II South American Dark Matter Workshop
ICTP-SAIFR, Sao Paulo, Brazil
November 21-23, 2018

List of Abstracts

TALKS

Dark matter within and outside of galaxies: establishing constraints on small and large scales

Karin Menendez-Delmestre

(Observatorio do Valongo, Universidade Federal do Rio de Janeiro)

The existence of dark matter became irrefutable just over 50 years ago, when astronomer Vera Rubin analyzed the orbits of stars and gas in galaxy outskirts. Today we know that it represents 85% of the matter content in the universe. Its gravitational interaction with normal matter allows us to use the distribution of luminous matter (stars, gas, galaxies) to trace the underlying dark matter distribution. Thus a careful characterization of stellar mass distribution in galaxies should in principle allow us to establish critical constraints on competing dark matter models at galactic scales. To probe the largest scales, it becomes necessary to extend our view out to the distant universe, where (and when) dark matter is expected to collapse into halo potential wells into which baryonic matter falls along filamentary and sheet-like structures to form large groups of galaxies, which ultimately virialize into the clusters of galaxies that we see today. I will provide a brief review on our current understanding of how DM distribution affects the establishment of stellar structures in galaxies and the growth of large scale structure. I will also present how we are pursuing both these lines of study exploiting on the one hand large imaging surveys of nearby galaxies and on the other undertaking deep observations of galaxy-overdense regions in the distant universe.

Dark Matter Scenarios In the Light of the Faintest Galaxies in the High-z Universe

Pier Stefano Corasaniti

(CNRS & Observatoire de Paris)

Over the past years there has been significant progress in the detection of very faint galaxies in the high-redshift universe (z>6). Dedicated observational programs have targeted faint distant objects that constitute the population of galaxies that are thought to be responsible for the cosmic reionization. However, the census of these faint galaxies has far wider implications, since these measurements provides a test of the nature of dark matter particles in the universe. In this presentation I will give a review of the state-of-art of the bounds on dark matter scenarios from measurements of the faint-end of the galaxy luminosity function at high-z. I will highlight the degeneracy between astrophysical processes and the imprint of dark matter and discuss future prospects.

Wilky Way dark matter density profile and its reconstruction

Ekaterina Karukes

(International Centre for Theoretical Physics South American Institute for Fundamental Research (ICTP-SAIFR))

In this talk I am going to present the results of the dark matter density reconstruction of the Milky Way galaxy. In our analysis we assume a gNFW profile and we use the global rotation curve mass modeling. We further apply a Markov Chain Monte Carlo approach in order to perform the five parameter model fitting. We then validate the accuracy of the results on a suite of mock rotation curves where we a priori know the parameters of the underlying gNFW dark matter profile. We show that the local dark matter density values are recovered with a very good accuracy (within uncertainties < 10 per cent). We also find degeneracy between the scale radius and the inner dark matter density slope. Besides, we demonstrate an important dependence of the quality of the gNFW parameters reconstruction on the underlying baryonic morphology. Lastly, we check the level of the bias on the dark matter profile reconstruction when assuming the spherical symmetry of the a priori triaxial dark matter halo.

Particle Dark Matter constraints: the effect of Galactic uncertainties

Maria Benito

(IFT-UNESP)

The interpretation of results from in/direct dark matter (DM) searches depend on the adopted DM distribution within the target. In particular, the reconstruction of the DM profile in the Milky Way proceeds from astrophysical observations, all affected by quantifiable uncertainties. I will show how with a full data-driven analysis, actual uncertainties on the relevant astrophysical observations of such quantities (such as e.g. the Sun's Galactocentric distance) affect the interpretation of in/direct detection (or lack thereof). I will present a practical tool to propagate uncertainties on astrophysical quantities into the DM particle parameter space.

