Evolution of the inhomogeneous universe: From Inflation to structure formation

Report of Contributions

https://conference-indico.kek.jp/e/292

Contribution ID: **1** Type: **not specified**

EFT for inflation and LSS:

TBA

Presenter: MIRABABAI, Mehardad

Contribution ID: **2** Type: **not specified**

EFT for inflation and LSS

Wednesday, 6 November 2024 09:30 (1 hour)

TBA

Primary author: MIRBABAYI, Mehrdad

Presenter: MIRBABAYI, Mehrdad

Session Classification: Overview talks 1

Contribution ID: **3** Type: **not specified**

EFT-based forward models, partition function, and RG flow

Wednesday, 6 November 2024 10:30 (1 hour)

TBA

Primary author: SCHMIDT, Fabian

Presenter: SCHMIDT, Fabian

Session Classification: Overview talks 1

Contribution ID: **4** Type: **not specified**

Entropy in a Coherent Universe: Quantum Information in the Action of the Cosmic SuperWeb

Wednesday, 6 November 2024 13:15 (1 hour)

von Neumann of (thermal) quantum entropy fame purportedly responded to Shannon asking what his novel classical information content measure should be called: paraphrasing, entropy, nobody understands it anyway. Nowadays information entropy and thermal entropy have merged as ideas, and expanded to encompass phase info as well as counting info, aka quantum information. Its development and transport through all of the great cosmic epochs of instability accompanying transitions of phase is a unifying story of the Universe. This is a big topic which I will meander through, from the speculative emergence of coherence, through an inflation era, its preheating end in the matter-entropy burst, with attention on the cosmic neutrino background decoupling, cosmic photon thermal decoupling and its Compton scattering decoupling, and entropy development and transport in the gravitationally-unstable nonlinear cosmic web. With applications to observable entropic relics and the cosmic parameters we derive from them, such as the CnuB, CMB, the cosmic infrared background, line intensity mapping, and the thermal state of clusters, groups and the IGM. Whew, and that's not all: one quest is for information-laden Planck-epoch non-Gaussianities, scalar and tensor, beyond Planck the satellite, and towards LiteBird.

Primary author: BOND, J. Richard

Presenter: BOND, J. Richard

Session Classification: KEK-Cosmo special colloquium

Contribution ID: **5** Type: **not specified**

From Quantum Fields to Stochastic Random Variables: Why Starobinsky's Formalism Works

Wednesday, 6 November 2024 14:30 (1 hour)

Primary author: WOODARD, Richard

Presenter: WOODARD, Richard

Session Classification: Overview talks 2

Contribution ID: **6** Type: **not specified**

Separate universe, delta N and beyond.

Wednesday, 6 November 2024 15:30 (1 hour)

TBA

Primary author: NARUKO, Atsushi

Presenter: NARUKO, Atsushi

Session Classification: Overview talks 2

Contribution ID: **7** Type: **not specified**

Dyanamics of Primordial Black Hole Formation

Wednesday, 6 November 2024 17:00 (1 hour)

TBA

Primary author: YOO, Chulmoon

Presenter: YOO, Chulmoon

Session Classification: Overview talks 2

Contribution ID: **8** Type: **not specified**

Non-Gaussianity in Primordial Black Hole Formation

Thursday, 7 November 2024 09:20 (40 minutes)

I will briefly review the recent progress in the non-Gaussian effect on the formation of primordial black holes (PBHs) and the generation of induced gravitational waves (GWs).The most promising mechanism of generating PBHs is by the enhancement of power spectrum of the primordial curvature perturbation, which is usually accompanied by the the enhancement of non-Gaussianity that crucially changes the abundance of PBHs. I will discuss how non-Gaussianity is generated in single field inflation as well as in the curvaton scenario, and then discuss how to calculate PBH abundance with such non-Gaussianities. Non-Gaussianity only has mild effects on the induced gravitational waves (GWs), which gives robust predictions in the mHz and nHz GW experiments.

Primary author: PI, Shi

Presenter: PI, Shi

Session Classification: Inflation and Early Universe 1

Contribution ID: **9** Type: **not specified**

Radiation exchange in primordial gravitational waves

Thursday, 7 November 2024 10:00 (40 minutes)

TBA

Primary author: OTA, Atsuhisa

Presenter: OTA, Atsuhisa

Session Classification: Inflation and Early Universe 1

Contribution ID: **10** Type: **not specified**

Primordial Black Holes from double-field inflationary models

Thursday, 7 November 2024 11:00 (40 minutes)

Primordial black holes (PBHs) are a kind of black holes which may form during the primordial epoch of the universe. In this talk, I will discuss two different mechanisms of formation of PBHs (namely PBHs from enhancement of primordial curvature perturbations, and PBHs from the collapse of bubbles) in double-field inflationary models.

