# Colloque national Action Dark Energy 2021 - 5ème édition

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Institut Henri Poincaré

# Book of Abstracts

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## Planck constraints on the tensor-to-scalar ratio

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I will present constraints on the tensor-to-scalar ratio r using Planck data as described in [Tristram et al., A&A, 647, A128 (2021)].
In this paper, we use the latest release of Planck maps (PR4), processed with the NPIPE code, which produces calibrated frequency maps in temperature and polarisation for all Planck channels from 30 GHz to 857 GHz using the same pipeline. We computed constraints on r using the BB angular power spectrum, and we also discuss constraints coming from the TT spectrum. Given Planck's noise level, the TT spectrum gives constraints on r that are cosmic-variance limited (withσr =0.093),butweshowthatthe-marginalisedposteriorpeakstowardsnegativevaluesofrataboutthe1.2σlevel.Wederived Planck constraints using the BB power spectrum at both large angular scales (the 'reionisation bump') and intermediate angular scales (the 'recombination bump') from l = 2 to 150 and find a stronger constraint than that from TT, with σ(r) = 0.069. The Planck BB spectrum shows no systematic bias and is compatible with zero, given both the statistical noise and the systematic uncertainties. The likelihood analysis using B modes yields the constraint r < 0.158 at 95 % confidence using more than 50 % of the sky. This upper limit tightens to r < 0.069 when Planck EE, BB, and EB power spectra are combined consistently, and it tightens further to r < 0.056 when the Planck T T power spectrum is included in the combination. Finally, combining Planck with BICEP2/Keck 2015 data yields an upper limit of r < 0.044.

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## Non-ideal self gravity and cosmology: a possible solution to the dark mass and energy problems within the Newtonian limit?

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Inspired by the statistical mechanics of an ensemble of interacting particles (BBGKY hierarchy), we propose to account for small-scale inhomogeneities in self-gravitating astrophysical fluids by using a non-ideal Virial theorem and non-ideal Navier-Stockes equations that involve the pair radial distribution function (similar to the correlation function), as for the interaction energy and equation of state in liquids. Within this framework, small-scale correlations lead to a non-ideal amplification of the gravitational interaction energy that can account for the missing mass problem in galaxies and galaxy clusters.
Based on this non-ideal Virial theorem, we also propose an extension of the Friedmann equations in the non-ideal regime. We estimate the non-ideal amplification factor of the gravitational interaction energy of the baryons to lie between 5 and 20, potentially explaining the observed value of the Hubble parameter (since the uncorrelated energy account for ~ 5%). Within this framework, the

acceleration of the expansion emerges naturally because of the increasing number of sub-structures induced by gravitational collapse, which increases the gravitational interaction energy. A simple estimate predicts a non-ideal deceleration parameter qni ⊠ -1 which may be the first determination of the observed value based on an intuitively physical argument.
We also show that a transition to a viscous regime induced by the gravitational interactions at small scales in bound structures (spiral arms or local clustering) can lead to flat rotation curves, potentially explaining the dichotomy between spiral and LSB elliptical galaxy profiles. Overall, our results suggest that non-ideal effects need to be taken into account in order to properly determine the real "dark part" of our universe.

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# Flat rotation curves, MOND-like behavior, and CMB spectrum in the Dirac-Milne universe

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The Dirac-Milne (D-M) universe, a symmetric matter-antimatter universe, i.e. with equal quantities of matter and antimatter, but where antimatter behaves as a negative mass component repulsing both matter and itself (see G. Manfredi et al., Phys. Rev. D 98, 023514 (2018) for a precise definition) presents several concordance properties with our universe (age, luminosity distance, nucleosynthesis, LSS). Here, using 1D and 3D simulations of structure formation in the D-M universe, we show that the antimatter component mimics the presence of nearly spherical Dark Matter halos around every massive structure, induces flat rotation curves, and creates a MOND-like behavior, effectively providing an explanation for MOND.
We present a preliminary study of the CMB spectrum in D-M, evidencing strong additional elements of concordance between our universe and the D-M universe.

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# On the Hubble tension and primordial magnetic fields

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# Contributions TBD

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# (g-2) of the muon and screened modified gravity

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The Fermilab measurement of the anomalous magnetic moment of muons seems to be at odds with the standard model of particle physics. Coupled scalar fields such as the chameleon or the symmetron, which modify gravity locally, could account for the discrepancy.

