MOCa 2018: Materia Oscura en Colombia

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Other Institutes

Book of Abstracts

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Spin-2 Portal Dark Matter

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The expected shape of the Milky Way's dark matter halo

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Given the elusive nature of Dark Matter (DM), indirect measurements are the most common approach to study it observationally. However, to make these studies possible, some assumptions must be made. These assumptions come from complicated theoretical frameworks and the analysis of state-of-the-art cosmolofical simulations. In this work we study the shape of the DM halo of Milky Way-like galaxies from the Auriga simulations. We focus on the radial and time dependence. We found that, on DM-only and Magneto-hydrodynamic (MHD) simulations, the shape of the DM halo is more triaxial in the inner-skirts than in the outter-skirts. We compared simulations with and without gas and verified that the presence of visible matter has an effect of rounding the DM halo which is amplified for smaller radii, where the gravitational potential of the galactic disk becomes more significant. Regarding the effect of time on the DM halo shape, we corroborated that it is well-conserved in comoving units until $z \approx 2$. This means that probing the halo shape in physical units at the virial radius for different redshifts is nearly equivalent to probing the shape at different radii at redshift 0. These results are in accordance with previous work on cosmological and galactic-size simulations, and may serve as guidelines to improve observational constraints on our MW DM halo.

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Simulating Collisional Dark Matter

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The search for dark matter is a joint quest between particle physics and astrophysics.
From astrophysical evidence we know that the dark matter particle should be outside the standard model.
Nevertheless, the dark matter particle should have well defined particle properties including its cross section.
This means that dark matter must be collissional to some degree.
However, dark matter has been simulated as a collisionless fluid.

This approximation has been successful at explaining large scale properties of the Universe.
But when it comes to smaller scales some inconsistencies are observed, provinding further evidence that dark matter should be collisional.
In this talk, I will present the first results of a simulation that takes explicitly into account the collisional nature of dark matter.
We do this with an integer lattice method to solve the Boltzmann equation, this allows us to simulate the phase space of a
collisional dark matter fluid.
We report results from 1D numerical simulations that model a simplified version of the Bullet Cluster.
This allows us to obtain information about the velocity distribution, which is also of interest to dark matter direct detection efforts.
We finalize by describing the extension of this work to develop 3D simulations that will also recreate more realistic initial conditions.

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Minimal Z' models

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We present the most general solutions for the charges of a Z' with a minimal content of fermions. From our analysis,
we show the existence of three different scenarios which, as far as we know, are new in the literature.
However, these solutions reduce to very well-known cases for particular choices of the free parameters.
We also define several benchmark models in order to show the flexibility of our parameterizations.
In order to make a connection with the phenomenology, we show that it is possible to adjust some of these benchmark models to several observables, including C_9 and C_{10} which are involved in the LHCb anomalies.
We use the upper limits on the Z' cross-sections
of extra gauge vector bosons Z' decaying into dileptons from the ATLAS data at 13 TeV with an accumulated luminosity of 36.1~fb^{-1}
to set the 95\% CL allowed regions in the parameter space for a Z' mass of 5~TeV.

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Current constraints on the Doublet-Triplet fermion dark matter model

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We present a simplified dark matter (DM) model that arises from the interplay of a Majorana triplet and a vector-like doublet, both odd under a Z_2 symmetry that stabilizes the DM. The region where DM mass lies at the electroweak scale is severely constrained from relic abundance and Higgs diphoton decay. For this reason, we study the model within the framework of non-standard cosmology, where relic may be set by more intricate processes than just the WIMP freeze-out. We then use the latest experimental results coming from XENON1T, electroweak production at colliders, Higgs diphoton decay, indirect detection from gamma-rays both in the diffuse and line-like spectrum to constrain the model. As a result, we find that though large portions of the parameter space are ruled out, there are still viable regions, most of them will be explored in coming years by direct detection and diffuse gamma-rays spectrum.

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Inflationary axions with non-minimal couplings with gravity

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We consider a scenario in which the inflaton is a pseudoscalar field non-minimally coupled to gravity and to an emsamble of U(1) gauge fields through axial couplings. It is well known that the presence of axial couplings leads to a production of gauge particles which acts as a friction term in the dynamics of the inflaton, producing a slow-roll regime even in presence of a steep potential and that this interaction provides an efficient mechanism for the sourcing of chiral gravitational waves. In this talk we discuss some consequences of the introduction of the non-minimal coupling to gravity in this system. During the talk we review some details about the non-minimally coupled dynamics, and discuss the constraints on the model coming from the measurements of cosmological parameters. We put some emphasis on the issue of sourced tensor modes in this model. Finally, we comment on a mechanism in which the axion is coupled to a massive vector field.