Presenter: ZHANG, Ying-li

Session Classification: Inflation and Early Universe 1

Contribution ID: **11** Type: **not specified**

STOLAS: STOchastic LAttice Simulation of cosmic inflation

Thursday, 7 November 2024 14:00 (40 minutes)

We develop a C++ package of the STOchastic LAttice Simulation (STOLAS) of cosmic inflation. It performs the numerical lattice simulation in the application of the stochastic-deltaN formalism. STOLAS can directly compute the three-dimensional map of the observable curvature perturbation without estimating its statistical properties. In its application to two toy models of inflation, chaotic inflation and Starobinsky's linear-potential inflation, we confirm that STOLAS is well-consistent with the standard perturbation theory. Furthermore, by introducing the importance sampling technique, we have success in numerically sampling the current abundance of primordial black holes in a non-perturbative way.

Primary author: TADA, Yu-ichiro

Presenter: TADA, Yu-ichiro

Session Classification: Inflation and Early Universe 2

Contribution ID: **12** Type: **not specified**

Analytical methods in stochastic inflation

Thursday, 7 November 2024 14:40 (40 minutes)

The stochastic formalism of cosmic inflation enables us to describe the large-scale dynamics non-perturbatively. Even in the slow-roll regime, however, it is in general difficult to solve the fundamental equations analytically due to the stochastic nature of fluctuations. I will present the two analytical methods in stochastic inflation. One is a class of all the possible exact solutions for a test field, which can for instance be applied to a curvaton scenario to study the structure of the parameter space. The other is the constrained formalism of stochastic inflation, which gives an easy and efficient way to analyse statistically rare realisations that would divert the field-space trajectories towards single-field attractors.

Primary author: TOKESHI, Koki

Presenter: TOKESHI, Koki

Session Classification: Inflation and Early Universe 2

Contribution ID: **13** Type: **not specified**

Extending Starobinsky's formalism to general relativity

Thursday, 7 November 2024 15:20 (40 minutes)

TBA

Primary author: MIAO, Shun-Pei

Presenter: MIAO, Shun-Pei

Session Classification: Inflation and Early Universe 2

Contribution ID: **14** Type: **not specified**

On the IR divergences in de Sitter: loops, resummation and the semi-classical wavefunction

Thursday, 7 November 2024 16:30 (40 minutes)

Detecting local Non-Gaussianity provides valuable insights into the early universe's particle composition. Interactions between the inflaton and light particles yield distinctive signatures, potentially observable in upcoming surveys. However, addressing IR divergences in light fields on de Sitter spacetimes requires careful treatment. Stochastic inflation offers a solution, but its relationship with perturbative computations remains unclear.

In this presentation, we establish a clear connection between perturbation theory and the stochastic formalism through the wavefunction formalism. We will explain how the leading-order Fokker-Planck equation arises from the classical saddle point of the wavefunction, and how subleading terms can be interpreted as quantum corrections to the wavefunction.

Primary author: CASTILLO, Sebastian M.Cespedes

Presenter: CASTILLO, Sebastian M.Cespedes

Session Classification: Inflation and Early Universe 3

Contribution ID: **15** Type: **not specified**

Effective Treatment of Schwinger Pair Production during Axion Inflation

Thursday, 7 November 2024 17:10 (40 minutes)

TBA

Primary author: FUJITA, Tomohiro

Presenter: FUJITA, Tomohiro

Session Classification: Inflation and Early Universe 3

Contribution ID: **16** Type: **not specified**

Cosmological Information in Perturbative Forward Modeling

Friday, 8 November 2024 10:00 (40 minutes)

I discuss how well perturbative forward modeling can constrain cosmological parameters compared to conventional analyses. In perturbation theory the field-level posterior can be computed analytically in the limit of small noise. In the idealized case where the only relevant parameter for the nonlinear evolution is the nonlinear scale, I argue that information content in this posterior is the same as in the n-point correlation functions computed at the same perturbative order. In the real universe other parameters can be important, and there are possibly enhanced effects due to nonlinear interactions of long and short wavelength fluctuations that can either degrade the signal or increase covariance matrices. I discuss several different parameters that control these enhancements and show that for some shapes of the linear power spectrum they can be large. This leads to degradation of constraints in the standard analyses, even though the effects are not dramatic for a ΛCDM-like cosmology. The aforementioned long-short couplings do not affect the field-level inference which remains optimal. Finally, I show how in these examples calculation of the perturbative posterior motivates new estimators that are easier to implement in practice than the full forward modelling but lead to nearly optimal constraints on cosmological parameters.

