Frontiers of Fundamental Physics 14

List of speakers in conference Cosmology

Updated on January 8, 2015

Lasma **Alberte** (BGU) **July, 18, 17h30 – 17h50, Amphi "Sciences Naturelles", Cosmology**

Massive Gravity with Two Stückelberg Fields

We consider non-linear massive gravity with two Stückelberg fields [1]. In this case we find the analytic expression for the determinant of the kinetic matrix of the scalar field Lagrangian and perform the full constraint analysis. This theory admits a charged anti-de Sitter black brane solution and has recently been used in holographic context as a bulk description of a boundary field theory with momentum dissipation [2,3]. We derive the previous results for the holographic conductivity in a coordinate independent way.

References

[1] L. Alberte and A. Khmelnitsky, *Reduced Massive Gravity with Two Stückelberg Fields*, Phys. Rev. D **88** (2013) 064053 [arXiv:1303.4958 [hep-th]].
[2] D. Vegh, *Holography without translational symmetry*, arXiv:1301.0537 [hep-th]
[3] M. Blake and D. Tong, *Universal Resistivity from Holographic Massive Gravity*, Phys. Rev. D **88** (2013) 106004 [arXiv:1308.4970 [hep-th]].

Julien **Bel** (OAB) **July, 16, 15h30 – 15h50, Amphi "Charve", Cosmology**

Probing the matter power spectrum with the galaxy clustering ratio

The galaxy clustering ratio [1,2] is a new clustering statistic that provides access to characteristic parameters of the power spectrum of mass density fluctuations without the need to specify the galaxy biasing function nor a model for peculiar velocity distortions. I will demonstrate the method using galaxy simulations as well as real redshift data (from the VIPERS and the SDSS surveys) and show that it allows to fix the reduced density of matter to a precision of nearly 6%. I will argue that this approach will be instrumental in searching for evidences of new physics beyond the standard model of cosmology and in planning future redshift surveys such as EUCLID.

References

[1] J. Bel, C. Marinoni, 2014, A&A, 563, 36
[2] J. Bel, C. Marinoni, B. Granett et al. (the VIPERS collaboration), 2014, A&A 563, 37

Alain **Blanchard** (IRAP) **July, 15, 17h00 – 17h30, Amphi "Sciences Naturelles", Cosmology**

Clusters for Cosmology

The properties of clusters are known to provide critical information of cosmological relevance. I will discussed the various observationnal probes on clusters and how physical models of clusters can be build based on simple scaling laws. I will show haw the standard predictions of these models within the concordance picture conflict with present day observations, leading to the *cluster conendrum*: x-ray temperature distribution of clusters at different redshift conflicts with standard scaling expectations, SZ clusters counts as obtained by PLANCK lead to cosmological parameters in tension with those obtained from the CMB fluctuations. Solutions to evade this problem will be discussed as well as ways to progress on this issue.

References

[1] Blanchard, A., Evidence for the fifth element. Astrophysical status of dark energy, A&A Rev., **18**, 595 (2010)
[2] Blanchard, A., & Douspis, M., Evidence for new physics from clusters? , A&A **436**, 411 (2005)
[3] Linder, E. V., Cosmology with x-ray cluster baryons, JCAP **4**, 4 (2007)

Chiara **Caprini** (IPhT) **July, 17, 15h40 – 16h00, Amphi "Sciences Naturelles", Cosmology**

Magnetic field generation during inflation

Large scale magnetic fields are ubiquitous in the universe: they are observed in galaxies and clusters, even at high redshift, and recently a lower bound on the magnetic field amplitude in the inter-galactic medium has been established using gamma ray telescopes. The origin of cosmological magnetic fields is still unknown, but their presence in the voids among structures points towards a generation in the very early universe. However, there is currently consensus about the absence of a satisfactory model, based on a gauge invariant lagrangian, able to produce during inflation the magnetic fields present in voids. After reviewing the considerations that lead to such conclusion, I will discuss how it is possible to evade them.

Inyong **Cho** (SeoulTech) **July, 17, 15h20 – 15h40, Amphi "Sciences Naturelles", Cosmology**

Inflationary perturbations in Eddington-inspired Born-Infeld gravity

We briefly introduce the inflation model driven by a massive scalar field in Eddington-inspired Born-Infeld gravity [1] investigated in [2]. We present the recent results of the tensor perturbation in this model investigated in [3]. For short wave-length modes, the perturbation feature is very similar to that of the usual chaotic inflation. For long wave-length modes, the perturbation exhibits a peculiar rise in the power spectrum which may leave a signature in the cosmic microwave background radiation. We also briefly discuss the scalar perturbation in this model.

