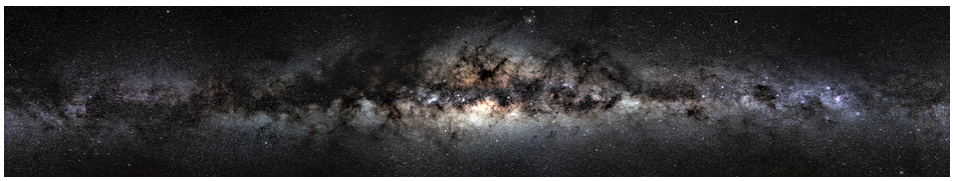
Dark Sectors of Astroparticle Physics (AstroDark-2021): Axions, Neutrinos, Black Holes and Gravitational Waves



Report of Contributions

https://indico.ipmu.jp/e/397

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

Welcome Address by Kavli IPMU Director Hirosi Ooguri

Tuesday, 7 December 2021 06:50 (10 minutes)

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

New Developments in Indirect Searches for Dark Matter

Tuesday, 7 December 2021 07:40 (40 minutes)

The nature and origin of dark matter is one of the key unresolved questions of fundamental physics. Astrophysical and cosmological data provide powerful probes of dark matter properties, although to date no signal has been confirmed. I will give a status update on current constraints, future prospects, and open questions, including excesses/anomalies that are not yet fully understood.

Primary author: SLATYER, Tracy (MIT)

Presenter: SLATYER, Tracy (MIT)

Session Classification: Review

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

Hidden Sector Dark Matter and Ideas for Its Detection

Tuesday, 7 December 2021 08:50 (40 minutes)

Primary author: ZUREK, Kathryn (Caltech)

Presenter: ZUREK, Kathryn (Caltech)

Session Classification: Review

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

Dark Matter, Pulsars, and the Galactic Center Gamma-Ray Excess

Tuesday, 7 December 2021 09:30 (40 minutes)

A bright and statistically significant flux of GeV-scale gamma rays has been detected from the region surrounding the Galactic Center. While the spectrum, angular distribution, and intensity of this signal is consistent with the predictions of annihilating dark matter matter particles, it has also been suggested that these gamma rays could potentially be produced by a large population of millisecond pulsars. In this talk, I'll review the arguments for each of these interpretations, and discuss the current status of the hunt for dark matter particles using gamma-ray telescopes.

Primary author: HOOPER, Dan (Fermilab/Chicago)

Presenter: HOOPER, Dan (Fermilab/Chicago)

Session Classification: Plenary

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

New Techniques for Gravitational Wave Detection

Tuesday, 7 December 2021 10:10 (40 minutes)

I will discuss gaps in our coverage of the gravitational spectrum and possible new methods for filling them. Atom interferometry shows promise for detecting gravitational waves in the frequency range around a Hz, the "mid-band" between LIGO and LISA. Intermediate-scale atomic detectors are currently under construction. These would demonstrate the technology, paving the way for full-scale detectors in the mid-band. Recently it has been realized that there is unique science available only in the mid-band from observations of objects such as binary black holes or white dwarfs. Finally, I will also discuss the gap in the gravitational wave coverage from about 100 nHz to 0.1 mHz and new ideas for possible detection techniques in that band.

Primary author: GRAHAM, Peter (Stanford U.)

Presenter: GRAHAM, Peter (Stanford U.)

Session Classification: Plenary

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

Axions From the Laboratory to the Cosmos

Wednesday, 8 December 2021 07:00 (40 minutes)

I will review the current status of the search for the QCD axion.

Primary author: SAFDI, Benjamin (UC Berkeley)

Presenter: SAFDI, Benjamin (UC Berkeley)

Session Classification: Review

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

The Current Theoretical Status of Axions

Wednesday, 8 December 2021 07:40 (40 minutes)

I will review the current status of theoretical work on the QCD axion.

Primary author: HOOK, Anson (Maryland)

Presenter: HOOK, Anson (Maryland)

Session Classification: Review

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

Dark Matter: What's Beyond the WIMP Lamppost?

Thursday, 9 December 2021 07:40 (40 minutes)

Despite intensive searches, dark matter has not yet been discovered as a particle. Why not? Arguably, most searches are like looking for lost keys only under the lamppost, because that's where we can see. I will assess how thoroughly we have really searched under the WIMP lamppost, point out opportunities for progress, and discuss the ultimate limitations of such searches. Then I will discuss what's beyond this lamppost, where we have searched much less thoroughly, and where new ideas — exploiting cosmic rays, neutron stars, and more — are catalyzing progress.

Primary author: BEACOM, John (Ohio State)

Presenter: BEACOM, John (Ohio State)

Session Classification: Review

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

Neutrino Astronomy

Thursday, 9 December 2021 07:00 (40 minutes)

Neutrinos are fascinating elementary particles heralding the dawn of the multi-messenger astronomy era. Neutrinos affect the stellar dynamics, drive the formation of new elements, and carry signatures of the yet mysterious physics ruling cosmic accelerators. Recent developments on neutrinos from cosmic sources will be reviewed together with detection prospects.

Primary author: TAMBORRA, Irene (NBI, Copenhagen)

Presenter: TAMBORRA, Irene (NBI, Copenhagen)

Session Classification: Review

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

Search for Primordial Black Holes with Microlensing

Friday, 10 December 2021 07:00 (40 minutes)

In this talk I present the recent constraints on primordial black holes (PBHs) with microlensing methods, based on the Subaru Hyper Suprime-Cam (HSC) and the Optical Gravitational Lensing Experiment (OGLE) data. With Subaru HSC data, we obtained the tightest bound on the abundance of PBHs in the mass range of masses from asteroid to moon masses, but found a possible one candidate. We also reported the ultra-short timescale microlensing events of OGLE can be interpreted by PBHs of Earth mass scales. In fact we argue that both HSC microlensing event and OGLE events are consistent with PBHs of Earth mass scale, and a further study would be worth exploring, e.g. with VRO LSST observation of Galactic bulge.

Primary author: TAKADA, Masahiro (Kavli IPMU, Tokyo)

Presenter: TAKADA, Masahiro (Kavli IPMU, Tokyo)

Session Classification: Review

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

PBH-GW Cosmology

Friday, 10 December 2021 07:40 (40 minutes)

Primary author: SASAKI, Misao (Kavli IPMU, Tokyo)

Presenter: SASAKI, Misao (Kavli IPMU, Tokyo)

Session Classification: Review

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

Keynote

Friday, 10 December 2021 10:30 (1 hour)

Presenter: RANDALL, Lisa (Harvard)

Session Classification: Keynote

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

Dark Matter and Line Intensity Mapping

Friday, 10 December 2021 08:40 (40 minutes)

Line intensity mapping (LIM) is a rapidly developing new technique to study astrophysics and cosmology. With LIM, the luminosity density of a given atomic/molecular emission line is mapped in a three-dimensional volume. I will discuss how this technique can be used to determine the distribution of dark matter and to also probe specific dark-matter candidates. I will also describe how the measurements may complement other measurements that probe the expansion history, dark energy, and the Hubble tension.

Primary author: KAMIONKOWSKI, Marc (Johns Hopkins)

Presenter: KAMIONKOWSKI, Marc (Johns Hopkins)

Session Classification: Plenary

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

Primordial Black Holes: New Formation Scenarios and Astrophysical Manifestations

Friday, 10 December 2021 09:20 (40 minutes)

I will review some recently proposed scenarios for PBH formation, as well as astrophysical consequences of dark matter in the form of primordial black holes.

Primary author: KUSENKO, Alexander (UCLA/Kavli IPMU, Tokyo)

Presenter: KUSENKO, Alexander (UCLA/Kavli IPMU, Tokyo)

Session Classification: Plenary

Contribution ID: **18** Type: **not specified**

High-Energy Multimessenger Particle Astrophysics

Thursday, 9 December 2021 08:50 (40 minutes)

The discovery of high-energy cosmic neutrinos opened a new window of astroparticle physics. Their origin is a new mystery in the field, which is tightly connected to the long-standing puzzle about the origin of cosmic rays. I will discuss theoretical implications of the latest results on high-energy neutrino and cosmic-ray observations, and demonstrate the power of multi-messenger approaches. I will also highlight recent developments about astrophysical neutrino emission and discuss some possibilities of utilizing high-energy neutrinos as a probe of physics beyond the Standard Model.

Primary author: MURASE, Kohta (Penn State/YITP, Kyoto)

Presenter: MURASE, Kohta (Penn State/YITP, Kyoto)

Session Classification: Plenary

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

Probing Neutrino Physics in the Early Universe and Compact Objects

Thursday, 9 December 2021 09:30 (40 minutes)

Neutrino decoupling in the high entropy early universe is a protracted process (T ~ 10 MeV to T~ 10 keV) that plays out over hundreds of Hubble times and is a key influencer of BBN and CMB observables. Any new physics operating in this period that alters entropy flow and the time-temperature-scale factor relationship could leave "fingerprints" that show up in future high precision measurements of these observables. By contrast, gravitational collapse of massive stars can involve low entropy, lepton degenerate environments that are exquisitely sensitive to lepton number violating BSM physics, especially in the neutrino sector. I will discuss both of these venues and the prospects for future cosmological and gravitational wave measurements to enable them to probe new physics.

Primary author: FULLER, George (UCSD)

Presenter: FULLER, George (UCSD)

Session Classification: Plenary

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

CEvNS Heaven

Thursday, 9 December 2021 10:10 (40 minutes)

Neutrinos interact with matter via a large cross-section interaction, coherent elastic neutrino-nucleus scattering (CEvNS). This interaction is both a background for dark matter experiments, and an astrophysical signal in itself. This talk will review terrestrial CEvNS measurements and prospects for the use of CEvNS for measurement of neutrinos from astrophysical sources.

Primary author: SCHOLBERG , Kate (Duke)

Presenter: SCHOLBERG , Kate (Duke)

Session Classification: Plenary

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

Galactic Probes of Dark-Sector Physics

Wednesday, 8 December 2021 08:50 (40 minutes)

Primary author: LISANTI, Mariangela (Princeton University)

Presenter: LISANTI, Mariangela (Princeton University)

Session Classification: Plenary

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

Fundamental Axions

Wednesday, 8 December 2021 09:30 (40 minutes)

Axion-like fields appear in many string theory constructions. I will discuss a proposed explanation for why they are so ubiquitous: they play a crucial role in eliminating would-be global symmetries from the theory. This also gives a new perspective on axion interactions with magnetic monopoles. I will explain how magnetic monopole loops give rise to an axion potential.

Primary author: REECE, Matthew (Harvard University)

Presenter: REECE, Matthew (Harvard University)

Session Classification: Plenary

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

Dark Matter Production in the Backdrop of Unusual Cosmologies

Wednesday, 8 December 2021 10:10 (40 minutes)

The abundance of dark matter is a key piece of information that informs any fundamental theory aiming to describe its properties. However, mapping this measurement onto the parameters of the underlying theory relies on the cosmology at early times, which is itself not well-anchored by observation. I will describe a few ways in which the properties of the Universe at early times could deviate from our expectations, and explore how they would influence the parameter space of dark matter models that one would infer as a result.

Primary author: TAIT, Tim (University of California, Irvine)

Presenter: TAIT, Tim (University of California, Irvine)

Session Classification: Plenary

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

Primordial Black Hole Domination: Dark Matter, Dark Radiation, and Gravitational Waves

Wednesday, 8 December 2021 11:20 (40 minutes)

If even a relatively small number of primordial black holes (PBH) were created in the early universe, they will constitute an increasingly large fraction of the total energy density as space expands. It is thus well-motivated to consider scenarios in which the early universe was dominated by short lived PBH (M < 10^9 grams, t < 1 sec) whose Hawking radiation produces both the Standard Model radiation bath and other exotic gravitationally coupled species. Within this context, we consider Hawking radiation as a mechanism to produce dark radiation and dark matter. In a PBH dominated era, we find that Schwarzschild Hawking evaporation produces dark radiation at a level ΔNeff~0.03–0.2 for each light and decoupled species of spin 0, 1/2, or 1. During this era, dark matter could also originate as Hawking radiation, although such dark matter candidates must be very heavy (m >10^11 GeV) to avoid overproduction. Furthermore, if the PBH undergo mergers before evaporating, the subsequent population acquires nonzero spin, so the resulting Kerr Hawking radiation efficiently produces gravitons whose contribution to ΔNeff is within the reach of future CMB experiments; such mergers also predict a characteristic spectrum of primordial gravitational waves at high frequencies correlated with the progenitor PBH mass.

