Euclid Theory Working Group and Euclid IST:forecast Meeting

Rapport sur les contributions

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ID de Contribution: **1** Type: **TWG talk**

Measuring Dark Energy with Euclid

Determining the equation of state of Dark Energy using Galaxy Clustering and Weak Lensing.

Summary

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ID de Contribution: **2** Type: **TWG talk**

Weak gravitational lensing as a (3D) probe of gravity

Cosmic shear, the weak gravitational lensing caused by the large-scale structure, is one of the primary probes to test gravity on cosmological scales with current and future surveys such as Euclid. In particular, cosmic shear is sensitive to both standard GR cosmological parameters and those that describe modified theories of gravity, such as those belonging to the Horndeski class. These models include the majority of universally coupled extensions to ΛCDM with one scalar degree of freedom in addition to the metric, which are still in agreement with current observations.

There are two main techniques to analyse a cosmic shear survey; a tomographic method, where correlations between the lensing signal in different redshift bins are used to recover redshift information, and a 3D approach, where the full redshift information is carried through the entire analysis.

In this talk, I will start presenting the first constraints on Horndeski gravity obtained from the analysis of tomographic cosmic shear data from the KiDS survey, in cross-correlation with galaxy-galaxy lensing and angular clustering data from the GAMA survey. I will show in particular how this analysis could be repeated and improved with future data coming from Euclid.

I will then compare the constraining power of the tomographic and the 3D approach on Horndeski gravity and on standard cosmological parameters, presenting Fisher matrix forecasts for Euclid. Due to its increased amount of redshift information, a future 3D analysis has the power to constrain both standard gravity and Horndeski theories better than a tomographic one, producing in particular a decrease in the errors on the Horndeski parameters of the order of 20 - 30% and an error on the sum of the neutrino masses three times smaller than in tomography. This makes the 3D approach particularly appealing in view of future applications to the Euclid satellite.

Summary

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ID de Contribution: **3** Type: **TWG talk**

Double curvatures model using Fisher spectroscopic forecasts for Euclid

One of the main prediction of inflationary cosmology is the spatial flatness of the universe. The combination of observed CMB fluctuations with SNIa observations and BAO leads to a prediction of the spatial curvature parameter lower than 1e-4. Observations have shown the acceleration of the expansion of the universe revealing the existence of two dark component : the dark matter and the dark energy. According to general relativity as the geometrical tensor is set equal to the matter energy tensor, the curvature parameter is uniquely related to it's energy content. It is therefore possible to test the general relativity at the background level by considering two independent parameters : a dynamical curvature related to the universe energy content, and a geometric curvature related to its curvature, which have both worse constraints than in the GR case.
This presentation will mainly focus on the estimation of the constraints we can provide on the dark energy equation of state parameters and on the two curvature parameters using forecasts with a Fisher approach. To do so we use a slight modified version of the spectroscopic Fisher code validated inside the IST. Since we are adding these two new parameters during the projection part of the code, no modification of the Boltzmann code is needed then we don't modify any input. These constraints will be compared to those obtained from present day data.

Summary

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ID de Contribution: **5** Type: **TWG talk**

Generalized dark matter model with the Euclid satellite

In a LCDM framework, dark energy may be described as a fluid with equation of state parameter equal to -1, and sound velocity equal to 1, while dark matter may be described as a fluid with null pressure and null sound velocity. In this talk we will focus on dark matter allowing a more general fluid description. We will first briefly provide the theoretical framework for this phenomenological approach, and present the results from state-of-the-art cosmological observations. We will then present preliminary Euclid forecasts for this model, showing the power of Euclid to improve our knowledge on dark matter properties, as well as the importance of considering the cross-correlations between cosmological probes when constraining theoretical models.

Summary

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ID de Contribution: **7** Type: **TWG talk**

Inflation meets dark energy: α-attractor quintessential inflation in the era of Euclid

Over the last few years, a large family of cosmological attractor models has been discovered, which can successfully match the latest inflation-related observational data. Many of these models can also describe a small cosmological constant Λ. In this talk, I will present a recently discovered class of α-attractor models with dynamical dark energy, including the cosmological constant Λ as a free parameter. Predominantly, the models with $\Lambda > 0$ converge to the asymptotic regime with the equation of state $w = -1$. However, there are some models with $w \neq -1$, which are compatible with the current observations. In the simplest models with $\Lambda = 0$, one has the tensor to scalar ratio $r = \frac{12\alpha}{N^2}$ and the asymptotic equation of state $w = -1 + \frac{2}{9\alpha}$. For example, in the seven disk M-theory related model with $\alpha = 7/3$ one finds $r \sim 10^{-2}$ and the asymptotic equation of state is $w \sim -0.9$. Future observations, including large-scale structure surveys such as Euclid as well as B-mode detectors will test these, as well as more general models that I will present in this talk. I will also discuss gravitational reheating in models of quintessential inflation and argue that its investigation may be interesting from the point of view of inflationary cosmology. Such models require a much greater number of e-folds, and therefore predict a spectral index n_s that can exceed the value in more conventional models by about 0.006. This suggests a way to distinguish the conventional inflationary models from the models of quintessential inflation, even if they predict $w = -1$.

Summary

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ID de Contribution: **9** Type: **TWG talk**

Propagation of gravitational waves in doubly-coupled bigravity

I will discuss the implications of the recent detection of gravitational waves emitted by a pair of merging neutron stars and their electromagnetic counterpart, events GW170817 and GRB170817A, on the viability of the doubly-coupled bimetric models of cosmic evolution, where the two metrics couple directly to matter through a composite, effective metric. I will show that the bounds on the speed of gravitational waves place strong constraints on the doubly-coupled models, forcing the two metrics to be proportional at the background level or the models to become singly-coupled. Proportional backgrounds are particularly interesting as they provide stable cosmological solutions with phenomenologies equivalent to that of LCDM at the background level as well as for linear perturbations, while nonlinearities are expected to show deviations from the standard model.

Summary

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ID de Contribution: **11** Type: **TWG talk**

Growth index implementations for different parameterizations of modified gravity

The growth rate of linear perturbations is well described using a simple parametric function $f = \Omega_m^\gamma$, where a detection of deviation of the growth index γ from fiducial ~ 0.55 would indicate a deviation from General Relativity. γ was designated in Euclid red book as one of the parameters that could be well measured, alone or when mixed with other cosmological parameters like the dark energy equation of state w.

However, if we want to use it consistently in different Euclid probes alone or combined with CMB data, it needs to be explicitly related to parameterizations of the metric gravitational potentials that are able to describe the evolution of the perturbations unambiguously. The γ parametrization lacks also a relation to other approaches that could describe a wider space of theories of modified gravity like effective fields approaches (EFT).

We discuss methods and show results of implementing the growth index in cosmic linear anisotropy integrators and solver codes and their modified gravity extensions for different background evolution like LCDM or $w_0 w_a$. We show also preliminary forecasts of γ using Euclid probes. Finally we talk about the work in progress in trying to relate and implement the growth index to EFT extensions of the previous cosmic codes

Summary

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