References

[1] M. Banados and P. G. Ferreira, *Eddington's theory of gravity and its progeny*, Phys. Rev. Lett. **105**, 011101 (2010) [arXiv:1006.1769 [astro-ph.CO]].
[2] I. Cho, H.-C. Kim and T. Moon, *Precursor of Inflation*, Phys. Rev. Lett 111, **071301** (2013) [arXiv:1305.2020 [gr-qc]].
[3] I. Cho and H.-C. Kim, *Inflationary Tensor Perturbation in Eddington-inspired Born-Infeld gravity*, arXiv:1404.6081 [gr-qc].

Antonaldo **Diaferio** (UniTo) **July, 15, 17h30 – 18h00, Amphi "Sciences Naturelles", Cosmology**

Measuring the growth of galaxy clusters

I will review how, with the caustic technique, we can measure the mass profile of galaxy cluster out to their infall regions where dynamical equilibrium does not necessarily hold. I will then show how we can use the caustic technique to directly measure the mass accretion rate of clusters, a key prediction of structure formation models. I will present the first measures of the accretion rate of clusters, extracted from the CIRS and HeCS catalogues, out to redshift $z = 0.3$.

Vladimir **Dzhunushaliev** (KazNU) **July, 17, 17h30 – 17h50, Amphi "Sciences Naturelles", Cosmology**

Gravitational waves attenuation in a non-perturbative spinorial vacuum

The propagation of gravitational waves on the background of non-perturbative vacuum filled with a spinor field is considered. It is shown that there are several distinction with the propagation of gravitational waves in a flat space: (a) there exists a phase shift between $h_{yy,zz}$ and h_{yz} waves; (b) there exists an attenuation of waves; (c) for given frequency there exist two waves with different wave vectors. The experimental verification of obtained results is discussed. It is shown that the experimental measurements of such waves give us the tools for the investigation of non-perurbative quantum field theories.

Chang-Young **Ee** (Sejong Univ.) **July, 18, 17h50 – 18h10, Amphi "Sciences Naturelles", Cosmology**

Friedmann equation and the emergence of cosmic space

This talk is based on [1]. We show that Padmanabhan's conjecture for the emergence of cosmic space [2] holds for the flat Friedmann-Robertson-Walker universe in Einstein gravity but does not hold for the non-flat case unless one uses the aerial volume instead of the proper volume. We also show that various works extending Padmanabhan's conjecture to non-Einstein and non-flat cases have serious shortfalls. This analysis is done using the Friedmann equation with the further assumptions of the holographic principle and the equipartition rule of energy.

References

[1] Ee Chang-Young and Daeho Lee, *Friedmann equation and the emergence of cosmic space*, JHEP **04** (2014) 125 [arXiv:1309.3084].
[2] T. Padmanabhan, *Emergence and expansion of cosmic space as due to the quest for holographic equipartition,* [arXiv:1206.4916].

Martin **Feix** (Technion) **July, 15, 15h30 – 15h50, Amphi "Sciences Naturelles", Cosmology**

Tracing the cosmic velocity field at $z \sim 0.1$ from galaxy luminosities in the SDSS DR7

Spatial modulations in the distribution of observed luminosities (computed using redshifts) of around 5×10^5 galaxies from the SDSS Data Release 7, probe the cosmic peculiar velocity field out to $z \sim 0.1$ [1]. Allowing for luminosity evolution, the *r*-band luminosity function, determined via a spline-based estimator, is well represented by a Schechter form with $M^\star(z) - 5\log_{10}h = -20.52 - 1.6(z - 0.1) \pm 0.05$ and $\alpha^\star = -1.1 \pm 0.03$. Bulk flows and higher velocity moments in two redshift bins, $0.02 < z < 0.07$ and $0.07 < z < 0.22$, agree with the predictions of the ΛCDM model, as obtained from mock galaxy catalogs designed to match the observations. Assuming a ΛCDM model, we estimate $\sigma_8 \approx 1.1 \pm 0.4$ for the amplitude of the linear matter power spectrum, where the low accuracy is due to the limited number of galaxies. While the low-z bin is robust against coherent photometric uncertainties, the bias of results from the second bin is consistent with the $\sim 1\%$ magnitude tilt reported by the SDSS collaboration. The systematics are expected to have a significantly lower impact in future datasets with larger sky coverage and better photometric calibration.

