SOME PROBLEMS OF PHYSICAL DISTRIBUTION IN RELATIVISTIC COSMOLOGY

THESIS SUBMITTED TO BODOLAND UNIVERSITY
IN PARTIAL FULFILMENT
FOR THE AWARD FOR THE DEGREEE OF
DOCTOR OF PHILOSOPHY IN MATHEMATICS

By

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Ph. D. REGISTRATION No.: FINAL/09MAT0013 of **2017 - 2018**

UNDER THE SUPERVISION OF

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2022

Chapter 8

Conclusions, Limitations and Future Aspects

This thesis focuses on "SOME PROBLEMS OF PHYSICAL DISTRIBUTION IN RELATIVISTIC COSMOLOGY" to study the universe and its behavior. Since the dark energy is the responsible for the current accelerated expansion of the universe so, recently it becomes one of the most broadly researched topics in the cosmology. This is the main inspiration that drives this present research work. For this purpose, a few cosmological energy models have been considered and discussed from the Chapter 2 to Chapter 6. We have solved different equations for the exact solutions using different parameters that help to explain the significance of these models. Though there is an individual conclusion in each chapter, however, in this chapter, we have briefly summarized the results of the proposed models. We have also discussed the limitations and future aspects.

In **Chapter 2**, in this chapter, Robertson-Walker universe have been studied in the context of Brans-Dicke theory of gravitation corresponding to perfect fluid distribution of matter source. After solving the field equations for this theory of gravitation, we have presented closed, open and flat Robertson-Walker radiating universe corresponding to perfect fluid in five-dimensional spacetime. In this BD scalar tensor theory, the fifth dimension plays a vital role in early stage evolution of universe and in driving the present accelerated expansion of the universe. At a particular case, if $\omega \rightarrow -2$, we see that the scalar field $\phi \rightarrow 0$. In such case, the scale factor of the fifth dimension is considered to be the source of dark energy. Though it acts as a source of dark energy, the fifth dimension contracts and is therefore not visible to the present epoch. The solution obtained here represents a five-dimensional expanding universe and helps to discuss the role of perfect fluid in investigating an inflationary model universe in this modified theory of gravitation. So, our findings will be useful for better understanding of the present universe.

In **Chapter-3**, in this work, we investigated the role of bulk viscous fluid attached to the string cloud by considering a time dependent deceleration parameter in present scenarios of the evolution in FRW model universe in the context of Lyra Geometry. Here, we restricted our study to a constant deceleration parameter as predicted from observation. The solutions of the model have been obtained for flat, closed, and open bulk viscous string FRW universe in five dimensions. The physical parameters have been plotted for $b \neq -1$. However, in the case of $b = -1$, all the parameters vanish rapidly within a short period of time. This fact indicates that the solution represents an early era of the evolution of the universe. The incorporation of bulk viscosity in our investigation is to replace the condition of material distribution other than perfect fluid. The bulk viscosity plays a significant role in the present scenario of the evolution of the universe. So, our model will contribute to a better understanding of spatially homogeneous and isotropic accelerating universe (Bamba, 2012) in five dimensions.

In **Chapter 4**, we have presented a five-dimensional FRW Cosmological model by considering power law expansion as $a(t) = t^n$ with certain physical assumption of the scalar σ and expansion scalar θ interact with perfect fluid. We also made the assumption based on observed relation between velocity and red shift for an extra galactic source which predicted the Hubble expansion is isotropic. Our solution supports the finding of Thore (1967) and Kristran and Sachs (1966). We also presented for the different model of universe like open and closed universe. In order to test the stability of our proposed model we have examined the energy Condition such as null energy condition (NEC), weak energy condition (WEC), dominated energy condition (DEC) and strong energy condition (SEC). In all the conditions we found that our proposed model supports the condition of present observational findings. Such a model will be benefitted to the new researchers to investigate about the evolution of our present day universe other than the other cosmological models.

In **chapter-5**, study of early stage of the universe with FRW cosmological models in the frame work of Einstein theory plays an important role. Also, it is well established that the mathematical formulation of different cosmological models through the laws of physics becomes an essential component in understanding the nature of the universe. Hence, in this present work, we have investigated FRW cosmological model in the context of Einstein theory of gravitation. We have studied time varying dark energy states of two different assumptions, from which we found a phantom phase during spatially open universe for $\Lambda \propto [a(t)]^n$ and all remaining results indicates a quintessence phase. We observed that the Hubble parameter approaches to infinite when time approaches to zero, this indicates the universe describes a power law inflation. The temperature and entropy density of the model remain positive for both the cases. In view of energy conditions, the assumptions yields identical results. our study suggests the Strong Energy Condition violates for our model, that indicates an accelerating expansion of the universe. From our discussion we conclude that during both the assumptions the second law of thermodynamics remain impactless. Moreover, the study suggests our universe is of finite life time. All the obtained results are consistent with respect to observational constraints.

In **Chapter 6**, we attempt to explain the behaviour some of unknown phenomenon of the universe. five-dimensional FRW model universe in scalar tensor theory of gravitation using Quadratic equation of state is studied with the use of certain physical assumptions, which are agreeing with the present observational findings. The field equations for five-dimensional FRW model universe in scalar tensor theory of gravitation have been obtained and exact solutions are obtained. The model represents to have anisotropic phase throughout the evolution of the universe which is in agreement with the present observational data made by COBE (Cosmic Background Explorer) and WMAP (The Wilkinson Microwave Anisotropy Probe). Also, the model represents an expanding universe that starts with small finite volume at cosmic time $t = 0$ and expands with acceleration. Our model satisfies the energy conditions $\rho \geq 0$. Also, the shear scalar become nonzero as $t \to \infty$. So, our model represents a shearing cosmological model universe for large values of cosmic time t.

In **chapter-7**, we have investigated a higher dimensional flat FRW model with variable G and Λ. The cosmological parameters and state finder parameters have been obtained for dust, radiation and stiff matter. The different models are obtained for different stages of the universe. We have discussed the physical parameters of the models.

The constant G and Λ are allowed to depend on the cosmic time t. We hope that our results may throw some light in understanding of the real universe. This study will throw some light on the structure formation of the universe, which has astrophysical significance. The expanding universe has singular at $t = 0$. In this way the unified description of early evolution of the universe is possible with variables G and Λ in the framework of higher dimensional space time.

Limitations: All studies have limitations and these limitations indicate the further research. The research area of the present work is very vast but to complete the work within a fixed period we have to minimize its area. In this thesis, we have studied the SOME PROBLEMS OF PHYSICAL DISTRIBUTION IN RELATIVISTIC COSMOLOGY and investigated its nature using limited parameters to know the expansion history of the universe. The graphical representations of the proposed models are also limited. The future aspects by the latest development in the field of cosmology, the researchers may be motivated for the further research work on Relativistic Cosmology along with more physical and cosmological parameters to know the real expansion history of the universe. As per the scope of our study, we wish to draw the attention for the researchers on the following aspects,

(i) To establish the correspondence of Relativistic Cosmology with the newly proposed scalar fields.

(ii) To study the cosmic behaviors of the physical distribution of relativistic Cosmology with various parameters.