Self-gravitating systems of elementary particles as models for DM halos & structure formation

Carlos R. Argüelles

(Instituto de Astrofísica de La Plata - Universidad Nacional de La Plata - CONICET)

The problem of describing dark matter (DM) halos in terms of self-gravitating (fundamental) particles has gained considerable attention in the last years, given they may provide solutions to many of the unsuccessful predictions of the cold dark matter (CDM) paradigm arising below ~10 kpc scales. Such models are mainly comprised between (i) The case of ultra light bosons with masses in the range m~1-100x10^(-22) eV; (ii) The case of fully degenerate fermions of masses below the keV scale, and (iii) The case of semi-degenerate fermions including for temperature as well as relativistic effects (i.e. the RAR model). I will describe the underlying physical properties of the above theories, their astrophysical consequences to DM halos in galaxies and structure formation, as well as the tensions and success when contrasted with different observational data-sets.

Absence of a fundamental acceleration scale in galaxies

Davi Cabral Rodrigues

(Federal University of Espirito Santo)

The Radial Acceleration Relation confirms that a nontrivial acceleration scale a0 can be found from the internal dynamics of several galaxies. The existence of such a scale is not obvious as far as the standard cosmological model is concerned, and it has been interpreted as a possible sign of modified gravity. We consider 193 high-quality disk galaxies and, using Bayesian inference, we show that the probability of existence of a fundamental acceleration is essentially zero. We conclude that a0 is of emergent nature. In particular, the MOND theory, a well-known alternative to dark matter that is based on the existence of a fundamental acceleration scale, or any other theory that behaves like it at galactic scales, is ruled out as a fundamental theory for galaxies at 10σ.

Testing a modified gravity theory in the Milky Way

Susana Judith Landau

(Instituto de Fisica de Buenos Aires)

We perform a test of John Moffat's Modified Gravity theory (MOG) within the Milky Way, adopting the well known ``Rotation Curve'' method. We use the dynamics of observed tracers within the disk to determine the gravitational potential as a function of galactocentric distance, and compare that with the potential that is expected to be generated by the visible component only (stars and gas) under different ``flavors'' of the MOG theory, making use of a state--of--the--art setup for both the observed tracers and baryonic morphology. Our analysis shows that the theory fails to reproduce the observed rotation curve. We conclude that in none of its present formulation, the MOG theory is able to explain the observed Rotation Curve of the Milky Way

The effects of baryons on dark matter halos

Cecilia Scannapieco

(Departamento de Física, Universidad de Buenos Aires)

In this talk I will discuss the results of cosmological, hydrodynamical simulations of galaxy formation which include the baryonic component. In particular, I will review our current knowledge on baryonic effects on the dark matter, as well as the state-of-the-art in terms of the numerical models. I will also discuss the apparent inconsistencies between the predictions of these models in the standard cosmology and observational results.

IFT-Colloquium: Simulations of galaxy formation and evolution in a cosmological context

Cecilia Scannapieco

(Departamento de Física, Universidad de Buenos Aires)

During the last three decades simulations of the formation of galaxies

in the context of the standard cosmological paradigm have made fantastic progress, overcoming problems such as the angular momentum catastrophe and producing galaxies that resemble disk-bulge systems similar to those observed. In this talk, I will discuss such progress focusing on the formation and evolution of disks in galaxies similar to our Milky Way, and on the relevance of feedback processes on the determination of galaxy properties.

I will also present the results of simulations that use constrained initial conditions of the Local Group, where a system composed of a Milky Way-Andromeda-like system forms, and discuss environmental effects that might play a role in the formation and evolution of our Galaxy.

Dwarf galaxies and the small scale problems of CDM

Azadeh Fattahi

(Institue for Computational Cosmology, Durham University)

Despite its success in explaining the large scale structure of the Universe, the standard model of cosmology (LCDM) has faced a number of problems in explaining the properties of dwarf galaxies. Detailed studies of these intrinsically faint objects are only possible in the Local Universe. The Local Group of galaxies therefore serves as a laboratory for studying galaxy formation scenarios and for testing predictions of cosmological models.