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## DESI Survey Validation

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DESI est un relevé spectroscopiques de 35 millions de galaxies et de quasars réalisé sur un télescope de 4m à Kitt Peak (Arizona). Le but est d'étudier les BAO et les RSD pour des redshifts de 0. à 3.5. Le projet durera 5 ans. Il vient de terminer en mai 2021 le relevé de validation et de commencer les observations du relevé principal.
L'objectif de cette présentation est de montrer les résultats du relevé de validation et de montrer les objectifs de science que DESI pourra atteindre au bout de 5 ans.

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## On the impact of lensing magnification on galaxy clustering analysis

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In this talk I will discuss about the impact of magnification bias on the determination of the growth rate from redshift-space clustering. We use a the RayGal suite of $N$-body simulations that accounts for the fully non-linear structure formation and perform realistic galaxy clustering analyses, similarly as in observations, in different regime of magnification bias. We investigate a minimal model to account for the magnification effect on the multipole moments of the redshift-space correlation function, and study the accuracy with which the the growth rate of structure parameter can be recovered.

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## Are classification metrics good proxies for science output?

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Population-level transient studies dependent on light curve classifiers often use classification performance as a proxy for metrics of the physical parameters of interest. This strategy allows a complete separation between the relatively straightforward classification stage and the more computationally intensive science analysis, meaning that design decisions for each are made independently of one another. Nevertheless, to many scientific questions, these stages are not independent. We illustrate this effect using photometric classifications of type Ia supernovae in a cosmological application as a case study. We show the non-linear relation between proxy metrics (i.e. classification performance) and physically motivated metrics (i.e. discrepancies between posterior samples of the inferred dark energy equation of state parameter). Our experimental design uses the PLAsTiCC data set and archetypical mock classifiers to build light curve samples for a SN Ia cosmology analysis and evaluates multiple metrics of classification quality and cosmological parameter constraining power. We find that classification metrics are insensitive to nonuniform contamination by diverse transient populations, whereas the science metrics respond to the identity of the contaminants in addition to the rate of contamination. We thus urge caution when using classification metrics in place of metrics of the physical parameters of interest for any downstream study conditioned on classification results.

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# Prédictions de performances de l'analyse combinée Euclid et CMB

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Grâce aux mesures de lentillage gravitationnel et de clustering des galaxies, Euclid posera des contraintes sans précédent sur l'Univers récent. D'autre part, des observations CMB de haute qualité (Planck et futures expériences) sont capables d'imposer des contraintes strictes sur l'Univers primordial. La combinaison de ces deux sources d'informations cosmologiques peut constituer un bras de levier important et améliorer considérablement les contraintes sur notre modèle cosmologique, en particulier sur ses extensions non-standardes. Dans cet exposé, je présenterai les prédictions validées de performance des futures contraintes de corrélation croisée Euclid x CMB, effectuées par le groupe de travail scientifique "CMB-cross correlations". Ces résultats ont abouti à la rédaction d'un article officielle de la collaboration Euclid, accepté pour publication.

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# Y-a-t il une tension avec les amas ?

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Les mesures des fluctuations du fond diffus cosmologique (CMB) par Planck permettent de contraindre l'amplitude des fluctuations de la matière au décalage vers le rouge à $z \sim 1100$ dans le modèle $\Lambda$CDM, et donc de l'amplitude actuelle $\sigma_8$. D'autre part, l'abondance des amas Sunyaev-Zeldovich (SZ) détectés par Planck, avec des masses déduites sous l'hypothèse d'équilibre hydrostatique, conduit à une valeur nettement inférieure du même paramètre.
Je présenterais une détermination directe de $\sigma_8$ à l'époque actuelle dans $\Lambda$CDM, et ainsi des calibrations de la masse des amas à l'aide des mesures de $f\sigma_8$ issues de l'analyse du Sloan Digital Sky Survey (SDSS) eBOSS. Les contraintes ainsi obtenues sur les calibrations, par self-calibration, ont des valeurs qui sont entièrement cohérentes avec les résultats obtenus à partir de la combinaison complète des données du CMB et des amas uniquement. Un tel accord indique une absence

de tension dans le modèle ΛCDM entre les estimations de $\sigma_8$ basées sur le CMB et les contraintes sur l'univers à bas redshift mais indique une tension avec la calibration standard des masses des amas.

