Second EuCAPT Annual Symposium

Report of Contributions

Contribution ID: **2** Type: **early universe cosmology**

Inflationary flavour oscillations and the cosmic spectroscopy

Inflationary scenarios motivated by high-energy physics generically contain a plethora of degrees of freedom beyond the primordial curvature perturbation. The latter interacts in a simple way with what we name inflationary flavor eigenstates, which differ in general from freely propagating inflationary mass eigenstates. We show that the mixing between these misaligned states results in a new striking behavior in the three-point function of the primordial curvature perturbation. Indeed, depending on the mass spectrum but also on the mixing angles of the theory, its squeezed limit displays either modulated oscillations, a broken power law, or a transition from oscillations to a power law, thus offering a detailed cosmic spectroscopy of the particle content of inflation.

Based on: https://arxiv.org/pdf/2112.05710.pdf

Primary author: PINOL, Lucas

Co-authors: AOKI, Shuntaro (Waseda University); RENAUX-PETEL, Sébastien (IAP); YAMAGUCHI, Masahide (Tokyo Institute of Technology)

Presenter: PINOL, Lucas

Contribution ID: **4** Type: **late universe (including CMB, dark energy, astrostatistics)**

Dark energy interactions near the Galactic Center

We investigate scalar-tensor theories, motivated by dark energy models, in the strong gravity regime around the black hole at the center of our galaxy. In such theories general relativity is modified since the scalar field couples to matter. We consider the most general conformal and disformal couplings of the scalar field to matter to study the orbital behavior of the nearby stars around the galactic star center SgrA*. Markov chain Monte Carlo simulation yields a bound on the parameters of the couplings of the scalar field to matter. Using Bayesian analysis yields the first constraints on such theories in the strong gravity regime.

Primary authors: Prof. DAVIS, Anne (University of Cambridge); BENISTY, David (Cambridge University)

Presenter: BENISTY, David (Cambridge University)

Contribution ID: **7** Type: **particle astrophysics (including cosmic rays, neutrinos, nuclear astrophysics)**

Stringent axion constraints with Event Horizon Telescope polarimetric measurements of M87*

The hitherto unprecedented angular resolution of the Event Horizon Telescope (EHT) has created exciting opportunities in the search for new physics. Recently, the linear polarization of radiation emitted near the supermassive black hole M87*was measured on four separate days, precisely enabling tests of the existence of a dense axion cloud produced by a spinning black hole. The presence of an axion cloud leads to a frequency-independent oscillation in the electric vector position angle (EVPA) of this linear polarization. For a nearly face-on M87*, this oscillation in the EVPA appears as a propagating wave along the photon ring. We propose a novel differential analysis procedure to reduce the astrophysical background, and derive stringent constraints on the existence of axions in the previously unexplored mass window ~(10^{-21} –10^{-20}) eV.

Primary author: XUE, Xiao (II. Institute of Theoretical Physics, Universitat Hamburg)

Co-authors: CHEN, Yifan (ITP-CAS); SHU, Jing (ITP-CAS); YOSUKE, Mizuno; LIU, yuxin; ZHAO, Yue; YUAN, Qiang (IHEP); LU, Ru-sen

Presenter: XUE, Xiao (II. Institute of Theoretical Physics, Universitat Hamburg)

Contribution ID: **12** Type: **early universe cosmology**

Mapping the viable parameter space for testable leptogenesis

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

Primary authors: Prof. DREWES, Marco (UCLouvain); Mr GEORIS, Yannis (UCLouvain); Dr KLARIC, Juraj (UCLouvain)

Presenter: Mr GEORIS, Yannis (UCLouvain)

Contribution ID: **18** Type: **gravitational waves**

Using gravitational wave lensing to constraint models of dark matter

As the number of event that gravitational wave detector detect increases the probability of finding lensed events gets bigger, with estimations of 0(100)/year for 3G detectors. The number and nature of this events is going to be a powerful prove on dark matter substructures. We will show recent developments on lensing by primordial black holes, dark stars and dark matter halos and how they offer a complementary tool to microlensing of light.

