Colloque national Action Dark Energy 2020 - 4ème édition

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Book of Abstracts

Contents

1

From the Early Trans-Planckian Vacuum to the Late Dark Energy

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Du Vide trans-Planckian à l'Energie Noire dans le Modele Standard de l'Univers

Le Résummé sera envoyé plus tard pour inclure plus des résultats récents

Merci pour votre comprehension !

A bientot et bien amicalement à vous,

NS

2

The role of cross-correlations in future galaxy surveys

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The future large galaxy surveys will allow for precise cosmological analyses using the clustering of galaxies and cosmic shear. The cross-correlation between these probes can tighten constraints and it is therefore important to quantify its impact for future surveys. In this talk I will present the latest results of the Euclid Collaboration quantifying the role of the cross-correlation between angular galaxy clustering and cosmic shear, not only on the cosmological parameters but also on the systematic effects. I will finish by presenting the missing ingredients to fully combine future photometric and spectroscopic datasets taking into account all cross-correlations.

3

1-point statistics of Aperture mass

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I will present a theoretical description of the weak-lensing Aperture-mass field with large deviation theory. I will highlight the difficulty I encountered comparing the formalism to ray-tracing numerical simulations and emphasize the need for accurate tests of non gaussian statistics in such numerical suites if we are to correctly use them in future large surveys.

4

E-BOSS Summary

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5

15 years of baryonic oscillations

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6

Backlighting the missing baryons with the CMB: implications for large-scale structure and galaxy formation

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The feedback mechanisms that regulate galaxy formation, exploding stars and accretion onto supermassive black holes, are poorly understood. This results in an order unity uncertainty in the distribution of the gas inside halos, the missing baryon problem". Because baryons are 15% of the total mass in the universe, this baryonic uncertainty is also the largest theoretical systematics for percent precision dark energy surveys like Euclid.
By measuring the kinematic and thermal Sunyaev-Zel'dovich effects (kSZ and tSZ), cosmic microwave background (CMB) experiments can solve these issues and determine the gas thermodynamics in galaxy groups and clusters, at high redshift and out to the outskirts of the halo. I will present joint tSZ, kSZ and dust measurements of BOSS (CMASS) galaxy groups. Using data from the Atacama Cosmology Telescope (ACT), we produce the highest significance kSZ measurement to date. This measurement shows with high statistical confidence that the gas is more spread out than the dark matter. It informs the modeling of the CMASS galaxy-galaxy lensing data, and shows that the small-scalelensing is low" tension is not entirely caused by baryonic effects. Finally, comparing the observed kSZ and tSZ to hydrodynamical simulations reveals insight about galaxy formation.

7

Beyond the Standard Model Explanations of GW190521

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8

Ateliers Theory / Tools / Probes

10

LiteBIRD, in quest for the primordial gravitational waves

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Cosmological inflation is the leading hypothesis to resolve the problems in the Big Bang theory, predicting that primordial gravitational waves were created during the inflationary era, which then imprinted large-scale curl patterns in the cosmic microwave background (CMB) polarization map, called the B-modes. Measurements of the CMB B-mode signals are known as the best probe to detect the primordial gravitational waves.
LiteBIRD is a JAXA's strategic large mission (planned to be launched in 2029) inside an international collaboration including strong contributions from Europe, and designed to map the polarization of the CMB radiation over the full sky at large angular scales with unprecedented precision, which will offer us a crucial test of cosmic inflation. It will also serve as the first crucial test of quantum gravity such as superstring theory. Precise polarization maps of LiteBIRD will also provide us with valuable pieces of information on particle physics and astrophysics.

12

The SPHEREX All-Sky Spectral Survey

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13

The dark universe under the light of numerical simulations

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Given the increasing supercomputing power that comes along with increasing precision of the next generation cosmological surveys, numerical simulations appear to be an ideal tool to reach the targeted percent accuracy of future measurements.
In this talk, I will present the interest of numerical simulations for observational cosmology.

