Dark Matter and Cosmic Rays

Report of Contributions

https://agenda.infn.it/e/41831

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

A model for superheavy dark matter that can possibly be tested with Pulsar Timing Arrays

Monday, 11 November 2024 11:40 (10 minutes)

I propose to discuss a scenario where superheavy Dark Matter (DM) can be generated from ultra-light Primordial Black Holes in the early universe. If we go to a bit more fundamental level (e.g., think of how the DM becomes massive after a phase transition), we can associate the scenario with gravitational waves and their possible detection with the Pulsar Timing arrays (PTAs). It might be an interesting probe of superheavy DM in addition to cosmic rays.

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Session Classification: Introduction and brainstorming talks

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

Hot Spots, Gamma Rays and Dark Matter

Monday, 11 November 2024 11:30 (10 minutes)

PBHs in the so called “asteroid mass” range may still constitute all of the relic DM. The low mass end of this range is constrained by the non-observation of extra-galactic gamma rays. If asteroid mass PBHs form hot spots, one should expect firstly some attenuation of the primary gamma ray signal by the hot spot, and secondly a secondary component from the hot spot. Re-examining these constraints including the effect of the hot-spot may shed more light on the asteroid mass gap.

The formation and evolution of these hot spots has been studied during the PBH lifetime but there exist no studies on the fate of hot spots after evaporation ceases. At the moment the evaporation of the PBH becomes too weak to sustain the hot spot (either due to the loss of mass or memory burden) it will begin to cool. However the dynamics of this cooling are unclear and DM in the cooling hot spots may never fully thermalise with the rest of the universe. Indeed, analytical estimates suggest that the cooling of the hot spot may be slower than the cooling of the background universe, suggesting an ever expanding hot spot. The implications of remnant hot spots on structure formation, BBN and the CMB are currently unstudied, and potentially very interesting.

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Session Classification: Introduction and brainstorming talks

Contribution ID: **5** Type: **not specified**

Astrophysical transient constraints on BSM physics

Monday, 11 November 2024 11:10 (10 minutes)

While it is way too early to make a final judgement, it is noteworthy that searches at LHC and direct detection experiments reported null results, therefore boosting the ever growing interest in sub-GeV dark sector candidates. Owing to their high temperature and density, the cores of proto-neutron stars, remnant of core-collapse supernovae and neutron star mergers, can be factories of particles with mass of up to several hundreds MeV. In this talk, we will summarize the state of the art of transient-based searches, and identify open questions and future directions.

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Session Classification: Introduction and brainstorming talks

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

Relic Neutrino Background from Cosmic-Ray Reservoirs

Monday, 11 November 2024 10:50 (10 minutes)

The relic ν background (RνB) is the 'holy grail'of neutrino physics and it is also the only known Dark Matter subcomponent. Yet, it has so far escaped detection attempts, mainly due to the very low energies and very weak cross-sections involved in the detection channels. In this talk, I will describe the mechanism by which ultra-high energy (UHE) cosmic rays, stored in cosmic reservoirs for $\sim$ Gyr timescales, can upscatter the RνB to ultra-high energies. For sufficiently high overdensities of the RνB in the location of the source, which may potentially be induced by BSM effects, the up-scattered neutrino flux is within the reach of future UHE neutrino detection experiments (e.g. IceCube-Gen2 and GRAND) and distinguishable from other neutrino signals via its unique features such as its spectral shape and flavour composition. The non-detection of this flux at current UHE neutrino experiments sets the current most stringent bound on neutrino overdensities on the scales of galaxy clusters.

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Session Classification: Introduction and brainstorming talks

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

Thermal effects in freeze-in neutrino dark matter production

Monday, 11 November 2024 11:50 (10 minutes)

We present a detailed study of the production of dark matter in the form of a sterile neutrino via freeze-in from decays of heavy right-handed neutrinos. Our treatment accounts for thermal effects in the effective couplings, generated via neutrino mixing, of the new heavy neutrinos with the Standard Model gauge and Higgs bosons and can be applied to several low-energy fermion seesaw scenarios featuring heavy neutrinos in thermal equilibrium with the primordial plasma. We find that the production of dark matter is not as suppressed as to what is found when considering only Standard Model gauge interactions. Our study shows that the freeze-in dark matter production could be efficient.

