Dark Matters 2022

Report of Contributions

https://indico.global/e/13070

Contribution ID: **1** Type: **not specified**

Welcome

Wednesday 30 November 2022 09:55 (15 minutes)

Contribution ID: **2** Type: **not specified**

Observing dark matter clumps and asteroid-mass primordial black holes in the solar system with gravimeters and GNSS networks

Wednesday 30 November 2022 14:55 (15 minutes)

Presenter: CUADRAT-GRZYBOWSKI, Miguel

Session Classification: Dark astro

Contribution ID: **3** Type: **not specified**

Primordial black holes: formation and cosmological signatures

Wednesday 30 November 2022 10:10 (40 minutes)

Presenter: MUSCO, Ilia

Session Classification: Primordial Black Holes

Contribution ID: **4** Type: **not specified**

Primordial black holes: a connection between LIGO/Virgo mergers and constraints on the early universe

Wednesday 30 November 2022 11:20 (40 minutes)

Primordial Black Holes (PBHs) might comprise a significant fraction of dark matter in the Universe and can give rise to observable signatures in current and future gravitational wave (GW) experiments. Focusing on the formation PBHs in the mass range probed by the LIGO/Virgo/Kagra detectors, I will first discuss the main features of a population of PBH mergers, highlighting the smoking-gun signatures that can be searched for with current and future GW detectors.
I will then discuss the results of a Bayesian multi-population inference of the GWTC-3 dataset including a subpopulation of PBH mergers and directly modeling curvature power spectrum parameters. This allows setting constraints on both the PBH abundance as well as on the inflationary dynamics underlying PBHs formation within the standard scenario.

Presenter: FRANCIOLINI, Gabriele

Session Classification: Primordial Black Holes

Contribution ID: **6** Type: **not specified**

Constraints on primordial black holes from observation of stars in dwarf galaxies

Wednesday 30 November 2022 12:15 (15 minutes)

We propose a way to constrain the primordial black hole (PBH) abundance in the range of PBH masses around 10ˆ20g based on their capture by Sun-like stars in dwarf galaxies, with subsequent star destruction. We calculate numerically the probability of a PBH capture by a star at the time of its formation in an environment typical of dwarf galaxies. Requiring that no more than a fraction of stars in a dwarf galaxy is destroyed by PBHs translates into an upper limit on the PBH abundance.

Author: ESSER, Nicolas

Presenter: ESSER, Nicolas

Session Classification: Primordial Black Holes

Contribution ID: **7** Type: **not specified**

Discussion

Wednesday 30 November 2022 12:30 (30 minutes)

Contribution ID: **8** Type: **not specified**

Constraints on Primordial Black Holes

Wednesday 30 November 2022 14:00 (40 minutes)

Presenter: SERPICO, Pasquale (LAPTh - CNRS & Univ. Savoie (FR))

Session Classification: Dark astro

Contribution ID: **9** Type: **not specified**

Cosmic radiation backgrounds from primordial black holes

Wednesday 30 November 2022 14:40 (15 minutes)

Recent measurements of the cosmic X-ray and radio backgrounds (CXB and CRB) unveil an excess of radiation with respect to what is expected from known sources, suggesting the presence of an elusive population of still undiscovered emitters. We investigate the hypothesis that the CXB and CRB excesses are due to primordial black holes (PBHs) which may constitute an arbitrary fraction of dark matter (DM). We present a novel semi-analytical model to compute gas accretion onto PBHs, assuming that they are distributed both inside DM haloes and in the intergalactic medium, including a self-consistent treatment of heating and ionizing feedback on the surrounding environment. We assume bolometric corrections to obtain the X-ray (2-10keV) luminosity and the fundamental plane relation to calculate the radio (1.4GHz) luminosity. By integrating the X-ray and radio emission through the entire cosmic history, we find that (i) the contribution of PBH emission to the CXB and CRB is dominated by accretion onto PBHs in DM haloes; ii) even a small fraction of PBH in DM (0.3%) can reproduce the total observed CXB excess and contribute up to 1% to the CRB one. We finally comment on the implications of our findings on the 21 cm emission, detectable by current (e.g. EDGES) and future (e.g. SKA) radio experiments.

Presenter: ZIPARO, Francesco

Session Classification: Dark astro

Contribution ID: **10** Type: **not specified**

Dark Matter in the form of Compact Objects

Wednesday 30 November 2022 15:10 (40 minutes)

I will entertain the possibility that part of dark matter is in the form of primordial black holes formed in a matter dominated phase of the Universe. I will also address the possibility that strongly interacting dark matter might form its own compact objects.

