Executive Summary of the Major Research Project

Estimating Cosmological Parameters from CMB Anisotropy Measurements

The Planck observation and polarization data opened up a new frontier for studying the most intricate details of the CMB sky. Analysing the highly precise and accurate observational data, it is understood that there are many anomalous features in the power-spectra which can not be completely accounted as perturbations to the FRW universe. We attempted to produce best fit models for the observations by using different approximation techniques and also by considering Bianchi model universes.

Wenzel-Kramers-Brillouin (WKB) approximation is used to derive the scalar and tensor power-spectra. We use the Power-law inflation as the base model as it allows comparison with exact results. The advantage with this method is that, it is valid even when slow-roll approximation fails. We solve the equations to get the scalar and tensor power-spectra with WKB approximation and it is seen that the power-spectra are scale-invariant and the spectral indices come very close to the observed data from WMAP and Planck experiments. With this alternate approximation we get $n_s - 1 = n_T = 3.12177276e - 04$ while Planck observations give the value as $n_s = 0.9624 \pm 0.0075$.

The impact of WKB approximation techniques on the tensor-to-scalar ratio(r) is studied. r gives the energy scale of universe as it depends on the time-evolution of the inflaton field, it helps in removing the degeneracies between cosmological parameters and also determines the number of e-fold evolution of the universe.The recent Planck observations constrained the tensor-to-scalar ratio to be $r_{0.002} < 0.10$ at 95% C.L with only the TT,TE,EE and lensing data.

The present work used WKB approximation to produce the Tensor and the Scalar power-spectra and also the variation in the cosmological parameters. We use CosmoMC, to establish the constrains on the parameters and to identify the maximum likelihood region in the parameter space. The primordial power-spectrum in CAMB of CosmoMC is changed to the WKB approximation power spectrum with the same amplitude priors. We get the value of r= 0.13 and likelihood fits with BICEP, BAO and WMAP data. This gives us a window into higher order corrections and better fit to the Planck results. The obtained values of the spectral index is $n_s = 0.97$ with $H_o = 68 km/sec/Mpc$ which are in the 95% C.L of Planck Observations. Hence we can conclude that the WKB approximation is a viable candidate to replace the Slow-roll approximation technique.

For providing a valid explanation towards CMB anomalies which is seen in the observational data, use of the Bianchi model spacetime is proposed. Best-fit models for different Bianchi type universes is studied based on the minor discrepancies of the CMB data and the Cosmological parameters are estimated.