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Caderno de Resumos - Pôsteres

Exploring modified gravity through non-Gaussian features in HSC-Y3

Autores: Amanda Freitas Cruz, Gabriela Antunes Marques
Centro Brasiliero de Pesquisas Físicas (CBPF)

The accelerated expansion of the Universe, commonly attributed to the cosmological constant (Λ) in the framework of General Relativity, remains one of the central open questions in modern physics. A standard approach to probing cosmology with large-scale structure data relies on two-point statistics, which, while powerful, are limited to capturing Gaussian information and thus fail to account for signatures arising from the non-linear growth of structure. This project aims to leverage the Year 3 data release of the Hyper Suprime-Cam Subaru Strategic Program (HSC-Y3) to investigate non-Gaussian probes, such as higher-order statistics and morphological descriptors, applied to weak lensing maps. These measurements will be systematically compared to simulated predictions generated under both the standard ΛCDM paradigm and alternative modified gravity scenarios, such as f(R) models. By exploiting the additional information encoded in the non-Gaussian features of the cosmic matter distribution, this research seeks to tighten cosmological constraints and explore possible deviations from General Relativity that may provide insights into the physics driving cosmic acceleration.

Gamma-ray fluxes for dark matter indirect detection

Ana Clara da Rocha e Silva, Clarissa Martins Siqueira
Observatório Nacional

The existence of dark matter (DM) is well established through multiple gravitational evidence at different scales. One of the main approaches to investigating its nature is indirect detection, searching for gamma-ray signals and exploiting the sensitivity of the Cherenkov Telescope Array Observatory (CTAO) and the Southern Wide Field Gamma-ray Observatory (SWGO) to indirect DM detection. In this context, among the most important ingredients is the simulation of the flux generated by a dark matter annihilation for different targets, which includes the spectrum generated by the annihilation channel and the J-factor, which is the line-of-sight integral of the dark matter density distribution for a given astrophysical object. To this end, in this initial stage, we used the PPPC4DM ID numerical package, which is based on Mathematica software. We compared the computed flux for different channels with results from the literature (Cirelli et al., 2011). As a future step, we will compute the sensitivity for the above-mentioned experiments, using the ON-OFF approach to calculate the sensitivity of the SWGO and CTAO experiments, with the latest instrument response functions.

Teorias newtonianas da gravitação modificada

Bruna da Silva Amorim Bragato
Universidade Federal do Espírito Santo (UFES)

A Teoria da Gravitação Universal de Newton descreve a força gravitacional entre dois corpos como proporcional ao produto de suas massas e inversamente proporcional ao quadrado da distância entre eles. Em escala planetária, essa formulação apresenta excelente precisão, tendo permitido, por exemplo, a descoberta de Netuno a partir das anomalias observadas na órbita de Urano.

Apesar de seu sucesso, a teoria newtoniana possui limitações importantes: não explica integralmente a precessão do periélio de Mercúrio e pressupõe uma ação instantânea à distância, incompatível com os princípios da Relatividade Restrita. Esses impasses motivaram, no início do século XX, o surgimento da Teoria da Relatividade Geral, de Einstein, que reformulou o entendimento da gravitação ao incorporar a geometria do espaço-tempo.

Ainda assim, o modelo de Newton mantém ampla aplicabilidade — desde o estudo do Sistema Solar até a dinâmica de galáxias — por sua simplicidade e eficiência. Este projeto propõe extensões do potencial gravitacional newtoniano, introduzindo termos corretivos que preservam sua estrutura clássica, mas buscam aproximar seus resultados das observações astronômicas e atenuar suas limitações teóricas.

