Tensions in Cosmology

Report of Contributions

https://indico.cern.ch/e/1191458

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

How many h are there? And what do they mean?

Thursday, 8 September 2022 09:00 (30 minutes)

The current expansion rate of the Universe is captured by the so-called Hubble constant, or its dimensionless equivalent, "little h", which is a key parameter in the, extremely successful, standard model of cosmology. The Hubble constant relates measurements of the expansion history of the Universe to its components, and "little h"appears in all astrophysical quantities which measurement or calibration somewhat depend on the background cosmology. The 'Hubble tension' has motivated the exploration of extensions to the standard cosmological model in which higher values of H0 can be obtained from CMB measurements and galaxy surveys. The Hubble trouble, however, goes beyond H0. Modifications invoked to address the Hubble tension affect other quantities too, such as cosmic times, age of the Universe and the matter density. Any Hubble trouble has implications well beyond H0 itself. I will recap some recent results and try to look at the tension in both a model-dependent and model independent way.

Presenter: Prof. VERDE, Licia (Instituto de Ciencias del Cosmos (ICC))

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

Constraints on Cosmological Expansion With Type Ia Supernovae

Thursday, 8 September 2022 09:30 (30 minutes)

I will discuss recent results from the Pantheon+ team on constraining multiple cosmological parameters with Type Ia supernovae. The Pantheon+ and SH0ES teams released likely their final major update to the measurement of the Hubble constant, which parameterizes the current expansion rate of the universe. The result is in 5sigma tension with constraints from the Cosmic Microwave Background. I will overview the new measurements on the local side, and discuss the extensive work on systematic covariances between these measurements. I will go over various past challenges to the local-side measurement and detail how our new analyses have addressed them. I will then discuss next steps and challenges, and particularly what we will learn from upcoming analyses like DES, and future ones like LSST and Roman.

Presenter: Prof. SCOLNIC, Daniel (Duke University)

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

Toward Cosmological Concordance with New Physics in the Dark Sector

Thursday, 8 September 2022 10:00 (30 minutes)

I will discuss recent and ongoing work focused on attempts to restore concordance amongst cosmological data sets, motivated by discrepancies between some measurements of the cosmic expansion rate (H_0) and the matter clustering amplitude (S_8). Particular attention will be paid to models invoking new physics in the high-redshift universe, including quasi-accelerating early dark energy models (and extensions thereof) and generalized decaying particle scenarios. In particular, I will discuss constraints on these models derived using the latest CMB measurements from the Atacama Cosmology Telescope (ACT) and from the Planck satellite, amongst other data sets. I will conclude with a look ahead to forthcoming CMB data from ACT, which will provide a powerful test of these scenarios in the low-noise, high-resolution regime.

Presenter: Prof. HILL, Colin (Columbia University)

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

Addressing cosmological tensions with new emerging probes: a perspective from cosmic chronometers

Thursday, 8 September 2022 10:30 (20 minutes)

In the era of precision cosmology, exploring new and complementary approaches to measure how the Universe (and the structures therein) have evolved is of fundamental importance, to increase the accuracy in the measurements and keep under control systematic effects. In this talk, I will present a novel approach to obtain constraints on the expansion rate of the Universe based on the differential age evolution of "cosmic chronometers". The strength of this method is that it allows a direct measurement of the Hubble parameter H(z) without relying on any cosmological assumptions, providing an ideal framework to test cosmological models.

Presenter: Dr MORESCO, Michele (University of Bologna)

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

Measuring H0 with strongly lensed quasars

Thursday, 8 September 2022 10:50 (20 minutes)

Time-delay cosmography with lensed quasars is the only single-step method to measure H0. It has its own advantages and drawbacks that I will review, before presenting the different avenues adopted by the TDCOSMO collaboration to improve results. Part of this effort resides in time delay measurements obtained at high temporal cadence for 50 lensed quasars, illustrating the need for medium-size telescope(s) to complement LSST.

Presenter: Prof. KOOPMANS, Leon (Kapteyn Astronomical Institute)

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

Inhomogeneous Hubble diagram from vector K-mouflage

Thursday, 8 September 2022 11:30 (20 minutes)

I will present the Hubble diagram for a Universe where dark matter is universally charged under a dark non-linear electromagnetic force which features a screening mechanism of the K-mouflage type for repulsive forces. I will explicitly show that the cosmological evolution generates an inhomogeneous Hubble diagram that corresponds to a curvature dominated expansion at short distances and converges to the cosmological one of ΛCDM. We discuss the potential impact of this inhomogeneous profile on the Hubble tension.

Presenter: Dr BRAX, Philippe (CEA Saclay)

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

A uniform Zwicky Transient Facility-tip of the red giant branch distance ladder Implications for the Hubble constant

Thursday, 8 September 2022 11:50 (20 minutes)

The Hubble tension is arguably the largest open question in modern cosmology. It could be a sign of new cosmological physics or unknown sources of systematics. To definitively answer this question, we need percent level measurements of the local distance scale. In this talk, I will present our recent work on calibrating the absolute luminosity of Type Ia supernovae from the wide-field Zwicky Transient Facility. This distance ladder is uniform in that both the calibrator and Hubble flow SNe Ia are observed with a single, untargeted survey, which sidesteps the two largest systematics in the local distance ladder, i.e. photometric cross-calibration and selection biases depending on host environment. Finally, I'll preview the upcoming work on building this distance ladder in the JWST era.

Presenter: Dr DHAWAN, Suhail (University of Cambridge)

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

Cosmological tension analyses in extended theories of gravity: artificial neutral path

Thursday, 8 September 2022 12:10 (20 minutes)

The current cosmological probes have provided an extraordinary confirmation of the standard LCDM cosmological model, that has been constrained with unprecedented accuracy. However, with the increase of the experimental sensitivity a few statistically significant tensions between different independent cosmological datasets emerged. While these tensions can be in portion the result of systematic errors, the persistence after several years of accurate analysis strongly hints at cracks in the standard cosmological scenario and the need for new physics. In this talk I will list a few interesting new cosmological models in the direction of extended theories of gravity that could solve this tension and discuss how the new computational techniques will be crucial in this role.

Presenter: Prof. ESCAMILLA-RIVERA, Celia (Nuclear Institute of Science (Instituto de Ciencias Nucleares). Universidad Autonoma de Mexico. ICN-UNAM)

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

Large-Scale Anomalies in the Cosmic Microwave Background Current Status, Future Prospects, and Possible Explanations

Thursday, 8 September 2022 12:30 (20 minutes)

Even though the current observational data show an extremely high level of agreement with predictions of the standard model of cosmology, LambdaCDM, the cosmic microwave background (CMB) temperature fluctuations measured by the WMAP and Planck satellites have shown a number of persistent anomalous features on large-angular scales that are unexpected or extremely unlikely in LambdaCDM cosmology. These anomalies, which are properties of the observed sky and not instrumental artefacts, are all related to violation of statistical isotropy, and even though they could, individually taken, be statistical flukes, they may also be hints of new physics beyond the standard cosmological model. In this talk, after providing a critical review of the CMB large-angular-scale anomalies, their history and their current status, I will discuss some of the existing explanations for the features, ranging from the fluke hypothesis and astrophysical foregrounds within LambdaCDM to different physical models beyond the standard picture, in particular the possibility that the Universe has a non-trivial topology, and will review phenomenological expectations for each explanation. I will argue that, in addition to the new perspectives on existing data that the powerful and continuously advancing computational and statistical techniques may provide, it is also essential to investigate the anomalies further with upcoming and future high-precision cosmological data, including observations of the CMB polarisation and the cosmic large-scale structure. This is because any observations of similar or related anomalies in any data sets other than the CMB temperature sky will ameliorate concerns about look-elsewhere penalties for the a posteriori statistical characterization of the CMB temperature anomalies while dramatically increasing the statistical significance of the features to a level which will inevitably force us to revise or rethink the standard model of cosmology. Finally, I will discuss potential connections between the CMB anomalies and the recently reported tensions in the measured values of the cosmological parameters of the LambdaCDM model and argue that a combination of these tensions and anomalies may provide a smoking gun for the existence of new physics beyond the standard model of cosmology.