Primary author: KRNJAIC, Gordan (Fermilab/Chicago)

Presenter: KRNJAIC, Gordan (Fermilab/Chicago)

Session Classification: Plenary

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

Cosmological Tests of the Early Matter-dominated Epoch by Observing Cosmic Neutrino Background, Gravitational Wave Background and Primordial Black Holes

Wednesday, 8 December 2021 12:00 (40 minutes)

After aLIGO detected the gravitational wave (GW) produced by mergers of binary black holes (BHs), researchers have aggressively studied the origin of the BHs with masses of the order of O(10) M_sun. In addition to astrophysical origins through evolutions of Pop.III/Pop.II stars, one of the attractive candidates of those BHs should be Primordial Black Holes (PBHs). The PBHs can be produced even in the early matter dominated Universe due to collapses of regions which have a large curvature perturbation. I will explain the mechanism of PBH formations in the early matter dominated Universe in detail. Next, I will discuss some ideas to test the early matter-dominated epoch realized, e.g., just after inflation by observing the effective number of neutrino species which can be less than three, distinctive spectra of gravitational wave background and a nonzero spin of primordial black holes in future.

Primary author: KOHRI, Kazunori (KEK)

Presenter: KOHRI, Kazunori (KEK)

Session Classification: Plenary

Contribution ID: **38** Type: **not specified**

New Insights Into GeV-scale Dark Matter From Rotation Curves, Direct Detection Experiments, Astrophysics and Cosmology

Tuesday, 7 December 2021 07:00 (40 minutes)

I will report on two new developments in GeV-scale dark matter phenomenology.
1) A comprehensive analysis of 129 SPARC rotation curves — Loizeau + GF (2021) — significantly disfavors standard LCDM profiles. The best-fit is obtained with a (puffy) dark matter disk; a flexible Einasto profile is next best, and SIDM considerably worse.
2) Previous analyses of constraints on DM-baryon interactions in the micro-barn to barn range inappropriately used the Born approximation scaling sigma_A = (A mu_A/ mu_p)^2 sigma_p to relate cross-sections on different nuclei. This dramatically distorts the interpretation for much of the relevant parameter space, for instance significantly exaggerating the He contribution to the CMB limits. I will report results of Xu+GF(2021a) - a complete reanalysis of limits from CMB, XQC, CRESST, gas clouds, Ly-alpha, and dwarf galaxies, using exact non-perturbative treatment. I will also report new stronger limits - Xu+GF(2021b) - from combining the constraints of a novel dewar experiment with those from BBN.
The puffy disk result hints at a DM-baryon interaction, as can arise with Sexaquark Dark Matter, but the other searches for evidence of interactions are not yet sensitive enough to expect to find a signal.

Primary author: FARRAR, Glennys (NYU)

Presenter: FARRAR, Glennys (NYU)

Session Classification: Plenary

Contribution ID: **39** Type: **Oral**

Friendship in the Axiverse

Tuesday, 7 December 2021 12:14 (18 minutes)

A generic low-energy prediction of string theory is the existence of a large collection of axions, commonly known as a string axiverse. In a realistic axiverse, string axions can be distributed densely over many orders of magnitude in mass, and are expected to interact with one another through their joint potential. In this talk, I will show how non-linearities in this potential can lead to a new type of resonant energy transfer between axions with nearby masses. This resonance generically transfers energy from axions with larger decay constants to those with smaller decay constants, leading to a multitude of signatures. These include enhanced direct detection prospects for a resonant pair comprising even a small subcomponent of dark matter, and boosted small-scale structure if the pair is the majority of DM. Near-future iterations of experiments such as ADMX and DM Radio will be sensitive to this scenario, as will astrophysical probes of DM substructure.

Primary author: CYNCYNATES, David (Stanford, SITP)

Presenter: CYNCYNATES, David (Stanford, SITP)

Session Classification: Parallel 1: Axions and Other Dark Matter Particles

Contribution ID: **40** Type: **Oral**

Gravitational Wave Probes of Axion Kination

Tuesday, 7 December 2021 11:56 (18 minutes)

We establish a paradigm where the (QCD) axion's novel cosmological evolution, a rotation in the field space, gives rise to dark matter and the baryon asymmetry. The axion rotations also provide a natural origin for a kination era, where the total energy density is dominated by the kinetic term of the axion field, preceded by an early era of matter domination. We investigate the effects of this cosmological scenario on the spectrum of possible primordial gravitational waves from inflation or cosmic strings and find that the spectrum features a triangular peak. As a result, future gravitational wave observations can probe the viable parameter space of kination, including regions that produce axion dark matter by the kinetic misalignment mechanism or the baryon asymmetry by axiogenesis.

Primary author: CO, Raymond (University of Minnesota)

Presenter: CO, Raymond (University of Minnesota)

Session Classification: Parallel 1: Axions and Other Dark Matter Particles

Contribution ID: **41** Type: **Oral**

Ionization and Thermal Histories with Dark Matter Energy Injection

Tuesday, 7 December 2021 11:38 (18 minutes)

Measurements of the cosmic microwave background, the Lyman-Alpha forest and future 21-cm results can set significant constraints on dark matter annihilation or decay. To obtain such limits, a good understanding of how dark matter energy injection affects the ionization and thermal history of the universe is crucial. In this talk, I will present an open-source code package called DarkHistory, which will compute these histories efficiently and accurately. I will then discuss how this code can be used to obtain state-of-the-art constraints on dark matter annihilation and decay from the evolution of the intergalactic medium temperature deduced from Lyman-Alpha forest observations.

Primary authors: RIDGWAY, Gregory; LIU, Hongwan (New York University / Princeton University); SLATYER, Tracy; QIN, Wenzer

Presenter: LIU, Hongwan (New York University / Princeton University)

Session Classification: Parallel 1: Axions and Other Dark Matter Particles

Contribution ID: **42** Type: **Oral**

Axion and Dark Photon Experiments, a Translators Dictionary for the Perplexed

Tuesday, 7 December 2021 12:50 (18 minutes)

The dark photon is a massive hypothetical particle that interacts with the Standard Model by kinetically mixing with the visible photon. Due to the similarity with the electromagnetic signals generated by axions, many putative bounds on dark photon signals are simply reinterpretations of historical bounds set by axion haloscopes. However, the dark photon has a property that the axion does not: an intrinsic polarization. Due to the rotation of the Earth, accurately incorporating this polarization into dark photon analyses is nontrivial, and highly experiment-dependent. Several well-known searches for axions employ techniques for testing signals that preclude their ability to set exclusion limits on dark photons, and hence should not be reinterpreted as such. Most experiments do not have a straight forward reinterpritation for polarized dark photons. On the other hand, we find that if one does account for the dark photon's polarization, and the rotation of the Earth, an experiment's discovery reach can be improved by an order of magnitude. Here, we detail the strategies that would need to be taken to properly optimise a dark photon search. These include a judiciously choosing the orientation of the experiment, as well as strategically timing any repeated measurements and splitting measurements into multiple parts. Such strategies have significant impact on limits without additional time or cost.

Primary author: MILLAR, Alexander (Stockholm University)

Presenter: MILLAR, Alexander (Stockholm University)

Session Classification: Parallel 1: Axions and Other Dark Matter Particles

Contribution ID: **43** Type: **Oral**

A Measurement of Small-scale Structure with Hubble Legacy Fields

Tuesday, 7 December 2021 11:20 (18 minutes)

I will describe a new measurement of the small-scale matter power spectrum using UV luminosity-functions (UVLFs) from the Hubble Space Telescope. These data trace the abundance of the first galaxies forming during the epoch of reionization. Since the first galaxies were much less massive than their counterparts today, they provide us with a handle on the clustering of dark matter at smaller scales. I will present the public code GALLUMI, which is built to efficiently marginalize over astrophysical uncertainties and obtain cosmological constraints. Our analysis is able to measure small-scale matter fluctuations at $k = 0.5 - 10\mathrm{Mpc}^{-1}$ and $z = 4 - 10$ to roughly 30\% precision. This measurement sheds light onto the nature of dark matter in a currently uncharted range of scales and redshifts.

Primary authors: BLAS, Diego; MUNOZ, Julian B. (Harvard-Smithsonian Center for Astrophysics); SABTI, Nash

Presenter: MUNOZ, Julian B. (Harvard-Smithsonian Center for Astrophysics)

Session Classification: Parallel 1: Axions and Other Dark Matter Particles

Contribution ID: **44** Type: **Oral**

Cosmological Probes of Dark Matter Physics

Tuesday, 7 December 2021 12:32 (18 minutes)

Cosmology plays a central role in understanding the nature of dark matter (DM), with the power to test models which are hard to access by other means. The ultra-light axion is a compelling particle candidate that is motivated, e.g., by the string theory "axiverse" and as a possible solution to the so-called "small-scale crisis" of the cold dark matter model, if its mass is ~ 10^-22 eV. I will present new, robust bounds on the axion mass that improve by over an order of magnitude relative to previous studies. This now significantly excludes the canonical mass scale of 10^-22 eV. The bounds exploit cosmological data from the cosmic microwave background, galaxy clustering, galaxy weak lensing and, in particular, spectroscopic observations of the intergalactic medium: the Lyman-alpha forest. In the search for light, sub-GeV dark matter, cosmology is highly complementary to direct detection experiments, which have limited sensitivity to light DM by nuclear recoil. I will present the strongest cosmological bounds on the dark matter – proton cross section for DM masses from 10 keV to 100 GeV. This exploits a dark matter "emulator", which is a machine learning method to exploit the full power of cosmological simulations in setting limits.

Primary author: ROGERS, Keir (University of Toronto)

Presenter: ROGERS, Keir (University of Toronto)

Session Classification: Parallel 1: Axions and Other Dark Matter Particles

Contribution ID: **45** Type: **Oral**

Astrophysical Neutrino Decay

Tuesday, 7 December 2021 11:20 (18 minutes)

Neutrino decay modifies neutrino propagation in a unique way; not only is there flavor changing as there is in neutrino oscillations, there is also energy transport from initial to final neutrinos. The most sensitive direct probe of neutrino decay is currently IceCube which can measure the energy and flavor of neutrinos traveling over extragalactic distances. For the first time we calculate the flavor transition probability for the cases of visible and invisible neutrino decay, including the effects of the expansion of the universe, and consider the implications for IceCube. As an example, we demonstrate how neutrino decay addresses a tension in the IceCube data.

Primary author: DENTON, Peter (Brookhaven National Laboratory)

Presenter: DENTON, Peter (Brookhaven National Laboratory)

Session Classification: Parallel 2: Neutrinos

Contribution ID: **46** Type: **Oral**

Intrinsic Background for Astrophysical Tau-neutrino Searches

Tuesday, 7 December 2021 11:38 (18 minutes)

A precise characterization of the astrophysical neutrino flux is feasible as neutrino telescopes collect data. IceCube has already measured the spectral shape and flavor composition of this flux. Several projected experiments will be able to further constrain the nature of cosmic neutrinos. Most of these experiments look for neutrinos that cross the Earth, so it is fundamental to understand the propagation of high-energy neutrinos through dense mediums. In this work, we present neutrino flux predictions accounting for new Earth propagation effects that were not included before. In particular, we calculate the flux of secondary leptons produced as neutrinos travel through, which can not be ignore by new generation of experiments. Finally, we will study the effect of this flux on the latest IceCube's HESE analysis.

Primary authors: GARCIA SOTO, Alfonso Andres (Harvard University); ARGÜELLES, Carlos; SAFA, Ibrahim; ZHELNIN, Pavel

Presenter: GARCIA SOTO, Alfonso Andres (Harvard University)

Session Classification: Parallel 2: Neutrinos

Contribution ID: **47** Type: **Oral**

Dark Matter Searches and NSI Search with Super-Kamiokande

Tuesday, 7 December 2021 12:32 (18 minutes)

By looking for an excess of neutrinos in the direction of the Galactic center, Sun or Earth above the atmospheric neutrino background, WIMP hypothesis is tested. Thanks to the accurate characterization of the atmospheric neutrinos, competitive sensitivity to light WIMPs with masses down to 1 GeV is achieved. Furthermore, some scenarios predict boosted DM that can be directly detected in the neutrino experiments via DM-electron scattering. In this talk, the latest results of the indirect and direct dark matter searches using the Super-Kamiokande (SK) data collected during the SK-I - IV period will be presented. The precise measurement of atmospheric neutrino flux also allows to probe the subdominant effects induced by new physics. The resent Nonstandard interaction (NSI) study using 5326 days of SK atmospheric neutrino data will be presented.

Primary author: SUPER-KAMIOKANDE COLLABORATION

Presenter: CHOI, Koun (IBS)

Session Classification: Parallel 2: Neutrinos

Contribution ID: **48** Type: **Oral**

Terrestrial Upscattering and Heavy Neutral Leptons

Tuesday, 7 December 2021 11:56 (18 minutes)

Neutrinos passing through the Earth can scatter off nuclei and produce heavy neutral leptons (HNLs). For HNL decay lengths on the order of, or shorter than, the radius of the Earth these HNLs can be efficiently detected by searching for their decay products in large volume detectors. I will discuss prospects for discovery of HNLs produced from solar and atmospheric neutrinos in large volume detectors.

