the domain of the invisible and the unknown. It is like a blind man receiving the eyes to see all the lights coming from the universe.

At the end my greatest thanks go to my wife Ragne Birte Lund, who has supported me all the way and thus kept a window of light open for me to see the working of the profound universe.

Chapter 1

PREFACE