I will demonstrate how the “small scale problems” of LCDM are resolved or persist in the state-of-the-art LCDM hydrodynamical simulations of the localuniverse. I will particularly focus on the too-big-to-fail and the core-cusp problems andtheir solution.

The formation of the First Stars in Warm Dark Matter vs Cold Dark Matter cosmologies

Umberto Maio

(Leibniz Institute for Astrophysics (AIP))

I will present latest results about the formation of the first stars and galaxies in Warm Dark Matter vs Cold Dark Matter cosmologies, as predicted from numerical hydrodynamical chemistry simulations.

DarkSide Experiment: Venturing in the Low Mass Dark Matter Region

Ivone Freire da Mota e Albuquerque

(IFUSP)

In this talk I will highlight important features of dark matter direct detection, focusing on recent results of the DarkSide experiment. This experiment searches for Weakly Interacting Massive Particles. Its target is composed of Liquid Argon, which fills a Time Projection Chamber. I will focus on their low mass WIMP search, which currently holds the best exclusion limit. I will also discuss direct detection prospects for the near future.

Status and Results from the XENON1T Dark Matter Experiment

Adam Brown

(University of Zurich, Physik-Institut)

XENON1T, the first tonne-scale dual-phase xenon time projection chamber, is currently taking data at the Laboratori Nazionali del Gran Sasso in Italy. The experiment is sensitive to the scattering of weakly interacting massive particle (WIMP) dark matter within a 2 t target volume. By using both the scintillation and ionisation signals induced by an interaction it is possible to discriminate WIMP-induced events from the main electronic recoil background. The electronic-recoil background rate of 82 ev / (t yr keV) is the lowest achieved in such a detector. Using data from a 1 t yr exposure, XENON1T has set the most stringent limit on the cross-section of spin-independent elastic WIMP-nucleon scattering of 4.1×10−47 cm2 for 30 GeV/c2 WIMPs at a 90% confidence level. This talk will present the results of this WIMP search as well as the current status and future plans for the experiment.

DARWIN: the ultimate dark matter detector

Yanina Biondi

(Physik-Institut)

DARk matter WImp search with liquid xenoN (DARWIN) will be an experiment for direct detection of dark matter using a multi-ton time projection chamber filled with xenon at its core. DARWIN will aim at pushing the sensitivity to WIMPS to unprecedented levels in order to eventually cover the entire experimentally accessible parameter space, before neutrino interactions dominate. Its results will shed light on WIMP dark matter candidate over a wide mass region, from 5 GeV/c2 to above 10 TeV/c2, via various possible couplings (spin-independent, spin-dependent, inelastic). In addition, its ultra-low background level will also make DARWIN suited for a large number of other rare-event searches, such as solar neutrinos, neutrinoless double beta-decay of 136Xe without isotopic enrichment, axions and axion-like particles, neutrinos from supernovae and different rare nuclear processes. We discuss here the concept of DARWIN, the ongoing R&D and the expected sensitivities to various of these physics channels.

Directional Dark Matter search with optical readouts and the CYGNO project

Elisabetta Baracchini

(Gran Sasso Science Institute)

We are going to present the project for CYGNO, a 1kg gaseous TPC Dark Matter directional experiment, to be hosted at Laboratori Nazionali del Gran Sasso. CYGNO (a CYGNus TPC with Optical readout) fits into the context of the wider CYGNUS collaboration, for the development of a Galactic Nuclear Recoil Observatory at the ton scale with directional sensitivity. The most innovative CYGNO's features will be the exploitation of sCMOS cameras and PMTs, coupled to GEMs amplification of an He:CF4 gas mixture at atmospheric pressure. Compared to other optical approaches, these choices provide an improved signal/noise ratio, thanks to the 1-2 e-/pixel noise of sCMOS and high GEMs gains, combined with full 3D reconstruction, including head-tail, exploiting the large PMT signals. We will discuss the results of the Italian R&Ds with a 10 L detector prototype, demonstrating 3D tracking and background discrimination capabilities for O(100) keV nuclear and electron recoils, with O(100) um spatial resolution over 20 cm drift distance. We will conclude with the foreseen CYGNO-1kg experiment performances and preliminary sensitivity.