Symphony no 41 in C R3BP: Searching for Small Bodies in Planetary Systems with Two Jupiter-like Exoplanets via the Circular Restricted Three-Body Problem

Gabriela Rufino Travassos, Maisa de Oliveira Terra
Instituto Tecnológico de Aeronáutica

Small bodies are essential for the comprehension of the present-day dynamics and the evolutionary pathways that led to the current configurations of our planetary system. Although the dynamical structures that arise from the circular restricted three-body problem (CR3BP) appear in subsystems - such as the Trojans of Jupiter - they do not dominate the dynamics of the Solar System. However, the CR3BP dynamics may play a much more significant role in less crowded planetary systems, particularly those composed of massive planets in close proximity to their host star. One such example is HD 159243, a solar-type star hosting two Jupiter-like planets within an orbital distance of less than one astronomical unit. In this system, the considerable mass ratios between the star and each planet, combined with their compact configuration, suggest a strong contribution from three-body dynamics. Furthermore, the proximity of the planets may allow for overlapping invariant manifold structures with similar energy values, potentially giving rise to heteroclinic connections that act as transport channels for small bodies. Nevertheless, at small separations between planets, MMRs become wider; also, planets on orbits close to the central star may undergo orbital evolution due to tidal dissipation. Both effects perturb the three-body model and should be considered. This project focuses on HD 159243, which is not unique; similar planetary systems — such as HD 13908 and β Pictoris — may exhibit comparable dynamics, allowing us to infer an average behavior for this class of systems. HD 159243 was discovered within the observations made with the SOPHIE spectrograph on Observatoire de Haute-Provence (France); it has all the orbital parameters and its data available, enabling model validation against observational data. Our objective is to develop a detailed dynamical model for the HD 159243 system to find possible locations where remnant small bodies are most likely to be, and extend this model to similar planetary systems in order to trace their average dynamical behavior. We will begin with a preliminary analysis using the Planar Circular Restricted Three-Body Problem (PCR3BP), followed by the inclusion of resonant dynamics and tidal interactions between HD 159243b and its host star.

Determining the shape and size of the Trojan 1143 Odysseus through stellar ocultations technique and 3D modeling

J.A.N. Rodrigues, F. Braga-Ribas, J. Desmars, J. L. Ortiz, B. Sicardy, M. Kretlow
Universidade Tecnológica Federal do Paraná

Jupiter Trojan objects are minor bodies of the Solar System located in the Lagrangen points of Jupiter, approximately 5.2 astronomical units (au) from the Sun. One of the largest individuals is (1143) Odysseus, discovered on January 28th 1930 by Reinmuth, K. at Heidelberg. Some of its physical and orbital characteristics available in the literature are its diameter (114,6 ± 0,6 km), its rotational period at (10,114 ± 0,079 h), and its absolute magnitude (8,418 ± 0,003).This work makes use of the stellar occultations and light curve inversion techniques to determine its shape and dimensions more accurately. For that we use data from mult and single-chord occultations observed from October 2023 to April 2024, and rotation curves ranging from 2014 up to 2022, available in the ALCDEF database. This data set also provides precise astrometric positions that improve the object's ephemeris and predictions of future occultation events for the body. We will present the first three dimension shape obtained for Odysseus along with it's precise size and albedo. A non-convex is obtained, showing that these bodies may have evolved in a highly collisional environment.

Reconstructing the luminosity distances of Type Ia Supernovae using machine learning

Jezebel Oliveira, Carlos Bengaly
Observatório Nacional ´

Machine Learning algorithms (ML) are very useful tools in cosmology to reconstruct cosmological observables such as the Hubble parameter H(z) and the luminosity distance DL(z). In this work, we aim to reconstruct DL using Type Ia supernova (SNe Ia) data from the Pantheon+ compilation with ML models: Support Vector Regression (SVR), Multi-Layer Perceptron (MLP), Extra Trees, Random Forest, and Gradient Boosting. We evaluate the performance of these models in reproducing the features of the SNe Ia Pantheon+ sample and in estimating the associated uncertainties through resampling techniques. Our results show that SVR provides the most accurate and stable reconstructions of DL(z), which highlights the potential of ML algorithms as model-independent approaches for cosmological data analysis

Analysis of a possible ring of particles around the Earth: a computational approach

José Eduardo Rodrigues, Rafael Sfair
UNESP/FEG

The study of craters dating from the Ordovician period (485 to 443 million years ago) has reignited the debate about the possible existence of a ring around Earth. The shadow cast by this structure may have contributed to the drop in global temperature associated with the Ice Age that occurred during this period. However, from a dynamic perspective, there is no information about the stability and physical characteristics of the ring. This work seeks to investigate this hypothesis through numerical simulations with the N-Body integrator REBOUND and to obtain details about the dynamic properties of this structure, including the mechanism that could have caused its dissipation after, or even before, the estimated period.