Primary author: CABASS, Giovanni

Presenter: CABASS, Giovanni

Session Classification: LSS-1

Contribution ID: **17** Type: **not specified**

Implication of nonlinear-supersymmetric general relativity

Friday, 8 November 2024 11:00 (20 minutes)

Considering (unstable) Riemann space-time whose tangent space possesses NLSUSY structure specified by fermionic coordinate ψαi (i=1⋯N) and the ordinary Minkowski coordinates xa we can find the unified vierbein waμ and perform the ordinary geometric argument of the general relativity principle on such Riemann space-time and obtain straightforwardly new Einstein-Hilbert(EH)-type action LNLSGR (waμ) with the global NLSUSY invariance and equipped with the cosmological term. Due to NLSUSY structure of space-time LNLSGR (waμ) would break down(Big collapse) to the ordinary EH action for graviton, NLSUSY action for Nambu-Goldstone(NG) fermion ψαi (superon) and their gravitational interaction called superon-graviton action LSGM. (eaμ ψαi). Simultaneously, as shown in the toy model, the universal attractive force graviton would dictate the evolution(vacuum) of superon-graviton model LSGM (eaμ, ψαi) and produce, as shown in the toy model, all possible gravitational composites of superons except graviton corresponding to the eigenstates of ordinary SO(N) super-Poincare'(sP) LSUSY algebra of the particle physics(supergravity). which may be the ignition of the Big Bang of the universe. NLSGR/NLSGM paradigm may give new insight to the NLSGR paradigm may bridge potentially cosmology and the low energy particle physics which provides new insights into unsolved problems of cosmology, SM and mysterious relations between them, e.g. the space-time dimension four, the origin of SUSY breaking, the dark energy and dark matter, the dark energy density□(neutrino mass)4□the tiny neutrino mass, the three-generations structure of quarks and leptons, the rapid expansion of space-time and the fate of black hole etc. NLSGR/SGM may describe new paradigm for unification of space-time, matter and cosmological term before Big Bang.

Primary author: SHIMA, Kazunari

Presenter: SHIMA, Kazunari

Session Classification: Parallel Session-Inflation and EU

Contribution ID: **18** Type: **not specified**

Non-linear treatment of cosmological perturbations

Friday, 8 November 2024 11:20 (20 minutes)

Linear-perturbation theory has proven to be an extremely powerful tool to compare inflationary models with observational data. Recently, the newcoming high-precision observations call for predictions beyond linear perturbations. Such effects are known to be relevant for example in the production of primordial black holes or scalar-induced gravitational waves. The separate-universe approach proposes to capture some of these non-linearities. It describes the universe as a set of causally disconnected homogeneous and isotropic patches (FLRW). In this talk, I will show that by allowing the patches to exhibit constant curvature, the separate-universe approach can be extended to non-slow-roll models. I will discuss the case of ultra-slow roll where this new approach allows to correctly predict the power spectrum of scalar perturbations together with non-Gaussianities.

Primary author: ARTIGAS, Danilo

Presenter: ARTIGAS, Danilo

Session Classification: Parallel Session-Inflation and EU

Contribution ID: **19** Type: **not specified**

Stochastic inflation and entropy bound in de Sitter spacetime

Friday, 8 November 2024 11:40 (20 minutes)

We analyze the entropy behavior of the de Sitter spacetime during the inflationary phase. A cosmological horizon in de Sitter spacetime that constrains the causally accessible region of an observer exhibits thermal properties analogous to the event horizon of a black hole. According to the principles of holography, the entropy within a causally connected region for an observer is limited by its boundary. This entropy bound is violated during the late inflation stage. To address the issue of entropy bound violations from a quantum information perspective, we adopted a stochastic approach to cosmic inflation. We consider Shannon entropy of the probability distribution of the inflaton field, which shows the same behavior as the entanglement entropy of a Hubble-size region in stochastic inflation. Adopting the volume-weighted probability distribution for the inflaton field, we show a meaningful entropy behavior in the de Sitter spacetime.

Presenter: TAJIMA, Hiromasa

Session Classification: Parallel Session-Inflation and EU

Contribution ID: **20** Type: **not specified**

Primordial Black Hole Formation from Power Spectrum with Finite-width

Friday, 8 November 2024 12:00 (20 minutes)

Primordial Black Holes (PBHs) may be produced by gravitational collapse in regions with a large amplitude of density contrasts in the early Universe. They may provide the seeds for galaxy formation, account for a population of the LIGO-Virgo events, and the candidates of cold dark matter. The main purpose of our study is to develop a more accurate estimation for PBH abundance. We will address the calculation of the PBH abundance by applying peak's theory to primordial field perturbations with a Gaussian probability distribution. Our study may make the application of peak's theory in PBH abundance estimation no longer limited to monochromatic perturbations, power spectrum with any width or shape could be generally solved by handling the smoothing effects in a proper way.

