An Introduction to

INFLATIONARY COSMOLOGY

(from theory to data analysis)

CosmoVerseSchool @Corfu

— Hands-on Session —

Image: Planck's View of BICEP2/Keck Array Field. Credit: Jet Propulsion Laboratory, NASA and Caltech

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Lecture materials: Google Drive Folder

For any further materials/clarifications/questions/curiosities/ feedback, feel free to Contact Me

Exercises Lecture 1

Exercise 1

Using CAMB, study the effects of changing the amplitude A_S and the tilt n_s of the primordial scalar spectrum on the CMB angular power spectra C_ℓ^{TT}, C_ℓ^{TE} and C_ℓ^{EE}. Provide a physical explanation of your findings.

Exercise 2

Using CAMB, study the effects of the running of the spectral index $\alpha_s = dn_s/d\ln k$ on the CMB angular power spectra and plot the primordial scalar spectrum $\mathcal{P}_s(k)$ for $\alpha_s = 0$ and $\alpha_s \neq 0$

Exercise 3

Using CAMB, study the effects of changing the amplitude of the spectrum of primordial Gravitational waves r on the CMB angular power spectra C_ℓ^{TT}, C_ℓ^{TE} and C_ℓ^{EE} and C_ℓ^{BB}. Assume the slow roll consistency relation $n_T = -r/8 < 0$. Repeat the same exercise considering a positive tensor tilt $n_T > 0$

Exercise 4

Using CAMB, compute the tensor transfer function $T^T_{\ell=10}(k)$ and $T^E_{\ell=10}(k)$ and $T^B_{\ell=10}(k)$ and compare them to the scalar ones.

Exercise 5

Using CAMB, provide convincing evidence that in order to measure primordial inflationary gravitational waves, it is better to look at B-mode polarization at large angular scales ($\ell \lesssim 100$)

Exercises Lecture 2

Exercise 1

Using GetDist and the MCMC chains for the ΛCDM model, make a triangular containing all the 6 parameters of standard model.

Exercise 2

Using GetDist and the MCMC chains for the ΛCDM model, define the number of e-folds before the end of inflation $\mathcal{N}$, using the Starobinsky relation

$$n_s = 1 - \frac{2}{\mathcal{N}}$$

Derive constraints at 68% CL and 95% CL on this parameter.

Exercise 3

Using GetDist, compare $\min(\chi^2)$ for ΛCDM and ΛCDM+α_s. Provide an explanation of your findings from a statistical point of view.

Exercise 4

Using GetDist and the chains for ΛCDM+Ω_k, perform a re-weighting sample imposing a Gaussian prior $\Omega_k = 0.00 \pm 0.01$. Test the convergence of the reweighted chains and compare them with the original ones. Additionally, identify which parameters are most affected by the new prior.

Exercise 5

Using GetDist, compute the statistical metric AIC (Akaike Information Criterion) to quantify whether ΛCDM+α_s (i.e., a model where the running of the spectral index is left as a free parameter) is favored or disfavored compared to ΛCDM (where the running of the spectral index is fixed to $\alpha_s = 0$)