Presenter: Dr AKRAMI, Yashar (IFT Madrid & CWRU, USA)

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

”Hubble tension: Understanding the theoretical uncertainties of TRGB calibrations theoretical uncertainties of TRGB > calibrations”

Thursday, 8 September 2022 15:30 (20 minutes)

Presenter: Dr SALTAS, Ippocratis (CEICO, Institute of Physics of the Czech Academy of Sciences, Czechia)

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

Inferring cosmological parameters from Baryon Acoustic Oscillations datasets

Thursday, 8 September 2022 15:50 (20 minutes)

Baryon acoustic oscillations (BAO) involve measuring the spatial distribution of galaxies to determine the growth rate of cosmic structures. In this talk we discuss the use of different BAO dataset to infer the parameters of different cosmological models. Explicitly, we use BAO + Chronometers data, the Pantheon type Ia supernova, and the Hubble diagram of gamma-ray bursts and quasars to put a limit on the Hubble constant in LCDM, OkCDM and wCDM . Then we marginalize over H0rd to infer the parameters of a set of dark energy models.

Presenter: Prof. STAICOVA, Denitsa (Institute for Nuclear Research and Nuclear Energy, BAS)

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

Towards solutions to the Hubble problem beyond Einstein's Gravity

Thursday, 8 September 2022 16:10 (20 minutes)

Discrepant measurements of the Hubble parameter may signal physics beyond the standard cosmological model. I will present different mechanisms to solve the Hubble problem in viable theories beyond General Relativity, testing them against cosmological data and discussing their implications for precision tests of gravity. Among them, a simple model relying on an enhanced strength of gravity at early times reduces the Planck+BAO tension with SH0ES from 4.4 sigma of LCDM to 2.6 sigma (2020 data). While further model building is required to fully resolve the H0 problem, these examples show the wealth of possibilities to solve cosmological tensions beyond Einstein's General Relativity.

Presenter: Dr ZUMALACÁRREGUI, Miguel (Max Planck Institute for Gravitational Physics - Albert Einstein Institut)

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

Next generation cosmological analysis with nested sampling

Thursday, 8 September 2022 16:30 (20 minutes)

Presenter: Dr HANDLEY, Will

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

The Etherington-Hubble relation

Friday, 9 September 2022 18:30 (20 minutes)

Presenter: Dr RENZI, Fabrizio (Lorentz Institute for Theoretical Physics, Leiden University)

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

A 1% calibration of the Galactic Cepheid Luminosity scale based on cluster Cepheids strengthens the Hubble tension

Thursday, 8 September 2022 16:50 (20 minutes)

I present our recent 1% calibration of the Galactic Leavitt Law (period-luminosity calibration) based on Gaia astrometry of Cepheid-hosting open star clusters as well as individual Cepheids (Cruz Reyes, Anderson et al. in prep.). We identified host clusters in the vicinity of Cepheids using our own clustering method to identify clusters whose average parallax can be safely used in lieu of Cepheid parallaxes for Leavitt law calibration. This method provides average cluster parallaxes with typical uncertainties of ˜ 6 micro arcsec for clusters, including angular covariance terms and improving by a factor of ˜2.8 on the typical uncertainty of Cepheid parallaxes used for Leavitt law calibration. Using the LMC for comparison, we show that cluster parallaxes are accurately corrected for known Gaia parallax systematics by applying the Lindegren et al. (2021) based on quasars. Hence, additional (beyond Lindegren et al.'s) corrections for parallax offsets that are required for individual Cepheids are not required for average cluster parallaxes. This allows us to calibrate the Milky Way Leavitt law to unprecedented accuracy in a variety of photometric bands and reddening-free Wesenheit magnitudes while simultaneously solving for the residual individual Cepheid parallax offset. Using two photometrically independent sets of Wesenheit magnitudes, we measure the most precise value for the Cepheid parallax offset to date with a significance of 6 sigma. At the same time, we determine the absolute magnitude of Solar metallicity Cepheids of 10 day period to an accuracy as good as 1%, exclusively relying on data of Milky Way Cepheids without a need for data from other galaxies or the distance ladder. Importantly for the Hubble tension, we find a Cepheid luminosity scale in 0.9 sigma agreement with the same number determined by the SH0ES team (Riess et al. 2022) based on an extragalactic distance ladder fit as used to determine the Hubble constant. Our methodology is maximally different from the SH0ES distance ladder, yet obtains results consistent to within 1 sigma and at an accuracy of 1%. This lends strong support to the veracity of the Hubble tension and shows that Gaia astrometry can deliver on its potential to calibrate the Cepheid luminosity scale to better than 1% in future data releases.

Presenter: Dr ANDERSON, Richard

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

Resolving tensions in cosmology via the modified measures approach to control vacuum energies

Friday, 9 September 2022 19:30 (20 minutes)

Introducing modified measures re defines the scalar field potentials while providing spontaneous breaking of scale invariance. In this way one can obtain potentials with two flat regions , one suitable for inflation and the other suitable for the late universe. With two scalar fields the scalar potential can have three flat regions after spontaneous symmetry breaking, one for inflation and the other two for the late universe, showing the possibility of early dark energy, which has been invoked for the resolution of the H0 tension. Other phenomena present in the modified measures theory, like dark energy from fermions the avoidance of the 5th force problem and the justification in terms of modified measure theory of the the phenomenological model of Afshordi et. al. for the resolution the H0 tension will be discussed.

Presenter: Dr GUENDELMAN, Eduardo (Ben Gurion University)

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

The multipole structure of the local expansion rate

Saturday, 10 September 2022 12:30 (20 minutes)

The failure to converge on a consensus value of the Hubble's constant triggered investigations into the reliability of geometric descriptions of the local spacetime that deviate from the standard cosmological metric. The question that arises is whether metrics with lower symmetries, while still simple, provide a reliable description of the data in the local patch of the universe where global uniformity is violated.

Presenter: Dr MARINONI, Christian (Aix-Marseille University)

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

Cosmological Constraints using Alternative Hubble Expansion Tracers

Friday, 9 September 2022 09:00 (30 minutes)

Presenter: Prof. PLIONIS, Manolis (NOA)

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

A possible non-linear solution to the S8 tension

Friday, 9 September 2022 09:30 (30 minutes)

I will review the evidence for a low value of S8 from cosmic shear. I will then argue that the discrepancy with the Planck value of S8 may be a caused by uncertainties in the theoretical predictions for cosmic shear arising from the modelling of the mass fluctuations on small scales. In other words, the S8 discrepancy may reflect a tension between small and large scales rather than a tension between physics at early and late times.

Presenter: Prof. EFSTATHIOU, George

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

The Dark Energy Survey and the S8 tension

Friday, 9 September 2022 10:00 (30 minutes)

"I will present the cosmological weak lensing results from the Dark Energy Survey (DES) using its first three years of data taken using the Dark Energy Camera on the 4m Blanco telescope. This analysis spans the full DES footprint, roughly 1/8th of the
night sky, with the final galaxy catalogue containing more than 100 million galaxies in riz photometric bands, constituting the most powerful weak lensing dataset to date. The comparison of DES cosmological constraints on dark matter and dark energy from WL and LSS in the low-redshift Universe to CMB constraints provides an unprecedented test of the standard cosmological model, across high and low redshift. I will mention the main challenges that our analysis is susceptible to, and the summarise the approach our team took to account for these and deliver robust cosmological constraints. I'll contextualise these with other low S8 results in the field. Finally, I'll present a plausible solution to the S8 tension. "

Presenter: Dr AMON, Alexandra (Stanford U)

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

Modified gravity with 2 d.o.f. as a tool to address tensions in cosmology

Friday, 9 September 2022 10:30 (20 minutes)

Presenter: Prof. MUKOHYAMA, Shinji (Yukawa Institute for Theoretical Physics, Kyoto University)

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

How to address tensions in cosmology by modified gravity with 2 d.o.f.

Friday, 9 September 2022 10:50 (20 minutes)

Presenter: Prof. DE FELICE, Antonio

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

Current and Future Constraints on H0 from Infrared SBF

Friday, 9 September 2022 11:30 (20 minutes)

We recently published a new measurement of the Hubble constant H0 determined from distances to over 60 early-type galaxies out to 100 Mpc measured by the Surface Brightness Fluctuations (SBF) method using data from the WFC3 Infrared Channel on the Hubble Space Telescope (HST). More than a third of these galaxies have hosted well-measured Type Ia supernovae, and we use these to do detailed comparisons of SBF and SNIa distances. If we recalibrate SNIa using SBF, we find a steeper dependence of supernova peak luminosity on decline rate in early-type galaxies, but the resulting value of H0 is indistinguishable from the values given independently by SNIa and SBF when each are calibrated from Cepheids. We discuss these recent SBF results from HST/WFC3 as well as the excellent prospects for a fully independent TRGB-calibrated SBF precision measurement of H0 using JWST.

Presenter: Dr BLAKESLEE, John

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

Tensions with cosmological singularities: Should we try to avoid their appearance?

