Conformal anomaly and applications to cosmology: new results on (modified) Starobisnky inflation

Ilya L. Shapiro

Starobinsky model of inflation is based on the action which included the square of the scalar curvature. At the same time there are additional non-local terms which can be useful to explain the initial conditions for inflation. In a recent work we discussed the transition from stable to unstable inflationary solutions which take place in the full theory with the non-local terms.

Mode-sum construction of the graviton two-point function in de Sitter space-time

William Couto Corrêa de Lima

Quantum fields on de Sitter space-time received increasing attention in the last decades due to its relevance to inflationary cosmology. Yet, the existence of a de Sitter-invariant vacuum state for free gravitons is still a matter of contention in the literature. This thirty-year long controversy has its roots in the infrared (IR) behaviour of the free graviton field modes in the conformally flat (Poincaré) patch of the de Sitter space. In this talk we will approach this problem by constructing the graviton two-point function for a two-parameter family of linear covariant gauges in n-dimensional de Sitter space. The construction is performed via the mode-sum method in the Bunch-Davies vacuum in the Poincaré patch, and we introduce a Fierz-Pauli mass term as an IR regulator. The resulting two-point function is de Sitter invariant and free of IR divergences in the massless limit, although analytic continuation with respect to the mass for the pure-gauge sector of the two-point function is necessary. However, if one starts with strictly zero mass theory, the IR divergences are absent only for a specific value of one of the two parameters, with the other parameter left generic

Is ΛCDM an Effective CCDM Cosmology?

José Ademir Sales Lima

The successful cosmic concordance model (ΛCDM) is plagued with two profound mysteries challenging our present understanding of fundamental physics: the cosmological constant and coincidence problems. The former is related to the huge discrepancy between the vacuum energy density and the estimates from quantum field theory with a convenient high energy cut-off and the latter with the unexpected current fine tunning between the constant vacuum energy density and the decreasing matter energy densities. By assuming Λ=0, we discuss how gravitationally induced particle production of an arbitrary number of cosmic components can mimick the standard ΛCDM model both at the background and perturbative levels [1]. [1] J. A. S. Lima, R. C. Santos and J. V. Cunha, JCAP 03 (2016) 027, ArXiv: 1508.07263

Low-energy effects in a superrenormalizable gravity model with real and complex massive poles

Breno Loureiro Giacchini

The most simple superrenormalizable model of quantum gravity is based on the general local covariant six-derivative action. It was recently shown that such a theory may also have unitary S-matrix, in case the massive poles are complex. In the present work we construct the modified Newton potential and explore the gravitational light bending in a general six-derivative theory. In both cases we generalize and extend previous considerations to the most interesting case of complex massive poles, and present potentially observable signatures of higher-derivatives in gravity. (Work in collaboration with A. Accioly and I.L. Shapiro.)

Building black hole spacetimes from cosmological type conformal transformations of spherical geometries.

Marina Machado Cunha e Mello

Using as starting point a non-stationary metric obtained by means of a conformal transformation of the Shwarzschild metric, where the conformal factor is an arbitrary function of the time coordinate only, we investigate several situations including some where the final state is a central object with constant mass. The metric is such that there is an initial big-bang type singularity and the final state depends on the chosen conformal factor. The Misner-Sharp mass are calculated and a localized central object may be identified as well as a contribution of a term depending on the energy-density of the spacetime that cannot be attributed to a localized source. The trapping horizons, geodesic and causal structure of the resulting spacetimes are investigated in detail. Many scenarios depending on the scale factor a(t) were analyzed, presenting situations where the evolutions yield geodesically complete or incomplete spacetimes with no event horizon, also other that are geodesically incomplete with no horizons but with a lightlike singularity, presenting solutions with and without black-holes. Even more when a(t) asymptotes a constant, the spacetime presents an event horizon and its maximum extension reveals black-hole/white-hole regions. The energy-momentum content and other properties of the respective spacetimes are then investigated.