Primary author: URRUTIA, Juan

Presenter: URRUTIA, Juan

Contribution ID: **19** Type: **early universe cosmology**

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

The formation of ultra rare supermassive black holes (SMBHs), with masses of $\mathcal{O}(10^9\ M_\odot)$, 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 $\mathcal{O}(10^{-20}$ 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 $\mathcal{O}(10^9\ M_\odot)$ 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_{eff}. On general grounds, we also expect primordial gravitational waves - from the assumed first order phase transition - characterized by frequencies of $\mathcal{O}(10^{-12} - 10^{-9}$ 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 author: GEHRLEIN, Julia

Co-authors: DAVOUDIASL, Hooman; DENTON, Peter (Brookhaven National Laboratory)

Presenter: GEHRLEIN, Julia

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

O3 LIGO/Virgo Results

Monday, 23 May 2022 09:30 (30 minutes)

Presenter: TROVATO, Agata

Session Classification: Gravitational Waves

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

Recent Results from Pulsar Timing Arrays

Monday, 23 May 2022 10:00 (30 minutes)

Presenter: CHEN, Siyuan

Session Classification: Gravitational Waves

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

Stochastic Gravitational Wave Backgrounds

Monday, 23 May 2022 10:40 (30 minutes)

Presenter: RICCIARDONE, Angelo

Session Classification: Gravitational Waves

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

Dark Energy

Monday, 23 May 2022 14:00 (30 minutes)

Presenter: ZUMALACÁRREGUI, Miguel

Session Classification: Late Universe

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

Lensing

Monday, 23 May 2022 14:30 (30 minutes)

Presenter: CHISARI, Elisa

Session Classification: Late Universe

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

Astro-statistics

Monday, 23 May 2022 15:15 (30 minutes)

Presenter: LANUSSE, François

Session Classification: Late Universe

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

New Ideas in Wave-like Dark Matter Detection

Tuesday, 24 May 2022 10:00 (30 minutes)

Presenter: MILLAR, Alex

Session Classification: Dark Matter

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

Novel Tests of Dark Matter in Stellar Physics

Tuesday, 24 May 2022 10:45 (30 minutes)

Presenter: ELLIS, Sebastian

Session Classification: Dark Matter

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

Dark Matter Models

Tuesday, 24 May 2022 09:30 (30 minutes)

Presenter: SHAKYA, Bibhushan

Session Classification: Dark Matter

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

Neutrino Properties from Astrophysical Probes

Tuesday, 24 May 2022 14:00 (30 minutes)

Presenter: SHALGAR, Shashank

Session Classification: Particle Astrophysics

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

NP from Neutron Stars

Tuesday, 24 May 2022 14:30 (30 minutes)

Presenter: GARANI, Raghuveer (INFN, Florence)

Session Classification: Particle Astrophysics

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

GRBs as the Sources of UHECRs and Neutrinos

Tuesday, 24 May 2022 15:15 (30 minutes)

Presenter: RUDOLPH, Annika

Session Classification: Particle Astrophysics

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

Cosmological Approaches to Naturalness

Wednesday, 25 May 2022 09:30 (30 minutes)

Presenter: D'AGNOLO, Raffaele

Session Classification: Early Universe

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

Axion Cosmology

Wednesday, 25 May 2022 10:00 (30 minutes)

Presenter: FERREIRA, Ricardo Zambujal

Session Classification: Early Universe

Contribution ID: **35** Type: **not specified**

Phase Transitions/Baryogenesis

Wednesday, 25 May 2022 10:45 (30 minutes)

Presenter: TURNER, Jessica

Session Classification: Early Universe

Contribution ID: **36** Type: **not specified**

Lightning Talks (6 x 5 min)

Monday, 23 May 2022 11:10 (30 minutes)

Presenters: BAGUI, Eleni (Université Libre de Bruxelles (ULB)); RUBIRA, Henrique; URRUTIA, Juan; KIERKLA, Maciej; BRAGLIA, Matteo (IFT UAM-CSIC); LEVI, Noam (Tel Aviv University)

Session Classification: Gravitational Waves

Contribution ID: **37** Type: **not specified**

Discussion

Monday, 23 May 2022 11:40 (30 minutes)

Session Classification: Gravitational Waves

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

Lightning Talks (6 x 5 min)

Monday, 23 May 2022 15:45 (30 minutes)

Presenters: BENISTY, David (Cambridge University); LUCCA, Matteo (ULB, Bruxelles); JOSEPH, Melissa; ARENDSE, Nikki (Oskar Klein Centre, Stockholm University); CASTELLO, Sveva (University of Geneva); QIN, Wenzer (MIT)

Session Classification: Late Universe

Contribution ID: **39** Type: **not specified**

Discussion

Monday, 23 May 2022 16:15 (30 minutes)

Session Classification: Late Universe

Contribution ID: **40** Type: **not specified**

Lightning Talks (8 x 5 min)

Tuesday, 24 May 2022 11:15 (40 minutes)