Friday, 9 September 2022 11:50 (20 minutes)

The appearance of an initial (and sometimes also a final) cosmological singularity in practically all realistic models of the evolution of the universe is distinguishing feature of the modern cosmology. Tensions concerning this question are always present.There are attempts to construct cosmological models where the geometry is always regular. However, some approaches based on the description of the possible passage through the singularities were also developed recently. We have tried to elaborate a general formalism, telling when it is possible and when the singularity present unsurmountable obstacle.

Presenter: Prof. KAMENSHCHIK, Alexander (Bologna University)

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

A robust explanation of CMB anomalies with a new formulation of inflationary quantum fluctuations

Friday, 9 September 2022 12:10 (20 minutes)

In this talk, we introduce CMB anomalies, especially the hemispherical asymmetry that has been consistently observed by WMAP and Planck data. These anomalies have been extensively discussed in the last decade as a signature of new physics and several scalar field models of inflation have been proposed in this regard. We will present a new understanding of inflationary quantum fluctuations which is model-independent and can robustly explain the hemispherical asymmetry anomaly of the CMB. Based on our approach to the new construction of quantum theory on curved space-time, we also present new predictions with exact numerical values for the CMB temperature fluctuations at low multipoles. We further comment on how one can determine observationally the quantum nature of inflationary fluctuations and how our study will impact the problem of time in quantum cosmology.

Presenter: Mr KUMAR, Sravan K. (Universidade da Beira Interior)

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

Electromagnetic Accelerating Universe

Friday, 9 September 2022 12:30 (20 minutes)

Assuming that the entropy of the contents of the universe saturates the holographic bound, we extend the PBH idea for dark matter within galaxies and clusters of galaxies by populating the universe with extremely masAssuming that the entropy of the contents of the universe saturates the holographic bound, we extend the PBH idea for dark matter within galaxies and clusters of galaxies by populating the universe with extremely massive PBHs having masses extending up to values close to the mass of the universe. The Great Attractor is one possible example of such additional dark matter.sive PBHs having masses extending up to values close to the mass of the universe. The Great Attractor is one possible example of such additional dark matter.

Presenter: Dr FRAMPTON, Paul

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

Barrow holographic dark energy and a possible reduction of the Hubble tension

Friday, 9 September 2022 12:50 (20 minutes)

I will make some short reminiscent about the geometrical idea of Barrow entropy for black holes and its cosmological horizon applications in the context of dark energy. I will relate it to some other nonextensive entropies such as Renyi and Tsallis –the former being formally related to that of Barrow. Finally, I will show that, amazingly, Barrow holographic dark energy gives a strong Bayesian evidence against ΛCDM and can also weaken
the Hubble tension.

Presenter: Prof. DABROWSKI, Mariusz (National Center for Nuclear Research)

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

A reanalysis of the SH0ES data for H_0: Effects of new degrees of freedom on the Hubble tension

Friday, 9 September 2022 13:10 (20 minutes)

A reanalysis of the SH0ES data for H_0: Effects of new degrees of freedom on the Hubble tension

Presenter: Prof. PERIVOLAROPOULOS, Leandros (University of Ioannina)

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

Asymptotic Safety and the Cosmic Coincidence Problem

Friday, 9 September 2022 15:30 (10 minutes)

Asymptotic Safety (AS) Paradigm is an interesting set of ideas and methods towards a meaningful quantization of Gravity. A brief review of phenomenological consequences in the context of AS regarding cosmology with emphasis on dark energy is given. Furthermore, recent studies that suggest a natural explanation of the recent cosmic acceleration and its coincidence using large-scale structure and AS framework will be analyzed.

Presenter: Prof. ZARIKAS, Vasileios (Univ. of Thessaly)

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

A Mechanism of Baryogenesis for Causal Fermion Systems

Friday, 9 September 2022 15:30 (10 minutes)

Causal Fermion Systems is a new approach to unify General Relativity and the Standard Model of particle physics. The theory has been developed by Felix Finster over the past decade. I will give an introduction to the fundemental mathematical structures of the theory and explain how to obtain familiar descriptions as an effective description. Further i will give an overview of results obtained from the Causal Action Principle such as the Gauge group of the Standard Model, 3 generations of fermions and second quantization as a minimizing condition as well as Einsteins field equations. Finally I will give an outlook on the prospects of deriving an explanation for the matter/anti-matter asymmetry in the universe and the potential consequences of this explanation for the cosmic evolution especially the H0 tension.

Presenter: Dr PAGANINI, Claudio (Mathematische Fakultät Universität Regensburg/ Albert Einstein Institute)

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

Domaine walls low tension

Friday, 9 September 2022 15:40 (10 minutes)

Usually domaine walls are considered excluded from realisitic cosmology because the theoretical expectations for domaine wall tensions and thus also energy densities per area from high energy physics become so huge for cosmological purposes that they tend to spoil completely our cosmological models. However, we have under the attempts to fit the domaine wall tension in our model for dark matter in which the dark matter consisits of pearls of a new vacuum surounded by a domaine wall then obtained the for us surprising low value of the tension S= (\sim MeV)ˆ3. Such low tension domaine walls could be imagined as sacs arround voids between the galaxy clusters and only contributing energidensities of the order of the critical density. In fact such domaine walls could be naturally arranged to with their negative pressure replace the dark energy. If gas inside the large bubbles of the new vacuum get cooled to form H-atoms and if one measures the fine structure constant inside the clouds in the new vacuum it is expected to deviate slightly - of the order 1/10ˆ5 of the fine structure constant in the usual vacuum -. The so far found very uncertain deviations from constancy of the fine structure constant from place to place could match well. Using the idea of assuming several vacua with the SAME energy densities we once before the Higgs was found predicted it mass with only 10 GeV deviation (the uncertainty in our PREdiction).

Presenter: Prof. NIELSEN, Holger Bech (Niels Bohr Institute)

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

Slicing through the tension: getting more cosmology from weak lensing

Friday, 9 September 2022 15:40 (10 minutes)

Cosmological information contained within the non-linear regime of the Universe may prove crucial in solving the tension currently observed between weak lensing and CMB probes. However, this information lies beyond the reach of our conventional analyses which use two-point statistics. In this talk, I present the improvements in cosmological constraining power offered by an alternative weak lensing statistic, the projected matter density PDF. For realistic lensing survey specifications, this statistic yields >50% improvements in the constraints on the matter energy density parameter, $\mathbb{O}_m$, and the amplitude of the matter power spectrum, $_8$. We also find significantly improved precision for the Hubble parameter, H_0, and the dark energy equation of state parameter, w_0. I will demonstrate how these gains in cosmological constraining power can be made reality with tailored numerical simulations paired and machine learning.

Presenter: Dr GIBLIN, Benjamin (University of Barcelona / University of Edinburgh)

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

Towards realistic constraints on alternative theories of gravity

Friday, 9 September 2022 15:50 (10 minutes)

I will start by overviewing the main motivations to test gravity at cosmological scales. In particular, I shall focus on current cosmological constraints and the use of dark energy and alternative theories of gravity to alleviate cosmological tensions. Then, I will describe what are the main methods and tools – including the Einstein-Boltzmann solver hi_class – used to reach the precision needed by the next generation of surveys. I shall concentrate on their caveats, missing features and improvements required to get believable results. Finally, I will outline the road ahead and future perspectives for cosmological tests of gravity.

Presenter: Dr BELLINI, Emilio (INFN Trieste)

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

Consistent lensing and clustering in a low-S8 Universe with BOSS, DES Year 3, HSC Year 1 and KiDS-1000

Friday, 9 September 2022 15:50 (10 minutes)

"I will discuss our recent study were we have evaluated the consistency between lensing and clustering probes of large-scale
structure based on measurements of projected galaxy clustering from the Baryon Oscillation Spectroscopic Survey (BOSS) combined with overlapping galaxy–galaxy lensing from three surveys: the Dark Energy Survey Year 3 (DES Y3), the Hyper-Suprime Cam survey (HSC) Year 1, and the Kilo- Degree Survey (KiDS-1000). As part of this work we have investigated small scale systematics in modelling lensing and clustering measurements and how they limit our ability to improve our cosmological constraining power. Also in this work, we have performed an intra-lensing-survey study. I will present joint fits to both the clustering and lensing measurements and show how this analysis demonstrates the statistical power of these small-scale measurements, but also indicates that caution is still warranted given current uncertainties in modelling baryonic effects, assembly bias, and selection effects in the foreground sample. "

Presenter: Dr ROBERTSON, Naomi (University of Cambridge)

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

Is a new cosmological tension emerging from the (Lyman-α) forest?