References

[1] M. Feix, A. Nusser, and E. Branchini, *Tracing the cosmic velocity field at $z \sim 0.1$ from galaxy luminosities in the SDSS DR7*, ArXiv e-prints (2014) [arXiv:1405.6710].

Agnès **Ferté** (IAS) **July, 16, 17h20 – 17h40, Amphi "Charve", Cosmology**

Constraints on chiral gravity through the CMB polarization

If parity invariance is broken in the primordial universe, the cosmic microwave background *TB* and *EB* cross-correlations, usually vanishing, become non zero. Their detection would then constrain the level of parity violation, δ. I propose to present forecasts on the detection of this parameter by realistically estimating the uncertainties on the *TB* and *EB* spectra via the *pure* pseudo spectrum method, which efficiency has been shown in [1]. I will present the results of this forecast [2] in the case of two typical experimental setups: a small-scale experiment and a large scale survey. Our results show that no constraints can be put on δ in the former case. However a range of model would be accessible with a future CMB satellite-like mission: for instance, a parity violation of at least 50% with $r = 0.2$ could be detected.

References

[1] A. Ferté, J. Grain, R. Stompor, M. Tristram, *Efficiency of pseudo spectrum methods for estimation of the cosmic microwave background B-mode power spectrum*, 2013, Phys. Rev. D 88, 023524 (2013)

[2] A. Ferté and J. Grain, *Detecting chiral gravity with the pure pseudospectrum reconstruction of the cosmic microwave background polarized anisotropies*, 2014, to be published in Phys. Rev. D. (http://arxiv.org/abs/1404.6660)

Plamen **Fiziev** (JINR) **July, 18, 18h10 – 18h30, Amphi "Sciences Naturelles", Cosmology**

Dark Energy and Dark Matter in Stars Physic

This talk is based on papers [1,2,3]. We present the basic equations and relations for the relativistic static spherically symmetric stars (SSSS) in the model of minimal dilatonic gravity (MDG) which is locally equivalent to the $f(R)$ theories of gravity and gives an alternative description of the effects of dark matter and dark energy. The results for the simplest form of the relativistic equation of state (EOS) of neutron matter are represented. Our approach overcomes the well-known difficulties of the physics of SSSS in the $f(R)$ theories of gravity introducing two novel EOS for cosmological energy-pressure densities and dilaton energy-pressure densities, proper boundary conditions, as well as justifying the domain of SSSS in the phase space of the generalized Tolman-Openheimer-Volkov equations. It is shown that dark energy and dark matter play an essential role in the structure of SSSS due to natural chameleon like effect of MDG.

References

[1] P. Fiziev and D. Georgieva, *Inflation and oscillations of the Universe in 4D dilatonic gravity*, Phys. Rev. D **67**, 064016 (2003).

[2] P. P. Fiziev , *Withholding potentials, absence of ghosts, and relationship between minimal dilatonic gravity and f(R) theories*, Phys. Rev. D **87**, 044053 (2013).

[3] P. P. Fiziev, *Compact static stars in minimal dilatonic gravity*, arXiv:1402.2813.

Màrius Josep **Fullana i Alfonso** (IMM - UPV) **July, 15, 16h10 – 16h30, Amphi "Sciences Naturelles", Cosmology**

Some remarks on new numerical estimations of the Rees-Sciama effect

In previous editions of Frontiers of Fundamental Physics Symposia, [1,2,3,4,5] we have presented our numerical computations of Cosmic Microwave Background (CMB) anisotropies at high ℓ's. We have adapted our algorithm to calculate such anisotropies through different N-body codes: Particle-Mesh (PM), linear and parallel Adaptative-Particle-Particle-Particle-Mesh (AP3M) Hydra codes. This way we have been able to compute weak lensing, Rees-Sciama (RS) and Sunyaev-Zel'dovich contributions to the CMB anisotropy. The use of parallel AP3M makes more accurate computations [6,7]. In 2006, we computed RS effect using a PM N-body code [8]. In this work, we present the improvements on the computation of RS contribution using parallel Hydra code. We also make some remarks on the coupling of contributions at high ℓ's.