Primary authors: SHOEMAKER, Ian; GUSTAFSON, R. Andrew; PLESTID, Ryan (University Of Kentucky)

Presenter: PLESTID, Ryan (University Of Kentucky)

Session Classification: Parallel 2: Neutrinos

Contribution ID: **49** Type: **Oral**

A Closer Look at the pp-chain Reaction in the Sun: Constraining the Coupling of Light Mediators to Protons

Tuesday, 7 December 2021 12:14 (18 minutes)

The pp-chain of nuclear reactions is the primary route for energy production in the Sun. The first step in that reaction sequence converts two protons to a deuterium nucleus with the emission of a positron and electron neutrino. This reaction is extremely slow because it is a weak interaction, and significantly, it involves quantum tunneling through the Coulomb barrier. Though the reaction rate can be calculated with high confidence in the Standard Model, it has not been measured at solar energies. If there exist interactions that are engendered by non-standard mediators then the rate of this reaction in the Sun could be altered. We probe such non-standard interactions by comparing calculations of solar evolution to the current solar system age in the presence and absence of the non-standard mediators. These reveal ranges of non-standard mediator mass and couplings that are inconsistent with measured properties of the Sun, including solar neutrino results. Our constraints on these non-standard parameters, in many cases overlapping those derived via other considerations, could be extended further with better confidence in the value of the metalicity of the Sun and the solar neutrino CNO flux. Intriguingly, our work reveals a degeneracy between the solar metalicity and the presence of the invoked non-standard mediators.

Primary authors: SULIGA, Anna M. (University of California, Berkeley and University of Wisconsin-Madison); FULLER, George M.; SHALGAR, Shashank

Presenter: SULIGA, Anna M. (University of California, Berkeley and University of Wisconsin-Madison)

Session Classification: Parallel 2: Neutrinos

Contribution ID: **50** Type: **Oral**

Long Time Simulation Framework of Supernova Neutrino

Tuesday, 7 December 2021 12:50 (18 minutes)

Heavy stars can explode at their ends. This phenomenon is called supernova. Supernovae are very complicated systems so we need high cost computation to understand them. Supernovae release a lot of neutrinos at their explosion. If a supernova happens in our galaxy, a few thousands events could be detected with neutrino detectors in the world for about more than 10 seconds. We need long time simulations, which are longer than 10 seconds, to compare observation and theory. I will present our simulation framework for long time supernova simulation and recent development to address black hole formation.

Primary author: MORI, Masamitsu (University of Tokyo)

Presenter: MORI, Masamitsu (University of Tokyo)

Session Classification: Parallel 2: Neutrinos

Contribution ID: **51** Type: **Oral**

Ionization of Gravitational Atoms

Tuesday, 7 December 2021 11:20 (18 minutes)

Superradiant instabilities may create clouds of ultralight bosons around black holes, forming so-called "gravitational atoms." It was recently shown that the presence of a binary companion can induce resonant transitions between a cloud's bound states. When these transitions backreact on the binary's orbit, they lead to qualitatively distinct signatures in the gravitational waveform that can dominate the overall behavior of the inspiral. In this talk, I will show that the interaction with the companion can also trigger transitions from bound to unbound states of the cloud—a process which I will refer to as "ionization," in analogy with the photoelectric effect in atomic physics. Here, too, there is a type of resonance with a similarly distinct signature in the gravitational waveform, which may ultimately be used to detect any dark ultralight bosonic particles in our universe.

Primary authors: BAUMANN, Daniel; BERTONE, Gianfranco; TOMASELLI, Giovanni Maria; STOUT, John (Harvard University)

Presenter: STOUT, John (Harvard University)

Session Classification: Parallel 3: Black Holes and Gravitational Waves

Contribution ID: **52** Type: **Oral**

Asteroid Tracking Array and Space Quantum Technology for Fundamental Physics

Tuesday, 7 December 2021 11:38 (18 minutes)

We study for the first time the possibility of probing long-range fifth forces utilizing asteroid astrometric data, via the fifth force-induced orbital precession. We examine nine Near-Earth Object (NEO) asteroids whose orbital trajectories are accurately determined via optical and radar astrometry. Focusing on a Yukawa-type potential mediated by a new gauge field (dark photon) or a baryon-coupled scalar, we estimate the sensitivity reach for the fifth-force coupling strength and mediator mass in the mass range $m \simeq 10^{-21} - 10^{-15}\,\mathrm{eV}$. Our estimated sensitivity is comparable to leading limits from torsion balance experiments, potentially exceeding these in a specific mass range. The fifth forced-induced precession increases with the orbital semi-major axis in the small m limit, motivating the study of objects further away from the Sun. We discuss future exciting prospects for extending our study to more than a million asteroids (including NEOs, main-belt asteroids, Hildas, and Jupiter Trojans), as well as trans-Neptunian objects and exoplanets. Our work can also be applied to the studies of dark matter and gravitational waves. The new development of NASA/NIST proposals of Quantum technologies in Space could bring drastic improvements to our studies, which I will discuss briefly near the end of the talk. This talk is mainly based on https://arxiv.org/abs/2107.04038.

Primary author: TSAI, Yu-Dai (University of California, Irvine & Fermi National Accelerator Laboratory (Fermilab))

Presenter: TSAI, Yu-Dai (University of California, Irvine & Fermi National Accelerator Laboratory (Fermilab))

Session Classification: Parallel 3: Black Holes and Gravitational Waves

Contribution ID: **53** Type: **Oral**

Asymmetric Reheating by Primordial Black Holes

Tuesday, 7 December 2021 11:56 (18 minutes)

We investigate Hawking evaporation of a population of primordial black holes (PBHs) prior to Big Bang Nucleosynthesis (BBN) as a mechanism to achieve asymmetric reheating of two sectors coupled solely by gravity. While the visible sector is reheated by the inflaton or a modulus, the dark sector is reheated by PBHs. Compared to inflationary or modular reheating of both sectors, there are two advantages: (i) inflaton or moduli mediated operators that can subsequently thermalize the dark sector with the visible sector are not relevant to the asymmetric reheating process; (ii) the mass and abundance of the PBHs provide parametric control of the thermal history of the dark sector, and in particular the ratio of the temperatures of the two sectors. Asymmetric reheating with PBHs turns out to have a particularly rich dark sector phenomenology, which we explore using a single self-interacting real scalar field in the dark sector as a template. Four thermal histories, involving non-relativistic and relativistic dark matter (DM) at chemical equilibrium, followed by the presence or absence of cannibalism, are explored. These histories are then constrained by the observed relic abundance in the current Universe and the Bullet Cluster. The case where PBHs dominate the energy density of the Universe, and reheat both the visible as well as the dark sectors, is also treated in detail.

Primary authors: SHAMS ES HAGHI, Barmak (University of Utah); SINHA, Kuver; SANDICK, Pearl

Presenter: SHAMS ES HAGHI, Barmak (University of Utah)

Session Classification: Parallel 3: Black Holes and Gravitational Waves

Contribution ID: **54** Type: **Oral**

Cloud Cooling Bounds on Intermediate Mass and Light Primordial Black Holes

Tuesday, 7 December 2021 12:14 (18 minutes)

Primordial Black Holes (PBH) in the intermediate mass range can be seeds for supermassive black holes and recent LIGO detections of black hole mergers in the mass gap suggest PBH progenitors. I present a novel constraint on the PBH mass fraction spanning PBH masses of ~10-10^6 solar masses from thermal equilibrium considerations. A population of PBH in the central region of the dwarf galaxy Leo T will accrete gas from the interstellar medium and emit high energy photons and protons, depositing heat back into the ISM gas. Using semi-analytical accretion disk modeling, we balance the heating and cooling rates of the Leo T gas to derive competitive bounds. We extend our results to spinning PBH with shock heating from outflows as well as to light PBHs with Hawking evaporation.

Primary author: LU, Philip (Seoul National University)

Presenter: LU, Philip (Seoul National University)

Session Classification: Parallel 3: Black Holes and Gravitational Waves

Contribution ID: **55** Type: **Oral**

Gravitational Wave Signatures of Baryonic Dark Matter

Tuesday, 7 December 2021 12:32 (18 minutes)

Gravitational waves provide a unique method of testing theories with extended gauge symmetries. In particular, spontaneous symmetry breaking can lead to a detectable stochastic gravitational wave background generated by cosmic strings and first order phase transitions in the early universe. I will discuss the unique gravitational wave signature of a dark matter model with gauged baryon and lepton numbers, in which a high scale of lepton number breaking is motivated by the seesaw mechanism for the neutrinos, whereas a low scale of baryon number breaking is required by the observed dark matter relic density. This novel signature can be searched for in near-future gravitational wave experiments.

Primary author: FORNAL, Bartosz (Barry University)

Presenter: FORNAL, Bartosz (Barry University)

Session Classification: Parallel 3: Black Holes and Gravitational Waves

Contribution ID: **56** Type: **Oral**

Mergers as a Probe of Particle Dark Matter

Tuesday, 7 December 2021 12:50 (18 minutes)

Unusual masses of black holes being discovered by gravitational wave experiments pose fundamental questions about their origin. More interestingly, black holes with masses smaller than the Chandrasekhar limit (~ 1.4 solar mass) are essentially impossible to produce through any standard stellar evolution. Primordial black holes, with fine-tuned parameters, and with no compelling formation mechanisms, are the most discussed explanation of these objects. In this talk, I will discuss a simple production channel of these low mass black holes – particle dark matter with no antiparticle counterpart, owing to their interaction with stellar nuclei, can catastrophically accumulate inside compact stars, and eventually transmute them to sub-Chandrasekhar mass black holes, ordinarily forbidden by the Chandrasekhar limit. I will point out several avenues to test the origin of these low mass black holes, concentrating on the cosmic evolution of the binary merger rates. I will demonstrate how measurement of these merger rates, especially at higher redshifts, by the imminent gravitational wave detectors can conclusively determine the origin of these low mass black holes, and therefore, can test the particle dark matter hypothesis.

Primary author: RAY, Anupam (Tata Institute of Fundamental Research)

Presenter: RAY, Anupam (Tata Institute of Fundamental Research)

Session Classification: Parallel 3: Black Holes and Gravitational Waves

Contribution ID: **57** Type: **Oral**

On Microlensing of Axion Clumps

Thursday, 9 December 2021 12:50 (18 minutes)

A sizeable fraction of axion dark matter may be today in galactic halos in the form of Bose-Einstein condensate structures, which are known in the literature as “axion stars” or “axion clumps”. In this talk, I will address main astrophysical features associated with such gravitational bound objects and constraints over their abundance via gravitational microlensing, including finite lens and source size effects. I will consider axion stars composed of the QCD axion as well as axion-like particles. In addition, I will also consider clumps composed of a generic scalar dark matter candidate with repulsive self-interactions. My analysis certainly opens up a new window for the potential discovery of dark matter. This talk is mainly based on arXiv:2109.04283 [hep-ph] and JCAP 01 (2018) 037.

Primary authors: SCHIAPPACASSE, Enrico D. (University of Jyväskylä); FUJIKURA, Kohei; HERTZBERG, Mark P.; YAMAGUCHI, Masahide

Presenter: SCHIAPPACASSE, Enrico D. (University of Jyväskylä)

Session Classification: Parallel 1: Axions and Other Dark Matter Particles

Contribution ID: **58** Type: **Oral**

Seeding Supermassive Black Holes with Self-interacting Dark Matter

Thursday, 9 December 2021 11:20 (18 minutes)

Observations show that supermassive black holes (SMBHs) with a mass of one billion solar mass exist when the universe is just 6% of its current age. We propose a scenario where a self-interacting dark matter halo experiences gravothermal instability and its central region collapses into a seed black hole. The presence of baryons in protogalaxies could significantly accelerate the gravothermal evolution of the halo and shorten collapse timescales. The central halo could dissipate its angular momentum remnant via viscosity induced by the self-interactions. The host halo must be on high tails of density fluctuations, implying that high-z SMBHs are expected to be rare in this scenario. We further derive conditions for triggering general relativistic instability of the collapsed region. Our results indicate that self-interacting dark matter can provide a unified explanation for diverse dark matter distributions in galaxies today and the origin of SMBHs at redshifts around 6-7.

Primary author: ZHONG, Yiming (Kavli Institute for Cosmological Physics)

Presenter: ZHONG, Yiming (Kavli Institute for Cosmological Physics)

Session Classification: Parallel 1: Axions and Other Dark Matter Particles

Contribution ID: **59** Type: **Oral**

Cosmological Constraints on Light (but Massive) Relics

Thursday, 9 December 2021 11:56 (18 minutes)

An intriguing possibility for the particle makeup of the dark sector is that a small fraction of the observed abundance is made up of light, feebly-interacting particle species. Neutrinos, with their yet-unresolved masses, are a concrete example in this category, but more exotic candidates readily arise from new physics scenarios. Due to their weakness of interaction but comparatively large number abundance, cosmological datasets are particularly powerful tools to leverage here. In this talk I describe the impact of these new particle species on observables, present a comprehensive set of state-of-the-art constraints, and discuss the added power that near future experiments might lend us.