Friday, 9 September 2022 16:00 (10 minutes)

Observations of the Lyman-α flux have been long believed to be in overall good agreement with the ΛCDM cosmology inferred from early-time probes of the universe. However, recent analyses focused on the compatibility between the latter and various Lyman-α datasets have reported hints (at the 2-3σ level) of an apparent inconsistency in the determination of the tilt of the matter power spectrum at Lyman-α scales between the two estimates. Although a lot of work still needs to be carried out to understand the strength and solidity of such discrepancy, this has inevitably raised the intriguing question of whether a better fit to the data than ΛCDM can be found. In light of these considerations, in this talk I will first of all briefly introduce the evidence in support of this emerging tension and then propose some concrete examples of the potential for discovery that such eventuality would entail.

Presenter: Dr LUCCA, Matteo (ULB)

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

Alleviating the σ8 tension via Soft Cosmology and Modified Gravity

Friday, 9 September 2022 16:00 (10 minutes)

We examine the possibility of "soft cosmology", namely small deviations from the usual cosmological framework due to the effective appearance of soft-matter properties in the Universe sectors. One effect of such a case would be that dark energy and/or dark matter exhibit a different equation-of-state parameter at large scales (which determine the universe expansion) and at intermediate scales (which determine the sub-horizon clustering and the large-scale structure formation). These properties could help alleviate issues of the standard cosmological paradigm, such as the ï⊠8 tension. In this talk, we shall demonstrate how an f(R) modified theory of gravity could naturally facilitate such properties for the dark Universe sectors.

Presenter: Mr TZEREFOS, Charalampos (NOA/NKUA)

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

Quantum vacuum, a cosmic chamaleon

Friday, 9 September 2022 16:10 (10 minutes)

An universe with a Cosmological Constant has been the reigning paradigm in the last decades. However, the Cosmological Principle opens a window to the possibility of having a dynamical Vacuum Energy density, $\rho_{\rm vac}(t)$. In this talk we will summarize our results on the renormalization of the vacuum energy in the context of quantum field theory (QFT). The quantum scaling with the renormalization point turns into cosmic evolution as a series of powers of the Hubble parameter, $\rho_{\rm vac}(H)$. The resulting running is free from undesired large contributions coming from particle masses, $\sim m^4$. At low energies it also consists of an additive term plus a small dynamical component $\sim \nu H^2$, ($|\nu| \ll 1$), characteristic of the Running Vacuum Models. Higher powers may be relevant in the early universe, and could naturally drive a possible mechanism for inflation. We elucidate new features of the running vacuum energy with many interesting consequences from the phenomenological point of view, in particular their possible implications for the current σ_8 and H_0 tensions of modern cosmology.

Presenter: Dr MORENO PULIDO, Cristian (University of Barcelona)

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

Tilted cosmology and tensions with the ΛCDM model using SNIa

Friday, 9 September 2022 16:10 (10 minutes)

No real observers in the universe follow the smooth Hubble expansion but we all move relative to it. The Local Group of galaxies, for example, drifts at approximately 600km/s with respect to the Hubble flow. Such peculiar motions dominate the kinematics of the local universe. Recently, peculiar velocity surveys have reported the existence of bulk flows extending out to several hundreds of Mpc, in excess of those predicted by the standard cosmological model. This work looks into the implications of large-scale peculiar velocities from the viewpoint of a tilted cosmological model equipped with two families of observers. The first one follows the Hubble flow, while the second family consists of real observers residing in a typical galaxy (like our Milky Way) and moving relative to the universal expansion with non-relativistic peculiar velocities. We study a parametrization of the deceleration parameter in the tilted model using the Pantheon compilation of Type Ia supernovae. By means of a Markov Chain Monte Carlo (MCMC) method, we show that a tilted Einstein-de Sitter model, having one or two additional parameters that describe the assumed velocity flows, can reproduce the late-time cosmic acceleration without the need of a cosmological constant or dark energy. From our statistical analysis, we find that the tilted model performs similarly to the standard ΛCDM paradigm in the context of model selection criteria (Akaike information criterion and Bayesian information criterion).

Presenter: Ms ASVESTA, Kerkyra

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

The KBC void and Hubble tension in Î□CDM and Milgromian dynamics

Friday, 9 September 2022 16:20 (10 minutes)

The observed spatial arrangement of galaxies on scales ranging from 100 kpc to 1 Gpc is a very powerful test of different cosmological models and gravitational theories. The observed Keenan-Barger-Cowie (KBC) void is an immense local underdensity with an apparent density of about half the cosmic mean on a 300 Mpc scale. In my talk (based on Haslbauer et al., MNRAS, 499, 2845), I will first show that the KBC void falsifies the standard model of cosmology at high significance. This strongly suggests that structure formation is much more efficient than possible with Newtonâ□□s gravitational law, implying a long-range enhancement to gravity. Therefore, the second part of my talk will discuss the formation of structures in Milgromian dynamics (MOND) supplemented by 11 eV/cˆ2 sterile neutrinos. This Angus (2009) cosmological model has a standard expansion history, primordial abundances of light elements, and fluctuations in the cosmic microwave background (CMB). The model is also consistent with observations of galaxy clusters like the Bullet and El Gordo. I will show that the enhanced growth of structure in Milgromian gravitation leads to the formation of KBC-like voids, gravitational flows within it towards its edges explaining the locally measured Hubble constant. MOND has also made many successful a priori predictions on galaxy scales, which are quite difficult to reconcile with standard cosmology (e.g. the Local Group satellite planes and the radial acceleration relation). Therefore, I will argue that Milgromian dynamics supplemented by 11 eV/cˆ2 sterile neutrinos provides a more holistic explanation for astronomical observations across all scales.

Presenter: Mr HASLBAUER, Moritz

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

A new probe of dark energy

Friday, 9 September 2022 16:20 (10 minutes)

Despite the many successes of concordance ÎCDM cosmology, increasingly accurate cosmological datasets are starting to reveal tensions. In such a landscape, ones attention naturally shifts towards new avenues to probe cosmology. The turnaround scale, defined as the scale separating gravitationally bound structures from the Hubble flow, has properties that make it a promising cosmological probe (a) the matter enclosed by the turnaround radius has a characteristic average matter density (the âturnaround densityâ, Ïta) which is the same for structures of all masses at a given cosmic epoch. This means that for present cosmic epoch and for concordance cosmological parameters (Î©m â¼ 0.3, Î©Î â¼ 0.7) turnaround structures exhibit a density contrast with the matter density of the background Universe of Î´ â¼ 11. (b) The value of Ïta and its evolution with cosmic time depends on (and probes) the cosmological parameters Î©m and Î©Î. Although the behaviour of matter on the turnaround scale is well studied under the assumption of spherical symmetry, it is by no means a priori obvious that the properties that render it cosmologically interesting also survive in highly non-spherical realistic structures. To this end, we use N-body simulations of different cosmologies to examine whether a characteristic turnaround radius can be meaningfully identified for galaxy clusters in the presence of full three-dimensional effects. In particular, we show that by analysing radial velocity profiles around collapsed structures, extending out to many times the overdensity radius R200, one can unambiguously identify the turnaround radius as the largest non-expanding scale around the center of a cluster. We, also find that for halos of masses M > 10ˆ13 Msun, the turnaround radius Rta scales with the enclosed mass M as Mˆ1/3, as predicted by the spherical collapse model. This means that halos indeed exhibit a characteristic average density within the turnaround scale. Finally, we discuss the deviation of Ïta in simulated halos from its theoretical prediction and relate it to halo deviations from spherical symmetry.

Presenter: Mr KORKIDIS, Giorgos (University of Crete - Institute of Astrophysics FORTH)

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

A 0.9% calibration of the Galactic Cepheid luminosity scale based on Gaia DR3 open cluster astrometry

Friday, 9 September 2022 16:30 (10 minutes)

We present a study that calibrates the Galactic Leavitt law to the highest available accuracy using Cepheids residing in open star clusters. We developed a method for detecting open clusters near Cepheids. This has allowed us to discover 2 new host clusters and update the parameters of 31 previously discovered ones. Cluster member stars span a similar magnitude and color range as the quasars used by Lindegren et al. (2021) (hereafter L21) to determine Gaia parallax systematics, are non-variable, and are not subject to other complicating factors of Gaia data processing, such as the gating mechanism to avoid saturation of stars brighter than G â¼ 12. Using this approach, we find an average uncertainty in the cluster parallaxes of 7 Î¼as, an improvement of a factor of three over the uncertainties in the Cepheid parallaxes used to calibrate the distance ladder. Using the known distance to the Large Magellanic Cloud based on detached eclipsing binaries as a reference, we find that the L21 corrections accurately describe the parallax offset for this sample of clusters to within -3 +/- 6 Î¼as. In a combined fit using cluster parallaxes and Cepheid parallaxes simultaneously, we find excellent agreement with the Cepheid parallax zero-point offset determined by Riess, and confirm that cluster parallaxes and Cepheid parallaxes have different zero-point offsets. Lastly, we simultaneously calibrate the Leavitt law in several photometric bands while solving for the parallax offset, and obtain a 1.7% LL calibration for MW Cepheids.