References

[1] Fullana, M.J., Saez D.: Making Maps of the Rees-Sciama Effect. Sidharth, B.G., Honsell, F., de Angelis, A. (eds). Frontiers of Fundamental Physics: Proceedings of the Sixth International Symposium "Frontiers of Fundamental and Computational Physics". Udine, Italy, September 26-29, 2004. Springer, The Netherlands, 115-122 (2006)
[2] Fullana, M.J., Saez, D.: Status of CMB Radiation. Sidharth, B.G., Alfonso-Faus, A., Fullana i Alfonso, M.J. (eds.). Frontiers of Fundamental Physics: Eighth International Symposium FFP8. Madrid, Spain, 17-19 October, 2006. AIP Conference Proceedings **905**, New York, USA,13-22 (2007)
[3] Fullana, M.J., Arnau, J.V., Saez, D.: Weak Lensing on the CMB: Estimations Based on AP3M Simulations. Sidharth, B.G., Honsell, F., Mansutti, O., Sreenivasan, K.R., Angelis, A. de (eds.) Frontiers of Fundamental and Computational Physics: 9th International Symposium. Udine and Trieste, Italy, January 7-9, 2008. AIP Conference Proceedings **1018**, New York, USA, 80-85 (2008)
[4] Fullana, M.J., Arnau, J.V., Thacker R.J., Couchman H.M.P., Sáez D.: Observations and simulations of the CMB temperature anisotropy at very small angular scales. Kouneiher, J., Barbachoux, C., Masson, T., Vey, D. (eds.) Frontiers of Fundamental Physics: The Eleventh International Symposium. Paris, France, July 6-9, 2010. AIP Conference Proceedings **1446**, 252-260 (2012)
[5] Fullana, M.J., Arnau, J.V., Thacker R.J., Couchman H.M.P., Sáez D.: CMB anisotropy computations using Hydra gas code. Sidharth, B.G., Michelini, Sanit, L. (eds.) Frontiers of Fundamental Physics and Physics Education Research: 12th International Symposium. Udine Italy, November 21-23, 2011. Spinger Proceedings in Physics 145, Switzerland, 189-196 (2014)
[6] Fullana, M.J., Arnau, J.V., Thacker R.J., Couchman H.M.P., Sáez D.: Estimating small angular scale Cosmic Microwave Background anisotropy with high-resolution *N*-body simulations: weak lensing. Astrophys. J. **712**, 367-379 (2010)
[7] Fullana, M.J., Arnau, J.V., Thacker R.J., Couchman H.M.P., Sáez D.: A New Numerical Approach to Estimate the Sunyaev-Zel'dovich Effect. Garcia-Parrado, A. et al. (eds.) Progress in Mathematical Relativity, Gravitation and Cosmology. Guimarães, Portugal, September 3-7, 2012. Springer, The Netherlands, 277-282 (2014)
[8] Puchades, N., Fullana, M.J., Arnau, J.V., Sáez, D.: On the Rees-Sciama effect: maps and statistics. Mon. Not. R. Astron. Soc. **370**, 1849-1858 (2006)

Lam **Hui** (Columbia University) **July, 16, 15h00 – 15h30, Amphi "Charve", Cosmology**

Symmetries in Large Scale Structure

We will discuss the role of symmetries in three different areas of large scale structure:
1. how to test the equivalence principle using black holes in centers of galaxies;
2. how to measure gravitational redshifts using parity-violating signatures in correlation functions;
3. how spontaneously broken symmetries give us fully non-perturbative relations between N and $N+1$ point functions.

Stéphane **Ilic** (IRAP) **July, 15, 18h00 – 18h20, Amphi "Sciences Naturelles", Cosmology**

The baryon fraction in clusters and scaling relations in LCDM from X-ray and Planck data

Clusters are known to be a powerful probe of cosmology; however, their use is also known to be limited by the degeneracy that exist between their mass and their temperature. Here, we show that using the CMB temperature fluctuations (as measured by Planck) in conjunction with the temperature distribution function of local clusters, allows to break this degeneracy for a specified model (such as the concordance LCDM). The consistency of the aforementioned model can then be tested on baryon fraction and Sunyeav-Zeldovich scaling laws.

Andrei **Khmelnitsky** (BGU) **July, 16, 18h00 – 18h20, Amphi "Charve", Cosmology**

Scalar field dark matter and pulsar timing observations

This talk is based on [1]. An ultralight free scalar field with mass around $10^{-23} - 10^{-22}$ eV is a viable dark mater candidate, which can help to resolve some of the issues of the cold dark matter on sub-galactic scales. We consider the gravitational field of the galactic halo composed out of such dark matter. The scalar field has oscillating in time pressure, which induces oscillations of gravitational potential with amplitude of the order of 10^{-15} and frequency in the nanohertz range. We find that for a range of dark matter masses, the scalar field dark matter signal is comparable to the expected stochastic gravitational wave signal and can be detected by the planned SKA pulsar timing array experiment.