Presenters: SOKOLENKO, Anastasia; BLANCO, Carlos; EROENCEL, Cem; BERNAL MERA, Jose Luis; RAMBERG, Nicklas (Johannes gutenberg universität Mainz); MANCONI, Silvia (Institute for Theoretical Particle Physics and Cosmology, RWTH Aachen); VERMA, Sonali; WU, Yi-Peng (Laboratoire de Physique Théorique et Hautes Énergies (LPTHE))

Session Classification: Dark Matter

Contribution ID: **41** Type: **not specified**

Discussion

Tuesday, 24 May 2022 11:55 (30 minutes)

Session Classification: Dark Matter

Contribution ID: **42** Type: **not specified**

Lightning Talks (6 x 5 min)

Tuesday, 24 May 2022 15:45 (30 minutes)

Presenters: POMPA, Federica; PADILLA-GAY, Ian (University of Copenhagen - Niels Bohr Institute); AL-AWASHRA, Mahmoud; GUTIERREZ, Miguel; FORNIERI, Ottavio (GSSI); XUE, Xiao (II. Institute of Theoretical Physics, Universitat Hamburg)

Session Classification: Particle Astrophysics

Contribution ID: **43** Type: **not specified**

Discussion

Tuesday, 24 May 2022 16:15 (30 minutes)

Session Classification: Particle Astrophysics

Contribution ID: **44** Type: **not specified**

Lightning Talks (5 x 5 min)

Wednesday, 25 May 2022 11:15 (30 minutes)

Presenters: DE JONG, Eloy (King's College London); GEHRLEIN, Julia; PINOL, Lucas; MATTEINI, Marco (Jožef Stefan Institute); GEORIS, Yannis

Session Classification: Early Universe

Contribution ID: **45** Type: **not specified**

Discussion

Wednesday, 25 May 2022 11:45 (30 minutes)

Session Classification: Early Universe

Contribution ID: **47** Type: **late universe (including CMB, dark energy, astrostatistics)**

Hints of dark matter-neutrino interactions in Lyman-α data

Observations of the Lyman-α flux, in overall good agreement with ΛCDM, have long been known to be able to place stringent bounds on models predicting significant small-scale suppressions of the matter power spectrum. Nevertheless, an apparent inconsistency in the determination of the spectrum's tilt at Lyman-α scales has raised the question of whether an overall better fit to the data than ΛCDM can be found. In light of these considerations, in this talk I will discuss the case of one such scenario in which dark matter and (massive) neutrinos can interact. After constraining this model with CMB, BAO and, in particular, Lyman-α data, one finds a significant departure from ΛCDM, with a preference for an interaction strength about 3σ away from zero, whose origin can be traced back to the additional tilt that the interacting scenario can imprint on the Lyman-α flux, thereby solving the aforementioned tension between early-time and Lyman-α probes.

Primary author: LUCCA, Matteo

Presenter: LUCCA, Matteo

Contribution ID: **54** Type: **not specified**

EuCAPT discussion

Wednesday, 25 May 2022 14:00 (30 minutes)

Presenter: BERTONE, Gianfranco

Session Classification: EuCAPT discussion

Contribution ID: **62** Type: **particle astrophysics (including cosmic rays, neutrinos, nuclear astrophysics)**

Suppression of the TeV pair-beam plasma instability by a tangled weak intergalactic magnetic field

We study the effect of a tangled sub-fG level intergalactic magnetic field (IGMF) on the electrostatic instability of a blazar-induced pair beam. Sufficiently strong IGMF may significantly deflect the TeV pair beams, which would reduce the flux of secondary cascade emission below the observational limits. A similar flux reduction may result from the electrostatic beam-plasma instability, which operates the best in the absence of IGMF. Considering IGMF with correlation lengths smaller than a kpc, we find that weak magnetic fields increase the transverse momentum of the pair beam particles, which dramatically reduces the linear growth rate of the electrostatic instability and hence the energy-loss rate of the pair beam. We show that the beam-plasma instability is eliminated as an effective energy-loss agent at a field strength three orders of magnitude below that needed to suppress the secondary cascade emission by magnetic deflection. For intermediate-strength IGMF, we do not know a viable process to explain the observed absence of GeV-scale cascade emission.