Presenter: Dr CRUZ REYES, Mauricio

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

Late-time Accelerating Universe in Teleparallel Gravity

Friday, 9 September 2022 16:30 (10 minutes)

Even though the ΛCDM model is supported by overwhelming evidence, its predictive power has been recently called into question. In fact, the H_0 tension problem has prompted a reconsideration of novel approaches to formulating a consistent cosmological model. This issue might be resolved by considering theories beyond General Relativity. There exist many possible modifications of General Relativity which are largely built on correction terms to the Einstein-Hilbert action. Indeed, there is a growing interest in Teleparallel Gravity, a theory where torsion rather than curvature is considered as the form in which gravitation is expressed. In this context, we explore the behaviour of different cosmological models in the late Universe in which the modification is motivated by gravitational models in the literature such as $f(T)$ and $f(T, B)$ models.

Presenter: Ms BRIFFA, Rebecca (Institute of Space Sciences and Astronomy, University of Malta)

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

Observational Tensions in Kinetically Coupled Quintessence

Friday, 9 September 2022 16:40 (10 minutes)

Understanding the nature of the accelerated expansion of the Universe stands as one of the most important open questions in Cosmology. Currently the most well-accepted paradigm relies on the introduction of two unknown components to the standard model that govern the dynamics of the Universe at present times Dark Energy, proposed as the source for the acceleration, and Dark Matter, needed to make formation of structures in the Universe possible. While it provides for an impressive fit to a wide range of astrophysical data, some significant statistical discrepancies between observations seem to indicate unreconcilable cracks in the standard theory, when faced with increasingly precise experiments. In this talk I will show how describing dark energy as a canonical scalar field, coupled to dark matter through a kinetic term in the Lagrangian, may help address the observational tensions.

Presenter: Ms TEXEIRA, Elsa (University of Sheffield)

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

Well-Tempered Cosmology in Teleparallel Horndeski

Friday, 9 September 2022 16:40 (10 minutes)

The difference between the observational vacuum energy driving the expansion of the universe and the large vacuum energy density arising from zero point quantum field fluctuations has led to the cosmological constant problem. Well-tempering offers a formalism to dynamically cancel the cosmological constant and obtain a late-time, low energy vacuum state. The well-tempered recipe is applied within the teleparallel analogue of Horndeski theory a torsionful second-order scalar-tensor gravitational theory. This framework offers the possibility of reviving Horndeski terms which were once disregarded upon the confirmation of gravitational waves. In this work, well-tempering is applied wherein degeneracy in field equations is able to provide the necessary screening of particle physics scale vacuum energy, while teleparallel analogue of Horndeski offers broader viable cosmological model. Additionally, cosmological dynamics of a well-tempered model are analysed to verify dynamical stability of the vacuum, compatibility with matter era, and the stability of the vacuum through a phase transition in order to correspond with the cosmic history of the universe.

Presenter: Ms CARUANA, Maria (University of Malta (Institute of Space Sciences and Astronomy))

Contribution ID: **46** Type: **not specified**

A Legacy Calibration of the Tip of the Red Giant Branch Distance Scale as Constrained by the Hubble Space Telescope Implications for the Hubble Constant

Friday, 9 September 2022 16:50 (10 minutes)

The zero point calibration of the extragalactic distance scale is degenerate with any subsequent derivation of the Hubble constant (H0). Thus, it is imperative that calibration accuracy is continually improved for stellar standard candles. The optimal method for doing so is to closely match the observing conditions and underlying astrophysical environments between the calibration observations and those used to probe further distances, thereby constructing an optimally self-consistent distance ladder. This ideal, like-with-like calibration scenario is finally achieved for the Tip of the Red Giant Branch (TRGB) distance scale with brand new Hubble Space Telescope (HST) imaging of the stellar halo of the megamaser host galaxy NGC 4258 (PI Hoyt). By matching the observing conditions and local stellar environment to HST TRGB imaging of supernova host galaxies, systematic uncertainties in the TRGB calibration of H0 have been reduced to negligible levels, leaving the maser distance to NGC 4258 as the dominant systematic uncertainty (1.5%) in the error budget. This new, high-accuracy calibration will serve as the lasting standard for HST-based, TRGB distances determined from the stellar halos of ˜L* galaxies, and thus for calibrating direct measurements of H0.

Presenter: Dr HOYT, Taylor (The University of Chicago)

Contribution ID: **47** Type: **not specified**

Assessing the hemispherical power asymmetry with gravitational waves

Friday, 9 September 2022 16:50 (10 minutes)

Since WMAP and Planck some anomalous features appeared in the Cosmic Microwave Background (CMB) large-angle anisotropy, the so-called anomalies. One of these is the hemispherical power asymmetry, i.e. a difference in the average power on the two hemispheres centered around (l, b) = (221, -20), which shows a relatively high level of significance. Such an anomaly could be the signature of a departure from statistical isotropy on large scales. Another cosmological observable expected to show an analogous effect is the Cosmological Gravitational Wave Background (CGWB), detectable by future GW detectors. Indeed, the CGWB offers a unique window to explore the early Universe and can be used in combination with CMB data to shed light on the statistical isotropy of our Universe. Specifically, through the study of the evolution of gravitons in the presence of a modulating field in the scalar gravitational potentials, accounting for the hemispherical power asymmetry, it is possible to infer the amplitude of this modulating field through a minimal variance estimator, exploiting both constrained and unconstrained realizations of the CGWB. In this talk, I will show that the addition of the CGWB will allow an improvement in the assessment of the physical origin of the CMB power asymmetry. Accounting for the expected performances of LISA and BBO, I will also show that the latter is expected to be signal-dominated on large-scales, proving that the CGWB could be the keystone to assess the significance of this anomaly.

Presenter: Mr GALLONI, Giacomo (UniversitÃ di Roma Tor Vergata)

Contribution ID: **48** Type: **not specified**

A new era of fine structure constant measurements at high redshift

Friday, 9 September 2022 17:00 (10 minutes)

The most promising theoretical models to resolve the H0 tension also predict temporal or spatial variations of the constants of nature such as the fine structure constant, alpha. We make use of novel astronomical instrumentation to remove previously dominant systematic effects, thus reaching precision of 1 part per million or better in measuring any departure of the fine structure constant from its terrestrial value. A new advanced tool using Artificial Intelligence algorithms, AI-VPFIT, was developed to aid the analysis. AI-VPFIT provides robust and objective measurements free from human bias and allows us to explore the impact of model non-uniqueness for the first time. I will present our most recent results, including the first constraint on small-scale variations of alpha. Finally, we put constraints on Bekenstein and quintessence-type dark energy models.

Presenter: Dr MILAKOVIC, Dinko (Institute for Fundamental Physics of the Universe)

Contribution ID: **49** Type: **not specified**

Testing tension with GR using the mass profiles of galaxy clusters

Friday, 9 September 2022 17:00 (10 minutes)

Galaxy clusters are excellent natural laboratories at the edge between astrophyisics and cosmology, at those scales where possible departures from General Relativity (GR) can leave a detectable inprint. Moreover, clusters allow for jointly constraining both the relativistic and non-relativistic sectors of the gravitational interaction, through lensing and internal kinematics (of gas or member galaxies) respectively, giving interesting hints on the behaviour of gravity at large scales. I will discuss the recent results obtained applying the license-free code MG-MAMPOSSt to kinematic and lensing data of galaxy clusters analysed within the CLASH/CLASH-VLT collaborations, for two general classes of viable modified gravity/dark energy models. I will show how the combination of lensing and kinematic analyses can break the degeneracy in the parameter space, I will discuss possible sources of systematics and future improvements of this method in view of next generation imaging and spectroscopic surveys.