Presenter: KOUVARIS, Chris

Session Classification: Dark astro

Contribution ID: **11** Type: **not specified**

Thermalization of dark matter in neutron stars

Wednesday 30 November 2022 16:20 (40 minutes)

A promising probe to unmask particle dark matter is to observe its effect on neutron stars, the prospects of which depend critically on whether captured dark matter thermalizes in a timely manner with the stellar core via repeated scattering with the Fermi-degenerate medium. In this talk I will estimate the timescales for thermalization for multiple scenarios. These include: (a) spin-0
and spin-1/2 dark matter, (b) scattering on non-relativistic neutron and relativistic electron targets accounting for the respective kinematics, (c) interactions via a range of Lorentz-invariant structures,
(d) mediators both heavy and light in comparison to the typical transfer momenta in the problem. Analytic behavior of the thermalization time is discussed, as a function of the dark matter and mediator masses, and the stellar temperature. Finally, parametric ranges where both
stellar capture is efficient and thermalization occurs within the age of the universe are identified. For dark matter that can annihilate in the core, these regions indicate parametric ranges that can be probed by
upcoming infrared telescopes observing cold neutron stars.

Presenter: Dr GARANI RAMESH, Raghuveer (INFN, Florence)

Session Classification: Dark astro

Contribution ID: **12** Type: **not specified**

Towards reconstructing the halo clustering and halo mass function of N-body simulations using neural ratio estimation

Thursday 1 December 2022 17:25 (15 minutes)

High-resolution cosmological N-body simulations are excellent tools for modelling the formation and clustering of dark matter haloes. These simulations suggest complex physical theories of halo formation governed by a set of effective physical parameters. Our goal is to extract these parameters and their uncertainties in a Bayesian context. In this talk, I will explain how we make a step towards automatising this process by directly comparing dark matter density projection maps extracted from cosmological simulations, with density projections generated from an analytical toy halo model. To accomplish this we use marginal neural ratio estimation, an algorithm for simulation-based inference that allows marginal posteriors to be estimated by approximating marginal likelihood-to-evidence ratios with a neural network. In this case, we train a neural network with mock images to identify the correct values of the physical parameters that produced a given image. Using the trained neural network on cosmological N-body simulation images we are able to reconstruct the halo mass function, to generate mock images similar to the N-body simulation images and to identify the lowest mass of the haloes of those images, provided that they have the same clustering with our training data.

Presenter: DIMITRIOU, Androniki

Session Classification: DM pheno and experiments

Contribution ID: **13** Type: **not specified**

Discussion

Wednesday 30 November 2022 17:00 (30 minutes)

Contribution ID: **14** Type: **not specified**

Multi-phase criticality

Thursday 1 December 2022 09:40 (40 minutes)

I present a scale-invariant Higgs-dilaton model of dynamical symmetry breaking and dark matter which, in the multi-phase criticality regime, generates a huge hierarchy between the electroweak and new physics scales in a technically natural way. The hierarchy follows from tiny scalar couplings required by the multi-phase criticality. I discuss dark matter freeze-out and freeze-in processes as well as dilaton physics in this scenario.

Presenter: RAIDAL, Martti (National Institute of Chemical Physics and Biophysics (EE))

Session Classification: DM pheno theory

Contribution ID: **15** Type: **not specified**

Minimal sterile neutrino dark matter

Thursday 1 December 2022 10:20 (25 minutes)

We propose a novel mechanism to generate sterile neutrinos νs in the early Universe, by converting ordinary neutrinos να in scattering processes νs να → νs νs. After initial production by oscillations, this leads to an exponential growth in the νs abundance. We show that such a production regime naturally occurs for self-interacting νs, and that this opens up significant new parameter space where νs make up all of the observed dark matter. Our results provide strong motivation to further push the sensitivity of X-ray line searches, and to improve on constraints from structure formation.

Presenter: HUFNAGEL, Marco

Session Classification: DM pheno theory

Contribution ID: **16** Type: **not specified**

Metastable bound states in the early universe and dark matter freeze-out

Thursday 1 December 2022 11:40 (40 minutes)

If dark matter couples to force mediators that are much lighter than itself, then bound states appear in the spectrum of the theory. The formation and decay of metastable dark matter bound states in the early universe can deplete the dark matter abundance, thereby changing the predicted parameters and the interpretation of experimental constraints. I will discuss how metastable bound states give rise to a generalised Saha equilibrium, and describe their effect on the dark matter relic density in different models, emphasising the potentially dramatic effect of the Higgs doublet in such processes.