On the formation of Universal Horizons

ALAN MACIEL DA SILVA

Theories of gravity with a preferred foliation usually display arbitrarily fast signal propagation, changing the black hole definition. A new inescapable barrier, the universal horizon, has been defined and many static and spherically symmetric examples have been studied in the literature. Here, we translate the usual definition of universal horizon in terms of a scalar built with the preferred flow defined by the preferred spacetime foliation. The new expression have the advantage of being of quasi-local nature and independent of specific spacetime symmetries to be well defined. Therefore, we propose it as a definition for general quasi-local universal horizons. Using the new formalism we show that there are no universal analog of cosmological horizons for FLRW models for any scale factor function and we also state that quasi-local universal horizons are restricted to trapped regions of the spacetime. Using the evolution equation, we analyze the formation of universal horizons under a truncated Ho\v rava-Lifshitz theory, in spherical symmetry, showing the existence of regions in parameter space where the universal horizon formation cannot be smooth from the center, under some physically reasonable assumptions.

The Cosmic Supernova Recycling Program

Miguel Quartin

Type Ia supernovae distance measurements revolutionized cosmology and are still one of the main dark energy probes. But I will NOT focus on that. Instead, I will show that there is much more information on what is often considered the noise in the supernova data. In the Hubble diagram, weak-lensing introduces non-Gaussianity to the dispersion, while peculiar velocities correlate the supernovae. Both effects can be well modeled, allowing us to recycle this noise into signal. I will then show that together they allow one to infer the amplitude of the matter power spectrum and its growth in the late universe and I'll quantify this with both present and future data.

Evidences against cuspy dark matter halos in large galaxies

Davi Cabral Rodrigues

The cusp-core issue is one of the most cited problems of dark matter at small scales. While the dark matter simulations indicate a cuspy profile for all the galaxies, real galaxies data indicate a cored profile at least for some of them. A well known possible solution consideres that baryonic physics of the galaxies with stellar mass of ~10^8 solar masses may change the cusp into a core. Nonetheless, according to this approach large galaxies with stellar mass of ~10^10 solar masses should not be capable of doing the same transition, and hence they should have a cuspy dark matter profile. I will present some new techniques and their application for disclosing systematics on galaxy rotation curve analyses. All the tests were performed with a sample of 62 galaxies and diverse subsamples. Our results favour the cored profile (Burkert) over the cuspy NFW profile. Most importantly, the cored profile is not only favoured by the small galaxies, but large galaxies with stellar mass of ~10^10 solar masses also have better results with the Burkert profile than with the NFW one.

The universal rotation curve of dwarf disk galaxies

Ekaterina Karukes

We extended the concept of the spiral rotation curve universality down to dwarf galaxies. Our sample includes 36 dwarf disk galaxies of Local Volume (~11 Mpc) with HI and Halpha rotation curves carefully selected in literature. We find that, despite the large variations of our sample in luminosities (~ 2 of dex), the rotation curves in specifically normalized units, look all alike. We mass model V(R/Ropt)/Vopt), the double normalized universal rotation curve of dwarf disk galaxies: the results show that these systems are totally dominated by dark matter whose density shows a core size between 2 and 3 stellar disk scale lengths. Similar to galaxies of different Hubble types and luminosities, the core radius r0 and the central density rho0 of the dark matter halo of these objects are related by rho0 r0 ~ 100 Msun pc^-2.

Dark Matter distribution in the Galactic bulge

María Benito Castaño

I will present an analysis of the DM distribution in the Galactic bulge. Using an observational estimate of the total mass in the inner region of the Milky Way (< 2 Kpc) and a vast sample of observationally inspired morphologies of the Galactic bulge (and Galactic discs), we constrain the amount of Dark Matter (DM) therein. We find that cored profiles are forbidden only for very light configurations of the bulge, and that very cuspy profiles are allowed, but not necessarily preferred, in agreement with analysis of outer regions of the Galaxy. The uncertainty on the baryonic distribution -both statistical, and systematic- heavily affects the determination of DM presence and distribution in this region.

Particle DM constraints: the effect of Galactic uncertainties

Fabio Iocco

Collider, space, and Earth based experiments are now able to probe several extensions of the Standard Model which provide viable dark matter candidates. It is remarkable that often the experiments that allow to reach the core region of the parameter space of several models are either indirect, space based searches, or direct, earth based experiments. As it is well known, both types of experiments rely on inputs of astrophysical nature, such as e.g. the local dark matter density or the exact shape of the dark matter profile in the target. As it is equally well known, the determination of these quantities is affected by astrophysical uncertainties. The latter, especially those of our own Galaxy, are often ill--known, and not fully accounted for. Yet, a quantitative estimate of the effects of the latter uncertainties on the reconstruction of new physics parameters is still remarkably missing. I will present a systematic, quantitative estimate of how astrophysical uncertainties on core Galactic quantities (such as the e.g. local galactocentric distance or circular velocity, or the morphology of the stellar disk and bulge) eventually propagate to the parameters of the particle physics model in case, thus affecting the determination of new physics.