Presenter: Dr PIZZUTI, Lorenzo (Osservatorio Astronomico della Regione Autonoma Valle d'Aosta, Italy)

Contribution ID: **50** Type: **not specified**

Early Dark Energy meets massive neutrinos

Friday, 9 September 2022 17:10 (10 minutes)

Early dark energy (EDE) alleviates the H_0 tension at the cost of increasing the clustering amplitude and worsening the S_8 discrepancy. Motivated by massive neutrinos' ability to suppress structure, we study their impact on EDE combining Planck and BOSS full-shape clustering data. A Bayesian analysis returns no evidence for a non-zero neutrino mass sum M_ν ($< 0.15, \mathrm{eV}$ at 95%˜C.L.), with limits driven primarily by shifts in the BAO scale. A frequentist profile likelihood analysis reveals a correlation between M_ν and the EDE fraction f_{EDE}, which keeps H_0 fixed as M_ν increases. Compared to the best-fit baseline EDE model ($M_\nu = 0.06, \mathrm{eV}$), a model with $M_\nu = 0.15, \mathrm{eV}$ maintains the same H_0(km/s/Mpc)=(70.08, 70.12, respectively) whilst decreasing S_8=(0.837, 0.831 respectively), whilst still representing a better fit ($\Delta\chi^2 = -3.1$) relative to ΛCDM. Our results indicate that an EDE+M_ν model can keep the H_0 tension at the same level as baseline EDE while mitigating the enhanced clustering issue.

Presenter: Mr REEVES, Alexander (ETHZ)

Contribution ID: **51** Type: **not specified**

Teleparallel scalar-tensor gravity through cosmological dynamical systems and Its relevance to H0 Tension

Friday, 9 September 2022 17:10 (10 minutes)

"Scalar-tensor theories offer the prospect of explaining the cosmological evolution of the Universe through an effective description of dark energy as a quantity with a non-trivial evolution. In this work, we investigate this feature of scalar-tensor
theories in the teleparallel gravity context. Teleparallel gravity is a novel description of geometric gravity as a torsional- rather than curvature-based quantity which presents a new foundational base for gravity. Our investigation is centered on the impact of a nontrivial input from the kinetic term of the scalar field. We consider a number of model settings in the context of the dynamical system to reveal their evolutionary behaviour. We determine the critical points of these systems and discuss their dynamics. We have also discussed the possible approach to solve H0 tension problem using dynamical system analysis in teleparallel scalar tensor gravity."

Presenter: Mr KADAM, Siddheshwar (BITS-Pilani Hyderabad Campus.)

Contribution ID: **52** Type: **not specified**

Hubble tension and quantum gravity effects

Friday, 9 September 2022 18:50 (20 minutes)

Following a new pathway to the definition of the Stochastic Quantization, which hinges on the functional similarities between the Ricci-Flow equation and the Stochastic Quantization Langevin equations, while making use of the Arnowitt-Deser-Misner variables and their conjugated Hamiltonian momenta, we have pushed forward a novel approach to investigate, in a geometrical way, the renormalization group equation for gravity theories. The newly derived equations of the Ricci-Flow are understood in terms of the breaking of the diffeomorphism invariance of the classical theory and encode, as the equation associated to the shift vector, the Navier-Stokes equation with a stochastic source, while the fluctuations of the metric tensor components around the equilibrium configurations follow the Kardar-Parisi-Zhang equation, with intermittent statistics of the probabilistic distribution. Within this framework, we show that the cosmological constant appears as a macroscopic effect of the quantum fluctuation of the metric tensor. Finally, inspecting the cosmological Ricci-Flow of the Friedman-Lemaitre-Robertson-Walker metrics, we develop a phenomenological analysis in order to understand if this paradigm can provide a solution to the Hubble tension.

Presenter: Prof. MARCIANÒ, Antonino (INFN Frascati LNF)

Contribution ID: **53** Type: **not specified**

On the Hubble constant tension and its evolution.

Saturday, 10 September 2022 10:50 (20 minutes)

The Hubble constant (H0) tension between Type Ia Supernovae (SNe Ia) and Planck measurements ranges from 4 to 6 ÏĪ. To investigate this tension, we estimate H0 in the ÎĪCDM and w0waCDM models by dividing the Pantheon sample, a collection of 1048 SNe Ia, into 3, 4, 20, and 40 bins. For the first two divisions, a presence of SNe Ia in the hundreds for each bin is required to effectively account for systematic effects while the last two are required to test for results independence on the bin divisions. A preliminary consistency check is performed, considering the compatibility of contours for 3 and 4 bins with the ones of the total Pantheon sample through a 2-D analysis where the nuisance parameters are H0 and Î©0m. For each bin, a 1-D Monte Carlo Markov-Chain analysis for H0 with the D'Agostini method is performed in order to extract the value of H0, considering a fiducial absolute magnitude of SNe Ia M ˜ -19.25. We will show the MCMC application through the Cobaya package for Python. We fit the extracted H0 values with a function describing the redshift evolution g(z)=H'0/(1+z)Î±, where Î± is the evolutionary parameter and H'0=H0 at z=0. We find that H0 evolves with redshift, showing a slowly decreasing trend, with Î± coefficients in the order of 10-2, consistent with zero only from 1.2 to 2.0 ÏĪ. A subsequent correction for luminosity distance has been applied and it carries differences of ˜2% at z=11.09 (the redshift of the farthest galaxy so far discovered) with the standard ÎĪCDM luminosity distance. We measure locally a variation of H0(z=1)-H0(z=0)=0.4 km s-1 Mpc-1 in 3 and 4 bins. Interestingly, in the extrapolation of H0 to z=1100, the redshift of the last scattering surface, we obtain values of H0 compatible in 1 ÏĪ with Planck measurements independently of cosmological models. Thus, we have reduced the H0 tension from 54% to 72% for the ÎĪCDM and w0waCDM models, respectively. If the decreasing trend of H0 is real, it could be due to astrophysical selection effects, such as the stretch evolution, or to modified gravity, such as the f(R) theories.

Presenter: Prof. DAINOTTI, Maria (NAOJ)

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

Generaliz-
ing the Friedmann Model in Light of Cosmological Tensions

Saturday, 10 September 2022 10:30 (20 minutes)

The recent tensions between cosmological data sets are difficult to accommodate within the standard Friedmann cosmological models. In this talk I will discuss how we might consider more general cosmologies, which could provide more flexibility. I will introduce the mathematical formalisms required to understand Friedmann within this generalized context, and the challenges and difficulties that remain in applying these ideas to the real Universe.

Presenter: Dr CLIFTON, Timothy (Queen Mary, U. of London)

Contribution ID: **55** Type: **not specified**

Dynamical Vacuum Energy and Cosmological Tensions

Friday, 9 September 2022 19:10 (20 minutes)

Gravity and general relativity are considered as an Effective Field Theory (EFT) at low energies and macroscopic distance scales. The conformal anomaly of light or massless quantum fields has significant effects on macroscopic scales, which allows the effective value of the vacuum energy to change in space and time. The EFT of vacuum energy thereby replaces the fixed constant Lambda of the classical theory with a dynamical condensate whose natural ground state value in empty flat space is Lambda_eff = 0 identically, without any fine tuning. The implications for spatially inhomogeneous cosmology and resolution of cosmic tensions of LambdaCDM will be discussed.

Presenter: Prof. MOTTOLA, Emil (Univ. of New Mexico)

Contribution ID: **56** Type: **not specified**

Increasing Accuracy in the Measurement of H0

Friday, 9 September 2022 18:00 (30 minutes)

The Tip of the Red Giant Branch (TRGB) marks the luminosity at which the core helium flash in low-mass stars occurs, and provides a high-precision and accuracy standard candle. As such, the TRGB offers a critical, independent route to the measurement of Ho. Applied in the halo of galaxies, the TRGB method has a number of advantages: there is negligible extinction by dust, and it has little sensitivity to metallicity and to crowding/blending effects. A Chicago Carnegie Hubble Program (CCHP) calibration of SNe Ho based on HST TRGB measurements yields a value of Ho = 69.8 with an accuracy of 2.5%. A new and upcoming program with the James Webb Space Telescope will measure distances to the same galaxies using the TRGB, Cepheids and carbon stars, and provide robust constraints on current systematics in the measurement of Ho.

Presenter: Prof. FREEDMAN, Wendy (University of Chicago)

Contribution ID: **57** Type: **not specified**

Model-agnostic interpretation of 10 billion years of cosmic evolution traced by BOSS and eBOSS data

Sunday, 11 September 2022 09:00 (30 minutes)

In this talk I present the lastest re-analysis of BOSS and eBOSS spectroscopic survey data and its implication in the current LCDM paradigm. In the first part of the talk I review how the large scale structure of the universe measures cosmological parameters, such as the expansion rate H_0 or the matter density Om, from the baryonic acoustic oscillations (BAO), the redshift space distortions (RSD) and the shape of the power spectrum broadband. In the second part I will present the implication of these measurements within the context of LCDM models and extensions and the impact with the current tensions in cosmology.