Presenter: PETRAKI, Kalliopi

Session Classification: DM pheno theory

Contribution ID: **17** Type: **not specified**

Light thermal relics enabled by a second Higgs

Thursday 1 December 2022 12:20 (15 minutes)

Sub-GeV thermal relic dark matter typically requires the existence of a light mediator particle. We introduce the light two-Higgs-doublet portal, illustrated by a minimal UV-complete model for sub-GeV DM with kinematically forbidden annihilations into leptons. All new physics states in this scenario lie at or below the electroweak scale, affecting Higgs physics, the muon anomalous magnetic moment and potentially neutrino masses. Observation of radiative dark matter annihilation by future MeV gamma-ray telescopes would be key to identify the scenario.

Presenter: HERMS, Johannes (Max-Planck-Institut für Kernphysik)

Session Classification: DM pheno theory

Contribution ID: **19** Type: **not specified**

Discussion

Thursday 1 December 2022 12:35 (25 minutes)

Contribution ID: **20** Type: **not specified**

Dark Matter Searches with IceCube

Thursday 1 December 2022 14:55 (40 minutes)

Presenter: AGUILAR SANCHEZ, Juan Antonio

Session Classification: DM pheno and experiments

Contribution ID: **21** Type: **not specified**

Indirect dark matter searches

Thursday 1 December 2022 16:05 (40 minutes)

We live in a golden age for astro-particle physics, with a significant number of experiments actively monitoring high-energy Universe. Many of these probes provide excellent tests of particle physics models of dark matter particles. In particular, experiments such as Fermi -LAT, AMS-02, Ice Cube, ... are significantly cutting into the parameter space of one of the most popular candidates, the WIMPs. In this talk I will describe some of the strategies and methods used to search for dark matter with astrophysical data. Special attention will be given to the latest indications of an unaccounted gamma-ray excess at few GeV in the Fermi-LAT data in the region around the Galactic Centre, which steered lots of attention as it was shown to be consistent with putative signals of WIMP dark matter particles and complementary constraints provided by other experiments. Finally I will discuss projections of the expected sensitivities with upcoming experiments and continued data taking with current ones.

Presenter: Dr ZAHARIJAS, Gabrijela (University of Nova Gorica)

Session Classification: DM pheno and experiments

Contribution ID: **22** Type: **not specified**

Pulsar timing array search for scalar induced gravitational waves and primordial black holes

Wednesday 30 November 2022 12:00 (15 minutes)

In this work, we consider the formation of primordial black holes from large curvature perturbations at scales unconstrained by CMB observations. In addition to black holes, those curvature perturbations would induce gravitational waves able to explain the possible signal observed in the last NANOGrav 12.5-years data set and the second IPTA data release. We use here a log-normal profile for the curvature perturbation at small scales and perform bayesian search to find the parameter regions able to explain the signal. We compare this with constraints on primordial black holes.

Presenter: DANDOY, Virgile

Session Classification: Primordial Black Holes

Contribution ID: **23** Type: **not specified**

On machines learning about some dark matters

Thursday 1 December 2022 16:45 (40 minutes)

In this talk I plan to review Dark Matter studies which benefit from modern statistical algorithms and tools. I will start by motivating the use of such tools in nowadays physics, while stressing their most important "warnings", typically overlooked by our community. The discussion will then focus on some astrophysical DM studies, also including direct detection and collider searches.

Presenter: ZALDIVAR, Bryan

Session Classification: DM pheno and experiments

Contribution ID: **24** Type: **not specified**

Mapping the viable parameter space for testable leptogenesis

Thursday 1 December 2022 14:40 (15 minutes)

In this talk, we describe how one can map the range of active-sterile neutrino mixing angles in which leptogenesis is possible in the type I seesaw model with three heavy neutrinos with Majorana masses between 50 MeV and 70 TeV, covering the entire experimentally accessible mass range. Our study includes both, the asymmetry generation during freeze-in (ARS mechanism) and freeze-out (resonant leptogenesis) of the heavy neutrinos. The range of mixings for which leptogenesis is feasible is considerably larger than in the minimal model with only two right-handed neutrinos and extends all the way up to the current experimental bounds. For such large mixing angles the HL-LHC could potentially observe a number of events that is large enough to compare different decay channels, a first step towards testing the hypothesis that these particles may be responsible for the origin of matter and neutrino masses.

Presenter: GEORIS, Yannis

Session Classification: DM pheno and experiments

Contribution ID: **25** Type: **not specified**

Discussion

Thursday 1 December 2022 17:40 (30 minutes)

Contribution ID: **26** Type: **not specified**

Cosmological tensions and DM models

Presenter: LESGOURGUES, Julien (TTK, RWTH Aachen University)

Session Classification: Cosmo

Contribution ID: **27** Type: **not specified**

Axion Star Explosions in the Early Universe

Friday 2 December 2022 11:25 (40 minutes)

We consider axion stars which may explode at early times, changing the ionisation history of the Universe. We will explain the concept, the calculation and the constraints on parameter space.