Measurements will reach the precent-level accuracy thanks to the increased statistics and smaller-scale data. This regime is tougher to predict on a theoretical basis because of small-scale non linearities. But this is a well-posed numerical problem that can be solved at very small scales with high accuracy using numerical simulations. I will then go through recent progresses of dark-matter only simulations and N-body suites specifically constructed for cosmological surveys

Precision cosmology on small scales will also requires understanding the possible range of impacts of galaxy formation and feedback on the matter distribution, which is not described by analytical models. In this context, I will present the use of hydrodynamical simulations. A special emphasis will be made on the impact of AGN feedbacks on the Lya forest.

14

Recent results on cosmic shear

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I will present some results from the past 2-3 years of cosmic shear analyses. Current surveys (KiDS, DES, HSC) focus on understanding the recent tension on the structure growth parameter S8 found between the CMB and the weak-lensing probes. This is done by testing cosmological models beyond Lambda CDM, carefully studying every possible systematic bias, and re-analyzing and combining the different team results. In the meantime we are preparing for the next generation of cosmic shear surveys: Euclid, Vera Rubin Observatory (formerly LSST), and Nancy Grace Roman Telescope (formerly WFIRST). A growing number of cosmological forecasts now include new non-Gaussian estimators that outperform the standard two-point statistics traditionally used in cosmic shear studies.

15

Welcome

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16

Fink broker, enabling time-domain science with LSST

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Next generation experiments such as the Vera Rubin Observatory Legacy Survey of Space and Time (LSST) will provide an unprecedented volume of time-domain data opening a new era of optical big data in astronomy. To fully harness the power of these surveys, new methods must be developed to deal with large data volumes and to coordinate resources for follow-up of promising candidates. In this talk I will present Fink, a broker developed to face these challenges. Fink is based on high-end technology and designed for fast and efficient analysis of big data streams. In this talk I will introduce fink, its architecture and first science verification cases.

17

Lyman-alpha

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The Lyman-α forest, observed at optical wavelength, is a probe of large-scale matter density fluctuations at redshift higher than 2.1. It consists of absorptions in the electromagnetic spectrum of bright and distant sources such as quasars, due to the Lyman-α transition of intervening neutral hydrogen located along their lines-of-sight. As such, it provides a measurement of the amount of neutral hydrogen in the Intergalactic Medium (Croft et al. 1997).

The latest eBOSS data release (Dawson et al. 2016), provides Lyman-α forest data from 210,000 quasars. These spectra are a unique cosmological probe at high redshift range. The ongoing DESI observations will provide even more spectra with a higher density and resolution.

Large statistics Lyman-α forest data is used to measure the BAO scale using forest auto-correlation and cross-correlation with background quasars (du Mas des Bourboux et al. 2020). Using the small scale information of its 1D power spectrum, Lyman-α forest also offers strong constraints on neutrino and warm dark matter masses (Palanque-Delabrouille et al. 2019). Finally, I will also present a 3D tomographic map of Lyman-α absorption made from eBOSS data covering a near-Gpc^3 volume (Ravoux et al. 2020).

18

Forward modelling of the large-scale structure: perfectly parallel simulations and simulation-based inference

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I will first introduce a new, perfectly parallel approach to simulate cosmic structure formation, based on the spatial COmoving Lagrangian Acceleration (sCOLA) framework. Building upon a hybrid analytical and numerical description of particles' trajectories, sCOLA allows an efficient tiling of a cosmological volume, where the dynamics within each tile is computed independently. I will show that cosmological simulations at the degree of accuracy required for the analysis of the next generation of surveys can be run in drastically reduced wall-clock times and with very low memory requirements.
In a second part, I will discuss how such simulations can be used as "black-box" models within data analysis. I will focus on two recent algorithms (SELFI and BOLFI), aiming at inferring the primordial matter power spectrum and cosmological parameters. I will present an application to a Euclid-like configuration and discuss prospects for simulation-based inference from Euclid data.