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Neutrino Background in Dark Matter Direct Detection Experiments: Standard Model and beyond

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Negative results of direct detection searches so far have driven proposals for the next generation experiments with higher exposures. Nevertheless, such future facilities will face an irreducible background coming from the elastic scattering of solar and atmospheric neutrinos with the nuclei in the detector. Such background is usually parametrized through the introduction of the so-called neutrino floor. Interestingly, if beyond the Standard Model interactions are present in the scattering, the neutrino floor can be significantly modified; thus, direct detection experiments can constrain such new interactions. We will present flavour dependent and independent scenarios in which neutrinos can couple with the Dark Matter particle, and we will show their impact in future searches.

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Novel constraints on the phase space of fermionic dark matter in dwarf galaxies

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Since the pioneering work of Tremaine & Gun to the present, many approaches has been presented to constrain the dark matter (DM) particle mass from its phase-space density (PSD) evolution until the virialization of DM halos today. In particular, in the context of recent numerical simulations of fermionic DM particles, developed to investigate the effects of primordial thermal velocities of fermionic DM particles on the PSD of sub-halos, an strong tension arises between the particle mass required to produce the expected core size of dwarf spheroidal (dSph) halos and the corresponding lower mass limit set by observations of Lyman-α forest. We propose in this work an alternative first principle physics approach, based on quantum statistics and gravity, to describe the fermionic phase-space density of dSph galaxies. In particular, we consider a semi-degenerate model of keV fermions which describes the distribution of DM in galaxies. We show then that this novel semi-degenerate configuration of fermions successfully describes dSph observables with a particle mass in agreement with constraints of Lyman-α forest, alleviating thus former inconsistencies. Furthermore, the DM configurations presented in such an analysis also provide a good fit for the projected velocity dispersion profile of nearby dSph galaxies which permits us to establish a reliable lower bound for the fermion mass in accordance with the aforementioned astrophysical and cosmological constraints

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Choosing the On-Shell Renormalization Scheme in the Complex MSSM

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Choosing OnShell Renormalization Scheme in the Complex MSSM.

We analyze the possible choices of on-shell (OS) renormalization schemes (RS)
in the chargino/neutralino sector of the the Minimal Supersymmetric Standard Model with complex parameters (cMSSM). These RS have been implemented in the FeynArts/FormCalc (FA/FC) package. However, the specific choice needs to be set manually by the user, often without rigorous criteria. Our analiysis will allow to automate this choice and implement it into FA/FC, allowing to set the optimal choice of conditions which define the most convenient RS for any set of parameters. As is well known, each choice of OS-RS fails to converge for certain supersymmetric parameters. Any scan over a wide range of parameters may have to switch between different RS. It is therefore necessary to obtain the conditions under which any of those RS converges. We analyze several processes involving charginos and neutralinos at the one loop level for all possible OS-RS choices as a function of the relevant supersymmetric parameters, and compare these results with those already obtained for the one-loop mass shifts. A key issue for any parameter scan is the matching between schemes and the estimate of the corresponding theoretical uncertainty.

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Search for Hevy Neutral Leptons in ATLAS and DUNE Experiment

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Extensions of the SM have been suggested to solve questions of the modern particle physics like the origin of the neutrino masses, one of this extensions is the neutrino Minimal SM (νMSM). In the νMSM every left-handed fermion has a right-handed counterpart, that can be responsible form neutrino masses, dark matter and baryogenesis. In this talk a summary of the searches for HNL in the ATLAS experiment and DUNE is presented.

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Bound-state dark matter and neutrino mass

Author: Oscar Zapata[None]

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 theory can be falsified by dark matter nuclear recoil direct detection experiments, leading also to possible signals at a next generation hadron collider.