What have we learned after 5 years aboard the ISS ? An overview of AMS-02 results

Manuela Vecchi

The AMS-02 experiment is collecting data aboard the International Space Station since May 2011, and it is expected to continue its operations until 2024. In this talk we will review the experimental challenges of the operations in space, and we will discuss the published results. In particular we will discuss the precise measurements of protons and He nuclei, together with the fluxes of electrons, positrons and antiprotons. We will also discuss the interpretation of current AMS-02 data, in terms of cosmic rays sources, both astrophysical and exotic.

Particle Acceleration and Gamma Ray Emission around Black Hole Sources

Elisabete de Gouveia Dal Pino

Perspectives for the MIRAX mission

Joao Braga

The MIRAX (Monitor e Imageador de Raios X) mission aims at developing technology, launching and operating in space an X-ray astronomy experiment. In this presentation I will describe the current status of the mission and comment on the prospects of the space astronomy initiatives in Brazil.

GRMHD simulations of Sub Eddington Accretion Flows using full radiation transport

Danilo Morales Teixeira

In this talk I will describe the first thinnest accretion disk simulation using full radiation transport of a disk with scale-height of 0.1 around a spinning black hole with a=0.5. Our simulations were performed using the GRMHD code HARMRAD with solves the GRMHD equations and takes into account the radiative tansfer using the M1-closure scheme. The goal of this work is to study the accretion efficiencies by estimating how much is being carried out by the jet and wind and also present that the disks in the so called magnetically arrested disk state (MAD state) are stable in the inner regions different from situations where the magnetic pressure is small in the inner region of the disk. To finalize I will show to extract information from our simulations to compare with the observations from the Fermi Telescope.

Numerical Cosmology with NumCosmo

Sandro Dias Pinto Vitenti

The NumCosmo is a free software C library whose main purposes are to test cosmological models using observational data and to provide a set of tools to perform cosmological calculations. The current version has implemented three different probes: cosmic microwave background (CMB), supernovae type Ia (SNeIa) and large scale structure (LSS) observables, such as baryon acoustic oscillations (BAO) and galaxy cluster number counts. The next release (0.14.0) will include our new general purpose cross-correlation code and the CMB lensing and galaxy clustering kernels. The code supports a joint analysis of these data and the parameter space can include both cosmological and astrophysical parameters. The library is structured to simplify the inclusion of non-standard cosmological models. Besides the functions related to cosmological quantities, NumCosmo also implements mathematical and statistical tools. The former was developed to enable the inclusion of other probes and/or theoretical models, and to optimize the codes. The statistical framework comprises algorithms which define likelihood functions, minimization, Monte Carlo (MC), Fisher Matrix, Markov Chain MC, profile likelihood methods, among others. In short, NumCosmo provides a complete toolkit containing the codes for cosmological calculations, likelihood for several probes, MCMC (serial or parallel) and MCMC output analysis/diagnostics, and other statistical and mathematical tools.

Calibrating the Planck Cluster Mass Scale with CLASH

Mariana Penna Lima Vitenti

We determine the mass scale of Planck galaxy clusters using gravitational lensing mass measurements from the Cluster Lensing And Supernova survey with Hubble (CLASH). We compare the lensing masses to the Planck Sunyaev-Zeldovich (SZ) mass proxy for 21 clusters in common, employing a Bayesian analysis to simultaneously fit an idealized CLASH selection function and the distribution between the measured observables and true cluster mass. We use a tiered analysis strategy to explicitly demonstrate the importance of priors on weak lensing mass accuracy. In the case of an assumed constant bias, bSZ, between true cluster mass, M500, and the Planck mass proxy, MPL, our analysis constrains $1-bSZ=0.73\pm0.10$ when moderate priors on weak lensing accuracy are used. Our analyses explicitly accounts for possible selection bias effects in this calibration sourced by the CLASH selection function. Our constraint on the cluster mass scale is consistent with recent results from the Weighing the Giants programme and the Canadian Cluster Comparison Project. It is also consistent, at slightly more than 1σ, with the value needed to reconcile the Planck SZ cluster counts with Planck's base ΛCDM model fit to the primary cosmic microwave background anisotropies.