Direct detection

Christopher McCabe

(King's College London)

Dark matter (DM) particles with mass in the sub-GeV range are an attractive alternative to heavier weakly-interacting massive particles, but direct detection of such light particles is challenging. In this talk, I'll discuss how existing dual-phase xenon detectors can probe the DM-nucleon interaction of DM with a sub-GeV mass through a search for photon or electron emission from the recoiling xenon atom. This allows xenon detectors to set exclusion limits that are comparable to the exclusion limits from experiments that are optimised to search for sub-GeV DM particles. Based on arXiv:1702.04730 and arXiv:1711.09906.

New Theory Tools to Unveil the Mystery of Dark Matter

Francesco D'Eramo

(Università di Padova)

Weakly Interacting Massive Particles (WIMPs) are motivated dark matter candidates. They are currently searched for by complementary strategies that probe WIMP couplings at different energy scales. I will show how such a separation of scales has important consequences in connecting different experimental information, and I will present theoretical tools to properly connect the different energy scales.

Testing Minimal Freeze-in Models at the LHC

Andre Lessa

(Universidade Federal do ABC)

Simple freeze-in models in which the observed Dark Matter abundance in the Universe is explained via the decay a parent particle into Feebly Interacting Massive Particles are an interesting alternative to the standard WIMP scenario. Due to its suppressed decays to DM, the parent particle can be long-lived at collider scales and provide interesting collider signatures. In such cases the LHC constitutes a powerful probe of freeze-in dark matter production and can further provide interesting information on the early Universe cosmology.

Colored scotogenic

Diego Restrepo

(Instituto de Física, Universidad de Antioquia)

We propose a simple theory for the idea that cosmological dark matter (DM) may be present today mainly in the form of stable neutral hadronic thermal relics. In our model neutrino masses arise radiatively from the exchange of colored DM constituents, giving a common origin for both dark matter and neutrino mass. The conservation (violation) of B−L symmetry ensures dark matter stability and the Dirac (Majorana) nature of neutrinos. The theory can be falsified by dark matter nuclear recoil direct detection experiments, leading also to possible signals at a next generation hadron collider.

Coupling-independent regime for mesonic DM in Hidden Valley models

Giovanni Grilli di Cortona

(University of Sao Paulo)

It is a distinct possibility that a Hidden Valley sector would have a spectrum of light particles consisting of both stable and unstable dark mesons. The simultaneous presence of these two types of particles can lead to novel mechanisms for generating the correct dark matter relic abundance, which in turn can reflect themselves into new exotic signatures at colliders (displaced vertices, emerging jets and semivisible jets). We study the viability of such sectors for various Hidden Valley models. In most of the allowed parameter space, the relic density is determined by stable mesons annihilating to unstable ones which in turn decay quickly to Standard Model particles.

Spin-2 Portal Dark Matter

Nicolás Bernal

(Universidad Antonio Nariño)

We generalize models invoking a spin-2 particle as a mediator between the dark sector and the Standard Model. We show that a massive spin-2 messenger can efficiently play the role of a portal between the two sectors. The dark matter is then produced via a freeze-in mechanism during the reheating epoch. In a large part of the parameter space, production through the exchange of a massive spin-2 mediator dominates over processes involving a graviton with Planck suppressed couplings. We perform a systematic analysis of such models for different values of the spin-2 mass relative to the maximum and the final temperature attained at reheating.