Primary authors: DVORKIN, Cora; MUNOZ, Julian B.; XU, Weishuang (UC Berkeley/LBL)

Presenter: XU, Weishuang (UC Berkeley/LBL)

Session Classification: Parallel 1: Axions and Other Dark Matter Particles

Contribution ID: **60** Type: **Oral**

The Companion Axion

Thursday, 9 December 2021 12:14 (18 minutes)

Colored gravitational instantons, known as Eguchi-Hanson instantons, mediate vacuum-vacuum transitions in an analogous way to the well-known BPST instantons. As a result, a new source of CP-violation is present in gauge theories, described by an additional 'quantum gravity' vacuum angle. This second angle spoils the usual axion as a solution to the strong CP problem. The simplest solution to this issue is to instead introduce two axions, which are necessarily coupled in order to solve the strong CP problem. Such models possess extremely rich and novel phenomenology. In this talk I will summarize the companion axion theory and investigate phenomenology and constraints relating to the axion-photon coupling, with some focus as well on the new two-axion system as dark matter.

Primary authors: KOBAKHIDZE, Archil; O'HARE, Ciaran; PIEROBON, Giovanni; PICKER, Zachary (University of Sydney); CHEN, Zhe

Presenter: PICKER, Zachary (University of Sydney)

Session Classification: Parallel 1: Axions and Other Dark Matter Particles

Contribution ID: **61** Type: **Oral**

Thermal Perturbations from Cosmological Constant Relaxation

Thursday, 9 December 2021 12:32 (18 minutes)

We probe the cosmological consequences of a recently proposed class of solutions to the cosmological constant problem. In these models, the universe undergoes a long period of inflation followed by a contraction and a bounce that sets the stage for the hot big bang era. A requirement of any successful early universe model is that it must reproduce the observed scale-invariant density perturbations at CMB scales. While these class of models involve a long period of inflation, the inflationary Hubble scale during their observationally relevant stages is at or below the current Hubble scale, rendering the de Sitter fluctuations too weak to seed the CMB anisotropies. We show that sufficiently strong perturbations can still be sourced thermally if the relaxion field serving as the inflaton interacts with a thermal bath, which can be generated and maintained by the same interaction. We present a simple model where the relaxion field is derivatively (i.e. technically naturally) coupled to a non-abelian gauge sector, which gets excited tachyonically and subsequently thermalizes due to its nonlinear self-interactions. This model explains both the smallness of the cosmological constant and the amplitude of CMB anisotropies.

Primary authors: KAPLAN, David E.; TANIN, Erwin (Johns Hopkins University); JI, Lingyuan; RAJENDRAN, Surjeet

Presenter: TANIN, Erwin (Johns Hopkins University)

Session Classification: Parallel 1: Axions and Other Dark Matter Particles

Contribution ID: **62** Type: **Oral**

Recent Searches for Dark Sectors and Axion-Like Particle with BABAR

Thursday, 9 December 2021 13:08 (18 minutes)

Many scenarios of physics beyond the Standard Model predict new particles with masses well below the electroweak scale. Low-energy, high luminosity colliders such as BABAR are ideally suited to discover these particles. We present several recent searches for low-mass dark sector particles at BABAR, including leptophilic scalars, new gauge bosons coupling only to the second and third generation of leptons, and axion like particles produced in B decays. We also present recent result of a search for dark matter bound states (darkonium). These examples show the importance of -factories in constraining and discovering new dark-sector physics beyond the Standard Model.

Primary author: BABAR COLLABORATION,

Presenter: LI, Yunxuan (California Institute of Technology)

Session Classification: Parallel 1: Axions and Other Dark Matter Particles

Contribution ID: **63** Type: **Oral**

Connecting the Extremes: A Story of Supermassive Black Holes and Ultralight Dark Matter

Thursday, 9 December 2021 11:20 (18 minutes)

The formation of ultra rare supermassive black holes (SMBHs), with masses of $ord10^9 M_{odot}$, in the first billion years of the Universe remains an open question in astrophysics. At the same time, ultralight dark matter (DM) with mass in the vicinity of $ord10^{-20}$ eV has been motivated by small scale DM distributions. Though this type of DM is constrained by various astrophysical considerations, certain observations could be pointing to modest evidence for it. We present a model with a confining first order phase transition at ~ 10 keV temperatures, facilitating production of $ord10^9 msol$ primordial SMBHs. Such a phase transition can also naturally lead to the implied mass for a motivated ultralight axion DM candidate, suggesting that SMBHs and ultralight DM may be two sides of the same cosmic coin. We consider constraints and avenues to discovery from superradiance and a modification to $N_{\rm eff}$. On general grounds, we also expect primordial gravitational waves – from the assumed first order phase transition – characterized by frequencies of $ord10^{-12} - 10^{-9}$ Hz. This frequency regime is largely uncharted, but could be accessible to pulsar timing arrays if the primordial gravitational waves are at the higher end of this frequency range, as could be the case in our assumed confining phase transition.

Primary authors: DAVOUDIASL, Hooman; GEHRLEIN, Julia (Brookhaven National Laboratory); DENTON, Peter B.

Presenter: GEHRLEIN, Julia (Brookhaven National Laboratory)

Session Classification: Parallel 2: Neutrinos

Contribution ID: **64** Type: **Oral**

Decaying Dark Matter at IceCube and its Signature in High-Energy Gamma-Ray Experiments

Thursday, 9 December 2021 11:38 (18 minutes)

Observations of high-energy astrophysical neutrinos in IceCube have opened the door to multi-messenger astronomy, by way of which questions in particle physics could be explored through a combination of IceCube data and optical experiments such as Fermi-LAT. However, the origin of these astrophysical neutrinos is still largely unknown. Among the tensions that still need to be addressed, for example, is the excess of neutrinos observed in the energy range of 40-200 TeV, a contribution that could come from heavy dark matter decay. The dark matter decay hypothesis can be tested through comparisons with gamma-ray data, because a coincident gamma-ray flux is expected to accompany the neutrino flux that IceCube observes. However, gamma-rays become heavily suppressed for sources dominating in particular energy ranges. In the case of the Galactic center, the γ-sky is partially opaque in the (0.1-10) PeV range. This is due to properties of the traversed medium, which can generally consist of extragalactic background light (EBL), the cosmic microwave background (CMB), and the intergalactic magnetic field. These significantly alter the initial spectrum through intermediate processes such as absorption and Inverse-Compton scattering, giving rise to anisotropy and energy features in the final spectrum that reaches telescopes on Earth. The existence of competing photon background models, moreover, complicates estimates of dark matter constraints. In this presentation, we address these questions by studying the impact that these different models have on indirect measurements of heavy dark matter decay. I present my predictions for galactic, inverse-Compton, and extragalactic gamma-ray spectra undergoing attenuation by different backgrounds.

Primary authors: SKRZYPEK, Barbara (Harvard University); ARGUELLES, Carlos; CHIANESE, Marco

Presenter: SKRZYPEK, Barbara (Harvard University)

Session Classification: Parallel 2: Neutrinos

Contribution ID: **65** Type: **Oral**

The Diffuse Supernova Neutrino Background at Super-Kamiokande: Latest Results and Future Prospects

Thursday, 9 December 2021 12:50 (18 minutes)

The latest results from a search for the Diffuse Supernova Neutrino Background (DSNB) at Super-Kamiokande (SK) is presented, incorporating 22.5×2970 kton.days of data from its fourth data-taking phase, covering an overall antineutrino energy range of 9.3–81.3 MeV, and combining results with previous SK data-taking periods, for a combined analysis of nearly 20 years of data. The analysis achieves a 90% C.L. sensitivity to the DSNB flux comparable to various DSNB predictions. No significant evidence for a DSNB signal has been observed, and upper limits on the DSNB flux are placed, reaching about 2.6 antineutrinos/cm^2/s at 90% C.L. for a wide range of models. Identifying the neutron produced by the interaction of DSNB antineutrinos is an important part of our search, as it allows the removal most backgrounds from cosmic muon spallation and atmospheric neutrino interactions, but is particularly challenging in pure water and is a limitation of the current search. Since 2020, Gadolinium has been dissolved in the SK water, dramatically increasing the efficiency of the neutron tagging procedure and, consequently, the sensitivity to the DSNB. The impact of the SK-Gd project on future DSNB searches is discussed.

Primary author: SUPER-KAMIOKANDE COLLABORATION

Presenter: GIAMPAOLO, Alberto (LLR - Ecole Polytechnique)

Session Classification: Parallel 2: Neutrinos

Contribution ID: **66** Type: **Oral**

Results From a Search for Dark Matter Using 6 years of IceCube Data

Thursday, 9 December 2021 12:14 (18 minutes)

The IceCube neutrino observatory is the to-date largest neutrino telescope installed in the Antarctic ice. It consists of 5,160 photomultiplier-tubes spread among 86 vertical strings making a total detector volume of more than a cubic kilometer. It detects neutrinos via Cherenkov light of charged relativistic particles from neutrino interactions with the detector volume. IceCube is, due to its size and photosensor spacing, particularly sensitive to high-energy neutrinos. In this analysis we search for dark matter that annihilates into a metastable mediator that subsequently decays into Standard Model particles. These models yield an enhanced high-energy neutrino flux from dark matter annihilation inside the Sun compared to models without a mediator. Neutrino signals that are produced directly inside the Sun are strongly attenuated at higher energies due to interactions with the solar plasma. In the models considered here, the mediator can escape the Sun before producing any neutrinos, thereby avoiding attenuation. IceCube, due to its module spacing and sensitivity to high energy neutrinos, is ideal to search for this enhanced high-energy neutrino signal. We present the results of an analysis of six years of IceCube data looking for dark matter in the Sun. In this contribution we will present the results of a search for secluded dark matter using 6 years of IceCube data with dark matter masses of up to 75 TeV.

Primary author: ICECUBE COLLABORATION

Presenter: TOENNIS, Christoph (Sungkyunkwan University)

Session Classification: Parallel 2: Neutrinos

Contribution ID: **67** Type: **Oral**

Searching for Pseudo-Dirac Neutrinos in Supernovas

Thursday, 9 December 2021 11:56 (18 minutes)

The discovery of a non-zero mass for neutrinos invites to consider whether they are Dirac or Majorana particles. But those are not the only two possibilities, there is a third one, in which neutrinos are Majorana, but they behave as if they were Dirac particles, that is called pseudo-Dirac particles. The scenario predicts an oscillation between active and sterile neutrinos, with an oscillation length that depends on their mass-squared differences. The present constraints indicate that a low energy neutrino flux that propagates over astrophysical distances is the best candidate to look for any evidence. Therefore, we will concentrate on the neutrino flux emitted from supernovas (SN). In particular, we will analyze the measurement of the SN1987A done by Kamiokande-II, IMB, and Baksan. In case of a SN in the future, the next generation of experiments can also search for an active-sterile oscillation. We concentrate on Hyper-kamiokande and DUNE, that are expected to collect hundreds of events in case of a 10kpc SN, to determine the future sensitivity to this scenario.

Primary author: MARTINEZ-SOLER, Ivan (Harvard U.)

Presenter: MARTINEZ-SOLER, Ivan (Harvard U.)

Session Classification: Parallel 2: Neutrinos

Contribution ID: **68** Type: **Oral**

Unstable Cosmic Neutrino Capture on Tritium

Thursday, 9 December 2021 12:32 (18 minutes)

We forecast constraints on neutrino decay via capture of the Cosmic Neutrino Background (CνB) on tritium, with emphasis on the PTOLEMY-type experiment. Although direct observations of the CνB are still in their very early stages, future direct observations of the CνB will impose significant constraints on a neutrino lifetime in the region of the age of the universe. We discuss the would-be observed spectra for unstable neutrinos, and the constraints on a neutrino lifetime in cosmic neutrino capture on tritium, and the required energy resolution and exposure. This presentation is based on arXiv: 2109.02900.

Primary authors: KENSUKE, Akita (IBS-CTPU); LAMBIASE, Gaetano; YAMAGUCHI, Masahide

Presenter: KENSUKE, Akita (IBS-CTPU)

Session Classification: Parallel 2: Neutrinos

Contribution ID: **69** Type: **Oral**

Tidal Deformation and Dissipation of Rotating Black Holes

Thursday, 9 December 2021 11:20 (18 minutes)

Black holes are never isolated in realistic astrophysical environments; instead, they are often perturbed by complicated external tidal fields. How does a black hole respond to these tidal perturbations? In this talk, I will discuss both the conservative and dissipative responses of the Kerr black hole to a weak and adiabatic gravitational field. The former describes how the black hole would change its shape due to these tidal interactions, and is quantified by the so-called "Love numbers". On the other hand, the latter describes how energy and angular momentum are exchanged between the black hole and its tidal environment due to the absorptive nature of the event horizon. In this talk, I will describe how the Love numbers of the Kerr black hole in a static tidal field vanish identically. I will also describe how the Kerr black hole's dissipative response implies that energy and angular momentum can either be lost to or extracted from the black hole, with the latter process commonly known as the black hole superradiance. I will end by discussing how these tidal responses leave distinct imprints on the gravitational waves emitted by binary black holes.

