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Abstract

In this thesis, we have discussed different aspects of cosmology which are relevant in different era of cosmic evolution. The key findings are following.

We have investigated a successful inflationary scenario with an effective α-attractor potential in RS II brane. This model has two main parameters, the brane tension λ and α specific to α-attractor models. We have constrained these parameters in the light of recent observation. In this case, non-canonical field displacement remains sub-Planckian when $\alpha < \frac{1}{6}$, this condition is important to maintain the flatness of the quintessential region of the potential. We have shown that under the allowed region of observation, $r < 0.06$, this condition is met provided that, $\frac{M^4}{\lambda} > 150$, where M is the inflationary scale. Keeping $\frac{M^4}{\lambda} \gg 1$ is also necessary to justify the high energy limit approximations used. So these two conditions are automatically satisfied in our model.

We have considered a bigravity model where the two matrices are connected by a disformal coupling with a scalar field, ϕ. This allows the mass term to be dependent on the environment so that chameleon mechanism can be implemented to restore solar system physics. We found that the theory essentially leads to a Horndeski model with 3 degrees of freedom where the extra degree of freedom is carried by massive graviton. We have found that there are two attractors. One attractor basin is relevant for standard cosmology where an effective cosmological constant generated by the mass of the graviton gives late-time acceleration. Other attractor solution is not cosmologically viable as there is no radiation era present. This attractor is also disfavored as the speed of gravitational waves C_T deviates too much from unity which is not observationally tenable. This gives large fine-tuning of the parameter in theory. The first one is consistent with gravitational waves constraint. We have also studied a case where the coefficient of the mass term is field dependent. We have demonstrated that a viable late time cosmology is obtained in this case.

We have considered a potential, $V(\phi) \propto \left(\frac{\phi}{M_{Pl}}\right)^m exp\left[-\lambda\left(\frac{\phi}{M_{Pl}}\right)^n\right]$ which is very general by its construction. We found that this potential gives scaling type of solution in the asymptotic regime. We have constructed a different type of dynamical system to capture the behavior. This type of dynamical system is unique by its nature and necessary for studying a potential with dynamical slope $\frac{V'}{V} \propto f(\phi)$. It is shown that this system also captures the standard exponential scenarios. We have analyzed the scaling behavior numerically and also

use reconstruction to give its analytical form.

We studied baryogenesis in the paradigm of quintessential inflation. We have considered spontaneous baryogenesis scenario, where breaking of some $U(1)$ symmetry gives non conserving baryon current interaction of the type $\frac{\lambda'}{M} J^{\mu}_{B} \partial_{\mu}\phi$ in an effective field theory framework. Since the interaction is CPT violating the net baryon number can be generated in thermal equilibrium. We have shown that a single scalar field can give rise to inflation then successful baryogenesis. We have analyzed in a model independent way, where the results are independent of inflationary potential. With the assumption that inflation is followed by a kinetic regime, we found that baryon asymmetry can be generated in a wide range of temperatures, from the thermal equilibrium to the beginning of the radiation era. We have shown that within the observational limit from inflation, the freeze-out temperature can be, 10^{12} GeV $> \mathrm{T_F} > 10^{8}$ GeV which gives bound on the cut-off scale, $M_{Pl} > M > 10^{-2} M_{Pl}$. We have used instant preheating mechanism as a reheating process. We also have discussed the prospects of detection of relic gravitational waves in the future experiments like SKA, LISA, A-LIGO and DECIGO. We have shown that with constraint from BBN, our model can not be probed by these experiments, since the amplitude of the spectrum is below the present sensitivity level. However, for increased sensitivity at high frequency region, the probe may be possible.