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Session Classification: Introduction and brainstorming talks

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

Sub-GeV Boosted Dark Matter by Blazars

Monday, 11 November 2024 11:00 (10 minutes)

As the WIMP paradigm for Dark Matter (DM) is increasingly challenged by the non detection of DM, this motivates the investigation of other DM mass ranges.
In the latest years the focus shifted towards the study of sub-GeV DM, which direct detection is limited by the low energy recoil that it imprints on nuclei. However, the assumption that it has a non zero interaction cross section with the Standard Model, implies that there is a component which is unavoidably up-scattered by high energy cosmic rays.
We consider blazars, AGN accelerating particles in two back-to-back jets, one of which closely alligned to our line of sight as sources of these cosmic rays.
We improve on the previous literature on blazar up-scattering by considering realistic, energy dependent dark matter-nucleon cross sections, including the contribution of inelastic scattering, and we study the recoil produced by DM on nuclei at present and future neutrino detectors, such as Super-K and DUNE.
For some of the possible mediators considered in our work, we set novel bounds on DM-nucleon cross section and we also discuss the role played by astrophysical uncertainty on DM distribution around blazars.

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Session Classification: Introduction and brainstorming talks

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

The Milky Way mass in GAIA era

Monday, 11 November 2024 12:10 (10 minutes)

A recent anlysis of GAIA's data suggest claims to have seen the beginning of the decline of the Milky Way's rotation curve.
This would have interesting implications for the Milky Way mass determination, if true.
I propose a critical assessment of the the analysis, followed by an independent analysis of of the MW mass distribution in light of GAIA's new data.

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

Do we really need AGN components to describe the low energy part of the IceCube astrophysical flux?

Monday, 11 November 2024 10:40 (10 minutes)

The diffuse astrophysical neutrino flux measured in the very high energy range introduced unresolved issues about the origin of these events and underlined as a viable solution the multi-component scenario. Recent studies show that galaxies with high star formation rate (above teens Mo/year) can be responsible of a seizable fraction of the observed astrophysical flux.
Despite their low luminosity, they can be considered as guaranteed "factories"of high energy neutrinos, being "reservoirs"of accelerated cosmic rays and hosting a high density target gas in the central region. On the other hand, in the same range of energies, recent measurements of IceCube and Antares telescopes set the contribution correlated with the diffuse Galactic emission. The Milky Way is a prominent astrophysical lab to correlate the high-energy diffuse emission with the physics of cosmic-ray injection and propagation as well as with the measured molecular gas distribution.
In this contribution we describe in details these two diffuse astrophysical components, presenting recent phenomenological studies and reviewing current observations made by high-energy neutrino telescopes

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Session Classification: Introduction and brainstorming talks

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

Cosmic-ray anomalies

Monday, 11 November 2024 10:30 (10 minutes)

I review some anomalies in the measured fluxes of Galactic charged cosmic rays and the associated non-thermal emission (in particular: high-energy positrons, features in the proton spectrum, gamma-ray hardening towards the Galactic centre, 511 keV line). These anomalies may point towards interesting aspects of cosmic-ray production and propagation or new physics.

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Session Classification: Introduction and brainstorming talks

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

Estimating Dark Matter Distributions Around Galaxies Using Machine Learning Techniques

Monday, 11 November 2024 12:00 (10 minutes)

This project aims to explore the use of novel machine learning methods to estimate dark matter distributions around galaxies, offering a more flexible approach compared to traditional techniques. Conventional methods, such as analysing galaxy rotation curves, depend on numerous assumptions—many of which may not hold true for real galaxies, leading to potential inaccuracies in dark matter modelling. Machine learning techniques, by contrast, can handle complex and diverse datasets without relying on rigid assumptions. Accurate and precise estimation of dark matter density is critical for both direct and indirect dark matter detection, as the expected signals from potential dark matter candidates are highly dependent on local density distributions. This interdisciplinary effort aims to enhance our understanding of dark matter and improve detection prospects.

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Session Classification: Introduction and brainstorming talks

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Memory-burdened Primordial Black Holes

Monday, 11 November 2024 11:20 (10 minutes)

Primordial Black holes (PBHs) are hypothetical black holes formed in the earliest times of the Universe, as a result of inflationary scenarios or physics beyond the Standard Model. These intriguing objects have attracted significant attention over the last decade, especially in the context of dark matter and detectability of the Hawking radiation from PBH evaporation. Recent studies have pointed out that quantum effects, referred to as "memory burden", may slow down the evaporation of black holes, allowing for light PBHs to account for a significant fraction of the dark matter energy density. I will discuss the interesting phenomenological consequences of this scenario.

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