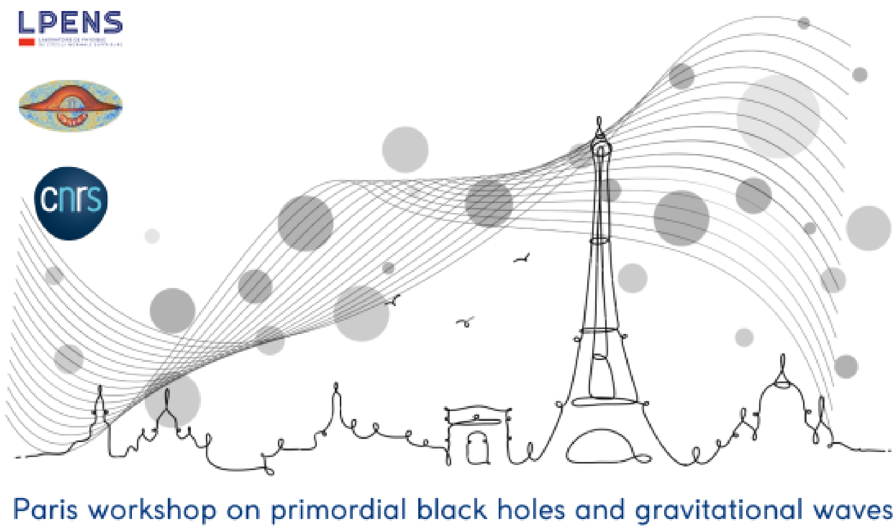
Paris workshop on primordial black holes and gravitational waves

lundi 27 novembre 2023 - mercredi 29 novembre 2023

Institut Henri Poincaré, Paris



Recueil des résumés

Contents

Enhanced small-scale density fluctuations and loop effects 1

Gravitational Waves and Planck Constraints from PBH Dark Matter Seeded by Multifield Inflation 1

Signatures of no-scale supergravity in Nanograv and beyond 1

Primordial black holes from the pre-big bang 2

Prospects for detection of ultra high frequency gravitational waves from compact binary coalescenses with resonant cavities 2

Imprint of PBH domination on gravitational waves generated by cosmic strings 3

Einstein vs. Hawking: gravitational waves from evaporating Primordial Black Holes binaries 3

Can primordial black holes form without fine-tuning? 4

Back-reaction in the early universe 4

Spacetime symmetries in the early Universe 4

Ultra high frequency gravitational waves from primordial black holes hyperbolic encounters 5

Peaks in the power spectrum and Loops 5

Stochastic sources for primordial perturbations 6

Primordial Black Holes from Supercooled Phase Transitions 6

Observable gravitational waves from hyperkination in Palatini gravity and beyond . . . 6

Primordial black hole reheating in post-inflationary universe 7

Quantum Gravity Effects on Dark Matter and Gravitational Waves 7

Primordial black holes and gravitational waves from long-range scalar forces 7

The Formation of Primordial Black Holes with a Spectator Field 8

Dark Matter and Dark Energy from First Principles: How can Primordial Black Holes determine the Universe 8

Closing in on primordial black holes 8

Large $|\eta|$ approach to single field inflation 9

Primordial black holes and gravitational waves from dissipation during inflation 9

Local non-Gaussianity, exponential tails, and trapped vacuum bubbles 9

Primordial black holes and numerical stochastic inflation 9

Primordial Black Holes during the QCD phase-transition 10

On Axion Inflation, Non-Gaussianities, PBH and GW 10

Lattice simulations during inflation 10

Welcome 10

3

Enhanced small-scale density fluctuations and loop effects

Auteur: Sébastien Renaux-Petel[1]