Primary author: HORNG SHENG, Chia (Institute for Advanced Study)

Presenter: HORNG SHENG, Chia (Institute for Advanced Study)

Session Classification: Parallel 3: Black Holes and Gravitational Waves

Contribution ID: **70** Type: **Oral**

Searching for New Compact Objects with Gravitational Waves

Thursday, 9 December 2021 12:50 (18 minutes)

To date, the only direct evidence of gravitational waves (GWs) comes from the detection of merging black holes and neutron stars by the LIGO and Virgo detectors. Observations of these mergers have provided a wealth of astrophysical information as well as constraining theories of modified gravity. However, no convincing signs of new physics have yet been found in GW data. In this talk I will describe my work on enabling searches for compact objects (COs) other than black holes and neutron stars. In particular, I will focus on COs with enhanced spin-induced quadrupoles such as boson stars or black holes with superradiant clouds. First, I will show how signals from these objects can easily be missed in current search pipelines. Second, I will describe our work on finding effective approximations to these high dimensional waveforms in order to make searching for these COs computationally feasible. Third, I will briefly describe how a modern computational method called automatic differentiation can be used to efficiently generate template banks. Finally, I will report on our initial search results for these novel COs in O3a data.

Primary authors: ZIMMERMAN, Aaron; COOGAN, Adam; SETZER, Christian; WENIGER, Christoph; MESSICK, Cody; CHIA, Horng Sheng; FREESE, Katherine; GEORGE, Richard N.; EDWARDS, Thomas (Stockholm University)

Presenter: EDWARDS, Thomas (Stockholm University)

Session Classification: Parallel 3: Black Holes and Gravitational Waves

Contribution ID: **71** Type: **Oral**

Search for Black Holes in the Galactic Halo by Gravitational Microlensing

Thursday, 9 December 2021 12:32 (18 minutes)

Gravitational microlensing constrains the abundance of massive compact objects in the Galactic halo. Historical studies (MACHO, EROS, OGLE, MOA) have excluded objects lighter than 10 solar masses as a major component of Galactic dark matter. The detection of coalescences of heavier black holes by LIGO/Virgo has rekindled interest in dark matter as compact objects. The effectiveness of previous microlensing studies was limited for high lensing masses, due to the long duration of the expected events. The combination of the historical EROS and MACHO databases, which cover distinct periods, allows us to obtain light curves with a duration exceeding 10 years duration. As a result, the microlensing search sensitivity could be extended to mass lenses up to several hundred solar masses. I will present and discuss the results of this combination of the MACHO and EROS surveys.

Primary authors: MONIEZ, Marc (IJCLab-IN2P3); BLAINEAU, Tristan

Presenter: MONIEZ, Marc (IJCLab-IN2P3)

Session Classification: Parallel 3: Black Holes and Gravitational Waves

Contribution ID: **72** Type: **Oral**

Detecting New Forces in the Gravitational Wave Background

Thursday, 9 December 2021 11:38 (18 minutes)

Supermassive black hole binary mergers generate a stochastic gravitational wave background detectable by pulsar timing arrays. While the amplitude of this background is subject to significant uncertainties, the frequency dependence is a robust prediction of general relativity. We show that the effects of new forces beyond the Standard Model can modify this prediction and introduce unique features into the spectral shape. In particular, we consider the possibility that black holes in binaries are charged under a new long-range force, and we find that pulsar timing arrays are capable of robustly detecting such forces. Supermassive black holes and their environments can acquire charge due to high-energy particle production or dark sector interactions, making the measurement of the spectral shape a powerful test of fundamental physics.

Primary authors: LEHMANN, Benjamin; PATEL, Hiren H.; DROR, Jeff A.; PROFUMO, Stefano

Presenter: LEHMANN, Benjamin

Session Classification: Parallel 3: Black Holes and Gravitational Waves

Contribution ID: **73** Type: **Oral**

Black Hole Superradiance of Self-Interacting Scalar Fields

Thursday, 9 December 2021 11:56 (18 minutes)

Black hole superradiance is a powerful probe of light, weakly-coupled hidden sector particles. Particles with a Compton wavelength comparable to the black hole's radius lead to an instability, extracting mass and angular momentum from the black hole. Many ultralight candidates, such as axions, generically have self-interactions that can influence the evolution of the superradiant instability. Self-interactions lead to energy exchange between bound levels and particle emission to infinity; for large self-couplings, superradiant growth is saturated at a quasi-equilibrium configuration of reduced level occupation numbers. In this talk, I will review the basic aspects of black hole superradiance and give a qualitative picture of how it changes when quartic self-interactions are present. Finally, I will discuss possible signatures, which include coherent, monochromatic gravitational and axion waves that can be probed in current or future experiments.

Primary author: GALANIS, Marios (Stanford University)

Presenter: GALANIS, Marios (Stanford University)

Session Classification: Parallel 3: Black Holes and Gravitational Waves

Contribution ID: **74** Type: **Oral**

Dark Matter, Black Holes and Phase Transitions

Thursday, 9 December 2021 12:14 (18 minutes)

We describe a new production mechanism of particle dark matter, which hinges on momentum filtering during a first-order cosmological phase transition. We then show that this mechanism can be modified to provide a new production mechanism of primordial black holes, which have not yet been observed but could solve a number of problems in cosmology.

Primary author: BAKER, Michael (University of Melbourne)

Presenter: BAKER, Michael (University of Melbourne)

Session Classification: Parallel 3: Black Holes and Gravitational Waves

Contribution ID: **75** Type: **Oral**

Primordial Black Hole Dark Matter Evaporating on the Neutrino Floor

Thursday, 9 December 2021 13:08 (18 minutes)

Primordial black holes hypothetically generated in the first instants of life of the Universe are potential dark matter (DM) candidates. Focusing on Primordial black holes masses in the range [5×10^{14}-5×10^{15}]g, we point out that the neutrinos emitted by PBHs evaporation can interact through the coherent elastic neutrino nucleus scattering producing an observable signal in multi-ton Dark Matter direct detection experiments. We show that with the high exposures envisaged for the next-generation facilities, it will be possible to set bounds on the fraction of Dark Matter composed by Primordial black holes improving the existing neutrino limits obtained with Super-Kamiokande. We also quantify to what extent a signal originating from a small fraction of Dark Matter in the form of Primordial black holes would modify the so-called “neutrino floor”, the well-known barrier towards detection of weakly interacting massive particles as the dominant Dark Matter component.

Primary authors: PALAZZO, Antonio; FIORILLO, Damiano F.G.; MIELE, Gennaro; CALABRESE, Roberta (Università degli studi di Napoli ”Federico II”); MORISI, Stefano

Presenter: CALABRESE, Roberta (Università degli studi di Napoli ”Federico II”)

Session Classification: Parallel 3: Black Holes and Gravitational Waves

Contribution ID: **86** Type: **Oral**

Ion Traps as Dark Matter Detectors

Thursday, 9 December 2021 11:38 (18 minutes)

Millicharge particles with charge just evading accelerator bounds, possess charge large enough to accumulate on earth and cause gigantic build-up over the age of the earth. I introduce a new idea that sets exquisite bounds on millicharge particle dark matter and promises to reach interesting parameter space in the near future. The new detection concept involves the remarkable sensitivity of standard model ions trapped in E&M fields which are being developed for quantum computing.

Primary author: RAMANI, Harikrishnan (Stanford University)

Presenter: RAMANI, Harikrishnan (Stanford University)

Session Classification: Parallel 1: Axions and Other Dark Matter Particles

Contribution ID: **87** Type: **Oral**

New Neutrino Interactions at COHERENT

Thursday, 9 December 2021 13:08 (18 minutes)

A possible sub-leading effect originating from new physics beyond the Standard Model may affect the propagation of neutrinos. In this talk, we shall discuss the potential to prove light extra gauge Z boson inducing neutrino non-standard interactions (NSIs) in the coherent-elastic neutrino-nucleus scattering (CEνNS) experiments. Also, we shall explore the possibility of having a fermionic dark matter candidate within U(1)′ models for CEνNS experiments in light of the latest COHERENT data and the current and future dark matter direct detection experiments. Finally, the potential to prove "general neutrino interactions", exotic new physics interactions beyond the Standard Model interactions will also be presented.

Primary author: NATH, Newton (INFN Bari)

Presenter: NATH, Newton (INFN Bari)

Session Classification: Parallel 2: Neutrinos

Contribution ID: **89** Type: **Poster**

A Last Chance for Kinetic Mixing: Explaining $(g-2)_\mu$ with Semi-visible Dark Photons

Tuesday, 7 December 2021 08:20 (30 minutes)

The recent $(g-2)_\mu$ measurement by the E989 experiment at Fermilab has recently confirmed the previous results at the Brookhaven experiment. The current tension between experiment and the Standard Model (SM) predictions stands at $4.2\,\sigma$. In light of this tantalizing result, it is tempting to reconsider the few low-energy extensions of the SM that may explain the discrepancy. In particular, we revisit the contribution of a kinetically mixed dark photon to the $(g-2)_\mu$, which has been excluded in minimal models with fully visible and invisible dark photon decays. By explicitly re-evaluating constraints from B-factories and fixed target experiments, we show that dark photons with semi-visible decays can still explain the $(g-2)_\mu$ puzzle. Such solution would point to dark sectors with co-annihilating dark matter candidates or dark neutral leptons with fast decays

Primary authors: ABDULLAHI, Asli; MASSARO, Daniele (Alma Mater Studiorum - Università di Bologna / Université Catholique de Louvain); HOSTERT, Matheus; PASCOLI, Silvia

Presenter: MASSARO, Daniele (Alma Mater Studiorum - Università di Bologna / Université Catholique de Louvain)

Session Classification: Break and Poster Session

Contribution ID: **90** Type: **Poster**

Cosmological Black Holes

Tuesday, 7 December 2021 08:20 (30 minutes)

In the early universe, primordial black holes (PBHs) can no longer be described by the simple Schwarzschild metric– we need a metric which is locally surrounded by the cosmological fluid and asymptotically FLRW. It turns out that the phenomenology of PBHs is very sensitive to the choice of such a metric. In particular, the Thakurta metric stands out as perhaps the most justifiable metric for the radiation-dominated universe. In this description, PBHs have an effective mass proportional to the cosmological scale factor. We demonstrate two very significant effects of this choice of metric for the phenomenology of PBHs as dark matter (DM) candidates. Firstly, the binary abundance bounds which tightly constrain LIGO-size PBHs as DM candidates are entirely evaded. Secondly, these PBHs are significantly hotter and so evaporate very rapidly– we show that the smallest black hole which actually survives until today is of order 10^21 g, which fully closes the asteroid-mass window for DM candidates, which was previously totally unconstrained.

Primary author: PICKER, Zachary (University of Sydney)

Presenter: PICKER, Zachary (University of Sydney)

Session Classification: Break and Poster Session

Contribution ID: **91** Type: **Poster**

Quasi-local Photon Surfaces in General Spherically Symmetric Spacetimes

Tuesday, 7 December 2021 08:20 (30 minutes)

Based on the geometry of the codimension-2 surface in general spherically symmetric spacetime, we give a quasi-local definition of a photon sphere as well as a photon surface. This new definition is the generalization of the one provided by Claudel, Virbhadra, and Ellis but without referencing any umbilical hypersurface in the spacetime. The new definition effectively excludes the photon surface in spacetime without gravity. The application of the definition to the Lemaître–Tolman–Bondi (LTB) model of gravitational collapse reduces to a second order differential equation problem. We find that the energy balance on the boundary of the dust ball can provide one of the appropriate boundary conditions to this equation. Based on this crucial investigation, we find an analytic photon surface solution in the Oppenheimer– Snyder (OS) model and reasonable numerical solutions for the marginally bounded collapse in the LTB model. Interestingly, in the OS model, we find that the time difference between the occurrence of the photon surface and the event horizon is mainly determined by the total mass of the system but not the size or the strength of the gravitational field of the system.