Presenter: Dr GIL-MARÍN, Héctor

Contribution ID: **58** Type: **not specified**

Avoiding tensions with a functioning cosmological model

Saturday, 10 September 2022 09:30 (20 minutes)

The standard model of cosmology relies on the existence of dark matter particles which drive structure and galaxy formation. A rigorous prediction of this model is that each present-day galaxy must be embedded in a massive and extended halo of dark matter particles. The existence of such halos of dark matter can be tested for by applying Chandrasekhar dynamical friction. I will present the results that have been achieved on this with the conclusion that the galaxy–galaxy motion data do not support the existence of these halos. The implication of this tension is that gravitation becomes non-Newtonian on scales beyond the Solar System, in turn implying the need to develop a new cosmological model. Such models, based on Milgromian gravitation, now exist and these automatically solve the Hubble Tension. They also account for the observed very massive galaxy clusters such as El Gordo at a redshift of 0.87 and the closer Bullet cluster, and allow for significant matter density contrasts on spatial scales larger than a few hundred Mpc.

Presenter: Prof. KROUPA, Pavel (Charles University/Bonn University)

Contribution ID: **59** Type: **not specified**

The Cepheid Distance Scale and its Metallicity Dependence

Saturday, 10 September 2022 09:50 (20 minutes)

Cepheid variables are the best calibrated primary standard candles they are used to standardize the brightness of Type Ia supernovae (SNIa) in nearby galaxies and therefore are central in the determination of the local value of the Hubble constant (H0). The empirical measurement of the Hubble constant obtained by the SH0ES team from the Cepheid-SNIa method is now in 5-sigma tension with the Planck prediction based on the lambda-CDM model. While both estimates have reached a great precision, the source of the Hubble tension remains unknown and suggests evidence of new physics beyond the standard model. In this talk I will describe recent progress on the Cepheid distance scale involving Gaia parallaxes and HST photometry and I will identify the remaining issues and systematics associated with the calibration of their period-luminosity relation. In particular, differences in Cepheid metallicities between the Milky Way, Magellanic Clouds and nearby galaxies hosting SNIa must be corrected in order to provide a consistent distance calibration. Finally I will discuss how future missions and promising techniques are expected to improve again the precision of the empirical H0 value.

Presenter: Dr BREUVAL, Louise (Johns Hopkins University)

Contribution ID: **60** Type: **not specified**

A geometric measurement of H0 by the Megamaser Cosmology Project

Saturday, 10 September 2022 10:10 (20 minutes)

Water megamasers residing in the accretion disks around supermassive black holes (SMBHs) in active galactic nuclei (AGN) provide unique tools for bypassing the distance ladder and making one-step, geometric distance measurements to their host galaxies. Â The Megamaser Cosmology Project (MCP) is an international, multi-facility campaign to find, monitor, and map such AGN accretion disk megamaser systems, with the goal of constraining the Hubble constant to a precision of several percent. To date, the MCP has surveyed over 4000 active galactic nuclei for signs of 22 GHz water maser emission, resulting in the discovery of nearly a hundred new megamaser systems (constituting approximately half of all known such systems). 20 of these new systems have been mapped with the VLBA, providing "gold standard" black hole mass measurements, and 10 of them have been extensively observed with both multi-year spectral monitoring and deep VLBI mapping observations for the purposes of making distance measurements. The MCP measurements currently constrain the Hubble constant to 73.9 +/- 3.0 km/s/Mpc independent of distance ladders, the cosmic microwave background, and gravitational lenses, corroborating prior indications that the local Hubble constant exceeds the early-Universe prediction.

Presenter: Dr PESCE, Dominic (Center for Astrophysics | Harvard & Smithsonian)

Contribution ID: **61** Type: **not specified**

The H0 tension and the physics of the neutrino sector

Saturday, 10 September 2022 11:30 (20 minutes)

Neutrinos are a mysterious sector of the Standard Model with some unanswered fundamental questions. In the first part of our talk we will review the minimal framework with three neutrinos, and what cosmology can tell us about their masses and mixings. However, there also exist non-minimal frameworks which generically assume that the scale of new physics appears is just above 10 TeV (LHC). In this case we typically end up with new light particles, which are promising candidates to explain neutrino anomalies and cosmological tensions. In the second part of the talk we will present one of these scenarios, with a particle, the Majoron, associated to the spontaneous breaking of the lepton number, that significantly changes the thermal history of the Universe in a consistent way with current cosmological data.

Presenter: Dr CUESTA, Antonio J. (University of Cordoba)

Contribution ID: **62** Type: **not specified**

Cosmological Tensions: revisiting spatial curvature.

Saturday, 10 September 2022 11:50 (20 minutes)

Presenter: Dr COLEY, Alan (Dalhousie Univ.)

Contribution ID: **63** Type: **not specified**

Testing the foundations of the concordance model

Saturday, 10 September 2022 12:10 (20 minutes)

Tensions in the concordance model are a further motivation to devise and implement tests of a key foundation of the model - the Cosmological Principle. I will survey current and future tests of the CP.

Presenter: Prof. MAARTENS, Roy (University of Western Cape)

Contribution ID: **64** Type: **not specified**

Comprehensive Measurements of the Local Value of H0 with 1 km/s/Mpc Uncertainty from the SH0ES Team

Saturday, 10 September 2022 09:00 (30 minutes)

Presenter: Prof. RIESS, Adam (Johns Hopkins U)

Contribution ID: **65** Type: **not specified**

Cosmology with the Kilo Degree Survey

Sunday, 11 September 2022 09:30 (30 minutes)

Probes of the large scale structures can give us insight into the nature of the dark Universe. In this talk I will show the latest results from the Kilo Degree Survey (KiDS) and its combination with spectroscopic galaxy surveys. KiDS is a purpose-built gravitational lensing survey with high quality images and a wide photometric coverage, resulting in very high-fidelity data. Combining weak lensing data with other probes of the large scale structures, such as galaxy clustering, enables us to break degeneracies in cosmological parameters and control the systematics in the data. Finally, I will discuss the prospects for the KiDS final data release.

Presenter: Dr ASGARI, Marika (Edinburgh U.)

Contribution ID: **66** Type: **not specified**

Reconstructed gravity and cosmological tensions

Sunday, 11 September 2022 10:00 (20 minutes)

I will discuss some recent works on reconstruction of gravity from a combination of currently available cosmological data , under conditions of theoretical stability, highlighting the imprints of cosmological tensions.

Presenter: Prof. SILVESTRI, Alessandra (Instituut Lorentz (Leiden University))

Contribution ID: **67** Type: **not specified**

Current constraints on the curvature of the Universe

Sunday, 11 September 2022 10:20 (20 minutes)

I will present the current observational status on the curvature of the Universe.

Presenter: Prof. MELCHIORRI, Alessandro (UniversitÃ di Roma Sapienza)

Contribution ID: **68** Type: **not specified**

The Hubble tension and new physics at the eV scale The path to New Early Dark Energy

Sunday, 11 September 2022 10:40 (20 minutes)

I will discuss the possibility that the Hubble tension is the signature of a fast triggered phase transition in the dark sector. Such a phase transition is called New Early Dark Energy (NEDE) and must have taken place just before recombination at the eV scale to resolve the tension fully. After discussing the cosmological NEDE phase transition, I will discuss the details of possible particle physics realizations.

Presenter: Prof. SLOTH, Martin (CP3-Origins)

Contribution ID: **69** Type: **not specified**

3-forms as a mean of resolving tensions

Sunday, 11 September 2022 11:30 (20 minutes)

"In the current talk, I will present some dark energy models based on 3-forms that fully fit the available observational data. In addition, those models are harmless from a quantum point of view, in the sense
that the singularities or abrupt events they might induce are cured at the quantum level. Moreover, some of those models can support regular blackholes as well as wormholes that do not require matter with a
wrong kinetic term."

Presenter: Dr BOUHMADI LÓPEZ, Mariam (University of the Basque Country & IKERBASQUE)

Contribution ID: **71** Type: **not specified**

Resolving Dark Matter Tension: The impact of dynamical friction due to fuzzy dark matter on satellites with triaxial and logarithmic potentials

Sunday, 11 September 2022 11:50 (20 minutes)

A possible candidate for dark matter is an ultralight bosonic particle comprising the Fuzzy Dark Matter (FDM). The presence of FDM in a galactic cluster will impact the motion of satellites residing in such clusters, through dynamical friction. Here we present numerical simulations of the dynamical friction on satellites traversing an initially uniform FDM halo. The potentials of the satellites we have studied are triaxial and logarithmic. We find that the wakes created on the FDM halo due to the passage of such satellites are qualitatively different from those generated by spherically symmetric systems and we quantify the impact of fuzzy dark matter on the dynamical friction coefficient of the satellites.