19

PNG with interlopers in Euclid

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Euclid is going to reveal the exciting nature of our universe by observing Emission Line Galaxies (ELG) in the redshift region 1 < z < 2, with a high survey area of 15000 deg2. In this talk, I will describe the Systematic Effect of the Line-Misidentification, an important effect of Spectrophotometric observations on high contaminated galaxy samples from interlopers. Then, I will present its impact in measurements of local Primordial Non-Gaussianity (PNG) with Euclid as a baseline experiment.

20

Relativistic redshift-space distortions at quasi-linear scales

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The observed galaxy distribution via galaxy redshift surveys appears distorted due to redshift-space distortions (RSD). While one dominant contribution to RSD comes from the Doppler effect induced by the peculiar velocity of galaxies, the relativistic effects, including the gravitational redshift effect, are recently recognized to give small but important contributions. Such contributions lead to an asymmetric galaxy clustering along the line of sight, and produce non-vanishing odd multipoles when cross-correlating between different biased objects. However, non-zero odd multipoles are also generated by the Doppler effect beyond the distant-observer approximation, known as the wide-angle effect, and at quasi-linear scales, the interplay between wide-angle and relativistic effects becomes significant. In this paper, we present a quasi-linear model of the cross-correlation function taking a proper account of both the wide-angle and gravitational redshift effects, as one of the major relativistic effects. Our quasi-linear predictions of the dipole agree well with simulations even at the scales below $20h^{-1}$Mpc.

21

Clustering analysis of the DR16 eBOSS quasar sample

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I will present the clustering analysis of quasars of the final data release (DR16) of eBOSS. The sample contains $343\,708$ quasars between redshifts $0.8 \leq z \leq 2.2$ over $4699\,\mathrm{deg}^2$. We calculate the Legendre multipoles (0,2,4) of the anisotropic power spectrum and perform a BAO and a Full-Shape (FS) analysis at the effective redshift $z\mathrm{eff} = 1.480$. The errors include systematic errors that amount to 1/3 of the statistical error. The systematic errors comprise a modelling part studied using a blind N-Body mock challenge and observational effects studied with approximate mocks to account for various types of redshift smearing and fibre collisions. In the FS analysis, we fit the power spectrum using a model based on Regularised Perturbation Theory, which includes Redshift Space Distortions and the Alcock-Paczynski effect.

22

eBOSS QSO Mock Challenge

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The two-point clustering analysis of the eBOSS DR16 QSO sample provides our best cosmological measurements at an effective redshift z ~ 1.5. As part of the final analysis, we performed an N-body mock challenge using HOD mocks constructed from the OuterRim simulation. The aim of this was to validate the RSD models used in the analysis, and to measure the modelling systematic uncertainties. This was achieved by creating non-blind mocks, with a range of HOD models, that also included redshift uncertainties and catastrophic redshifts. We also used a technique to rescale the cosmology of the simulation in order to perform a blind analysis. In the mock challenge, we found that the choice of observer position strongly affected the growth rate measurement, despite the huge volume of the simulation. We show that this is due to an anti-correlation between quadrupole measurements for different lines of sight. Averaging over 3 orthogonal lines of sight can reduce the uncertainties in the quadrupole and growth rate measurements by a factor greater than sqrt(3). This will be very important for future mock challenges, enabling models to be constrained with less computational expense.