[1] *IAP-CNRS*

Auteur correspondant renaux@iap.fr

The possibility that density fluctuations are enhanced on small scales compared to cosmological scales is central is today's cosmology, as they can seed a sizeable amount of stochastic gravitational wave backgrounds and primordial black holes (PBH). Most predictions for such scenarios are made at tree-level in perturbation theory, although loop effects are expected to be important. In this talk, I will first consider an illustrative model where fluctuations are resonantly amplified due to oscillatory features in the inflaton potential, and demonstrate the breakdown of perturbation theory for models that lead to PBH. Second, I will point out the phenomenon of infrared rescattering, through which enhanced tree-level fluctuations lead to a cascade of power on larger scales. Based on 2211.02586 and 2307.08358

5

Gravitational Waves and Planck Constraints from PBH Dark Matter Seeded by Multifield Inflation

Auteurs: David Kaiser[1]; Evan McDonough[2]; Sarah Geller[3]; Shyam Balaji[4]; Wenzer Qin[1]

[1] *MIT*

[2] *University of Winnipeg*

[3] *Santa Cruz Institute for Particle Physics, MIT Center for Theoretical Physics*

[4] *LPTHE*

Auteurs correspondants: shyam.balaji@sydney.edu.au, dikaiser@mit.edu, e.mcdonough@uwinnipeg.ca, sgeller@mit.edu, wenzerq@mit.edu

In my talk, I will present recent work on the formation of primordial black hole dark matter and the resultant gravitational wave signal, drawing from recent results of https://arxiv.org/pdf/2303.02168.pdf, https://arxiv.org/pdf/2205.04471.pdf (with co-authors W. Qin, S. Balaji, D.I. Kaiser, and E. McDonough), as well as ongoing research.
In our work, we performed a Markov Chain Monte Carlo (MCMC) analysis of a simple yet generic multifield inflation model characterized by two scalar fields coupled to each other and non-minimally coupled to gravity, fit to Planck 2018 cosmic microwave background (CMB) data. In particular, model parameters are constrained by data on the amplitude of the primordial power spectrum of scalar curvature perturbations on CMB scales A_s, the spectral index n_s, and the ratio of power in tensor to scalar modes r, with a prior that the primordial power spectrum should also lead to primordial black hole (PBH) production sufficient to account for the observed dark matter (DM) abundance.
I will demonstrate that n_s in particular largely controls the constraints on our class of models and point out the implications of this behavior. Whereas previous studies of PBH formation from an ultra-slow-roll phase of inflation have highlighted the need for at least one model parameter to be highly fine-tuned, I will identify a degeneracy direction in parameter space such that shifts by ~10\% of one parameter can be compensated by comparable shifts in other parameters while preserving a close fit between model predictions and observations. Furthermore, I will show how this allowed parameter region produces observable gravitational wave (GW) signals in the frequency ranges to which upcoming experiments are projected to be sensitive, including Advanced LIGO and Virgo, the Einstein Telescope (ET), DECIGO, and LISA.
Time permitting, I will discuss ongoing work on the fitting of GW predictions from multifield mod

6

Signatures of no-scale supergravity in Nanograv and beyond

Auteur: Charalampos Tzerefos[1]

Co-auteurs: Dimitri Nanopoulos [2]; Emmanuel Saridakis [3]; Spyros Basilakos [3]; THEODOROS PAPANIKOLAOU [3]

[1] *University of Athens*

[2] *Texas A&M University*

[3] *National Observatory of Athens*

Auteurs correspondants: dimitri@physics.tamu.edu, msaridak@noa.gr, chtzeref@phys.uoa.gr, sbasil@noa.gr, papaniko@noa.gr

In this talk, I am going to present our recent work where we derive a characteristic three-peaked GW signal within the framework of no-scale Supergravity, which arises as a low energy limit of supertstring theory. We concentrate on the primordial gravitational wave (GW) spectrum induced due to second-order gravitational interactions by inflationary curvature perturbations as well as by isocurvature energy density perturbations of primordial black holes (PBHs) both amplified due to the presence of an early matter-dominated era (eMD) era before Big Bang Nucleosythesis (BBN). In particular, we work with inflection-point inflationary potentials naturally realised within Wess-Zumino type no-scale Supergravity and giving rise to the formation of microscopic PBHs triggering an eMD era and evaporating before BBN. Remarkably, we obtain an abundant production of gravitational waves at the frequency ranges of nHz, Hz and kHz and in strong agreement with NANOGrav/PTA GW data. The simultaneous detection of all three nHz, Hz and kHz GW peaks by NANOGrav/PTA, ET/BBO and electromagnetic GW detectors respectively can constitute a clear indication in favor of no-scale Supergravity.