Presenter: Prof. FAIRBAIRN, Malcolm (Physics, King's College London)

Session Classification: Cosmo

Contribution ID: **28** Type: **not specified**

Gravitational Dark Matter portal in extra dimensions

Friday 2 December 2022 10:00 (40 minutes)

I will discuss recent work about the possibility of Dark Matter interacting only gravitationally in extra dimensional scenarios.

Presenter: RIUS, Nuria (Valencia University)

Session Classification: Cosmo

Contribution ID: **29** Type: **not specified**

Gravitational-wave event rates as a new probe for dark matter microphysics

Friday 2 December 2022 12:05 (15 minutes)

Next-generation gravitational-wave (GW) observatories will provide exquisite measurements of the merger rate of high-redshift binary black holes (BBHs), detecting many thousands of these systems every year. The abundance of these binaries is a direct tracer of the early stages of star formation, and therefore of cosmic structure formation. This opens the possibility of using GW observations to probe the microphysical properties of dark matter (DM), particularly warm, fuzzy, or interacting DM models which suppress the matter power spectrum on small scales, and therefore suppress the BBH merger rate. In this talk, I will describe recent work to model this suppression using a full end-to-end pipeline from DM model parameters to synthetic populations of BBHs. I will present forecasts for future GW observatories, showing that these will probe DM-neutrino interactions 100 times weaker than the most stringent present constraints.

Presenter: JENKINS, Alexander C (University College London)

Session Classification: Cosmo

Contribution ID: **30** Type: **not specified**

New constraints on the dark matter-neutrino/photon scatterings

Friday 2 December 2022 12:20 (10 minutes)

In this talk, I will discuss the attenuation of high energy neutrinos and photons produced in a blazar when they propagate through the dark matter spike around the central black hole and the halo of the host galaxy. In particular, I will discuss new constraints on the dark matter-neutrino and dark matter-photon scattering cross sections obtained from the observation by IceCube of a few high-energy neutrino events from TXS 0506+056, and their coincident gamma-ray events. I will emphasize the dependence of the constraints with the location where the neutrinos and gamma-rays are produced, and the dependence with the dark matter self-annihilation cross section. The constraints are orders of magnitude more stringent than those derived from considering the attenuation through the intergalactic medium and the Milky Way dark matter halo. When the cross-section increases with energy, the constraints are also stronger than those derived from the CMB and large-scale structure.

Presenter: HERRERA, Gonzalo

Session Classification: Cosmo

Contribution ID: **31** Type: **not specified**

Discussion

Friday 2 December 2022 12:30 (30 minutes)

Contribution ID: **32** Type: **not specified**

The domain of thermal dark matter, and a hot, dark history of the Universe

Thursday 1 December 2022 10:45 (25 minutes)

Thermal dark matter (DM) covers a well-motivated class of candidates. In this talk, I will firstly consider DM in a hidden sector with temperature T', and find the allowed, model-independent parameter space in terms of the DM mass and the ratio T'/T. Then I will look specifically at the T'/T » 1 case, taking dark QED as a representative example, and show how large entropy production allows the model to go beyond the generic domain.

Presenter: COY, Rupert (ULB)

Session Classification: DM pheno theory

Contribution ID: **33** Type: **not specified**

Co-genesis in a dark sector

Thursday 1 December 2022 14:00 (40 minutes)

A dark sector with its internal structure can generate the observed dark matter abundance and baryon asymmetry and thus addresses the coincidence between the two. This talk focuses on the framework in which non-vanishing chemical potentials may grow in such a dark sector, leading to a rich phenomenology. I will discuss the models and the relevant phenomenological predictions, including dark matter detection signals, as well as potential effects on cosmology.

Presenter: CHU, Xiaoyong

Session Classification: DM pheno and experiments

Contribution ID: **34** Type: **not specified**

Dark matter freeze-in from semi-production

Friday 2 December 2022 10:40 (15 minutes)

We study a novel dark matter (DM) production mechanism based on the freeze-in through the inverse of semi-annihilation process. A peculiar feature of this scenario is that the production rate is suppressed by a small initial abundance of DM and consequently creating the observed abundance requires much larger coupling values than for the usual freeze-in. We provide a concrete example model exhibiting such production mechanism and study it in detail, extending the standard formalism to include the evolution of dark matter temperature alongside its number density and discuss the importance of this improved treatment. Finally, we confront the relic density constraint with the limits and prospects for the DM indirect detection searches. We show that, even if it was never in full thermal equilibrium in the early Universe, DM could, nevertheless, have strong enough present-day annihilation cross section to lead to observable signals.

Presenter: LALETIN, Maxim

Session Classification: Cosmo