References

[1] A. Khmelnitsky and V. Rubakov, "Pulsar timing signal from ultralight scalar dark matter," JCAP **1402** (2014) 019 [arXiv:1309.5888 [astro-ph.CO]].

Martín **López-Corredoira** (IAC) **July, 16, 17h40 – 18h00, Amphi "Charve", Cosmology**

Tests on the Expansion of the Universe

Almost all of the cosmologists accept nowadays that the redshift of the galaxies is due to the expansion of the Universe (cosmological redshift), plus some Doppler effect of the peculiar motions, but can we be sure of this fact by means of some of another independent cosmological test? In this talk, I will review some of the recent applications of this search: angular size test [1], Tolman or surface brightness test [2], in which we need to assume a very strong evolution of the galaxy sizes to fit the data with the standard cosmology; or Alcock-Paczynski test [3], an evaluation of the ratio of observed angular size to radial/redshift size, which is independent of the evolution of galaxies but it is affected by the redshift distortions produced by the peculiar velocities of the gravitational infall. In this last test, it results that the standard cosmology is compatible with the data but also with some models of static Universe.

References

[1] M. Lopez-Corredoira, *Angular-size test on the expansion of the Universe*, Int. J. Mod. Phys. D 19 (2010) 245.
[2] E. J. Lerner, R. Falomo and R. Scarpa, *UV surface brightness of galaxies from the local Universe to* $z \sim 5$, Int. J. Mod. Phys. D 23 (2014) id. 1450058.
[3] M. Lopez-Corredoira, *Alcock-Paczynski cosmological test*, Astrophys. J. 781 (2014) 96.

Antonino **Marciano** (Fudan) **July, 17, 16h00 – 16h20, Amphi "Sciences Naturelles", Cosmology**

Matter-Bounce Spin-Cosmology and consistency with BICEP2 data

A nonsingular bouncing cosmology can be achieved by introducing a fermion field with a condensation occurring at high energy scales. The gap energy density restored in the regular state of a cosmic fermion can yield a short period of ekpyrotic phase in a contracting universe. The unwanted primordial anisotropies can be diluted during the ekpyrotic contraction. To derive a nearly scale-invariant CMB spectrum, another matter field is required. We deepen one possible curvaton mechanism by involving one another fermion field without condensation and of which the mass is lighter than the background field. By virtue of the fermion curvaton mechanism, this model is consistent with the latest cosmological data.

Giovanni **Marozzi** (DPT - Unige) **July, 16, 15h50 – 16h10, Amphi "Charve", Cosmology**

The value of H_0 in the inhomogeneous Universe

In this talk I will show how local measurements of the Hubble expansion rate are affected by structures like galaxy clusters or voids. In particular, I will present a fully relativistic treatment of this effect, studying how clustering modifies the mean distance (modulus)-redshift relation and its dispersion in a standard ΛCDM universe. Our findings is that cosmic variance (i.e. the effects of the local structure) is, for supernova observations at small redshifts ($0.01 < z < 0.1$) of the same order of magnitude as the current observational errors.The cosmic variance has to be added to this observational uncertainties and it reduces the tension with the CMB measurement of H_0.

References

[1] I. Ben-Dayan, R. Durrer, G. Marozzi and D.J. Schwarz, arXiv:1401.7973 [astro-ph.CO].

Felix **Mirabel** (CEA-Saclay) **July, 15, 15h00 – 15h30, Amphi "Sciences Naturelles", Cosmology**

High energy sources during the re-ionization epoch of the universe

The cosmic dark ages are one of the major frontiers in cosmology. So far, most models of the re-ionization have considered the ultraviolet radiation from massive stars formed in the first galaxies. I will show that high energy sources of X-rays and relativistic jets determined the early thermal history of the universe and maintained it ionized over large volumes of space until the first billon years of the universe, when feedback from super-massive black holes (AGN) took over. High energy sources from compact stellar objects had a direct impact on the properties of the faintest galaxies at high redshifts, the smallest dwarf galaxies in the local universe, and on the cold dark matter model of the universe.