24

Galaxy Cluster Cosmology: the need for high-angular resolution follow-up studies

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Upcoming optical/IR surveys will have both the sensitivity and the area to push cluster detection to $z > 2$. The $Euclid$ and LSST cluster catalogs will contain of the order of $100,000$ cluster detections, which is two orders of magnitudes more than the number of clusters detected by $Planck$. As the largest gravitationally bound systems in the universe, galaxy clusters provide a low-redshift cosmological probe that is complementary to BAO, SN Ia, and CMB. Thus, it will be essential to use these objects to alleviate inherent degeneracies between cosmological parameters estimated with

each individual probe and to unveil potential new limits of the standard cosmological model that are hitherto not significant. This will only be feasible if all sources of systematic uncertainties associated with cluster cosmological constraints are characterized in details. In particular, the mass-richness relation and the halo mass function are both key ingredients driving the size of the final cosmological contours. The high-angular resolution SZ and X-ray follow-up of $Euclid$ and LSST richness-selected clusters will enable investigating the Intra-Cluster Medium properties at high redshift and improve our understanding of cluster formation. Such studies will be fundamental to precisely calibrate the mass-richness relation and the sub-grid physics in the numerical simulations used to infer the halo mass function.

I will present the on-going SZ/X-ray follow-up program of 10 high redshift clusters (z > 1) selected from the MaDCoWS and IDCS optical/IR surveys and its main goals. I will then describe the characterization of the first cluster of this sample: the very massive, high redshift, and morphological disturbed cluster MOO J1142+1527 from the first joint analysis of Chandra and NIKA2 data.

25

Horndeski and the Sirens

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Mergers of compact objects have been nicknamed *standard sirens*, by analogy with electromagnetic standard candles, because their waveform directly gives access to their distance. When an electromagnetic counterpart is observed, such sources thus allow us to construct a Hubble diagram, just as supernovae. Recently, the gravitational-wave Hubble diagram has been argued to be a key probe of alternative theories of gravity, such as Horndeski models. In this talk, I will discuss the foundations of this idea, and its limitations when the inhomogeneities of our Universe are taken into account.

26

CNN face à l'adversité autour d'un cas d'étude

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Mise en évidence de perturbations adversaires d'un modèle de CNN pour le photo-z, recherche de robustesse.

27

Une constante de gravitation variable ?

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La possibilité que la constante de gravitation évolue dans le temps est une éventualité qui a été explorée par le passé. Je présenterais quelques résultats récents sur cette possibilité en Cosmologie et la façon dont cela peut être une alternative au modèle standard.

28

Atmospheric calibration at Vera Rubin Observatory

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Preliminary
Next generation of large cosmological survey with a huge (10^9-10^10) statistics of sources (Galaxy, Clusters and Supernova) requires sub-percent photometric accuracy or better to improve systematic errors at similar level of the statistical errors on cosmological parameters.
Ground observatories are very sensitive to atmospheric conditions due to the fluctuations on clouds aerosols and water vapor transmission. Vera Rubin Observatory has built an auxiliary Telescope (AT, diameter 1.2 m, f =18, scale at focal plane
105 microns /arcsec), to monitor Spectra from a subset of so called calibration star (or standard candles) which Spectral Energy Distribution has been measured by HST or Gaia on satellites.
The calibration spectra will be routinely measured by setting a disperser (grating or hologram) in the converging beam of the AT, at 200 mm from the focal plane. A moderate spectroscopic resolution R~200-300 is sufficient to measure the parameters of interest.
After reviewing the photometric requirements induced by cosmology, we will introduce the key photometric and spectroscopic quantities that are required to be monitored. Then we will show how the AT will be able to estimate these quantities from its spectroscopic measurements.
The AT measurements are based on the atmospheric transmission model which depends on some varying components such as clouds, aerosols and precipitable water vapor.
The relevant atmospheric components can be estimated by using standard methods (MLE, MAP, ML-linear regression, gaussian processes…).
Preliminary results of these methods applied to both a toy-atmospheric model and to 2019- observations at Pic du Midi will be presented.

29

Precision cosmology with voids in the final BOSS data

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In this talk I present novel cosmological constraints obtained from cosmic voids in the final BOSS DR12 dataset. I briefly introduce voids as a tool for cosmology, and focus on illustrating how to

get constraints from the void-galaxy cross-correlation function, relying on measurements of the Alcock-Paczynski effect and of the redshift-space distortions pattern around voids. I discuss methodology and obtained results, with a particular focus on the advantages of calibration-independent approaches.