Phenomenology of the $\mu \nu$SSM: Displaced Vertices at the LHC and Indirect Dark Matter Signals at Gamma Ray Telescopes

Daniel Elbio Lopez-Fogliani

(Instituto de Física de Buenos Aires (Universidad de Buenos Aires & CONICET))

The μνSSM is a supersymmetric R-parity breaking model with the minimal natural matter content. The model has desirable properties as absent of mu-problem and the ability to reproduce neutrino physics experiments. In this context, we analyze relevant signals expected at the LHC. In particular we analyze a displaced dilepton signal expected at the LHC for a tau left sneutrino as the lightest supersymmetric particle with a mass in the range 45-100 GeV. We also discuss Axino-Gravitino dark matter candidates, giving the possibility of indirect dark matter signals at future and present gamma ray experiments telescopes.

Dark Matter in Two Higgs Doublet Models with $U(1)_{B-L}$ Gauge Symmetry

Daniel Camargo

(International Institute of Physics)

In this talk we explore the possibility to have a dark matter candidate in 2HDM with an extra B-L gauge symmetry.

Results on Dark Matter searches with the ATLAS detector

Edoardo Farina

(University of Pavia and INFN)

Dark Matter searches at colliders provide a complementary approach to the direct and indirect ones. Different signatures based on Effective Field theories, Simplified Models or more complex models are being exploited by the ATLAS Collaboration at the LHC in a broad and systematic search program.

In the talk we will review the latest results and prospectives.

Dark matter search at Belle II

Enrico Graziani

(INFN - Roma 3)

The Belle II experiment is a substantial upgrade of the Belle detector and will operate at the SuperKEKB energy-asymmetric e^+e^- collider. The accelerator has successfully completed the second phase of commissioning; with the first collisions in April 2018. The design luminosity of 8×10^{35} cm^{-2}s^{-1} and the Belle II experiment aims to record 50 ab^{-1} of data, a factor of 50 more than the Belle experiment. This large data set will be accumulated with low backgrounds and high trigger efficiencies in a clean e^+e^- environment; it will allow to probe New Physics scales that are well beyond the reach of direct production at the LHC and will complement the searches through indirect effects that are currently ongoing or planned. This data set offers also the possibility to search for a large variety of dark sector particles in the GeV mass range complementary to LHC and dedicated low energy experiments. These searches will profit both from the size of the Belle II data, and from specifically designed triggers for the early running of Belle II. This talk will review the detector upgrade, present results obtained from the first collision data analysis and prospects for the data taking that will start in early 2019; I will then focus on the planned dark sector searches and the discovery potential of the first data.

Light in the Dark -- Searching for sub-GeV Dark Matter

Ruth Poettgen

(Lund University, Department of Physics)

The origin and observed abundance of Dark Matter can be explained elegantly by the thermal freeze-out mechanism, leading to a preferred mass range for Dark Matter particles in the MeV-TeV region. The GeV-TeV mass range is being explored intensively by a variety of experiments searching for Weakly Interacting Massive Particles. The sub-GeV region, however, in which the masses of most of the building blocks of stable matter lie, is experimentally open territory. This mass range for particles and force carriers occurs naturally in Hidden Sector Dark Matter models. This talk gives an overview of accelerator-based experiments searching for MeV - GeV Dark Matter, targeting as a benchmark a model with a Dark Photon mixing kinetically with the SM photon. It will focus on searches for invisibly decaying Dark Photons and in particular the potential with the Light Dark Matter eXperiment, a proposed electron-beam fixed-target, missing-momentum experiment.

MeV Dark Matter Complementarity and the Dark Photon Portal

Clarissa Martins Siqueira

(International Institute of Physics - IIP/UFRN)

We discuss the phenomenology of an MeV-scale Dirac fermion coupled to the Standard Model through a dark photon with kinetic mixing with the electromagnetic field. We compute the dark matter relic density and explore the interplay of direct detection and accelerator searches for dark photons. We show that precise measurements of the temperature and polarization power spectra of the Cosmic Microwave Background Radiation lead to stringent constraints, leaving a small window for the thermal production of this MeV dark matter candidate. The forthcoming MeV gamma-ray telescope e-ASTROGAM will offer important and complementary opportunities to discover dark matter particles with masses below ~ 10 MeV . Lastly, we discuss how a late-time inflation episode and freeze-in production could conspire to yield the correct relic density while being consistent with existing and future constraints.