Antonio **Padilla** (UoN) **July, 15, 17h30 – 18h00, Room 405, Frontiers of Fundamental Physics**

Sequestering the Standard Model Vacuum Energy

This talk is based on [1, 2]. We propose a very simple reformulation of General Relativity, which completely sequesters from gravity *all* of the vacuum energy from a matter sector, including all loop corrections and renders all contributions from phase transitions automatically small. The idea is to make the dimensional parameters in the matter sector functionals of the 4-volume element of the universe. For them to be nonzero, the universe should be finite in spacetime. If this matter is the Standard Model of particle physics, our mechanism prevents any of its vacuum energy, classical or quantum, from sourcing the curvature of the universe. The mechanism is consistent with the large hierarchy between the Planck scale, electroweak scale and curvature scale, and early universe cosmology, including inflation. Consequences of our proposal are that the vacuum curvature of an old and large universe is not zero, but very small, that $\omega_{DE} \approx -1$ is a transient, and that the universe will collapse in the future.

References

[1] N. Kaloper and A. Padilla, Sequestering the Standard Model Vacuum Energy," Phys. Rev. Lett. **112** (2014) 091304 [arXiv:1309.6562 [hep-th]].
[2] N. Kaloper and A. Padilla, 'Sequestering the Standard Model Vacuum Energy," to appear

Roser **Pello** (IRAP) **July, 15, 14h30 – 15h00, Amphi "Sciences Naturelles", Cosmology**

Looking for the first star-forming galaxies in the univers

The presentation will be focused on the discussion of the latest results regarding the identification and study of the first star-forming galaxies in the universe, and the constraints derived from these studies on the reionization.

Federico **Piazza** (APC) **July, 18, 15h30 – 16h00, Amphi "Sciences Naturelles", Cosmology**

Dark Energy phenomenology: the effective field theory approach

The discovery of the accelerating expansion of the Universe is motivating an impressive amount of theoretical and observational activity. I will focus on recent and ongoing works that aim at a unifying description of dark energy and modified gravity models containing a scalar degree of freedom in addition to general relativity. Such an effective field theory approach allows, on the one hand, a transparent analysis of the possible theoretical mechanisms at the basis of dark energy; moreover, it provides a useful set of parameters that can be efficiently constrained with observations. I will show the present observational constraints based on the growth rate of cosmic structures and the forecasts for future surveys such as EUCLID.

Arnau **Pujol** (ICE-IEEC/CSIC) **July, 16, 17h00 – 17h20, Amphi "Charve", Cosmology**

The effects of assembly bias on galaxy clustering predictions

This talk is based on [1]. The HOD model is frequently used in surveys to predict the mass of the dark matter haloes from the clustering of galaxies. On the other hand, semi-analytical models of galaxy formation are often used to populate simulations according to some physical prescriptions and merger trees. We use the Millennium Simulation with their semi-analytical models of galaxy formation to reconstruct the galaxy bias from the halo bias assuming the HOD model in order to study the compatibility of the HOD model in these galaxy catalogues. We find that assembly bias affects the reconstructions for low masses.

[1] A. Pujol and E. Gaztañaga, *Are the halo occupation predictions consistent with large scale galaxy clustering?*, arXiv:1306.5761, MNRAS accepted.

Sabir **Ramazanov** (ULB) **July, 16, 16h10 – 16h30, Amphi "Charve", Cosmology**

Probing primordial statistical anisotropy with WMAP and Planck data

We constrain several models of the early Universe that predict statistical anisotropy of the cosmic microwave background (CMB) sky. We make use of WMAP9 and Planck maps deconvolved with beam asymmetries. As compared to previous releases of CMB data, they do not exhibit the anomalously large quadrupole of statistical anisotropy. This allows to strengthen the limits on the parameters of models established earlier in the literature. Among the others, we discuss constraints on the class of models with the Maxwellian term non-minimally coupled to the inflaton and a row of alternatives to inflation, i.e., Galilean genesis and conformal rolling scenario. The talk is based on the results obtained in the papers [1,2,3].

References

[1] S.R. Ramazanov and G. I. Rubtsov, *Statistical anisotropy of CMB as a probe of conformal rolling scenario*, JCAP **1205** (2012) 033, arXiv:1202.4357 [astro-ph.CO].
[2] S. R. Ramazanov and G. I. Rubtsov, *Constraining anisotropic models of the early Universe with WMAP9 data*, Phys. Rev. D **89** (2014) 043517, arXiv:1311.3272 [astro-ph.CO].
[3] G. Rubtsov, S. Ramazanov, F. Urban, M. Thorsrud, *Probing primordial statistical anisotropy with Planck data, work in progress.*

Subir **Sarkar** (UOXF & NBI) **July, 16, 14h30 – 15h00, Amphi "Charve", Cosmology**

Galactic foregrounds for the CMB

We find imprints of galactic structures viz. the 'radio loops'[1] in the derived maps of the cosmic microwave background, even at microwave frequencies where emission by dust dominates [2]. The emission mechanism may be magnetic dipole radiation from dust grains enriched by metallic iron, or ferrimagnetic molecules [3]. This new foreground is present at high galactic latitudes, in particular in theBICEP2 observational window, and potentially dominates over the expected B-mode polarisation signal due to primordial gravitational waves from inflation .