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## Mesure des fluctuations du monopole du fond diffus cosmologique

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Les raies d'absorption moléculaire de quasars distants et l'effet Sunyaez-Zel'dovich thermique permettent de mesurer le monopole du fond diffus cosmologique (CMB) à différents endroits et époques de l'univers. Cette mesure permettrait notamment de contraindre les fluctuations de la densité d'énergie de radiation. Chacune de ces méthodes a des caractéristiques propres qui seront décrites dans ce présentation: i) Les mesures de la température à partir des raies d'absorption moléculaire de quasars distants sont soumises à des effets RSD (redshift space distorsions). Elles permettent donc de mesurer la cross-correlation des champs de densité de matière et de radiation; ii) L'effet Sunyaez-Zel'dovich permet en principe de mesurer le monopole ainsi que les anisotropies primordiales d'ordre supérieur du CMB à la position de l'amas. Ces mesures permettraient de contraindre les paramètres cosmologiques, ainsi que de tester avec une grande précision l'homogénéité de l'univers.

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## Dark Gravity confronted with SN, BAO and the CMB

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Dark Gravity is a natural extension of general relativity in presence of a flat non dynamical background. Matter and radiation fields from its dark sector,
as soon as their gravity dominates over our side fields gravity, produce a constant acceleration law of the scale factor. After a brief reminder of the Dark Gravity theory foundations, the confrontation with the main cosmological probes is carried out. We show that, amazingly, the sudden transition between the usual matter dominated decelerated expansion law $a(t) \propto t^{2/3}$ and this accelerated expansion law $a(t) \propto t^2$ predicted by the theory is able to fit the main cosmological probes (SN,BAO, CMB and age of the oldest stars data) but also direct $H_0$ measurements with two free parameters only : $H_0$ and the transition redshift.

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## The cosmological constant as a classical eigenvalue

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We propose to recast Einstein's field equations as a nonlinear eigenvalue problem, where the cosmological constant Λ plays the role of the (smallest) eigenvalue. This mathematical interpretation is fully worked out for a simple classical model of scalar gravity. The essential ingredient for the feasibility of this approach is that the classical field equations be nonlinear, i.e., that the gravitational field is itself a source of gravity. The cosmological consequences and implications of this approach are developed and discussed.

G. Manfredi, *Gen Relativ Gravit* **53**, 31 (2021). ArXiv:2102.09601.

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## Can dark energy emerge from a varying G and spacetime geometry?

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The accelerated expansion of the Universe implies the existence of an energy contribution known as dark energy. Associated with the cosmological constant in the standard model of cosmology, the nature of this dark energy is still unknown. In this talk I will discuss an alternative gravity model in which this dark energy contribution emerges naturally, as a result of allowing for a time-dependence on the gravitational constant, G, in Einstein Field Equations. With this modification, Bianchi identities require an additional tensor field to be introduced so that the usual conservation equation for matter and radiation is satisfied. The equation of state of this tensor field is obtained using additional constraints, coming from the assumption that this tensor field represents the space-time response to the variation of G. I will also present the predictions of this model for the late Universe data, and show that the energy contribution of this new tensor is able to explain the accelerated expansion of the Universe without the addition of a cosmological constant. Unlike many other alternative gravities with varying gravitational strength, the predicted G evolution is also consistent with local observations and therefore this model does not require screening. I will finish by discussing possible other implications this approach might have for cosmology and some future prospects.

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## Scale-dependence in DHOST inflation

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We study the inflationary consequences of Degenerate Higher Order Scalar Tensor (DHOST) theories in a de Sitter background. We perturb the de Sitter background by operators breaking either the degeneracy condition, i.e scordatura DHOST, or the shift symmetry in the scalar field. We first consider derivative scordatura and find that in all cases the power spectra of curvature perturbations are scale-invariant. We then investigate small perturbations by an axion-like potential, and show that in this scenario the power spectrum becomes scale-dependent. The modifications to the spectral

index and its first two derivatives are compatible with the latest inflationary constraints. Moreover the tensor to scalar ratio and the non-Gaussianities of these models could be within reach of future experiments.

