Inflation

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CMB-S4 Spring Collaboration 2024

Charge from organizers

Review the technical status of this science book topic and discuss/identify a path forward to complete writing of the chapter.

Status

Review the technical status of this science book topic and discuss/identify a path forward to complete writing of the chapter.

Status

Currently under construction (like other science sections)

Path forward

Review the technical status of this science book topic and discuss/identify a path forward to complete writing of the chapter.

Path forward

- Background, motivation, and science targets
  - The background, science motivation, science targets have been laid out in Science Book v1, the DSR and PBDR reports.
  - There are some areas where updates are warranted, but this can all happen on a relatively short time scale.
  - Some have volunteered or been volunteered by others
    Peter Adshead, Dominic Beck, Colin Bischoff, Daniel Green, Daan Meerburg, Sarah Shandera, Clara Verges, Benjamin Wallisch,...
  - Anyone interested is welcome to contribute.

Path forward

Review the technical status of this science book topic and discuss/identify a path forward to complete writing of the chapter.

Path forward

- Forecasts
  - The forecasts are still work in progress.
  - The general framework can be described already.
  - Results can be added once the map-based AoA analyses have been completed.

Inflation

Comments received from the community, both in response to Science Book v1 and during reviews, led to changes in presentation for the DSR report.

- The original outline of Science Book v2 undoes these changes, but they should likely be kept.
    - We should distinguish between quantities we observe and the conclusions drawn from them by us and theorist in the community.
    - Even if all our existing theories of the early universe were incorrect, the measurements would still be valuable in constraining any new candidates.

Primordial gravitational waves and Inflation

Outline

- Overview
- Primordial gravitational waves
- Primordial density perturbations
- Uniqueness and synergies

Primordial gravitational waves and Inflation

- **Overview**
  - Highlight CMB-S4's unique potential to detect primordial gravitational waves, pristine relic from the early universe, irrespective of their origin.
  - Inflation, a period of nearly exponential expansion of the early universe, is regarded by many as the most compelling paradigm for the early universe.
  - The simplest models predict primordial gravitational waves within reach of CMB-S4.
  - Even an upper limit will transform our understanding of the early universe.
  - CMB-S4 will also provide unprecedented constraints on primordial density perturbations and will provide tight constraints on departures from Gaussianity, isocurvature perturbations, spatial curvature.
  - In combination with LSS, CMB-S4 will explore an important range of parameter space.

Primordial gravitational waves and Inflation

- **Primordial gravitational waves**

  - Introduction of key theoretical quantities and observables to keep the document self-contained.
  - Implications for inflation of a detection
  - Review the “characteristic scale” of the inflaton potential
  - Implications of an upper limit
  - Forecasts and n_s-r plot
  - Primordial gravitational waves beyond r

Primordial gravitational waves and Inflation

- **Primordial density perturbations**
  - Power spectrum of adiabatic mode
    - scalar spectral index and running
    - features and oscillations
  - Primordial non-Gaussianity
    - some coordination may be needed with LSS chapter
  - Isocurvature perturbations
  - Spatial curvature
  - Anomalies, cosmic strings, primordial magnetic fields, your favorite early universe scenario and CMB-S4

Primordial gravitational waves and Inflation

- **Uniqueness and synergies**

  - For the foreseeable future observations of the CMB are our only way to detect primordial gravitational waves from slow-roll inflation.
  - Departures from the simplest models could lead to signatures for PTAs or future ground- and space-based interferometers.
  - Combinations of CMB-S4 and LSS data (including SPHEREx) will provide powerful constraints on departures from Gaussianity, in particular local non-Gaussianity and could lead to a detection of departures from single-clock inflation.

Summary

- The “Inflation” chapter of Science Book v2 is currently still under construction.
- The background, science motivation and science goals have been laid out in Science Book v1, the DSR, PBDR reports and can be written quickly.
- Unlike the DSR report, which was more focused, the Science Book v2 can be broad and we could engage members of the community to broaden the scope.
- The forecasts are still a work in progress (and of course will be for a while)
- The conclusion of map-based forecasts for the AoA study would provide a natural snapshot for Science Book v2.
- It would be natural to have a preliminary version of the science book by the next collaboration meeting that can then be augmented, refined improved in time for a submission early next year.