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Search for dark matter produced in association with a Higgs boson decaying to pair of bottom quarks using $80\,fb^{-1}$ of proton collisions at $\sqrt{s} = 13$ TeV with ATLAS detector

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A search for dark matter production in association with a Higgs boson decaying to b-quarks is performed using pp collisions at a centre-of-mass energy of $\sqrt{s} = 13\,\mathrm{TeV}$. The dataset has an integrated luminosity of $80\ \mathrm{fb}^{-1}$and was recorded with the ATLAS detector at the Large Hadron Collider. Selected collision events comprise large missing transverse momentum and either two b-tagged small radius jets or a single large radius jet containing two b-tagged subjets. The identification of these subjects is based on a jet algorithm where the radius parameter is shrinked as the transverse momentum increases. The results are interpreted in the context of a simplified model (Z'-2HDM) which describes the interaction of dark matter and standard model particles via new heavy mediator particles. Also model independent limits on the fiducial cross-section for Higgs + missing transverse momentum production are provided.

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Search for Heavy Stable Charged Particles in the CMS Experiment using the RPC phase II upgraded detectors

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Several theoretical models inspired by the idea of supersymmetry (SUSY) accommodate the possibility of HSCPs (Heavy Stable Charged Particles). The phase-II upgrade of the CMS-RPC system will allow the trigger and identification of this kind of particles exploiting the Time of Flight Technique with the improved time resolution that a new DAQ system will provide (˜2ns). Moreover, new RPC chambers will be installed to extend the acceptance coverage up to $\eta < 2.4$ with similar time resolution and better spatial resolution to complement this search.
In this talk a trigger strategy to detect HSCPs with the RPC detectors is presented, its performance is studied with Monte Carlo simulations and the expected results with the High Luminosity LHC data are shown.

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Dark Matter and Vectors Boson Fusion

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This talk will present the importance of Vector Boson Fusion, as a potential discovery tool for Dark Matter and New Physics at the LHC.

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Transición de fase electrodébil en modelos más allá del Modelo Estándar

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El Modelo Estándar (ME) es una teoría de física de partículas cuyo aspecto más significativo es la unificación de tres de las cuatro fuerzas fundamentales de la naturaleza: la fuerza nuclear fuerte, la fuerza nuclear débil y el electromagnetismo. Es una teoría que, a bajas energías, otorga una descripción satisfactoria del comportamiento del universo. Sin embargo, existen varios fenómenos que poseen evidencia experimental pero, en el marco del ME y sus extensiones, su explicación no ha sido satisfactoria con los datos experimentales actuales: la materia oscura, la masa de los neutrinos y la asimetría materia–antimateria.
Una posible solución al problema de la asimetría materia-antimateria, es la bariogénesis electrodébil, teoría donde la salida del equilibrio térmico, en edades tempranas del universo, permite romper la simetría bariónica vía las interacciones del bosón de Higgs con el resto de partículas presentes en el "plasma primordial".
El propósito de este trabajo, fue entonces explorar la fenomenología de tres modelos que van más allá del ME y cuyo fin es establecer las condiciones óptimas que garanticen bariogénesis electrodébil: *i)* el singlete escalar real, *ii)* el doblete inerte y *iii)* el modelo escotogénico. Se calcularon las contribuciones que recibe el potencial escalar de cada modelo mediante las correcciones radiativas a los propagadores y a las masas de los modelos, tanto a temperatura cero, como a temperatura finita. Adicionalmente, se establecieron las condiciones físico-matemáticas para las cuales se puede obtener una transición de fase electrodébil fuerte y primer orden, para finalmente realizar un análisis detallado sobre las regiones del espacio de parámetros de los modelos en las cuales es permitido garantizar las condiciones para bariogénesis electrodédil.

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DM review

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{Beyond the standard model from noncommutative geomerty

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Connes' noncommutative geometry (NCG) provides a complete picture to build the full standard model (SM) of particle physics by adding some discrete dimensions to the underlying four-dimensional (continuous) space-time. Within this framework, one can go further and construct models beyond the standard model. But this task is very constrained since all the axioms of the theory must be satisfied. Consequently, one can use it as a guideline to seek for physics beyond SM as an alternative to the usual formulation by means of effective field theories where a huge amount of models are allowed. In this work, I will explore the inclusion of new fermionic and scalar particles in the NCG approach in order to explain some of the experimental facts like the presence of dark matter in the universe and neutrino masses (at tree and loop level), which are ones of the missing pieces of the SM.

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Minimal Dirac neutrino models

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We study systematically the models for Dirac neutrino masses with minimal fields and symmetries. Some of them can accommodate dark matter candidates.