Primary authors: AL-AWASHRA, Mahmoud; POHL, Martin

Presenter: AL-AWASHRA, Mahmoud

Contribution ID: **65** Type: **early universe cosmology**

PBH formation during matter domination with full numerical GR

I will talk about studying the formation of black holes from subhorizon and superhorizon perturbations in a matter dominated universe with 3+1D numerical relativity simulations. We find that there are two primary mechanisms of formation depending on the initial perturbation's mass and geometry – via direct collapse of the initial overdensity and via post-collapse accretion of the ambient dark matter. We find that the duration of the collapse process is roughly one Hubble time, that the PBH mass at formation time is around 1% of the Hubble mass and that the subsequent accretion rates are high. I will also comment on the influence of non-sphericity on the collapse.

Primary author: DE JONG, Eloy (King's College London)

Presenter: DE JONG, Eloy (King's College London)

Contribution ID: **67** Type: **gravitational waves**

The Supercooling Window at Weak and Strong Coupling

We study supercooled first order phase transitions which are typical of theories where conformal symmetry is (mainly) spontaneously broken. In these setups the fate of the flat direction parametrically depends on the explicit breaking of conformal symmetry. This need to be in a particular region to realize a supercooled first order phase transition. We identify the "supercooling window" in weakly coupled theories and strongly coupled CFTs and derive an analytical understanding of its boundaries. Mapping this parameter space allows us to paint a picture of how generic are early Universe phase transitions within the reach of present and future gravitational waves interferometers.

Primary author: LEVI, Noam (Tel Aviv University)

Co-authors: REDIGOLO, Diego (CERN-INFN Florence); OPFERKUCH, Toby (CERN)

Presenter: LEVI, Noam (Tel Aviv University)

Contribution ID: **80** Type: **particle astrophysics (including cosmic rays, neutrinos, nuclear astrophysics)**

New developments on the physics of neutrino fast flavor conversion

In dense astrophysical environments, the neutrino and antineutrino densities are so extreme that neutrino-neutrino coherent forward scattering leads to collective neutrino oscillations, perhaps affecting the core-collapse mechanism and the nucleosynthesis of elements heavier than iron in compact binary remnants. Due to the profound potential implications for the source's physics, the so-called neutrino fast pairwise flavor conversion (FFC) is a topic of intense research. Currently, FFC poses significant challenges for its implementation in realistic astrophysical environments due to its fast timescale, and thus a fully self-consistent simulation of astrophysical sources that includes FFC is not yet available. In this talk, I will discuss under which conditions one should anticipate large neutrino flavor conversion and answer the long-elusive question of identifying a systematic method to predict the final flavor outcome by relying entirely on the initial electron-lepton-number spectrum.

Primary author: PADILLA-GAY, Ian (University of Copenhagen - Niels Bohr Institute)

Co-authors: Prof. TAMBORRA, Irene (Niels Bohr Institute); Prof. RAFFELT, Georg

Presenter: PADILLA-GAY, Ian (University of Copenhagen - Niels Bohr Institute)

Contribution ID: **82** Type: **particle astrophysics (including cosmic rays, neutrinos, nuclear astrophysics)**

An absolute neutrino mass measurement with the DUNE experiment

Supernova (SN) explosions are the most powerful cosmic factories of all-flavors, MeV-scale, neutrinos. The presence of a sharp time structure during a first emission phase, the so-called neutronization burst in the electron neutrino flavor time distribution, makes this channel a very powerful one. Large liquid argon underground detectors, like the future Deep Underground Neutrino Experiment (DUNE), will provide precision measurements of the time dependence of the electron neutrino flux.
In this contribution, I derive a new neutrino mass sensitivity attainable at the future DUNE far detector, obtained by measuring the time-of-flight delay in the SN neutrino signal from a future SN collapse in our galactic neighborhood. Comparison of sensitivities achieved from the two neutrino mass orderings is discussed, as well as the effects due to Earth matter.

Primary author: POMPA, Federica

Co-authors: MENA, Olga (IFIC); SOREL, Michel (IFIC); CAPOZZI, Francesco (IFIC)

Presenter: POMPA, Federica

Contribution ID: **89** Type: **dark matter**

A model independent probe for dark sectors at neutrino experiments

Present and upcoming neutrino experiments can have considerable sensitivity to dark sectors that interact feebly with the Standard Model. We consider light dark sectors (DS) interacting with the SM through well-motivated irrelevant portals. We derive bounds on such scenarios using the decay of dark sector excitations inside the neutrino detector, placed downstream from the target. Our approach is model-independent and applies to a wide range of dark sector models. In this approach, the dark sector is characterised by two energy scales Λ_{UV} (mass scale of mediators generating the portals) and Λ_{IR} (mass gap of the dark sector). At intermediate energies, far away from these scales, the theory is approximately scale-invariant, and allows calculation of production rates independent of the threshold corrections. We look at various DS production processes such as meson decays, direct partonic production, and dark bremsstrahlung. Neutrino experiments are able to probe new regions of parameter space, inaccessible in high energy experiments, and are comparable to fixed-target/beam-dump experiments. Future neutrino experiments will probe new parts of parameter space on a fairly shorter time scale, as compared to other proposed experiments, and provide an efficient probe of dark sectors.