References

[1] P. Mertsch and S. Sarkar, *Loops and spurs: The angular power spectrum of the Galactic synchrotron background*, JCAP **1306** (2013) 041; arXiv:1304.1078 [astro-ph.GA].
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[3] B.T. Draine and A. Lazarian, *Magnetic dipole microwave emission from dust grains*, Astrophys. J. **512** (1999) 740-754 ;arXiv:astro-ph 9807009.

Sandrine **Schlögel** (UNamur) **July, 17, 17h50 – 18h10, Amphi "Sciences Naturelles", Cosmology**

Particle like solutions in modified gravity: the Higgs monopoles

This talk is based on [1]. Plethora of inflationary models based on modified gravity have been built in last decades and first experimental probes seem to appear in favor of the inflationary paradigm.

In this talk, I will focus on one of them, the Higgs inflation [2], and show the combined constraints required for such a model at cosmological and gravitational scales, i.e. for compact objects. In particular, I will show that Higgs inflation model gives rise to particlelike solutions around compact objects, dubbed Higgs monopoles, characterized by the nonminimal coupling parameter, the mass and the compactness of the object. For large values of the nonminimal coupling, forbidden compactnesses appear.

References

[1] A. Füfa, M. Rinaldi, S. Schlögel, *Particlelike distributions of the Higgs field nonminimally coupled to gravity*, Phys.Rev. Lett. **111** (2013) 12, 121103 [gr-qc 1305.2640]; S. Schlögel, M. Rinaldi, F. Staelens and A. Füzfa, *Particlelike solutions in modified gravity: the Higgs monopole*, submitted to PRD [gr-qc 1405.5476].

[2] F.L. Bezrukov and M.E. Shaposhnikov, *The Standard Model Higgs boson as the inflaton*, Phys. Lett. B **659** (2008) 703, [hep-th0710.3755]

Leonardo **Senatore** (Stanford) **July, 17, 14h30 – 15h00, Amphi "Sciences Naturelles", Cosmology**

Inflation Physics from the CMB and LSS

Inflation is the leading candidate for the earliest epoch of our universe. It consists of an early phase of de sitter like expansion that flattened the universe and produced the primordial fluctuations. How in detail did inflation happen? What is the Physics that governed that epoch? and, on a different topic, can we learn something on how inflation started? I will review our current knowledge of inflation and how we try to attack these questions through several observables in the CMB and large scale structures.

Heinrich **Steigerwald** (AMU) **July, 15, 15h50 – 16h10, Amphi "Sciences Naturelles", Cosmology**

Probing non-standard gravity with the growth index of cosmological perturbations

This talk is based on [1]. The growth index of cosmological perturbations is one of the most performant probes of the nature of Dark Energy (DE), the mysterious mechanism driving the late epoch acceleration of the universe. At variance with classical geometrical observables, such as distances, which only probe the background sector of a cosmological model, this observable provides insight into first order dynamical effects, and it is therefore a key test for modified gravity scenarios often invoked to explain away the DE issue.

In this talk I will first show how the whole information about the growth rate history of linear cosmic structures can be precisely encoded into a small set of growth index parameters whose amplitude can be analytically predicted by theory. Then I will go on demonstrating how these parameters naturally define a space where theoretical predictions can be compared against data in a model independent way. Finally [2], by exploiting the Effective Field Theory of dark energy, a formalism which describes virtually all the gravitational theories containing a single scalar degree of freedom in addition to the metric, I will explore which alternative cosmological scenarios are not in conflict with current growth data.

References

[1] H. Steigerwald, J. Bel, C. Marinoni, *Probing non-standard gravity with the growth index: a background independent analysis*, (accepted by JCAP) [arXiv:1403.0898].