Indirect search of Dark Matter with Cherenkov Neutrino Telescopes

Antonio Capone

(Physics Department of the University La Sapienza, Roma, Italy.)

The search for Dark Matter particles still has not achieved a success. Direct experiments are increasing their sensitivity and are exploring wide regions of the D.M. models parameters. Experiments like neutrino telescopes, searching for a non expected flux of neutrinos from massive objects (like the Sun, the Earth, the Galactic Center) can have an indirect evidence for the annihilations of D.M. particles. A review of most recent results, and of possible future achievements, will be done.

On the dark matter contribution to the IceCube diffuse neutrino flux

Arman Esmaili

(PUC Rio)

The high energy neutrino flux observed by the IceCube experiment can be interpreted in PeV-scale decaying dark matter scenario. I will review the current status of this proposal and possible future checks of this scenario.

Indirect dark matter search at the Galactic Centrer with H.E.S.S.

Lucia Rinchiuso

(Institut de recherche sur les lois fondamentales de l'Univers (Irfu), CEA, Saclay)

Ground based arrays of Imaging Atmospheric Cherenkov Telescopes are a unique tool to search for dark matter (DM) at very-high-energies. A two dimensions-binned likelihood approach has been developed to take into account the spectral and spatial features of the DM signal versus background. Using 10 years of observations towards the Galactic Center (GC) with the High Energy Spectroscopic System (H.E.S.S.) the most stringent constraints so far on the thermally-averaged velocity-weighted DM annihilation cross section $\langle\sigma v\rangle$ in the 300 GeV - 70 TeV range are derived. Assuming a cuspy DM density profile our constraints on the mono-energetic DM line signal reach $\langle\sigma v\rangle=4\times10^{-28}$ cm^{3}s^{-1} for a DM mass of 1 TeV. The possibility to test specific DM models with enhanced line-like features in their annihilation spectra has been investigated using mock H.E.S.S.-like events in the GC region. The forecast limits on $\langle\sigma v\rangle$ make use of the latest calculations of the wino annihilation spectrum at next-to-leading-logarithmic order. The limits are also interpreted as constraints on the J-factor or on the size of the DM halo core. The forecast show that H.E.S.S. should be able to probe several-kpc cores for thermal Wino DM.

Gamma-ray lines may reveal the CP nature of Dark Matter

Farinaldo da Silva Queiroz

(International Institute of Physics)

We will discuss dark matter complementarity of a MeV Dirac fermion that couples to Standard Model particles via a dark photon. We review the constraints stemming from direct, indirect and accelerators searches to find the region of parameter space where we can successfully host a thermally produced MeV dark matter fermion. We also explore different dark matter production mechanisms such as freeze-in and inflation.

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POSTERS

Collider Detection of Dark Matter Electromagnetic Anapole Moments

Antonio Carlos Oliveira Santos

(Universidade Federal da Paraiba)

Dark matter that interacts with the Standard Model by exchanging photons through higher multipole interactions occurs in a wide range of both strongly and weakly coupled hidden sector models. We study the collider detection prospects of these candidates, with a focus on Majorana dark matter that couples through the anapole moment. The study is conducted at the effective field theory level with the mono-Z signature incorporating varying levels of systematic uncertainties at the high-luminosity LHC. The projected collider reach on the anapole moment is then compared to the reach coming from direct detection experiments like LZ. Finally, the analysis is applied to a weakly coupled completion with leptophilic dark matter.