7

Primordial black holes from the pre-big bang

Auteur: PIETRO CONZINU[1]

[1] *University of Pisa & INFN*

Auteur correspondant pietro.conzinu@phd.unipi.it

I will discuss the possibility of producing a significant fraction of dark matter in the form of primordial black holes (PBHs) in the context of the pre-big bang scenario. To this purpose, I consider the enhancement of curvature perturbations possibly induced by a variation of the sound-speed parameter c_s that emerges naturally due to higher-order string corrections. We describe the production both in radiation and in matter dominated era.

8

Prospects for detection of ultra high frequency gravitational waves from compact binary coalescenses with resonant cavities

Auteurs: Aurélien Barrau[1]; Juan Garcia-bellido Capdevila[2]; Killian Martineau[None]; Thierry Grenet[3]

[1] *LPSC*

[2] *Universidad Autonoma de Madrid*

[3] *Institut Néel CNRS*

Auteurs correspondants: thierry.grenet@neel.cnrs.fr, martineau@lpsc.in2p3.fr, juan.garciabellido@uam.es, barrau@in2p3.fr

As underlined by recent events, numerous efforts are directed towards exploring gravitational waves (GWs) in the low frequency regime, below the LIGO-Virgo-KAGRA ranges. The high frequency regime, however, remains vastly unexplored. There is a good reason for that: no substantial signal is expected from known astrophysical or cosmological sources above few kHz. (Ultra) high frequency GWs are however expected from many beyond standard model sources, among which primordial black holes.

This presentation aims at clarifying the situation about compact binary coalescences that might be observed with haloscope experiments sensitive to gravitational waves in the 1-10 GHz band, taking the GrAHal experiment as a benchmark. Different relevant physical regimes are considered in details and some formulas encountered in the literature are revised.
Notably, the distances that can be probed and expected event rates are evaluated, taking into account degeneracies between physical parameters.
Finally, this presentation also discuss where experimental efforts should be focused to improve the sensitivity.

Based on: https://arxiv.org/pdf/2303.06006.pdf

9

Imprint of PBH domination on gravitational waves generated by cosmic strings

Auteur: Rishav Roshan[1]

[1] *University of Southampton*

Auteur correspondant r.roshan@soton.ac.uk

We study the effect of an ultra-light primordial black hole (PBH) dominated phase on the gravitational wave (GW) spectrum generated by a cosmic string (CS) network formed as a result of a high-scale U(1) symmetry breaking. A PBH-dominated phase leads to tilts in the spectrum via entropy dilution and generates a new GW spectrum from PBH density fluctuations, detectable at ongoing and planned near-future GW detectors. The combined spectrum has a unique shape with a plateau, a sharp tilted peak over the plateau, and a characteristic fall-off, which can be distinguished from the one generated in the combination of CS and any other matter domination or new exotic physics. We discuss how ongoing and planned future experiments can probe such a unique spectrum for different values of U(1) breaking scale and PBH parameters such as initial mass and energy fraction.

10

Einstein vs. Hawking: gravitational waves from evaporating Primordial Black Holes binaries

Auteur: Baptiste Blachier[1]

Co-auteurs: Killian Martineau ; Aurélien Barrau [2]

[1] *Université Catholique de Louvain*

[2] *LPSC*

Auteurs correspondants: barrau@lpsc.in2p3.fr, baptiste.blachier@uclouvain.be, martineau@lpsc.in2p3.fr

At the theoretical level, binary systems of evaporating primordial black holes (PBHs) are interesting situations in which the classical general relativistic dynamics related to the emission of gravitational waves (GWs), compete with the evolution driven by Hawking radiation. This competition is two-fold: first between the outspiralling dynamics produced by the loss of mass of the two bodies and its inspiralling counterpart due to GWs, leading to highly non-trivial orbital trajectories; second between spacetime excitations produced by GWs compared with those triggered by the Hawking emission of gravitons.