Dark energy effects on neutron stars from the Chaplygin gas

Juan M. Z. Pretel, Mariana Dutra, Sergio B. Duarte
Centro Brasiliero de Pesquisas Físicas (CBPF)

We examine the effect of a Chaplygin dark fluid (CDF) core on the stability of neutron stars (NSs). To address this study, we focus on the relativistic structure of stellar configurations composed by a dark-energy core, described by a Chaplygin-like equation of state (EoS), and an ordinary-matter crust. We analyze the impact of the rate of energy densities at the discontinuous surface, defined as $\alpha= \rho_{\rm dis}^-/\rho_{\rm dis}^+$, on the radius, total gravitational mass, oscillation spectrum and tidal deformability. Furthermore, we compare our theoretical predictions with several observational mass-radius measurements and tidal deformability constraints. These comparisons together with the radial stability analysis show that the existence of NSs with a dark-energy core is possible.

A Model Independent Approach for Obtaining Cosmological Constraints from the Galaxy Power Spectrum

Leonam B. Coelho
Universidade Federal do Rio de Janeiro - Observatório do Valongo

In the study of Large Scale Structure Cosmology, traditional analyses of the galaxy power spectrum from galaxy survey data assume an underlying cosmological model to define the theoretical linear power spectrum shape. However, this model dependency implies that such analyses cannot easily test different scenarios.
The recently proposed FreePower method seeks to obtain cosmological constraints from the galaxy power spectrum while remaining as model-independent as possible. In this approach, the linear matter power spectrum is divided into parameters, whose values are free to vary, corresponding to a number of k-bins. The power spectrum is then fitted to the data by adjusting these parameters during the analysis, without the need to previously assume a linear power spectrum shape given by an underlying cosmological model. This method has its basis on the combined effects of Redshift Space Distortions and the Alcock-Paczynski effect, and makes use of the Effective

Field Theory of Large Scale Structures (EFTofLSS) as its theoretical framework. Using this methodology, our research group has obtained, for instance, precise results for the Hubble parameter and linear growth rate from BOSS galaxy clustering data.
In this poster, we present an overview of the current status of the FreePower method. We start by giving an introduction that contextualizes the method within the field of LSS Cosmology and compares it to more traditional approaches. We then present the method's fundamentals and procedure, showcase some of the results already obtained, and end by discussing the next steps being taken for improving the methodology and applying it to new datasets.

Determination of Atmospheric Parameters for M Dwarf Stars in the Praesepe Open Cluster: A Comparative Study Using the DESI and APOGEE Surveys

