Abstract

It is now generally accepted that there was an epoch when the universe underwent a phase of rapid expansion known as inflation. In the last 30 years to realize the early inflation a number of gravitational theories with cosmological models published in the literature. But in spite of the attractive features of cosmological inflation, its mechanism of realization still remains *adhoc*. Consequently, in the literature a number of cosmological models came up to implement the early inflation. In recent years precision experiments in cosmology predicted another interesting phase of expansion of the late universe. It has been predicted that the present universe is expanding at a rate much faster than the rate estimated in the standard model. Such an accelerating phase however cannot be realized in general theory of relativity (GTR) with the fields of the standard model of particle physics. This is a challenge in theoretical physics, to overcome this a modification of the gravitational sector or the matter sector of the Einstein-Hilbert action or a new physics is required. In this thesis cosmological models are investigated which accommodate late accelerating phase making use of exotic matter as a modification of matter sector in Einstein gravity. Cosmological models are also explored in the framework of a modified theory of gravity namely, Horava-Lifshitz gravity in the presence of exotic kind of fluid. Observational constraints on the equation of state (EoS) parameters of the fluid taken to construct cosmological models are also determined.

- *In Chapter 1*, a brief review of the cosmological models and the methodology adopted here to determine the observational constraints on EoS parameters are presented.

- *In Chapter 2*, Emergent Universe (EU) model obtained by Mukherjee *et al.* with a non-linear EoS, $p = B\rho - A\rho^{\frac{1}{2}}$ is considered to estimate the constraints on A, B

parameters from cosmological observations. The following observational data namely, $(H(z) - z)$ data (OHD), a model independent BAO peak parameter and CMB shift parameter (WMAP 3 data) are considered to determine the unknown parameters in the theory. We observe that a viable cosmological model is permitted even with $B \to 0$. The magnitude of B is very small compared to A. The supernovae magnitudes μ *vs.* redshift (z) curve in the model is plotted which is then compared with the union compilation data. The cosmological model is found in good agreement with the above observations.

• *In Chapter 3*, EU models obtained by Mukherjee *et al.* for different values of B are studied. The parameter B is important as it determines the composition of fluids in the universe. Here we consider cosmologies with the following values of B namely, $B = -\frac{1}{3}, 0, \frac{1}{3}, 1$ respectively to analyze EU model employing the recent observational data. The observed Stern data for Hubble parameter and redshift $(H(z)$ *vs.* $z)$ (OHD) in addition to a model-independent measurement of BAO peak parameter and CMB shift parameter (WMAP 7 data) are employed here for the analysis. The recent cosmological observations is that the universe is filled with dark matter (DM) and dark energy (DE). It is observed that EU models permit a universe with a composition of DM and DE. Evolution of other relevant cosmological parameters, namely, density parameter (Ω), effective equation of state (EoS) parameter (ω_{eff}) are also investigated. It has also been noted that the model with $B = -\frac{1}{3}$ is ruled out in the light of the above observations.

• *In Chapter 4*, cosmological models have been obtained in GTR considering modified Chaplygin gas (MCG) as a candidate for dark energy and estimated the range of

values for a physically viable cosmological model. The EoS of MCG ($p = B\rho - \frac{A}{\rho^\alpha}$) involves three parameters namely, A, B and α. The constraints imposed on the EoS parameters by the following observations namely, dimensionless age parameter ($H_o t_o$) and ($H(z) - z$) data are determined. Specifically the observational constraints on B parameter in terms of α and A is determined in addition to the constraints originated from Cold Dark Matter (CDM) and Unified Dark Matter Energy (UDME) models respectively. The suitable range of B that is permitted by all the observations considered here, has also been determined.

• *In Chapter 5*, cosmological models obtained in GTR with MCG are studied using the linear growth function for the large scale structures of the universe. MCG is considered as one of the prospective candidates for the dark energy. A numerical analysis considering observational growth data for a given range of redshift from the Wiggle-Z measurements and $r.m.s$ mass fluctuations from Ly-α measurements is carried out to determine the observational constraints on the parameters of the MCG. The Wang-Steinhardt ansatz for growth index γ and growth function f (defined as $f = \Omega_m^\gamma(a)$) are also considered here for a numerical analysis in addition to the observational data relating Hubble parameter with redshift z (OHD) to constrain the EoS parameters. The best-fit values of the EoS parameters obtained here is employed to study the growth function f, growth index γ and equation of state parameter ω with redshift z. The observational constraints on MCG parameters obtained here are then compared with that of the GCG model for obtaining a viable cosmology. It is also noted that an accelerating phase of the universe followed by a matter domination with MCG is permitted.

• *In Chapter 6*, Holographic dark energy (in short, HDE) model of the universe is proposed considering MCG. Corresponding holographic dark energy field and the corresponding potential are determined. The stability of the HDE in this case is also discussed.

• *In Chapter 7*, a modified theory of gravity namely, Horava-Lifshitz theory of gravity is considered to obtain cosmological models with modified Chaplygin gas (MCG). The cosmological models are obtained here employing detailed balance condition. There are three unknown EoS parameters namely, A, α, B required to describe MCG fluid. The range of values of the parameters are determined making use of the observational data namely, $(H(z) - z)(OHD)$, BAO peak parameter and CMB shift data considering the detailed balance condition in HL gravity for a viable cosmological model. Further, the effective neutrino parameter (ΔN_ν) is employed here to determine the effective values of B and A_s by numerical technique.

• *In Chapter 8*, cosmological models are obtained in the framework of HL gravity considering beyond detailed balance condition with MCG. Using observational data from $(H(z) - z)(OHD)$, BAO peak parameter and CMB shift parameter, we probe cosmological models. The effect of dark radiation on the whole range of the effective neutrino parameter (ΔN_ν) is studied to constrain the matter contributing parameter B in this scenario. It has been observed that greater the dark radiation less is the value of the parameter B in MCG. To check the validity of beyond detailed balance scenario we plot supernovae magnitudes (μ) with redshift of Union2 data and then the variation of state parameter with redshift. It is observed that beyond detailed balance scenario is suitable for cosmological model in HL gravity with MCG.

In the framework of different theories of gravity and fields, a large variants of cosmological models are probed with various observational inputs to trace the observational constraints on EoS parameters.