Even at the level of a Newtonian analysis, in two recent works in collaboration with A. Barrau, K. Martineau, C. Renevey, A. Liu and M. Lalhou –see https://arxiv.org/pdf/2306.09069.pdf and https://arxiv.org/pdf/2308.15 –we will show that surprising features arise, in particular three distinct regimes, depending on the initial conditions of the system, including an intricate non-monotonic behaviour. For these three possible scenarios, an exhaustive study of the evolution of GW and graviton frequencies, powers, and cumulative energies was performed.

At the phenomenological level, in the light of classifying and studying hypothetical sources of high-frequencies GWs, we put a specific emphasis on the study of the possible imprints –in terms of frequencies or strains –left by such systems.

11

Can primordial black holes form without fine-tuning?

Auteur: Andrew Gow[1]

[1] *Institute of Cosmology & Gravitation, University of Portsmouth*

Auteur correspondant andrew.gow@port.ac.uk

Primordial black holes (PBHs) may form in the early universe, and could have relevance to cosmic evolution, particularly as a dark matter candidate. Forming PBHs requires increased power on small scales, corresponding to some kind of feature in the inflaton potential. I will present a study of the fine-tuning of PBH formation for four representative inflation models, discussing the different sources of tuning and potential mitigation methods.

12

Back-reaction in the early universe

Auteur: Laura Iacconi[1]

Co-auteurs: David Mulryne [1]; David Seery [2]

[1] *Queen Mary University of London*

[2] *University of Sussex*

Auteur correspondant l.iacconi@qmul.ac.uk

Single-field models of inflation that feature a non-attractor phase might lead to enhanced scalar fluctuation on scales much smaller than those seeding large-scale structure formation. In this scenario, it is possible that the spike of power at high wavenumber might spoil the successful predictions of a nearly Gaussian, scale-invariant power on large scales, e.g. in the form of loop corrections to the large-scale power spectrum. In this talk we discuss analytical estimates for the 1-loop correction, derived by applying the δN formalism. To clarify how our results relate with the existing literature, we make an explicit connection to results obtained by employing the in-in formalism.

13

Spacetime symmetries in the early Universe

Auteur: Nils Nilsson[1]

[1] *SYRTE, Observatoire de Paris*

Auteur correspondant nils.nilsson@obspm.fr

Testing the basic building blocks of General Relativity has gained a lot of interest in recent years. In this talk, we will present some recent results on the effects of explicit spacetime symmetry breaking on primordial tensor fluctuations using an effective field theory for Lorentz/CPT violation. We find that the graviton is still massless, but that the propagation speed of tensor modes is modified, and we obtain a constraint on the coefficient determining the symmetry breaking on the order of 10^{−15} from the recent measurements of the speed of gravitational waves. Due to the symmetry breaking, the de-Sitter phase is modified and during this inflationary epoch the power spectrum assumes a slow oscillation around the General Relativity limit; further, we find that the primordial tensor power spectrum retains its scale invariance, but that the amplitude is modified. We also find that the modes which become subhorizon during radiation domination acquire a phase shift proportional to the coefficient for Lorentz violation.

14

Ultra high frequency gravitational waves from primordial black holes hyperbolic encounters

Auteurs: Aurélien Barrau[1]; Killian Martineau[1]; Martin TEUSCHER[2]

[1] *LPSC Grenoble*

[2] *LPSC Grenoble / ENS Paris*

Auteurs correspondants: martineau@lpsc.in2p3.fr, martin.teuscher@ens.psl.eu, barrau@lpsc.in2p3.fr

Gravitational waves (GW) in the GHz band might be observed in the near future thanks to microwave cavities. In this work, we focus on GW sourced by hyperbolic encouters of black holes and take the GraHal experiment as a benchmark. We investigate in details the set of orbital conditions leading to a fixed emission frequency, analyze the typical time window of GW production and show how to maximize the signal. The associated maximum distance to the source is evaluated.