Primary authors: COSTA, Marco; VERMA, Sonali; MISHRA, Rashmish (Harvard University)

Presenter: VERMA, Sonali

Contribution ID: **93** Type: **dark matter**

Cosmic coincidences of primordial-black-hole dark matter

If primordial black holes (PBHs) contribute more than 10 percent of the dark matter (DM) density, their energy density today is of the same order as that of the baryons. Such a cosmic coincidence might hint at a mutual origin for the formation scenario of PBHs and the baryon asymmetry of the Universe. Baryogenesis can be triggered by a sharp transition of the rolling rate of inflaton with a transient ultra-slow-roll phase that produces large curvature perturbations for PBH formation in single-field inflationary models. Such a baryogenesis requirement encloses the PBH contribution to entire DM, in the ultralight asteroid mass range, with observable stochastic gravitational wave background for LISA, Advanced LIGO and Virgo.

Primary author: Dr WU, Yi-Peng (Laboratoire de Physique Théorique et Hautes Énergies (LPTHE))

Presenter: Dr WU, Yi-Peng (Laboratoire de Physique Théorique et Hautes Énergies (LPTHE))

Contribution ID: **105** Type: **gravitational waves**

A boosted gravitational wave background for primordial black holes with broad mass distributions and thermal features

Primordial black holes (PBHs) with a wide mass distribution imprinted by the thermal history of the Universe, which naturally produces a high peak at the solar mass scale, could explain the gravitational-wave events seen by LIGO/Virgo and up to the totality of the dark matter. We show that compared to monochromatic or log-normal mass functions, the gravitational wave backgrounds (GWBs) from early PBH binaries and from late binaries in clusters are strongly enhanced at low frequency and could even explain the NANOGrav observations. This enhancement comes from binaries with very low mass ratios, involving solar-mass and intermediate-mass PBHs at low frequency, solar-mass and subsolar-mass at high frequency. LISA could distinguish the various models, while in the frequency band of ground-based detectors, we find that the GWB from early binaries is just below the current LIGO/Virgo limits and above the astrophysical background, if they also explain black hole mergers. The GWB from binaries in clusters is less boosted but has a different spectral index than for neutron stars, astrophysical black holes or early PBH binaries. It is detectable with Einstein Telescope or even with the LIGO/Virgo design sensitivity.

Primary authors: BAGUI, Eleni (Université Libre de Bruxelles (ULB)); CLESSE, Sébastien (Université Libre de Bruxelles)

Presenter: BAGUI, Eleni (Université Libre de Bruxelles (ULB))

Contribution ID: **108** Type: **late universe (including CMB, dark energy, astrostatistics)**

A Step in Understanding the Hubble Tension

As cosmological data have improved, tensions have arisen. One such tension is the difference between the locally measured Hubble constant H_0 and the value inferred from the cosmic microwave background (CMB). Interacting radiation has been suggested as a solution, but studies show that conventional models are precluded by high-ℓ CMB polarization data. It seems at least plausible that a solution may be provided by related models that distinguish between high- and low-ℓ multipoles. When interactions of strongly-coupled radiation are mediated by a force-carrier that becomes non-relativistic, the dark radiation undergoes a "step" in which its relative energy density increases as the mediator deposits its entropy into the lighter species. If this transition occurs while CMB-observable modes are inside the horizon, high- and low-ℓ peaks are impacted differently, corresponding to modes that enter the horizon before or after the step. These dynamics are naturally packaged into the simplest supersymmetric theory, the Wess-Zumino model, with the mass of the scalar mediator near the eV-scale. We investigate the cosmological signatures of such "Wess-Zumino Dark Radiation" (WZDR) and find that it provides an improved fit to the CMB alone, favoring larger values of H_0. Utilizing a standardized set of measures, we compare to other models and find that WZDR is among the most successful at addressing the H_0 tension.