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## A 'variable' gravitational constant and consequence on cosmology.

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Constraints on the cosmological concordance model parameters are usually obtained using the locally measured value of the gravitational constant G. Here we relax this assumption and determine the impact of such hypothesis on the physics involved in the prediction of the cosmological observables. Using the latest CMB temperature and polarization correlations data and distance measurements from galaxy clustering, we update the constraints on G along with the other main cosmological parameters. We also show the impact of a variable G on the latest discrepancies found on the Hubble and the $\sigma_8$ parameter.

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## Scale-dependence in DHOST inflation

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## Flat rotation curves, MOND-like behavior, and CMB spectrum in the Dirac-Milne universe

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## Mesure des fluctuations du monopole du fond diffus cosmologique

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**Contributions / 29**

## Y-a-t-il une tension avec les amas?

**Corresponding Author:** alain.blanchard@irap.omp.eu

**Contributions / 30**

## A 'variable' gravitational constant and consequence on cosmology.

**Corresponding Author:** zsakr@irap.omp.eu

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## The cosmological constant as a classical eigenvalue

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## On the impact of lensing magnification on galaxy clustering analysis

**Corresponding Author:** michel-andres.breton@lam.fr

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## (g-2) of the muon and screened modified gravity

**Corresponding Author:** philippe.brax@cea.fr

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## Dark Gravity confronted with SN, BAO and the CMB

**Corresponding Author:** henry@cppm.in2p3.fr

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## DESI Survey Validation

**Corresponding Author:** christophe.yeche@cea.fr

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## Non-ideal self gravity and cosmology: a possible solution to the dark mass and energy problems within the Newtonian limit?

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## Can dark energy emerge from a varying G and spacetime geometry?

**Corresponding Author:** hanimeli@uni-bremen.de

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## A 'variable' gravitational constant and consequence on cosmology.

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## Weak lensing cluster masses and mass-richness relation in DESC DC2 simulations

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Constraining the mass-observable relations is a key ingredient for cluster cosmology. In particular, for optical surveys such as the Rubin LSST, the cluster abundance relies on the determination of the mass-richness relation. In that context, weak gravitational lensing by galaxy clusters can be used as a powerful tool to estimate cluster masses. We use the cluster-galaxy weak lensing in the simulated galaxy catalogs of the Data Challenge 2 (DC2) of the Dark Energy Science Collaboration to estimate the weak lensing mass-richness relation for RedMapper-detected DC2 galaxy clusters. In this presentation, we focus more particularly on how modelling choices of the weak lensing signal and photometric redshifts may impact the mass estimation.

**Discussion: un GDR cosmologie? / 40**

## un GDR cosmologie?

**Contributions / 42**

## Glimmers of a post Geometric Perspective.

**Author:** federico piazza[1]

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Quantum gravitational effects are usually associated with the Planck scale but they could also become important at low energy if the wavefunction of the metric field fails to be peaked around a classical configuration.
I try to understand such deviations from classicality within canonical quantum gravity by introducing a "fluid of observers" in the low energy theory and defining a distance operator "at equal time" among them. I find that a locally flat limit is always recovered in the neighbourhood of each observer. However, at larger separations the expectation value of the distance operator behaves differently than a standard Riemannian distance. In particular, it is non-additive and thus cannot be obtained by the integral of a differential line element. This emerging "beyond Riemannian" geometry is a metric space similar to embedded Riemannian manifolds equipped with chord distances that cut through the ambient space. Possible implications for cosmology will be briefly discussed.

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## Glimmers of a post Geometric Perspective.

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## Rotating Inflation

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We study Bianchi cosmologies coupled to a matter source that has the field theoretical description of a solid. Models
of solid inflation are known for not being very efficient in diluting away anisotropy. While confirming this fact, our study finds another potential feature of Solid inflation, namely a "rotation" of the principal axes of the expansion.
Such a rotation is not just a gauge artifact as in the case of Bianchi models alone or coupled to homogeneous scalar fields. Due to the anisotropic stress generated by the solid, rotation becomes a real dynamical quantity.

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## Planck constraints on the tensor-to-scalar ratio

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