15

Peaks in the power spectrum and Loops

Auteur: Jacopo Fumagalli[1]

[1] *ICCUB - Universitat de Barcelona*

Auteur correspondant jfumagalli@fqa.ub.edu

How small-scale enhanced scalar fluctuations influence large scales, for instance, the one probed by the CMB, has recently been the object of an intense debate. In this context, I will first show that one-loop corrections to the large-scale power spectrum from small-scale modes in non-slow-roll dynamics are always negligible, namely they are volume suppressed by the ratio of the short to long distance scales.
I will then discuss ways to have resonant IR cascades, namely cases where loop corrections can be significant in the near infrared.

16

Stochastic sources for primordial perturbations

Auteurs: Alejandro Perez Rodriguez[1]; Guillermo Ballesteros[None]; Julian Rey[2]; Marcos Alejandro Garcia Garcia[3]; Mathias Pierre[2]

[1] *Universidad Autonoma de Madrid, IFT UAM-CSIC*

[2] *DESY*

[3] *UNAM*

Auteurs correspondants: guillermo.ballesteros@uam.es, mathias.pierre@desy.de, alejandro.perezrodriguez@uam.es

Coupling the inflaton to light fields during inflation leads to the former dissipating part of its energy into a thermal bath. The thermal fluctuations of this bath act as a source for inflaton perturbations, potentially enhancing the inflationary scalar power spectrum and therefore increasing the predicted abundance of primordial black holes (and the corresponding scalar-induced gravitational waves). We discuss several assumptions and technical details about the calculation of the scalar power spectrum in this context, as well as their observational implications on different scales. The content of the talk is based on 2208.14978 and 2304.05978 with G. Ballesteros, M.A.G. García, M. Pierre, J. Rey.

17

Primordial Black Holes from Supercooled Phase Transitions

Auteur: Yann Gouttenoire[1]

Co-auteur: Tomer Volansky [1]

[1] *Tel Aviv University*

Auteurs correspondants: yann.gouttenoire@gmail.com, tomer.volansky@gmail.com

Cosmological first-order phase transitions (1stOPTs) are said to be strongly supercooled when the universe undergoes a vacuum-domination stage ended by percolation. The statistical variations in bubble nucleation histories imply that distinct causal patches percolate at slightly different times. Patches which percolate the latest undergo the longest vacuum-domination stage and as a consequence develop large over-densities triggering their collapse into primordial black holes (PBHs). Supercooled 1stOPTs which take more than 12% of a Hubble time to percolate produce observable PBHs.

18

Observable gravitational waves from hyperkination in Palatini gravity and beyond

Auteur: Samuel Sanchez Lopez[1]

[1] *Lancaster University*

Auteur correspondant s.sanchezlopez@lancaster.ac.uk

A generic prediction of inflation is the generation of stochastic primordial gravitational waves (GWs). In the standard picture, the resulting GW spectrum is too weak to be detectable in the near future by upcoming experiments such as LISA or advanced LIGO. This is not so in the context of quintessential inflation, as the spectrum for the modes re-entering the horizon during the period of kination is

substantially boosted. However, extending the signal to observable frequencies would overproduce enough GWs to destabilize BBN. In this talk, I introduce a period of hyperkination, prior to regular kination, where the energy density of the field is dominated by a quartic kinetic term, a setup that can be motivated by Palatini $R + R^2$ modified gravity. I show that the spectrum for the GW modes re-entering the horizon during hyperkination is flat, thereby truncating the kination peak, which now may be extended safely to observable frequencies. After a thorough analytical and numerical study, ample parameter space is obtained to make the GW spectrum detectable in the near future. If observed, the amplitude and "knee" of the spectrum will provide valuable insights into the background theory.