30

High-resolution SZ observations for cluster cosmology with NIKA2

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As the largest and most massive gravitationally bound objects in the universe, galaxy clusters are excellent tracers of cosmic structures evolution, and can therefore be used to probe the underlying cosmological parameters. In order to do so, a careful understanding of the systematic effects involved in the cosmological exploitation of cluster surveys is crucial. One source of such systematic uncertainty comes from the lack of knowledge of galaxy clusters at high redshift. Indeed, few high-z clusters have been imaged with a high angular resolution, preventing us from extracting precise information on their thermodynamic properties, *e.g.* their mass, pressure and entropy.

NIKA2 is a dual-band camera, containing $\sim$3000 KIDs (Kinetic Inductance Detectors) operated at $\sim$ 100 mK at the IRAM 30m telescope. With its high angular resolution (17.7 and 11.2 arcsec at 150 and 260 GHz respectively) and large field of view (6.5 arcmin), it allows us to map the Sunyaev-Zeldovich (SZ) effect in galaxy clusters with great sensitivity at both small and large angular scales. The NIKA2 SZ Large Program (LPSZ) is currently using the NIKA2 camera to get high-resolution SZ maps of 50 high-redshift clusters, and to infer precise measurements of the thermodynamic properties of their intra-cluster medium. These results will allow us to improve our knowledge of the pressure profile of galaxy clusters and of the scaling relation between cluster mass and SZ signal, which are both essential to cluster-based cosmological analysis. In this talk, I will present the NIKA2 SZ Large Program, along with its first cluster observations.

31

Carpooling to solve the cosmological simulation bottleneck

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To exploit the power of next-generation large-scale structure surveys, ensembles of numerical simulations are necessary to give accurate theoretical predictions of the statistics of observables. High-fidelity simulations come at a towering computational cost. Therefore, approximate but fast simulations, *surrogates*, are widely used to gain speed at the price of introducing model error. We propose a general method that exploits the correlation between simulations and surrogates to compute fast, reduced-variance statistics of large-scale structure observables *without model error* at the cost of only a few simulations. We call this approach Convergence Acceleration by Regression and Pooling (CARPool). In numerical experiments with intentionally minimal tuning, we apply CARPool to a

handful of GADGET-III N-body simulations paired with surrogates computed using COmoving Lagrangian Acceleration (COLA). We find ~ 100-fold variance reduction even in the non-linear regime, up to $k_{\max} \approx 1.2\ h\mathrm{Mpc}^{-1}$ for the matter power spectrum. CARPool realises similar improvements for the matter bispectrum. In the nearly linear regime CARPool attains far larger sample variance reductions. By comparing to the 15,000 simulations from the *Quijote* suite, we verify that the CARPool estimates are unbiased, as guaranteed by construction, even though the surrogate misses the simulation truth by up to 60% at high k. Furthermore, even with a fully configuration-space statistic like the non-linear matter density probability density function, CARPool achieves unbiased variance reduction factors of up to ~ 10, without any further tuning. Conversely, CARPool can be used to remove model error from ensembles of fast surrogates by combining them with a few high-accuracy simulations.

32

Estimation du taux de binarité stellaire avec les données GAIA DR2

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Pour estimer l'efficacité d'une analyse de recherche de microlentilles gravitationnelles, il est nécessaire de connaître le nombre de sources réellement observées. En effet une source identifiée peut être composée de plusieurs étoiles qui n'ont pu être séparées par l'instrument (blending). Ces étoiles peuvent être proches le long de la ligne de visée par le fait du simple hasard ou elles peuvent être physiquement groupées, comme dans le cas des binaires.
Nous analysons les données de GAIA DR2 en 3D de façon purement statistique entre 100 et 600pc afin d'estimer le taux de binarité pour évaluer son impact dans le comptage des effets de microlentille.