Madalena C. Maia, Katia Cunha
Observatório Nacional

M dwarf stars constitute the most numerous stellar class in the Milky Way. However, due to the complexity of their spectra, which are rich in molecular lines, they remain the least studied spectral type in the literature. In this work, we perform a detailed spectroscopic analysis of 19 M dwarf stars belonging to the Praesepe open cluster, using spectra from the Galactic survey SDSS/APOGEE. The spectral modeling was conducted in local thermodynamic equilibrium, focusing on molecular lines of OH and water, through a previously validated methodology that derives atmospheric parameters and metallicities with high precision. We obtained a mean metallicity for Praesepe of $\langle[M/H]\rangle = 0.14 \pm 0.07$ dex, in agreement with high-resolution optical studies of G and K dwarf stars, as well as red giants, and consistent with the premise of chemical homogeneity in open clusters. We determined that the Praesepe open cluster has $\langle[O/M]\rangle = -0.02 \pm 0.03$ dex, a result consistent with expectations for an open cluster belonging to the Galactic thin disk. When comparing our results with the parameters derived by the APOGEE ASPCAP pipeline, we find that the uncalibrated values of log g are physically implausible, and that ASPCAP systematically underestimates [M/H] relative to our results. Furthermore, when comparing the stellar parameters obtained in this work with those derived by the SP and RVS pipelines from the DESI Milky Way Survey, we note that, especially for SP, the estimates deviate significantly from values predicted by theoretical models. We identify systematic differences between the RVS results and ours for all analyzed parameters. The SP pipeline derives systematically higher values of [M/H] and log g compared to our determinations, however, its Teff values are consistent with those we determined. We also find that the RVS pipeline retrieves [M/H] values that are independent of the signal-to-noise ratio (SNR) of the DESI spectra in our sample, whereas the SP pipeline shows a trend with SNR, yielding more consistent [M/H] values and lower dispersions for spectra with higher SNR. This work not only provides a precise reference for M dwarfs, but also demonstrates that there are significant issues in the stellar parameter results for M dwarfs in the publicly available APOGEE and DESI data releases. These findings highlight important limitations in current parameter derivation pipelines for this

stellar class. Our results may serve as a benchmark for future improvements in the DESI and APOGEE pipelines.

Keywords: M dwarf stars, stellar atmospheric parameters, metallicity, open clusters, infrared spectrum, pipelines.

Dark Matter Halos in Milky Way-like Galaxies: An Evidence for a Universal Density Profile

Maria Clara Cavalcante Siviero, Karín Menéndez Delmestre
Centro Brasileiro de Pesquisas Físicas

We constrain the dark matter (DM) density in the Milky Way's (MW) solar neighborhood based on drawing analogies with the DM distribution in our sample of MW analog galaxies. To address the DM density in these systems we present a comprehensive study of DM distribution across galactic scales. We analyze a large sample of $>$100 galaxies from the state-of-the-art Illustris TNG-50 cosmological simulation, combined with 21cm line observations of nearby MW analogs. Using spatial and spectral high-resolution data from VLA and GMRT radio telescopes, we employ the 3D-Barolo algorithm to derive precise kinematic maps and rotation curves. We use Spitzer mid-IR imaging at 3.6/4.5um to perform a careful analysis of the baryonic component. We decompose the rotation curves into their different mass components (stars, gas, and DM), enabling the construction of a DM radial profile for each galaxy. This allows us to test the universality of DM halo shapes and possible deviations when taking baryonic physics into account.

Non-parametric reconstructions of cosmic curvature

Mariana L. S. Dias, Antônio F. B. da Cunha, Carlos A. P. Bengaly, Rodrigo S. Gonçalves and Jonathan Morais
Observatório Nacional

The assumption of a flat, homogeneous, and isotropic Universe on large scales constitutes one of the fundamental pillars of the standard cosmological model, ΛCDM. In this work, we assess this assumption through reconstructions of the cosmic curvature based on current observations, such as Type Ia Supernovae and Cosmic Chronometers, employing null tests derived from consistency relations of the standard model and non-parametric methods. In this way, our analysis relies on minimal assumptions about cosmological models. Our results do not show statistically significant deviations from the cosmological principle or from a vanishing curvature. Furthermore, we demonstrate that future measurements of the Hubble parameter from spectroscopic surveys, combined with gravitational-wave observations acting as standard sirens, may substantially reduce the uncertainties of current reconstructions.