Primary authors: CAO, Li-Ming; SONG, Yong (University of Science and Technology of China)

Presenter: SONG, Yong (University of Science and Technology of China)

Session Classification: Break and Poster Session

Contribution ID: **92** Type: **Poster**

A Cosmologically Consistent Millicharged Dark Matter Solution to the EDGES Anomaly

Tuesday, 7 December 2021 08:20 (30 minutes)

Analysis of EDGES data shows an absorption signal of the redshifted 21-cm line of atomic hydrogen at $z \sim 17$ which is stronger than expected from the standard ΛCDM model at a 3.8σ deviation. We present a particle physics model for the baryon cooling where a fraction of the dark matter resides in the hidden sector with a $U(1)$ gauge symmetry and a Stueckelberg mechanism operates mixing the visible and the hidden sectors with the hidden sector consisting of dark Dirac fermions and dark photons. The Stueckelberg mass mixing mechanism automatically generates a millicharge for the hidden sector dark fermions providing a theoretical basis for using millicharged dark matter to produce the desired cooling of baryons seen by EDGES by scattering from millicharged dark matter. We compute the relic density of the millicharged dark matter by solving a set of coupled equations for the dark fermion and dark photon yields and for the temperature ratio of the hidden sector and the visible sector heat baths. For the analysis of baryon cooling, we analyze the evolution equations for the temperatures of baryons and millicharged dark matter as a function of the redshift. We exhibit regions of the parameter space which allow consistency with the EDGES data. We note that the Stueckelberg mechanism arises naturally in strings and the existence of a millicharge would point to its string origin.

Primary authors: ABOUBRAHIM, Amin (Institute for theoretical physics, Muenster University); NATH, Pran; WANG, Zhu-Yao

Presenter: ABOUBRAHIM, Amin (Institute for theoretical physics, Muenster University)

Session Classification: Break and Poster Session

Contribution ID: **95** Type: **Poster**

Inflationary Cosmology - A New Approach Using Non-linear Electrodynamics

Tuesday, 7 December 2021 08:20 (30 minutes)

We explore a new kind of NLED field as a source of gravity, which can accelerate the universe during the inflationary era. We propose a new type of NLED lagrangian which is characterized by two parameters: α (dimensionless parameter) and β (dimensionful parameter). We investigate the classical stability and the causality aspects of this model of inflationary expansion by demanding that the speed of the sound wave c_s^2 > 0 and 0 ≤ c_s^2 ≤ 1. Corresponding to 0 ≤ c_s^2 ≤ 1, we find 0.382(1.828) ≤ βB 2 ≤ 0.288(1.469) for α = 0.1(1.0). The equation of state parameter ω = −1/3 requires β_B^2 = 0.126(0.757) corresponding to α = 0.1(1.0). We find that the universe is accelerating i.e. ä > 0 (which results in the deceleration parameter q < 0 (i.e. ω > −1/3)), provided β_B^2 ≥ 0.126(0.757). During inflation, the energy density ρ_B is found to be maximum and = 0.65/β. The magnetic field necessary to trigger the inflation is found to be B ‘ is given by B_max = 4 × 10^51 Gauss. Our model also predicts the e-fold number N = 71(64) that the magnetic field at the end of inflation is about B = 10^{−10} (10^{−4}) Gauss corresponding to z = 0(1000) and this agrees quite well with the experimental prediction of the e-fold number. With α = 0.3(1.0) and β_B^2 = 0.3974(0.8239), we find the scalar spectral index n_s = 0.9649, consistent with the PLANCK 2018 CMB data. Further, with α = 0.3(1.0), β_B^2 = 0.3974(0.8239), we predicts the tensor-to-scalar ratio r = 0.1417(0.1449) and the tensorial spectral index n_T = −0.0177(−0.0181). Journal Reference: Physica Scripta. 96, 065305 (2021).

Primary authors: SAMANTA, Gauranga Charan; SARKAR, Payel; DAS , Prasanta Kumar (Birla Institute of Technology and Science, Pilani – Goa Campus)

Presenter: DAS , Prasanta Kumar (Birla Institute of Technology and Science, Pilani – Goa Campus)

Session Classification: Break and Poster Session

Contribution ID: **96** Type: **Poster**

Dark Matter Decay to Neutrinos

Tuesday, 7 December 2021 08:20 (30 minutes)

Dark matter (DM) particles are predicted to decay into Standard Model particles which would produce signals of neutrinos, gamma-rays, and other secondary particles. Neutrinos provide an avenue to probe astrophysical sources of DM particles. We review the decay of dark matter into neutrinos over a range of dark matter masses from MeV/c2 to ZeV/c2. We examine the expected contributions to the neutrino flux at current and upcoming neutrino and gamma-ray experiments, such as Hyper-Kamiokande, DUNE, CTA, TAMBO, and IceCube Gen-2. We consider galactic and extragalactic signals of decay processes into neutrino pairs, yielding constraints on the dark matter decay lifetime that ranges from tau ~ 1.2×10^21 s at 10 MeV/c2 to 1.5x10^29 s at 1 PeV/c2.

Primary author: DELGADO, Diyaselis (Harvard University (US))

Presenter: DELGADO, Diyaselis (Harvard University (US))

Session Classification: Break and Poster Session

Contribution ID: **97** Type: **Poster**

Accurately Measuring Neutrinos, Massive Light Relics and Axions Using Cosmological Observables

Tuesday, 7 December 2021 08:20 (30 minutes)

Light relics are new degrees of freedom which decoupled from the Standard Model while relativistic. Nearly massless relics will both contribute to the radiation energy budget and, for relics with masses on the eV scale (meV-10 eV), will become non-relativistic before today, behaving as matter instead of radiation. Such relics leave an imprint in the large-scale structure of the universe as light relics have important streaming motions, as in the case of massive neutrinos. For massive neutrinos, in order to obtain unbiased estimates of the neutrino mass, the sensitivity of upcoming CMB and LSS surveys to two effects that can alter neutrino-mass measurements is explored. The first is the slight difference in the suppression of matter fluctuations that each neutrino-mass hierarchy generates at fixed total mass. The second is the growth-induced scale-dependent bias (GISDB) of haloes produced by massive neutrinos. Accounting for these effects, a forecast of how well current and upcoming cosmological surveys can probe generic light massive relics is discussed. This forecast considers minimal extensions to the Standard Model by both fermionic and bosonic relic degrees of freedom and predicts the significance at which relics with different masses and temperatures can be detected. In addition to thermal relics, Axion Like Particles (ALP) can imprint on the large-scale structure through their inability to cluster below scales set by their de Broglie wavelength. We discuss how the ALP mass and decay constant can be constrained by upcoming surveys, particularly through modeling effects on the halo bias.

Primary author: DEPORZIO, Nicholas (Harvard University)

Presenter: DEPORZIO, Nicholas (Harvard University)

Session Classification: Break and Poster Session

Contribution ID: **101** Type: **Poster**

Reshuffled SIMP dark matter

Tuesday, 7 December 2021 08:20 (30 minutes)

In this talk, we reanalyze the multi-component strongly interacting massive particle (mSIMP) scenario using an effective operator approach. As in the single-component SIMP case, the total relic abundance of mSIMP dark matter (DM) is determined by the coupling strengths of 3 to 2 processes achieved by a five-point effective operator. Intriguingly, we find that there is an unavoidable 2 to 2 process induced by the corresponding five-point interaction in the dark sector, which would reshuffle the mass densities of SIMP DM after the chemical freeze-out. We dub this DM scenario as reshuffled SIMP (rSIMP). Given this observation, we then numerically solve the coupled Boltzmann equations including the 3 to 2 and 2 to 2 processes to get the correct yields of rSIMP DM. It turns out that the masses of rSIMP DM must be nearly degenerate for them to contribute sizable abundances. On the other hand, we also introduce effective operators to bridge the dark sector and visible sector via a vector portal coupling. Since the signal strength of detecting DM is proportional to the individual densities; thereby, obtaining the right amount of DM particles is crucial in the rSIMP scenario. The cosmological and theoretical constraints for rSIMP models are discussed as well.

Primary authors: LU, Chih-Ting; KO, Pyungwon; HO, Shu-Yu (KIAS)

Presenter: HO, Shu-Yu (KIAS)

Session Classification: Break and Poster Session

Contribution ID: **102** Type: **Poster**

Search for Decaying Dark Matter in Galaxy Clusters and Galaxies with IceCube

Tuesday, 7 December 2021 08:20 (30 minutes)

The inferred abundance of dark matter in the Universe could be explained with heavy decaying dark matter. According to heavy dark matter models, the decay of dark matter in astronomical objects can produce highly energetic neutrinos detectable at the Earth. The IceCube Neutrino Observatory, located at the geographic South Pole, is to date the world's largest neutrino telescope. Over the past decade, a large amount of high-energy astrophysical neutrino events were observed with this detector, allowing us to test the heavy decaying dark matter hypotheses. We search IceCube data for neutrinos from dark matter decay in galaxy clusters, dwarf satellite galaxies of the Milky Way, and the Andromeda galaxy. The analysis uses a 9-year sample of upward-going track events. Sensitivities obtained with our analysis are compared for individual sources in the northern sky and stacked multiple targets. We focus on heavy dark matter with masses between 10 TeV and 10 PeV„ decaying into a pair of Standard Model particles. The analysis covers energies around 10 TeV where multiple theoretical works have claimed inclusion of dark matter contribution would improve fits of the diffuse astrophysical neutrino spectrum.

Primary author: JEONG, Minjin (Sungkyunkwan University)

Presenter: JEONG, Minjin (Sungkyunkwan University)

Session Classification: Break and Poster Session

Contribution ID: **103** Type: **Poster**

Long Baseline Oscillation Probability Approximation in a Model for Light Sterile Neutrinos.

Tuesday, 7 December 2021 08:20 (30 minutes)

An abundance of hints from recent neutrino experiments leads to the hypothesis of the existence of light sterile neutrinos; however, there are also many constraints from laboratory experiments experimentally and cosmological observations that constrain its mixing and mass. In light of these observations, we present a new model of light sterile neutrinos that aims to elucidate this confusing situation. The model starts from the generation of sterile neutrino by a scalar field — in analogy to the Higgs in the Standard Model — and the generation of its mass by an effective See-Saw mechanism. Under this "3+1" model, we work out a numerical approximation scheme for the oscillation probability of neutrino propagation in matter. Due to the cosmological constraints that disfavor the existence of sterile neutrinos at the 1eV energy scale, we are also investigating the reconciliation of bounds from Hubble parameter values in BBN and CMB measurements.

Primary authors: WAGNER, Carlos E.M.; JIN, Miaochen (Harvard University); SEVERINO, Paul; LI, Xueqi

Presenter: JIN, Miaochen (Harvard University)

Session Classification: Break and Poster Session

Contribution ID: **107** Type: **Poster**

Probing Extended Gravity with Neutrinos

Tuesday, 7 December 2021 08:20 (30 minutes)

We study neutrino oscillations within the framework of extended theories of gravity. Based on the covariant reformulation of Pontecorvo's formalism, we evaluate the oscillation probability of neutrinos propagating in static spacetimes described by gravitational actions quadratic in the curvature invariants. Calculations are carried out in the two-flavor approximation, for oscillations both in vacuum and matter. It is shown that the neutrino phase is sensitive to the violation of the strong equivalence principle. By way of illustration, we specialize our analysis to various extended models of gravity in order both to quantify such a violation and to understand how the characteristic free parameters of these models affect the neutrino phase. The possibility to fix new bounds on these parameters and to constrain extended theories of gravity is finally discussed.

Primary authors: LUCIANO, Gaetano (Università degli Studi di Salerno & Istituto Nazionale di Fisica Nucleare); BUONINFANTE, Luca; SMALDONE, Luca; PETRUZZIELLO, Luciano

Presenter: LUCIANO, Gaetano (Università degli Studi di Salerno & Istituto Nazionale di Fisica Nucleare)

Session Classification: Break and Poster Session

Contribution ID: **109** Type: **Poster**

From Axions to ALPs in the Post-inflationary Scenario

Tuesday, 7 December 2021 08:20 (30 minutes)

In the scenario in which the axion is born after inflation, the field develops significant inhomogeneity and evolves in a highly nonlinear fashion. Understanding the eventual abundance and distribution of axionic dark matter in this scenario therefore requires dedicated numerical simulations. Here, we go beyond the QCD axion, and perform a suite of simulations for a range of possible temperature dependencies in the axion mass growth, including the temperature independent axion-like particle case. We study the complex dynamics of the axion field's evolution, including the scaling of the axion cosmic string network, the decay of domain walls, and the lifetime of axitons; eventually leaving us with the seeds of miniclusters. Given the expanding experimental campaign to search for axions and axion-like particles, these simulations have potentially wide implications for present-day direct and indirect searches.

Primary authors: O'HARE, Ciaran; PIEROBON, Giovanni (UNSW Sydney); REDONDO, Javier; WONG, Yvonne

Presenter: PIEROBON, Giovanni (UNSW Sydney)

Session Classification: Break and Poster Session

Contribution ID: **111** Type: **Poster**

Axiogenesis From $SU(2)_R$ Phase Transition

Tuesday, 7 December 2021 08:20 (30 minutes)

The baryon asymmetry of the universe may be explained by rotations of the QCD axion in field space and baryon number violating processes. We consider the minimal extension of the Standard Model by a non-Abelian gauge interaction, $SU(2)_R$, whose sphaleron process violates baryon number. Assuming that axion dark matter is also created from the axion rotation by the kinetic misalignment mechanism, the mass scale of the $SU(2)_R$ gauge boson is fixed as a function of the QCD axion decay constant, and vise versa. Significant portion of the parameter space has already been excluded by new gauge boson searches, and the high-luminocity LHC will further probe the viable parameter space.