19

Primordial black hole reheating in post-inflationary universe

Auteur: Essodjolo Kpatcha[1]

[1] *IJCLab, Univ. Paris-Saclay*

Auteur correspondant essodjolo.kpatcha@ijclab.in2p3.fr

The conventional post-inflationary reheating phase is commonly attributed to the decay of coherently oscillating inflaton into radiation. In this talk I address novel perspectives on reheating and dark matter production after inflation, considering the intricate interplay between primordial black holes (PBHs) and inflaton dynamics.

20

Quantum Gravity Effects on Dark Matter and Gravitational Waves

Auteur: Xin Wang[1]

[1] *University of Southampton*

Auteur correspondant xin.wang@soton.ac.uk

In this talk, I will discuss how quantum gravity effects, manifested through the breaking of discrete symmetry responsible for both Dark Matter and Domain Walls, can have observational effects through CMB observations and gravitational waves. To illustrate this idea, I will propose a simple model with two scalar fields and two Z_2 symmetries, one being responsible for Dark Matter stability, and the other spontaneously broken and responsible for Domain Walls, where both symmetries are assumed to be explicitly broken by quantum gravity effects. The recent gravitational wave spectrum observed by several pulsar timing array projects can help constrain such effects. In addition, I will also briefly discuss the scenario where a fermion singlet serves as the dark matter.

21

Primordial black holes and gravitational waves from long-range scalar forces

Auteur: Marcos Flores[1]

[1] *Laboratoire de Physique de l'Ecole Normale Supérieure*

Auteur correspondant marcos.flores@phys.ens.fr

Most of the elementary particles discovered in the past century have Compton wavelengths that are much smaller than the size of the atom, and, therefore, they cannot mediate any long-range forces between atoms. This changes in the early Universe, when the horizon size is small. The forces that mediate attractive interactions between particles, such as Yukawa forces, are of particular interest in this early era. These attractive forces exhibit an instability similar to the gravitational instability, but are generally stronger. The effect of this instability is the formation of structure, even in a radiation dominated era. Simultaneously, this same attractive interaction enables the removal of energy and angular momentum through the emission of scalar radiation which facilitates collapse. The process of early structure formation and collapse, has a rich phenomenology and has been utilized to address numerous open questions in physics. In this talk, I will demonstrate how long-range forces and scalar radiation lead to the formation of primordial black holes (PBHs) as dark matter. Furthermore, we will explore the observational consequences of early structure formation, particularly possible contributions to the stochastic gravitational wave background. Lastly, I will talk about the implications of PBHs as dark matter, with a particular focus on the interactions between PBHs and neutron stars.

22

The Formation of Primordial Black Holes with a Spectator Field

Auteur: Ioanna Stamou[1]

[1] *Université libre de Bruxelles (ULB)*

Auteur correspondant ioanna.stamou@ulb.be

This presentation introduces a cosmological model featuring a spectator field and investigates its connection to the formation of primordial black holes (PBHs) and dark matter. By considering fluctuations during inflation, we uncover a natural PBH formation process that doesn't rely on exotic physics in the potential and the fine-tuning issue can be avoided. Observational constraints demonstrate the model's ability to reproduce PBH abundance and mass distribution. This research sheds light on early universe dynamics and contributes to our understanding of dark matter, inflation, and PBHs.

26

Dark Matter and Dark Energy from First Principles: How can Primordial Black Holes determine the Universe

Since the first detection of Gravitational Waves by LIGO/Virgo, we have seen a renaissance of interest on PBH as the main component of Dark Matter in the Universe. If PBH are also responsible for the seeds of galaxies at high redshift, as observed by the JWST, then it is possible that PBH are also responsible for the present cosmic acceleration of the Universe. I will give my personal vision of where the field is going, and describe how the next generation of experiments will allow us to challenge the new paradigm.