[2] F. Piazza, H. Steigerwald, C. Marinoni, *Phenomenology of dark energy: exploring the space of theories with future redshift surveys*, (accepted by JCAP) [arXiv:1312.6111]

Angelo **Tartaglia** (POLITO-DISAT) **July, 18, 16h00 – 16h30, Amphi "Sciences Naturelles", Cosmology**

The strained state cosmology

This talk presents an interpretation of the cosmological constant and of the dark energy, in terms of deformation energy density of space-time. The latter is treated as an elastic medium, whose Lagrangian density is built of terms proportional to the lowest (in practice the second) order scalars associated to the strain tensor, i.e. the difference between the actual and the Euclidean metric tensors, and its first and second order derivatives [1]. The new Einstein equations contain an additional 'source' corresponding to the deformation energy density of space-time. Global symmetries may be induced by texture defects in the manifold [2]. Solutions endowed with Robertson-Walker [2], Schwarzschild and Kerr symmetries are discussed.

References

[1] A. Tartaglia and N. Radicella, *A tensor theory of spacetime as a strained material continuum*, Class. Quantum Grav., Vol. 27 (2010) 035001.

[2] N. Radicella, M. Sereno and A. Tartaglia, *Cosmological constraints for the cosmic defect theory*, Int. J. Mod. Phys. D, Vol. 20, No. 6 (2011) 1039, 1051.

[3] N. Radicella, M. Sereno and A. Tartaglia, *Dark energy as an elastic strain fluid* MNRAS Vol. 429 (2013), 1149, 1155.

Yuko **Urakawa** (Nagoya) **July, 17, 15h00 – 15h20, Amphi "Sciences Naturelles", Cosmology**

Infrared physics in inflation and primordial perturbations

This talk is based on our works [2, 3] and our review article [1] about loop corrections of the primordial perturbations generated during inflation. A naive perturbation theory predicts that loop corrections generated during inflation suffer from various infrared (IR) divergences. We discuss the origin of the IR divergences and explore the regularity conditions, which will restrict the possible initial states of inflationary universe.

References

[1] T. Tanaka and Y. Urakawa, Class. Quant. Grav. **30**, 233001 (2013) [arXiv:1306.4461 [hep-th]].
[2] T. Tanaka and Y. Urakawa, PTEP **2013**, no. 6, 063E02 (2013) [arXiv:1301.3088 [hep-th]].
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Filippo **Vernizzi** (IPhT, CEA Saclay) **July, 18, 17h00 – 17h30, Amphi "Sciences Naturelles", Cosmology**

Healthy theories beyond Horndeski

I will present a new class of scalar-tensor theories that extend Horndeski theories. Despite possessing equations of motion of higher order in derivatives, their true propagating degrees of freedom obey well-behaved second-order equations and are thus free from Ostrogradski instabilities, in contrast to the standard lore. Remarkably, the covariant versions of the original galileon Lagrangians obtained by direct replacement of derivatives with covariant derivatives belong to this class of theories. These extensions of Horndeski theories exhibit an uncommon, interesting phenomenology: the scalar degree of freedom affects the speed of sound of matter, even when the latter is minimally coupled to gravity.

Alexander **Vikman** (LMU) **July, 18, 15h00 – 15h30, Amphi "Sciences Naturelles", Cosmology**

Cosmology with Mimetic Matter

This talk will be mostly based on [2]. I will discuss cosmology of the recently introduced "mimetic" modification of general relativity [1]. This modification is manifestly Weyl-invariant and can mimic practically any cosmological époque [2, 3]. In particular, this "mimetic" modification can naturally account for a part of dark matter [2, 3]. It is also possible to unify such dark matter with dark energy as it was shown, in [3]. Finally one can construct an interesting single-field model for the early universe inflation. This model has parametrically suppressed gravity waves but does not seem to produce any non-Gaussianity, moreover the usual consistency relation for the single-field inflationary models gets modified.

References

[1] A. H. Chamseddine, V. Mukhanov, *Mimetic Dark Matter*, JHEP **1311** (2013) 135, arXiv:1308.5410
[2] A. H. Chamseddine, V. Mukhanov, and A. Vikman, *Cosmology with Mimetic Matter*, JCAP **1406** (2014) 017, arXiv:1403.3961
[3] E. A. Lim, I. Sawicki, and A. Vikman, *Dust of Dark Energy*, JCAP **1005** (2010) 012, arXiv:1003.5751

Amanda **Weltman** (UCT) **July, 17, 17h00 – 17h30, Amphi "Sciences Naturelles", Cosmology**

Chameleon Cosmology Near and Far

In this talk we will explore the possibility of testing dark energy and dark matter in the laboratory and the sky. As an example we will discuss chameleon cosmology models of dark energy and consider their challenges and limitations.