Primary authors: HARIGAYA, Keisuke; WANG, Ruoquan (Rutgers University - NHETC)

Presenter: WANG, Ruoquan (Rutgers University - NHETC)

Session Classification: Break and Poster Session

Contribution ID: **112** Type: **Poster**

Cosmologically Consistent Self-interacting Dark Matter and Small-scale Galaxy Anomalies

Tuesday, 7 December 2021 08:20 (30 minutes)

A large amount of data from dwarf galaxies to galaxy clusters appears to indicate that dark matter (DM) acts like a collisional fluid at galaxy scales to a collisionless fluid at the scale of galaxy clusters. We will discuss a particle physics model with the standard model extended with a gauged abelian hidden sector to explain this phenomenon. In this model dark matter consists of fermions of the hidden sector and they have self interactions via exchange of dark photons which constitute a new dark force in the model. The analysis involves solutions to Boltzmann equations coupling the visible sector and the hidden sectors at different temperatures, one for each sector. The model produces a velocity-dependent DM cross section where the DM acts like a collisional fluid at small galaxy scales and acts collisionless at large galaxy scales, and we fit the data including those from THINGS, LSB and the Bullet Cluster. The talk is based on the paper Phys. Rev. D 103, 075014 (2021), arXiv: 2008.00529 [hep-ph], by Amin Aboubrahim, Wan-Zhe Feng, Pran Nath, and Zhu-Yao Wang.

Primary authors: IBRAHIM, Amin Abou; NATH, Pran; FENG, Wan-Zhe; WANG, Zhu-Yao (Northeastern University)

Presenter: WANG, Zhu-Yao (Northeastern University)

Session Classification: Break and Poster Session

Contribution ID: **113** Type: **Poster**

Primordial Black Holes from Confinement

Tuesday, 7 December 2021 08:20 (30 minutes)

A mechanism for the formation of primordial black holes is proposed. Here, heavy quarks of a confining gauge theory produced by de Sitter fluctuations are pushed apart by inflation and get confined after horizon re-entry. The large amount of energy stored in the colour flux tubes connecting the quark pair leads to black-hole formation. These are much lighter and can be of higher spin than those produced by standard collapse of horizon-size inflationary overdensities. Other difficulties exhibited by such mechanisms are also avoided. Phenomenological features of the new mechanism are discussed as well as accounting for both the entirety of the dark matter and the supermassive black holes in the galactic centres. Under proper conditions, the mechanism can be realised in a generic confinement theory, including ordinary QCD. Moreover, for particular values of the confinement scale, the produced gravity waves are within the range of recent NANOGrav events. Simple generalisations of the mechanism allow for the existence of a significant scalar component of gravity waves with distinct observational signatures.

Primary author: ZANTEDESCHI, Michael (Max Planck Institute for Physik, Munich)

Presenter: ZANTEDESCHI, Michael (Max Planck Institute for Physik, Munich)

Session Classification: Break and Poster Session

Contribution ID: **114** Type: **Poster**

Neutrinos From Captured Dark Matter Annihilation in a Galactic Population of Neutron Stars

Tuesday, 7 December 2021 08:20 (30 minutes)

Particulate dark matter captured by a population of neutron stars distributed around the galactic center while annihilating through long-lived mediators can give rise to an observable neutrino flux. We examine the prospect of an idealized gigaton detector like IceCube/KM3Net in probing such scenarios. Within this framework, we report an improved reach in spin-dependent and spin-independent dark matter nucleon cross-section below the current limits for dark matter masses in the TeV-PeV range.

Primary authors: BOSE, Debajit (IIT Kharagpur); MAITY, Tarak Nath; RAY, Tirtha Sankar

Presenter: BOSE, Debajit (IIT Kharagpur)

Session Classification: Break and Poster Session

Contribution ID: **116** Type: **Poster**

When Heavy Neutral Leptons Meet a Dark Sector

Tuesday, 7 December 2021 08:20 (30 minutes)

Heavy neutral leptons (HNLs) have been proposed to extend the standard model to explain the MiniBooNE anomaly. We demonstrate that, in the minimal scenario, this model is ruled out by a combination of neutrino beam experiments and cosmological constraints. However, HNLs could be portals to a dark sector. An extension of this model that incorporates a dark U(1) gauge theory can avoid the cosmological constraints, leaving some open parameter space to explain the MiniBooNE anomaly. We study the phenomenology of this model in the entire parameter space, showing how the T2K near detector could place the strongest constraints.

Primary author: FOPPIANI, Nicolo (Harvard University)

Presenter: FOPPIANI, Nicolo (Harvard University)

Session Classification: Break and Poster Session

Contribution ID: **117** Type: **Poster**

Dark Sector Freeze-out due to a Non-Boltzmann Suppression

Tuesday, 7 December 2021 08:20 (30 minutes)

Commonly known as Boltzmann suppression is the key ingredient to create chemical imbalance for thermal dark matter. In a degenerate/quasi degenerate dark sector chemical imbalance can also be generated from a different mechanism which is analogous to the radioactive decay law, known as co-decaying dark matter. In this work, we have studied the dynamics of a multicomponent thermally decoupled degenerate dark sector in a hidden $U(1)_X$ extension of the Standard Model. We compute the relic density and the temperature (T') evolution of the hidden sector by considering all possible $2 \to 2$ and $3 \to 2$ processes. We find that the production of energetic particles from $3 \to 2$ processes increase the temperature of the dark sector whereas the rate of growth of temperature is decelerated due to the presence of $2 \to 2$ processes and expansion of the Universe. We also study the prospect of detecting neutrino and $gamma$-ray signals from DM annihilation via one step cascade processes. We find that in the present scenario, all the existing indirect detection constraints arising from measured fluxes of atmospheric neutrinos by Super-Kamiokande and diffuse γ-rays by EGRET, Fermi-LAT, and INTEGRAL respectively can easily be evaded for the degenerate dark sector. However for the quasi degenerate scenario the constraints are significant.

Primary authors: BISWAS, Anirban; GANGULY, Sougata (Indian Association for the Cultivation of Science); ROY, Sourov

Presenter: GANGULY, Sougata (Indian Association for the Cultivation of Science)

Session Classification: Break and Poster Session

Contribution ID: **118** Type: **Poster**

Asymmetric Dark Matter from Scattering

Tuesday, 7 December 2021 08:20 (30 minutes)

We study possible particle-antiparticle asymmetry in the dark sector in two distinct scenarios. In both the scenarios dark matter (DM) scatterings play defining role in deciding the asymmetry as well as the density. In the first case, we demonstrate a general semi-annihilation of DM particles, leading to maximal asymmetry in DM sector (Ref :JHEP 08 (2020), 149). In the second case, We find an interesting interplay of the DM self-scatterings and annihilations in generating the present DM density, and possible particle-antiparticle asymmetry in the DM sector. The role of DM self-scatterings in determining its present density and composition is a novel phenomenon. The simultaneous presence of the self-scatterings and annihilations is required to obtain a non-zero asymmetry, which otherwise vanishes due to unitarity sum rules (arXiv : 2103.14009)

Primary authors: GHOSH, Avirup; GHOSH, Deep (Indian Association for the Cultivation of Science, Kolkata); MUKHOPADHYAY, Satyanarayan

Presenter: GHOSH, Deep (Indian Association for the Cultivation of Science, Kolkata)

Session Classification: Break and Poster Session

Contribution ID: **119** Type: **Poster**

Multi-messenger Lifetime Constraints on Heavy Decaying Dark Matter

Tuesday, 7 December 2021 08:20 (30 minutes)

Dark matter is one of the cornerstones of the standard cosmological model although we do not know its fundamental nature. Huge effort has been made in order to perform a direct detection of this dark matter component but up to now we have only seen it interacting gravitationally. In this regard the indirect detection is a promising method to search for dark matter, where we try to look at signatures of the dark matter on the astrophysical messengers. One of the best known astrophysical messengers are the gamma-rays. At very-high energies gamma-rays suffer from absorption, leaving the galactic prompt gamma-ray component as the dominant one. In this work we will adopt the prompt flux as the total one. Heavy dark matter with m_{DM}>10^7 GeV leads to higher fluxes in the decaying scenario rather than the annihilating one. In this work we focus on heavy decaying dark matter particles and we revisit the dark matter lifetime bounds placed by the gamma-ray measurements by means of the spectra provided by the recent code HDMSpectra. We provide lifetime limits for dark matter particles with m_{DM}=[10^7−10^{15}] GeV for a set of decay scenarios, where we include the current measurements that provide upper limits on the gamma-ray flux.

Primary authors: FIORILLO, Damiano F. G.; MIELE, Gennaro; CHIANESE, Marco; SAVIANO, Ninetta; HAJJAR, Rasmi (IFIC - SSM); MORISI, Stefano

Presenter: HAJJAR, Rasmi (IFIC - SSM)

Session Classification: Break and Poster Session

Contribution ID: **120** Type: **Poster**

Constraining Axion-like Particles Using the White Dwarf Initial-final Mass Relation

Tuesday, 7 December 2021 08:20 (30 minutes)

Axion-like particles (ALPs), a class of pseudoscalars common to many extensions of the Standard Model, have the capacity to drain energy from the interiors of stars and consequently can be constrained through their impact on stellar evolution. In this talk I will derive a new constraint on ALPs which couple exclusively to photons, based on their effects on the white dwarf initial-final mass relation (IFMR). I will highlight the sensitivity of the IFMR and the asymptotic giant branch (the late-life evolutionary phase of stars with initial masses less than 8M⊠) to ALPs in a presently unconstrained region of parameter space, the cosmological triangle. The future prospects of this constraint will also be discussed.

Primary authors: HISKENS, Frederick (The University of Melbourne); DOLAN, Matthew J.; VOLKAS, Raymond R.

Presenter: HISKENS, Frederick (The University of Melbourne)

Session Classification: Break and Poster Session

Contribution ID: **122** Type: **Poster**

Holographic ¥$beta$ function in de Sitter space

Tuesday, 7 December 2021 08:20 (30 minutes)

We investigate the resummation of infrared logarithms in inflationary Universe from holographic perspective. By the renormalization group, we derive gravitational Fokker-Planck and Langevin equations as the effective theory at the Horizon scale. We investigate the time evolution of the de Sitter entropy $S = ¥pi/G_N H^2(t)$. $H(t)$ is the time dependent effective Hubble parameter and G_N is the Newton's constant. Our approach focuses on the conformal modes to respect local Lorentz symmetry. As for the curvature perturbation , it is shown to be consistent with our result through ¥$deltaN$ formalism. We obtain the dynamical ¥$beta$ function of $g = 1/S$ under the Gaussian approximation. The dimensionless gravitational coupling g is asymptotically free toward the future. It also possesses the ultraviolet fixed point indicating that the Universe begun with the de Sitter expansion near the Planck scale with ¥$epsilon = 0$. We claim inflationary Universes subsequently dominate as the solutions of stochastic equations to maximize the entropy. This is a strong evidence for non-perturbative de Sitter duality between the classical slow roll inflaton and quantum stochastic effects around the Horizon.

Primary author: KITAZAWA, Yoshihisa (KEK Theory Center)

Presenter: KITAZAWA, Yoshihisa (KEK Theory Center)

Session Classification: Break and Poster Session

Contribution ID: **123** Type: **Poster**

SO(N) Model as Pion-like SIDM From Effective Range Theory

Tuesday, 7 December 2021 08:20 (30 minutes)

Effective range theory, which was originated in Bethe, was developed to study nucleon scattering. We applied this in the context of self-interacting dark matter (SIDM). We studied what kind of combination of parameters fit to the MCMC simulation of dark matter cross section from dwarf scale to cluster scale. As a result, scattering length is longer than our naive expectation. So we investigated Linear sigma model as effective theory of pion like DM. Pion like DM and their bound state may describe the parameter set. We propose this as one scenario in SO(N) gauge theory.

Primary author: KONDO, Dan (University of Tokyo)

Presenter: KONDO, Dan (University of Tokyo)

Session Classification: Break and Poster Session

Contribution ID: **124** Type: **Poster**

Leptophilic Dark Matter at International Linear Collider

Tuesday, 7 December 2021 08:20 (30 minutes)

Next energy frontier accelerators like ILC or CLIC are with immense possibilities to improve our understanding with nature's fundamental building block and to discover new particles e.g. WIMP dark matters along with other physics phenomena. In scenarios where dark matter does not or feebly couple with quarks, we can consider the dominant coupling of dark matter with charged leptons. We consider the pair production of fermion dark matter at 1TeV ILC using a class of Lorentz-invariant higher-dimensional leptophilic operators. Depending upon the visible particles to identify the events, we probe mono-photon and mono-Z (with Z decays leptonically and hadronically) channels. We also employ the beam polarisation scheme of ILC and present the 3σ sensitivity at 1000fb^{-1} in terms of the new physics (NP) scale Λ, for the three channels. I will discuss here how these operators perform in the quest of dark matter signature and how constrained the parameter space stand considering different experimental bounds.