Model-independent tests in cosmology

Vinicius Busti

Viscous cosmology

Júlio César Fabris

We study a unification model for the dark sector of the universe using bulk and shear viscosity. The shear viscosity has no contribution for an isotropic and homogeneous universe but its contribution at perturbative level is, at least, as relevant as the bulk viscosity term. The consequences for structure formation in the universe is investigated.

Cosmic discordance in decaying vacuum models ?

Luciano Casarini

We analyze a cosmological model in which the DE is described by a fluid

O que aprendemos com as primeiras detecções de ondas gravitacionais?

Odylio Denys de Aguiar

Em 11 de fevereiro de 2016 foi anunciada, pela Colaboração Científica LIGO (sigla LSC em inglês) e Colaboração Virgo, a primeira detecção de ondas gravitacionais, oriunda dos últimos momentos da coalescência de um sistema binário formado por dois buracos negros de massas da ordem de 30 vezes a massa do Sol. Esta detecção ocorreu alguns meses antes, em 14 de setembro de 2015, durante a primeira corrida observacional do Advanced LIGO (sigla aLIGO em inglês). Com este evento, foi inaugurada a Astronomia/Astrofísica de Ondas Gravitacionais. Outra detecção, ocorrida em 26 de dezembro de 2015, foi anunciada em 15 de junho de 2016, juntamente com um evento frustado, que não atingiu estatística para ser considerado como verdadeiro. Nesta apresentação serão resumidos os principais resultados de todos os papeis das duas colaborações publicados sobre estas primeiras detecções.

Detecting Gravitational Waves from a Gravitational Compass

Marcos Duarte Maia

We briefly review the theory behind gravitational wave detection and describe the concept of gravitational compass proposed by F. Pirani and P. Szekers. A practical upgrade some of the existing laser interferometer gravitational wave detectors to become Gravitational Compasses is proposed.

Effect of a variable cosmological constant on black hole quasinormal modes

Cecilia Bertoni Martha Hadler Chirenti

Many different cosmological models have been proposed to address the cosmological constant problem and the coincidence problem. We compare here four different models that can be used to describe an effective (time-dependent) cosmological constant $\Lambda(z)$. A numerical analysis of the $\Lambda(z)$ evolution obtained for each model shows that it can be used for distinguishing between all four models. We calculate next the $\omega(\Lambda)$ frequencies for quasinormal modes of gravitational perturbations of Schwarzschild-de Sitter black holes at different redshifts. Considering that the variation of Λ happens on cosmological timescales, the combined $\omega(\Lambda(z))$ could be used in principle to track the evolution of the cosmological constant. We quantify the resulting minute frequency shift in the quasinormal mode frequencies and show that the relative frequency shift grows as M^2. However, even in a most optimistic scenario with an extremely high mass supermassive black hole there is no prospect for the detection of this effect.

On Inflation, Neutrino masses and the strong CP problem in a 3-3-1 model.

Jamerson Gillis Batista Rodrigues

On adding a neutral scalar singlet to the 3-3-1 model, we extend the Peccei-Quinn symetry to the entire Lagrangian of the model, providing, in this, an elegant solution to the strong CP-problem and having the imaginary part of the neutral scalar singlet as the invisible axion, which turns out to be an interesting candidate for the dark matter of the universe. We show that, if we add right-handed neutrinos in the singlet form and couple them to the neutral scalar singlet through a Yukawa term, the real part of the neutral scalar singlet may drive inflation if radiative corrections are took into account, and the standard neutrinos gain small masses through the type I seesaw mechanism. In this way we will have a model that explains the smallness of the neutrino masses, solves the strong CP-problem, realizes inflation and has the axion as the dark matter candidate of the model.

Effects of Completeness and Purity on Cluster Dark Energy Constraints

Michel Aguena

The effect of matter structure on the gravitational waveform

Riccardo Sturani