A protocluster in formation traced by LAEs at z ~ 4.5 in the COSMOS field

Mariana Rubet da Costa, Karín Menéndez-Delmestre, Thiago Signorini Gonçalves
Universidade Federal do Rio de Janeiro - Observatório do Valongo

The densest structures of the Universe formed at the knots of the cosmic web at high redshifts and constitute the present-day clusters of galaxies. The early stages of these structures are called protoclusters. In this work, we use the submm source J1000+0234, representative of a population of dusty and distant starburst galaxies expected to inhabit peaks of matter density, as a target for a potential protocluster region. We use combined wide-band and narrow-band optical photometry to identify Lyα emitters (LAEs) within a 21cMpc radius from the submm source J1000+0234, at z = 4.54±0.03, to identify typical star-forming galaxies that may trace the underlying structure containing our target source. Our approach selects line emitters as narrow-band excess objects and we use the COSMOS2020 photometric redshift catalog to eliminate potential low-redshift interlopers whose line emission (e.g. [OIII] at z ~ 0.3) might be responsible for the observed excess in the narrow band. In comparison with the LAE density in the field, our results point to a mean LAE number overdensity of $\bar{\delta}$ = 3, spanning a region of 27 x 20 x 36 cMpc^3, probably evolving into a moderate-mass cluster (3 − 10 × 10^14 M☉) at z ~ 0. This structure likely forms an extension at z ~ 4.5, a few comoving Mpc away from the recently identified Taralay protocluster. This work supports the idea that submm sources, although offset from the major overdensity peaks, serve as traces of moderately massive, potentially infalling structures.

Uncovering galactic disk properties with GECKOS

Miguel de Loreto Neto, Paula Coelho, Francesca Pinna
Universidade de São Paulo - IAG

The edge-on inclination of galaxies in the sky allows the observational study of their vertical structure, the thickness of their disks, and the identification of different disk components. Most disk galaxies show a morphological structure with two disks of different thicknesses: the thick and the thin disk. Thick disks are faint and deep observations with long integration times are needed to analyze them in detail, making observations challenging and work limited to a small sample. The origin of thick disks and their evolutionary connection with thin disks is still a matter of debate.

In this work, we propose the study of thick and thin disks in the new integral field spectroscopy data from the GECKOS survey. The ongoing GECKOS survey, with a total sample of 35 edge-on galaxies observed with MUSE at VLT, provides an opportunity to put constraints on different formation scenarios for disk structures. For a subsample of 6 to 12 galaxies for which MUSE fully reduced data cubes are available to the GECKOS team, we will map stellar properties such as age, metallicity, and the abundance of α elements, and extract the star-formation history of thick and thin disks. This will allow us to reconstruct the history of these thick disks and unveil the internal or external origin, complementing our findings with results from the literature of numerical simulations of galaxies of similar masses.

Through the comparison between galaxies with a morphological structure with two distinct disks of different thicknesses and galaxies with only one disk, we will investigate mechanisms leading to or preventing the formation of a double-disk structure and discuss stellar formation history results in terms of formation models of disk structures.

Fitting the Galactic Center gamma-ray emission with dark matter

Murillo Gregorio Grefener da Silva, Aion Viana
Universidade de São Paulo - IFSC

Dark matter is thought to dominate the Universe's matter content. We investigate the gamma-ray source HESS J1745-290, coincident with the supermassive black hole Sagittarius A* at the Galactic Center, where the SMBH may cause adiabatic DM contraction, giving origin to a density spike. Extending previous results, which showed DM alone cannot explain the signal, we find that adding diffuse gamma-ray background and other non-thermal components significantly improves the fit, indicating that the total emission can be consistently described by these processes combined with a DM contribution.

Formação de galáxias

Stéfani Vitória Faller Ganda
Universidade Federal do Espírito Santo

O trabalho aborda a formação de galáxias no contexto da gravitação newtoniana, analisando tanto o regime linear quanto não linear das perturbações de densidade. Foram estabelecidas as equações hidrodinâmicas fundamentais (continuidade, Euler e Poisson) e derivadas as equações que descrevem a dinâmica cósmica e a instabilidade gravitacional, incluindo o mecanismo de Jeans e o Teorema do Virial. Como não há solução analítica para as equações não lineares, utilizou-se o software Mathematica para obter resultados numéricos e gráficos. Também foi discutida a recente detecção de galáxias distantes pelo JWST, em especial os "Little Red Dots", que desafiam o modelo cosmológico padrão e levantam questões sobre o processo de formação estelar nos primórdios do universo.