Flavored Dark Sectors running to low energy

Cristian Javier Caniu barros

(Instituto de Física da Universidade de São Paulo)

We consider the effective field theory generated by a heavy mediator that connects Standard Model particles to a Dark Sector, considering explicitly the flavor structure of the operators. In particular, we study the model independent running and mixing between operators, as well as their matching at the electroweak scale. In addition to the explicit expression of the Renormalization Group Equations, we show the numerical solutions as well as some approximate analytical expressions that help understanding these solutions. At low energy, our results are particularly important in the case of light dark sectors communicating to the b quark, and can be immediately applied to flavored Dark Matter.

Indirect Search of Dark Matter on Dwarf Irregular Galaxies with the HAWC Observatory

José Serna

(UNAM)

The dynamics of dwarf irregular (dIrr) galaxies are observed to be dominated by dark matter (DM). Recently, the DM density distribution has been studied for 31 dIrrs. Their extended DM halo (Burkert type profile) make this objects good candidates for DM searches. We present limits for DM annihilation cross-section and decay life-time with dIrr galaxies from three years of data of the High Altitude Water Cherenkov (HAWC) Observatory

The relation between the physical properties of the intracluster plasma and the large scale structure of the Universe

Natália Crepaldi Del Coco

(Institute of Astronomy, Geophysics and Atmospheric Sciences)

The main goal of this project is the study of the possible relation between the physical properties of the intracluster plasma, determined through X-ray observations, and the large scale environment where clusters are found. Based on the clusters X-ray analysis we will measure the density, temperature, and metallicity radial profiles, while the large scale structure in the neighborhood of clusters will be analyzed based on the galaxy spatial distribution (in the optical) as well as based on the spatial distribution of nearby groups and clusters (in X-ray, based on the ROSAT All-Sky Survey). We will identify the possible correlations between the intracluster plasma physical properties with the environment and evaluate what this information brings to our understanding of large structure formation in the Universe.

Structure's growth rate in interacting dark sector models

Patrícia Hepp Xavier

(Universidade Federal da Bahia)

We study the effects of vacuum energy perturbations on the evolution of the dark matter growth rate in a decomposed Chaplygin gas model with interacting dark matter and vacuum energy. We consider two different cases: (i) geodesic dark matter with homogeneous vacuum, and (ii) a covariant ansatz for vacuum density perturbations. In the latter case, we show that the vacuum perturbations are very tiny as compared to dark matter perturbations on sub-horizon scales. In spite of that, depending of the value of the Chaplygin gas parameter α, vacuum perturbations suppress or enhance the dark matter growth rate as compared to the geodesic model.

Cosmological bounds on dark matter-photon coupling : A solution for H_0 tension

Rafael da Costa Nunes

(UFJF)

We investigate an extension of the ΛCDM model where the dark matter (DM) is coupled to photons, inducing a non-conservation in the numbers of particles for both species, where the DM particles can undergo dilution throughout the cosmic history with a small deviation from the standard evolution decaying into photons, while the associated scattering processes are assumed to be negligible. In addition, we consider the presence of massive neutrinos with the effective number of species $N_{\rm eff}$ as a free parameter. The effects of the DM-photon coupling on the cosmic microwave background (CMB) and matter power spectra are analyzed. We derive the observational constraints on the model parameters by using the data from CMB, baryonic acoustic oscillations (BAO) measurements, the recently measured new local value of Hubble constant from the Hubble Space Telescope (HST), and large scale structure (LSS) information from the abundance of galaxy clusters. The DM-photon coupling parameter $\Gamma_{\gamma }$ is constrained to $\Gamma_{\gamma } \leq 1.3 \times10^{-5}$ (at 95\% CL) from the joint analysis carried out by using all the mentioned data sets. The neutrino mass scale $\sum m_{\nu}$ upper bounds at 95\% CL are obtained as $\sum m_{\nu} \sim 0.9$ eV and $\sum m_{\nu} \sim 0.4$ eV with and without the LSS data, respectively. We observe that the DM-photon coupling causes significant changes in the best fit value of $N_{\rm eff}$ but yields statistical ranges of $N_{\rm eff}$ compatible with the standard predictions, and we do not find any evidence of dark radiation. Due to non-conservation of photons in our model, we also evaluate and analyze the effects on the BAO acoustic scale at the drag epoch. The DM-photon coupling model yields high values of Hubble constant consistent with the local measurement, and thus alleviates the tension on this parameter.