Primary authors: BERLIN, Asher (NYU); ALONI, Daniel (Weizmann institute); SCHMALTZ, Martin; JOSEPH, Melissa; WEINER, Neal (NYU)

Presenter: JOSEPH, Melissa

Contribution ID: **112** Type: **particle astrophysics (including cosmic rays, neutrinos, nuclear astrophysics)**

A multichannel picture of the Sun at high energies

High energy cosmic rays reach the solar surface and induce a signal that could be observed in up to five different channels: (i) a cosmic ray shadow (HAWC has measured its energy dependence); (ii) a flux of gamma rays (observed by Fermi-LAT up to 200 GeV); (iii) a flux of high energy neutrons (unfortunately, there are no hadronic calorimeters in space); (iv) a muon shadow (detected by IceCube); (v) a flux of high energy neutrinos (not observed yet). We model these fluxes and show that they are tightly correlated, which reduces the uncertainty in the flux of high energy neutrinos expected from the solar disk.

Primary author: GUTIERREZ, Miguel

Co-author: Dr MASIP, Manuel (Universidad de Granada)

Presenter: GUTIERREZ, Miguel

Contribution ID: **137** Type: **particle astrophysics (including cosmic rays, neutrinos, nuclear astrophysics)**

The micro-physics of CR transport in galactic environments

We discuss the micro-physics of cosmic-ray (CR) diffusion as resulting from particle scattering onto the three modes in which the *Magneto-Hydro-Dynamics* (MHD) cascades are decomposed. Assuming that Alfvén modes are subdominant in confining CRs, due to their anisotropic cascading, we debate over the key points that need to be understood while considering fast-magnetosonic modes as the main responsible for CR diffusion. In particular, we show that the possible damping of these modes is crucial in shaping the diffusion coefficient that particles experience throughout the Galaxy. Based on this physics, we implement the resulting diffusion coefficients in a two-zone model in the DRAGON2 code, separating the *Halo* from the *Warm Ionized Medium*, and solve the transport equation. Remarkably, we obtain the correct propagated slope and normalization for the charged species taken into account, without any *ad-hoc* tuning of the transport coefficients. As expected, Alfvén modes are only relevant when their anisotropy is not developed yet, showing up as a feature in the diffusion coefficient that might be observed in the sub-PeV local CR spectra. Also, this framework cannot be responsible for CR confinement below $\sim 200\,\mathrm{GeV}$, implying that the Kraichnan-like scaling of the B/C might not be an imprint of the underlying turbulence.

Primary authors: Dr GAGGERO, Daniele (IFIC Valencia); Dr DE LA TORRE LUQUE, Pedro (Stockholm University); Dr CERRI, Silvio Sergio (CNRS Laboratoire Lagrange); Dr GABICI, Stefano (APC Paris)

Presenter: FORNIERI, Ottavio (GSSI)

Contribution ID: **140** Type: **early universe cosmology**

Analytic false-vacuum decay rate in the thin-wall approximation

We derive a closed-form false vacuum decay rate at one loop for a single real scalar field in the thin wall limit. We obtain the bounce solution, together with the Euclidean action, counter-terms and RG running, and we extract the functional determinant via the Gel'fand-Yaglom theorem. Our procedure is valid for a generic spacetime dimension D, and we provide an explicit finite renormalized decay rate in $D = 3, 4$.

Primary authors: IVANOV, Aleksandar; UBALDI, Lorenzo (SISSA); MATTEINI, Marco (Jožef Stefan Institute); NEMEVŠEK, Miha

Presenter: MATTEINI, Marco (Jožef Stefan Institute)

Contribution ID: **144** Type: **dark matter**

New Directions in Dark Matter Direct Detection

As the age of WIMP-scale dark matter (DM) draws to a close thanks to the ever-increasing sensitivity of direct detection experiments, the majority of DM parameter space outside of the weak scale remains to be explored. Sub-GeV DM can excite electronic transitions in a variety of molecular and nano-scale systems which have sub-eV scale thresholds. In particular, organic molecules, nanoparticles, and other mesoscopic targets can be used to detect the low momentum recoils imparted by the dark matter. We have demonstrated that aromatic molecules can be sensitive to DM as light as a few MeV. Additionally, their planar molecular structures lead to large anisotropies in the electronic wavefunctions, yielding a significant daily modulation in the event rate expected to be observed in crystals of these molecules. I will discuss the importance of molecular and mesoscopic systems as new directions in the direct detection of dark matter.