Presenter: WANG, Jianing

Session Classification: Parallel Session-Inflation and EU

Contribution ID: **21** Type: **not specified**

Parity-Odd Power Spectra: Concise Statistics for Cosmological Parity Violation

Friday, 8 November 2024 11:00 (20 minutes)

Discovering primordial parity violation would have profound implications for our understanding of early Universe physics and would greatly inform inflationary models. Recent evidence of cosmic parity violation in the four-point statistics of galaxy clustering is inconclusive due to uncertainty in observational systematics and covariance estimation. In this talk, I will present a new class of observables known as Parity-Odd Power (POP) spectra, designed to probe parity violation in N-point statistics. These spectra compress the six-dimensional parity-odd trispectrum into one-dimensional power spectra, providing a computationally efficient and complementary alternative to full four-point statistics. I will present measurements from simulations featuring a specific parity-odd trispectrum, demonstrating strong agreement with semi-analytic predictions. Additionally, I will discuss how these new statistics can be interpreted in terms of the trispectrum' s soft limits, highlighting their sensitivity and utility in future cosmological analyses.

Presenter: JAMIESON, Drew

Session Classification: Parallel Session-LSS

Contribution ID: **22** Type: **not specified**

Alleviate S8 tension by introducing scale dependence beyond power-law in the primordial power spectrum

Friday, 8 November 2024 11:20 (20 minutes)

There is an approximately 2-sigma discrepancy between the S8 values measured from CMB and CMB lensing, which probe large scales, and the values measured from the weak lensing survey, which is sensitive to small scales. This discrepancy, known as the “S8 tension”, can be regarded as a tension between large and small scales. These results are based on the standard LCDM model, which assumes a simple power-law form for the primordial power spectrum. In this talk, we explore whether introducing more complex scale dependence in the primordial power spectrum, such as allowing the spectral index to vary with scale (known as spectral index running), can help alleviate this tension. We present the joint analysis of Planck CMB, CMB lensing from ACT DR6, and cosmic shear data from HSC-Y3.

Presenter: TERASAWA, Ryo

Session Classification: Parallel Session-LSS

Contribution ID: **23** Type: **not specified**

Non-linear evolution of primordial parity violation

Friday, 8 November 2024 11:40 (20 minutes)

The discovery of parity violation in weak interactions dictated the structure of the standard model of particle physics. Recent hints of parity violation in the cosmic microwave background and large-scale structure of the universe make us wonder, whether parity can provide us any information about the mysteries of cosmology as well. In this talk, I will demonstrate, how primordial parity violation gets affected by the non-linear evolution of matter density fields and how it remains engraved in the large-scale structure of the universe.

Presenter: AZYZY, Shaghaiegh

Session Classification: Parallel Session-LSS

Contribution ID: **24** Type: **not specified**

Scale-dependent galaxy bias in local-type primordial non-Gaussianities with heavy-tailed models

Friday, 8 November 2024 13:30 (40 minutes)

Scale-dependent bias is a crucial indicator in the late-time universe for understanding local-type primordial non-Gaussianities. Previous studies have focused on low-order non-Gaussian models characterized by the f_NL (second order), g_NL and tau_NL (third order) parameters, with forecasts made for upcoming large-scale galaxy surveys. In this talk, we extend this framework to models exhibiting heavy tails in the probability density function of primordial curvature fluctuations. By utilizing cosmological N-body simulations tailored for a specific model of the heavy tail described by a logarithmic transformation, we provide a quantitative analysis of their impact on scale-dependent halo and galaxy bias.

Presenter: NISHIMICHI, Takahiro

Session Classification: LSS-2

Contribution ID: **25** Type: **not specified**

Divide and Conquer the Cosmos: Patching Simulation beyond Separate Universe

Friday, 8 November 2024 14:10 (40 minutes)

The separate universe simulation account for the mean density mode, and the mean tidal modes too in its anisotropic extension. I will present some recent work on perfect parallel simulation accounting for all long-wavelength modes through boundary conditions.

Primary author: LI, Yin

Presenter: LI, Yin

Session Classification: LSS-2

Contribution ID: **26** Type: **not specified**

On the bias renormalization in cosmological perturbation theory

Friday, 8 November 2024 15:20 (40 minutes)

I would like to briefly discuss the renormalization schemes of conventional perturbation theory (also EFTofLSS) and that of integrated perturbation theory (i.e., renormalized bias functions in iPT).

Presenter: MATSUBARA, Takahiko

Session Classification: LSS-3 and Closing

Contribution ID: **27** Type: **not specified**

Summary Talk

Friday, 8 November 2024 16:00 (1 hour)

Presenter: BOND, J. Richard

Session Classification: LSS-3 and Closing