Field theory models of interacting dark energy: observational constraints and model selection

Sandro Marcio Rodrigues Micheletti

(Universidade Federal do Rio de Janeiro - Campus Macaé)

We derive two field theory models of interacting dark energy, in which dark energy is associated with the quintessence and the tachyon scalar field. In both, instead of choosing arbitrarily the potential of scalar fields, these are specified implicitly by imposing that the dark energy fields must behave as the new agegraphic dark energy. The resulting models are compared with the Pantheon supernovae sample, CMB distance information from Planck 2015 data, baryonic acoustic oscillations (BAO) and Hubble parameter data. For comparison, we also consider the noninteracting case and the ΛCDM model. By use of information criteria, we obtain strong evidence in favor of an interaction in the dark sector of the universe, and for the two models the coupling constants are nonvanishing at more than 3σ confidence level.

Indirect DM searches with the HAWC Observatory

Sergio Hérnandez

(UNAM)

The High Altitude Water Cherenkov (HAWC) observatory is a wide-field-of-view (2sr) and high duty cycle (> 95%) gamma-ray detector which operates at an altitude of 4100 m in the state of Puebla, Mexico. HAWC performs indirect Dark Matter searches by detecting high energy photons (E > 1TeV) resulting from annihilation or decay of WIMPs. Since HAWC continuously surveys the sky, we investigated several targets as dSph galaxies, dwarf irregular galaxies, the Virgo Cluster and the Andromeda Galaxy. Although HAWC has not seen statistically significant excess from this sources, we will present the annihilation cross-section and decay lifetime limits (95% CL) for WIMP masses from 1 to 100 TeV.

No fundamental acceleration scale in disk galaxies

Valerio Marra

(Universidade Federal do Espírito Santo)

The Radial Acceleration Relation confirms that a nontrivial acceleration scale can be found in the average internal dynamics of galaxies. The existence of such a scale is not obvious as far as the standard cosmological model is concerned, and it has been interpreted as a possible sign of modified gravity. The implications could be profound: it could in principle explain galactic dynamics without large amounts of yet-undetected dark matter and address issues that the standard cosmological model faces at galactic scales. Here, we consider 193 disk galaxies from the SPARC and THINGS databases and, using Bayesian inference, we show that the probability of existence of a fundamental acceleration that is common to all the galaxies is essentially zero: the null hypothesis is rejected at more than 10 sigma. We conclude that the acceleration scale unveiled by the Radial Acceleration Relation is of emergent nature, possibly caused by a complex interplay between baryons and dark matter. In particular, the MOND theory, or any other theory that behaves like it at galactic scales, is ruled out as a fundamental theory for galaxies at more than 10σ.

First Direct-Detection Constraints on eV-Scale Hidden-Photon Dark Matter with DAMIC at SNOLAB

Victor Barreto Braga Mello

(Universidade Federal do Rio de Janeiro)

The DAMIC (Dark Matter in CCDs) experiment at SNOLAB employs the bulk silicon of scientific-grade CCDs as a target for ionization signals produced by interactions of particle dark matter from the galactic halo. In this work, we present the search for hidden photons, massive vector bosons proposed as candidates to explain the origin of the dark matter in the Universe, with DAMIC probing masses in the range 1.2–30 eV/c2. Under the assumption that the local dark matter is entirely constituted of hidden-photon, the experimental sensitivity to the kinetic mixing parameter (mixing between the field strength tensors of electromagnetism and its "hidden" counterpart) is competitive with constraints from solar emission and provides the most stringent direct detection constraints on hidden-photon dark matter in the galactic halo with masses 3-12 eV/c2