Primary author: BLANCO, Carlos

Presenter: BLANCO, Carlos

Contribution ID: **149** Type: **gravitational waves**

Invisible traces of conformal symmetry breaking

In our work we study the cosmological phase transition (PT) in a conformal extension of the Standard Model (SM). The model considered is called SU(2)cSM, it extends the SM gauge group by an additional hidden SU(2)$_X$ gauge group, and a scalar doublet (whilist singlet under SM gauge group). The tree-level potential has no mass terms, all the masses are generated via the Coleman-Weinberg mechanism. The new gauge boson X can be considered as a dark matter candidate, also the model may be extended in order to include a mechanism of baryogenesis as well. Due to the large supercooling a strong gravitational waves (GWs) signal can be generated during the PT.
We carefully investigate the PT, taking into account recent developments in order to improve existing results and provide meaningful information for the forthcoming LISA searches.
We study the RG improved potential, distinguish between percolation and nucleation temperature of the bubbles, discuss the hydrodynamics, i.e possible runaway, and present resulting GW spectra.
We briefly comment on the dark matter phenomenology.

Primary author: Mr KIERKLA, Maciej

Presenter: Mr KIERKLA, Maciej

Contribution ID: **151** Type: **dark matter**

ALP Dark Matter from Kinetic Fragmentation: Opening up the parameter window and Observational Consequences

Axion-like-particle (ALP) is a well-motivated candidate for dark matter, and it has been subject to extensive theoretical and experimental research in recent years. The most popular ALP production mechanism studied in the literature is the misalignment mechanism, where the ALP field has negligible kinetic energy initially, and it starts oscillating when its mass becomes comparable to the Hubble scale. Recently, a new mechanism called Kinetic Misalignment has been proposed where the ALP field receives large kinetic energy at early times due to the explicit breaking of the Peccei-Quinn symmetry. This causes a delay in the onset of oscillations so that the ALP dark matter parameter space can be expanded to lower values of the axion decay constant. At the same time, the ALP fluctuations grow exponentially via parametric resonance in this setup, and most of the energy in the homogeneous mode is converted to ALP particles. This process in known as fragmentation. In this talk, I will discuss the observational consequences of fragmentation for the axion miniclusters, and show that a sizable region of the ALP parameter space can be tested by future experiments that probe the small-scale structure.

Primary authors: EROENCEL, Cem; SERVANT, Geraldine (Deutsches Elektronen-Synchrotron (DE)); SØRENSEN, Philip (DESY / University of Hamburg); SATO, Ryosuke

Presenter: EROENCEL, Cem

Contribution ID: **155** Type: **dark matter**

QCD Axion Kinetic Misalignment: Observational Aspects

When the spontaneous breaking of the Peccei-Quinn (PQ) symmetry occurred, the resulting angular direction of the PQ field, i.e. the axion could have possessed an initial nonzero velocity arising from additional terms that explicitly break the PQ symmetry. This opens up the possibility for smaller values of the decay constant than in the conventional scenario. We elaborate further on the outcome of this "kinetic misalignment"framework, assuming that axions form the entirety of the dark matter abundance. The kinetic misalignment framework possesses a weak limit in which the axion field starts to oscillate at the same temperature as in the conventional scenario, and a strong limit corresponding to large initial velocities which delay the onset of oscillations. We show how this scenario impacts the formation of axion miniclusters, and we sketch the details of these substructures along with potential detecting signatures.

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Contribution ID: **160** Type: **dark matter**

Planck polarization data constrain synchrotron emission from Galactic dark matter

Dark Matter in our Galaxy may produce a linearly polarized synchrotron signal through the secondary emission of electrons and positrons originating from dark matter annihilations. Using the latest Planck data release, for the first time we use microwave synchrotron polarization to constrain Dark Matter annihilation in the Galaxy. We find that polarization is more constraining than synchrotron intensity by about one order of magnitude independently from uncertainties in the modeling of electron and positron propagation and the model of Galactic magnetic field.

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Contribution ID: **161** Type: **late universe (including CMB, dark energy, astrostatistics)**

Rescuing constraints on modified gravity through gravitational redshift

The distribution of galaxies provides an ideal laboratory to test deviations from General Relativity. In particular, redshift-space distortions are commonly used to constrain modifications to the Poisson equation, relating the spatial component of the gravitational field with the matter density. However, such constraints rely on the validity of the weak equivalence principle, which has never been tested for the dark matter component. In my talk, I will employ SDSS data to show that dropping this restrictive assumption leads to severe degeneracies in the parameter space. I will then demonstrate that it is possible to break such degeneracies and recover tight constraints on gravity modifications using relativistic effects in the galaxy distribution, which will be observable by the next generation of large-scale structure surveys.