Primary author: KUNDU, Saumyen (BITS Pilani, K.K. Birla Goa Campus)

Presenter: KUNDU, Saumyen (BITS Pilani, K.K. Birla Goa Campus)

Session Classification: Break and Poster Session

Contribution ID: **125** Type: **Poster**

Dark Matter Scattering in Gravitational Wave Detectors

Tuesday, 7 December 2021 08:20 (30 minutes)

We present prospects for discovering dark matter scattering in gravitational wave detectors. We study how a potential signal from a dark matter particle compares to typical background noises in gravitational wave detectors. The dark matter signal is modelled as an elastic scattering event with the interferometer components. For the background we focus on suspension thermal noise and quantum noise, which are the dominant noise components in the frequency range we are concerned about. We will start from a simple toy model and then extend it to a realistic case, KAGRA.

Primary author: LEE, Chun-Hao (National Tsing Hua University)

Presenter: LEE, Chun-Hao (National Tsing Hua University)

Session Classification: Break and Poster Session

Contribution ID: **126** Type: **Poster**

Neutrino Masses and Leptogenesis in a Le-Lμ-L Model

Tuesday, 7 December 2021 08:20 (30 minutes)

We present a simple extension of the Standard Model with three right-handed neutrinos in a SUSY framework, with an additional U(1)_F abelian flavor symmetry with a non standard leptonic charge for lepton doublets and arbitrary right-handed charges. We show how it is possible to provide the correct predictions for the mixing angles of the PMNS matrix and for the r=(Δm_sun)^2/(Δm_atm)^2 parameter, with a moderate fine tuning. The baryon asymmetry of the Universe is generated via thermal Leptogenesis through CP-violating decays of the heavy right-handed neutrinos. We present a detailed numerical solution of the relevant Boltzmann equation accounting for the impact of the distribution of the asymmetry in the lepton flavors.

Primary author: MARCIANO, Simone (University of Roma Tre)

Presenter: MARCIANO, Simone (University of Roma Tre)

Session Classification: Break and Poster Session

Contribution ID: **127** Type: **Poster**

Fermion-induced Electroweak Symmetry Non-restoration via Temperature-dependent Masses

Tuesday, 7 December 2021 08:20 (30 minutes)

In certain extensions of the Standard Model, the interactions between some new scalars and SU(2)_L Higgs doublet(s) can cause the electroweak(EW) symmetry to remain broken at temperatures well above the EW scale. We found that new fermions from renormalizable models can also induce this EW symmetry non-restoration effect, provided that they have the appropriate temperature-dependent masses. These masses can arise naturally from the interactions between the new fermions and scalar fields. I will present the novel thermal histories of these models. Certain cases predict that the EW phase transitions are strongly first-order and occur at temperatures much higher than the EW scale. The stochastic gravitational-wave background from these cosmological phase transitions may be visible at future gravitational wave observatories, such as BBO and DECIGO.

Primary author: NG, Yu Hang (University of Nebraska-Lincoln)

Presenter: NG, Yu Hang (University of Nebraska-Lincoln)

Session Classification: Break and Poster Session

Contribution ID: **128** Type: **Poster**

An Equation of State for Magnetized Neutron Star Matter and Tidal Deformation in Neutron Star Mergers

Tuesday, 7 December 2021 08:20 (30 minutes)

We derive an equation of state (EOS) for magnetized charge-neutral nuclear matter relevant for a neutron star (NS). The calculations are performed within an effective chiral model based on the generalization of the σ model with nonlinear self-interactions of the σ mesons along with the ρ–σ cross-coupling term. This model is extended by introducing the contributions of a strong magnetic field on the charged particles. The contributions arising from the effects of the magnetic field on the Dirac sea of charged baryons are also included. The resulting EOS for the magnetized dense matter is used to investigate the NS properties like its mass, radius, and tidal deformability. The magnitude of the magnetic field at the core of the NS considered here is in the range of 1015–1018 G, for which the relative deformation from spherical symmetry turns out to be less than 1%, giving a post facto justification for the spherically symmetric treatment of the NS structure. The dimensionless tidal deformability Λ1.4 is 526 for an NS with mass 1.4 M ⊠, which is consistent with the recent observation of GW 170817. The maximum mass of the NS in the presence of a strong magnetic field is consistent with the observational constraints on the mass of the pulsar PSR J0348–0432, and its radius at a mass of 1.4 M ⊠ is also in agreement with the empirical bounds.

Primary author: PATRA, Naresh Kumar (Birla Institute of Technology and Science, Pilani – Goa Campus)

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Session Classification: Break and Poster Session

Contribution ID: **129** Type: **Poster**

Constraining the Absolute Neutrino Mass via Time-of-flight Measurements of the Supernovae Electron Neutrinos with DUNE

Tuesday, 7 December 2021 08:20 (30 minutes)

Supernova (SN) explosions are the most powerful cosmic factories of all-flavors, MeV-scale, neutrinos. Their detection is of great importance not only for astrophysics, but also to shed light on neutrino properties. Since the first observation of a SN neutrino signal in the 1987, the international network of SN neutrinos observatories has been greatly expanded, in order to detect the next galactic SN explosion with much higher statistics and accuracy in the neutrino energy-time-flavor space. The Deep Underground Neutrino Experiment (DUNE) is a proposed leading-edge neutrino experiment, planning to begin operations in 2026. DUNE will have capability to extract precious information about SN neutrinos. In this contribution, I will discuss the constraints that we expect to achieve with DUNE on the absolute value of the neutrino mass, obtained by considering the time delay in the propagation of massive electron neutrinos from production in the SN environment to their detection in DUNE. Furthermore, the comparison of sensitivities achieved for the two possible neutrino mass orderings is discussed.

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Session Classification: Break and Poster Session

Contribution ID: **130** Type: **Poster**

Exploring the Cosmological Dark Matter Coincidence with Infrared Fixed Points

Tuesday, 7 December 2021 08:20 (30 minutes)

The 5:1 ratio between the cosmological mass densities of dark matter (DM) and visible matter (VM) hints at a deep connection between the origins of the two sectors. While models connecting the number densities of DM and VM have been well-explored, very little work has focused on relating the mass of DM to the proton mass. This can be achieved if the DM is a confining state of a dark QCD gauge group whose confinement scale is similar to that of standard QCD. We further develop a framework proposed by Bai and Schwaller which uses infrared fixed points of the two gauge couplings to dynamically relate the VM and DM confinement scales without invoking any high-scale symmetries. We analyse the dependence of the confinement scale relationship on the initial gauge coupling values in the UV, and thus investigate how feasible it is for this framework to produce composite DM with a mass close to that of the proton.

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Session Classification: Break and Poster Session

Contribution ID: **131** Type: **Poster**

Mixed Scalar Dark Matter and Dirac Neutrino Masses in an Extended B-L Model

Tuesday, 7 December 2021 08:20 (30 minutes)

The standard model(SM) is augmented by a $U(1)_{B-L}$ gauge symmetry. Three right-handed neutrinos(RHN) are added with $B-L$ charge -4,-4 and 5 required for the anomaly cancellation. Two vector-like fermion doublets(N_i), a doublet scalar(\eta), and two singlet scalars(\chi_1,\chi_2) are also added having nontrivial charges under the B-L group except \chi_1 particle. A Z_2 symmetry is also imposed to find a stable dark matter(DM) candidate. We showed that the tree level generation of neutrino mass is not possible in this model due to the non-trivial charges of the new RHNs. However, small Dirac masses for the active neutrinos can be generated at one loop level. The even component of the neutral doublet scalar(\eta) and the complete singlet scalar(\chi_1) mix with each other after the spontaneous symmetry breaking of the model. The lightest particle among the two emerges out as a viable DM candidate of the universe. We see that the coannihilation of the doublet fermions to the SM fields plays an important role when the mass difference between the DM and the corresponding coannihilating partner is kept small. The relic density can be solely determined by the coannihilation by the new odd sector particles while keeping the direct detection cross-section small.

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Session Classification: Break and Poster Session

Contribution ID: **134** Type: **Poster**

Non-adiabatic Evolution of Dark Sector in the Presence of $U(1)_{L_\mu - L_\tau}$ Gauge Symmetry

Tuesday, 7 December 2021 08:20 (30 minutes)

In secluded dark sector scenario, thermal equilibrium between dark and visible sector depends on the strength of portal coupling. To study the non-adiabatic evolution of the dark sector, we have considered a $U(1)_{L_\mu - L_\tau} \otimes U(1)_X$ extension of the standard model (SM). Here in this model the dark sector is charged only under $U(1)_X$ gauge symmetry whereas the SM fields are assumed to be singlet under this symmetry. In presence of tree-level kinetic mixing between $U(1)_X$ and $U(1)_{L_\mu - L_\tau}$ gauge bosons, we have studied the non-adiabatic evolution of the dark sector along with the temperature evolution of the dark sector. Furthermore we have also investigated the constraints on the model parameters from various laboratory and astrophysical searches. We have found that the parameter space is significantly constrained for $m_{Z'}$
$lesssim 100\,\mathrm{MeV}$ from the observations of beam dump experiments, stellar cooling etc. The relic density satisfied region of our parameter space is consistent with the bounds from direct detection, and self interaction of dark matter (SIDM) for the mass ratio $r \equiv m_{Z'}/m_\chi = 10^{-3}$. However the constraints from measurement of diffuse γ-ray background flux and cosmic microwave background (CMB) anisotropy are strongest for $r = 10^{-1}$.

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Session Classification: Break and Poster Session

Contribution ID: **138** Type: **Poster**

Indirect Detection of Long-lived Particles via a Less-simplified Dark Higgs Portal

Tuesday, 7 December 2021 08:20 (30 minutes)

Simplified models of light new physics provide an important theoretical and experimental benchmark. Models that extend such minimal scenarios by introducing other degrees of freedom are popular and well motivated ways to go beyond the Standard Model (SM). In this talk, I will focus on the light dark Higgs portal that connects the dark sector consisting of, among others, heavy, TeV-scale secluded scalar dark matter (DM) with the SM. I will illustrate the phenomenology of this model, focusing on the signatures of DM and long-lived particles (LLPs) in complementary experimental searches. These include i) the intensity frontier searches for light new physics, ii) indirect detection (ID) of secluded WIMPs, and iii) future CMB radiation surveys. Finally, I will highlight the important role of non-local effects present in the ID of LLP particles, which significantly affects the corresponding detection strategies, usually tailored to WIMPs. These effects include a) an additional contribution to the photon flux due to the "GC diffusion" effect, b) a linear flux decrease in the long-lived regime due to finite DM density support, and c) a faster flux decrease with LLP decay length for observations focused on small regions of interest, such as dwarf galaxies, compared to large ones, such as regions near the Galactic Center.

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Session Classification: Break and Poster Session

Contribution ID: **141** Type: **Poster**

A New Bound on Primordial Black Hole Abundance Using Interaction with Dust Tori in Active Galactic Nuclei

Tuesday, 7 December 2021 08:20 (30 minutes)

As primordial black holes (PBHs) are one possible candidate for dark matter (DM), various constraints on PBHs have been placed in wide mass ranges. Especially in the mass range above 10^-1 M_sun, the method using gas accretion on PBH has been taken. Here, we newly consider the gas accretion process in dust tori in active galactic nuclei (AGNs). The dust torus region is typically the central ten pc region of a galaxy and contains abundant gas. These conditions are suitable for PBH constraints. As an example, we consider a nearby AGN in NGC 1068 whose gas mass in the dust torus is recently estimated as 10^5 M_sun. By setting PBH radiation do not overheat the gas in the torus, we find \Omega_{PBH}/\Omega_{DM} goes down to 3×10^-3 at ~300 M_sun. This independent constraint is comparable to previous X-ray and gas heating bounds in the literature. Our method applies to a variety of AGN tori with gas measurements.

Presenter: YANAGISAWA, Kaoru (Osaka University)

Session Classification: Break and Poster Session

Contribution ID: **142** Type: **Poster**

Freeze-in Dark Matter Through Forbidden Channel in $U(1)_{B-L}$

Tuesday, 7 December 2021 08:20 (30 minutes)

We examine a scenario for freeze-in production of dark matter, which occurs due to the large thermal correction to the mass of a decaying mediator particle present in the thermal bath of the early Universe. We show that the decays, which are kinematically forbidden otherwise, can open up at very high temperatures and dominate the dark matter production. We explore such forbidden production of dark matter in the minimal U(1)B–L model, comparing dark matter phenomenology in the context of forbidden frozen-in with the standard picture.

Presenter: SHOW, Sudipta

Session Classification: Break and Poster Session