29

Closing in on primordial black holes

Observational constraints have closed off all but one mass-window for primordial black holes making up all of the dark matter, and there are some specific conditions required for their production in the first place. However, they remain a tantalising dark matter candidate because they require no new beyond the standard model particles and they would additionally provide a lot of information about the very early universe, particularly about inflation, if found. I will highlight some key recent results in the literature, with a focus on gravitational wave constraints, that describe how the viable parameter space for primordial black holes making up all of the dark matter is closing up, but also why it's worth checking every last window for signatures of their existence.

30

Large $|\eta|$ approach to single field inflation

Single field models of inflation capable to produce primordial black holes usually require a significant departure from the standard, perturbative slow-roll regime. In fact, in many of these scenarios, the size of the slow-roll parameter $|\eta|$ becomes larger than one during a short phase of inflationary evolution. In order to develop an analytical control on these systems, I explore the limit of $|\eta|$ large, and promote $1/|\eta|$ to a small quantity to be used for perturbative expansions. Formulas simplify, and analytic expressions for the two and three point functions of curvature fluctuations are obtained. I will then discuss the behaviour of loop corrections to inflationary observables in this framework.

36

Primordial black holes and gravitational waves from dissipation during inflation

39

Local non-Gaussianity, exponential tails, and trapped vacuum bubbles

A class of inflationary scenarios for primordial black hole (PBH) formation include a small barrier in the slope of the potential, leading to local type non-Gaussianity. In such models, there are two competing channels for PBH formation. One is the standard collapse of adiabatic perturbations. Alternatively, PBH may form by the supercritical implosion, during the radiation era, of localized regions of trapped false vacuum. We analyze such models, comparing both channels and establishing under what conditions one will dominate over the other. More generally, we point out that the existence of alternative channels can be inferred from unitarity considerations.

40

Primordial black holes and numerical stochastic inflation

Primordial black holes can arise from strong fluctuations produced during cosmic inflation. Stochastic inflation is a method to compute the fluctuation statistics non-perturbatively. It approximates the complicated, full quantum field theory computation and is needed for accurate black hole predictions. I discuss recent progress in the numerical implementation of the method and highlight the role of a constant-roll phase and the resulting non-Gaussian curvature distribution. As a new result, I present numerically solved profiles of the compaction function, the correct quantity to characterize the black hole collapse process.

41

Primordial Black Holes during the QCD phase-transition

Primordial black holes (PBHs) could have been formed in the very early Universe from large amplitude perturbations of the metric. Their formation is naturally enhanced during the quark-hadron phase transition, because of the softening of the equation of state: at a scale between 1 and 3 solar masses, the threshold is reduced of about 10% with a corresponding abundance of PBHs significantly increased by three order of magnitudes. Performing detailed numerical simulations we have computed the modified mass function for such black holes, showing that the minimum of the QCD transition works as an attractor solution. Making then a confrontation with the LVK phenomenological models describing the GWTC-3 catalog, we have found that a sub-population of such PBHs formed in the solar mass range is compatible with the current observational constraints and could explain some of the interesting sources emitting gravitational waves detected by LIGO/VIRGO in the black hole mass gap, such as GW190814, and other light events.

47

On Axion Inflation, Non-Gaussianities, PBH and GW

I will touch axion inflation and primordial GW, PBH formation in this model. In the second part I will touch induced gravitational waves and the superradiance of primordial black holes.

51

Lattice simulations during inflation

Inflationary models with significant amplification of small-scale scalar and tensor perturbations have attracted considerable attention in the literature due to their interesting observational signatures, such as primordial black holes and gravitational waves. However, the large enhancement of fluctuations often challenges our perturbative understanding of inflation. I will present a numerical study of inflation based on lattice simulations. I will show that including nonlinearities has important consequences for the inflationary dynamics and its predictions. I will mainly focus on a specific model known as axion inflation, where the inflaton is coupled to gauge fields via the Chern-Simons interaction. As a second example, I will consider a single-field model of inflation with a resonant feature in the potential.

54

Welcome

Auteur correspondant chiara.animali@phys.ens.fr