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Presenter: CASTELLO, Sveva

Contribution ID: **165** Type: **late universe (including CMB, dark energy, astrostatistics)**

An Effective Field Theory of 21 cm Radiation with Redshift Space Distortions

With the prospect of detecting the cosmological 21 cm signal from the epoch of reionization just over the horizon, methods for extracting maximal cosmological information from this signal are increasingly timely. I will discuss recent work to further develop the effective field theory (EFT) for the 21 cm brightness temperature field during the epoch of reionization, incorporating renormalized bias and a treatment of redshift space distortions. To validate our theoretical treatment, we fit the predicted EFT Fourier-space shapes to the Thesan suite of hydrodynamical simulations of reionization at the field level. We find that the resulting power spectra agree at the level of a few percent over the wavenumber range $k < 0.8$ h/Mpc and neutral fraction $x_{\mathrm{HI}} > 0.4$ that is imminently measurable by the Hydrogen Epoch of Reionization Array (HERA).

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Contribution ID: **170** Type: **dark matter**

Neutron stars as photon double-lenses: constraining resonant conversion into ALPs

Axion-photon conversion is a prime mechanism to detect axion-like particles that share a coupling to the photon. We point out that in the vicinity of neutron stars with strong magnetic fields, magnetars, the effective photon mass receives comparable but opposite contributions from free electrons and the radiation field. This leads to an energy-dependent resonance condition for conversion that can be met for arbitrary light axions and leveraged when using systems with detected radio component. Using the magnetar SGR J1745-2900 as an exemplary source, we demonstrate the potential sensitivity to improve current constraints on the axion-photon coupling by more than one order of magnitude over a broad mass range. With growing insights into the physical conditions of magnetospheres of magnetars, the method hosts the potential to become a serious competitor to future experiments such as ALPS-II and IAXO in the search for axion-like particles.

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Presenter: SOKOLENKO, Anastasia (University of Chicago)

Contribution ID: **173** Type: **dark matter**

The cosmic optical background excess and dark matter

Recent studies using New Horizons LORRI images have returned the most precise measurement of
the cosmic optical background to date, yielding a flux that exceeds that expected from deep galaxy counts by roughly a factor of two. We investigate whether this excess, detected at ~ 4σ significance, is due to dark matter that decays to a monoenergetic photon with a rest-frame energy in the range 0.5 − 10 eV. We derive the spectral energy distribution from such decays and the contribution to the flux measured by LORRI. The parameter space that explains the measured excess with decays to photons with energies E & 4 eV is unconstrained to date. If the excess arises from dark-matter decay to a photon line, there will be a significant signal in forthcoming line-intensity mapping measurements. Moreover, the ultraviolet instrument aboard New Horizons (which will have better sensitivity and probe a different range of the spectrum) and future studies of very high-energy γ-ray
attenuation will also test this hypothesis and expand the search for dark matter to a wider range of
frequencies.

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Presenter: BERNAL MERA, Jose Luis

Contribution ID: **182** Type: **gravitational waves**

Effect of density fluctuations on gravitational wave production in first-order phase transitions

We study the effect of density perturbations on the process of first-order phase transitions and gravitational wave production in the early Universe. We are mainly interested in how the distribution of nucleated bubbles is affected by fluctuations in the local
temperature.
We find that large-scale density fluctuations ($H_* < k_* < \beta$) result in a larger effective bubble size at the time of collision, enhancing the produced amplitude of gravitational waves.
The amplitude of the density fluctuations necessary for this enhancement is $calP_\zeta(k_*) > (\beta/H_*)^{-2}$, and therefore the gravitational wave signal from first-order phase transitions with relatively large β/H_* can be
significantly enhanced by this mechanism even for fluctuations with moderate amplitudes.

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Presenter: RUBIRA, Henrique

Contribution ID: **192** Type: **gravitational waves**

Constraining the SGWB from inflationary models with LISA

Early Universe dynamics beyond the standard single-field slow-roll paradigm may produce a Stochastic Gravitational Wave Background (SGWB) in the LISA band. In this talk, we will present recent advances from the LISA CosWP in creating a 'bank' of templates representing the SGWB produced in popular inflationary models. We adopt a recently developed data analysis pipeline to forecast the reconstructability of these templates and the constraints on the model parameters and discuss the implications of our forecast for inflationary model builders.

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Contribution ID: **197** Type: **not specified**

EuCAPT news

Monday, 23 May 2022 16:45 (1 hour)

Presenter: BERTONE, Gianfranco

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