Presenter: Dr GOURGOULIATOS, Kostas

Contribution ID: **72** Type: **not specified**

Explaining the Hubble tension and dark energy from alpha-attractors

Sunday, 11 September 2022 12:10 (20 minutes)

A compelling unified model of dark energy and early dark energy (EDE) is presented, using a scalar field with a simple exponential runaway potential, in the context of alpha-attractors. The field is originally trapped at an enhanced symmetry point, subsequently thaws to become successful EDE and eventually slow-rolls to become dark energy. EDE ameliorates the observed Hubble tension. Emphasis is put on concrete predictions of both EDE and dark energy to be tested in the near future.

Presenter: Prof. DIMOPOULOS, Konstantinos (Lancaster University)

Contribution ID: **73** Type: **not specified**

Cosmology under the fractional calculus approach: a possible H_0 tension resolution?

Sunday, 11 September 2022 12:30 (20 minutes)

Fractional cosmology has emerged recently, based on the formalism of fractional calculus, which modifies the standard derivative to one fractional derivative of order α. It generates changes in General Relativity, particularly in the Einstein field equations. In this mathematical framework, the Friedmann equations are modified with an additional term similar to an effective curvature. The standard evolution of the cosmic species densities depends on the α fractional parameter and the age of the Universe t_U. The hypothesis is that the Universe does not contain a dark energy component. The late accelerated expansion can be sourced by the additional term in the new equation governing the cosmic dynamics. To elucidate that, we estimate stringent constraints on the fractional parameter using cosmic chronometers, Type Ia supernovae and joint analysis. We obtain $\alpha = 2.839^{+0.117}_{-0.193}$ within one sigma confidence level that can provide a non-standard cosmic acceleration at late times; consequently, the Universe would be older than the standard estimations. Additionally, we present a dynamical system and stability analysis to explore the phase-space under the assumption of different α parameters. One late-time attractor, which is physical for $1 \leq \alpha < 5/2$, corresponds to a power-law (decelerated) late-time attractor for $\alpha < 2$. Moreover, an additional point not present in GR exists, which is physical for $\alpha > 1$ and a sink for $\alpha > 2$. This solution is a decelerated power-law if $1 < \alpha < 2$ and an accelerated power-law solution if $\alpha > 2$. This last result is consistent with the mean values obtained from the observational analysis. Therefore, under the fractional calculus, it is possible to obtain modified Friedmann equations at the background level, which provide a late cosmic acceleration without introducing a dark energy component. This radical approach could be a new path to tackle problems not resolved until now in cosmology. We analyse whether fractional cosmology can alleviate H_0 tension.

Presenter: Dr LEON, Genly (Universidad Catolica del Norte)

Contribution ID: **74** Type: **not specified**

Solving tensions faster with velocities

Sunday, 11 September 2022 12:50 (20 minutes)

Peculiar velocity surveys using supernovae or standard sirens can be combined with large-scale galaxy surveys to great benefit. I will present a new methodology to analyse in a comprehensive way standard candles and galaxy data at the linear level. I will show that this methodology also allows for competitive model-independent measurements of the expansion rate, i.e. without any assumptions on the cosmological model besides the FLRW metric. For supernovae, I will provide forecasts for future surveys like 4MOST, DESI and LSST, and show that this leads to increased precision in sigma8 and the growth rate compared to the traditional method using only galaxies. The measurements can have similar precision to those of the CMB but exhibit orthogonal degeneracies, and the combined constraints yield huge improvements in both cosmological background and perturbation parameters. For standard sirens observed with next-gen telescopes, similar precision can be achieved in sigma8 and the growth rate, but we can also get a very high precision of 0.1% in H0. This means that this methodology can help solve both the current H0 and sigma8 tensions.

Presenter: Prof. QUARTIN, Miguel (Heidelberg U. + U. Federal do Rio de Janeiro)

Contribution ID: **75** Type: **not specified**

BBN constraints in models that alleviate the H0 tension

Sunday, 11 September 2022 15:30 (10 minutes)

Presenter: Mr ASIMAKIS, Petros (NTUA)

Contribution ID: **76** Type: **not specified**

Alleviation of H0 tension in f(Q) gravity

Sunday, 11 September 2022 15:30 (10 minutes)

Presenter: Dr ANAGNOSTOPOULOS, Fotios (NKUA)

Contribution ID: **77** Type: **not specified**

The interacting galaxy cluster ”El Gordo” a massive blow to LCDM cosmology

Sunday, 11 September 2022 15:40 (10 minutes)

El Gordo (ACT-CL J0102-4915) is an extremely massive galaxy cluster (M200 = 2e15 Msun) at redshift z=0.87 composed of two subclusters with mass ratio 2 merging at speed Vinfall = 3000 km/s. Such a fast collision between individually rare massive clusters is unexpected in Lambda cold dark matter (LCDM) cosmology at such high z. Here, we determine the probability of finding a similar object in a LCDM context using the Jubilee simulation box with side length 6/h Gpc. We search for galaxy cluster pairs that have turned around from the cosmic expansion with properties similar to El Gordo in terms of total mass, mass ratio, redshift, and collision velocity relative to virial velocity. We fit the distribution of pair total mass quite accurately, with the fits used in two methods to infer the probability of observing El Gordo in the surveyed region. Detecting one pair with its mass and redshift rules out LCDM cosmology at 5.14sigma. Using a chi squared approach, the combined tension with the Bullet Cluster can be estimated as 5.50sigma. These systems arise naturally in a Milgromian dynamics (MOND) cosmology with light sterile neutrinos.

Presenter: Ms ASENCIO, Elena (University of Bonn)

Contribution ID: **78** Type: **not specified**

Alleviating H0 tension in Horndeski gravity

Sunday, 11 September 2022 15:40 (10 minutes)

Presenter: Ms PETRONIKOLOU, Maria (NTUA)

Contribution ID: **79** Type: **not specified**

Testing robustness of supernovae cosmological parameter inference with Gaussian process

Sunday, 11 September 2022 15:50 (10 minutes)

Inspired by the discussion in the literature about possible hidden systematic errors in late universe cosmological probes and non-trivial physical models that are developed to describe the Hubble tension we test Pantheon SNe sample for possible deviation from the baseline LCDM analysis. Our work is based on the assumption that this deviation can be described by a Gaussian process and we make no assumption on its origin. To simultaneously model systematics and model deviations we apply Gaussian processes to model the additional covariance while making no further assumption no its source. We explore different realizations of non-stationarity and possible redshift dependence. Using this model-independent approach we find no statistically significant evidence for missing covariance. We also test hypothesis that this process is hidden by overestimated statistical errors. We use different fittings and scaling relations for the statistical errors provided in the Pantheon sample. Inference of the Hubble parameter is robust against any treatment of covariance we explore.

Presenter: Mr BIDENKO, Bohdan (University of Groningen)

Contribution ID: **80** Type: **not specified**

The massless limit and tension in massive gauge theories

Sunday, 11 September 2022 15:50 (10 minutes)

We study massive non-linear gauge theories with mass added by hand. First, we consider the massive Yang-Mills theory. The standard perturbative approach suggests that the massless limit of this theory is not smooth. Nevertheless, we show that the longitudinal modes - the source of this discontinuity - become strongly coupled at the Vainshtein scale. Beyond it, we show that the massless theory is recovered up to small corrections and that the massless limit of the massive Yang-Mills theory is smooth. We then extend our study to the theories of massive Kalb-Ramond and Proca fields modified by a quartic self-interaction and show that the same strong coupling scale is present in both theories. In the Proca theory, the longitudinal mode enters the strongly coupled regime beyond this scale, while the two transverse modes propagate further and survive in the massless limit. In contrast, in the case of the massive Kalb-Ramond field, the two transverse modes become strongly coupled beyond the Vainshtein scale, while the pseudo-scalar mode remains in the weak coupling regime and survives in the massless limit. This indicates a contradiction with numerous claims in the literature that state that the massive Kalb-Ramond and Proca theories are dual to each other.

Presenter: Ms HELL, Anamaria (LMU Munich)

Contribution ID: **81** Type: **not specified**

A look beyond ΛCDM theory, phenomenology and observations

Sunday, 11 September 2022 16:00 (10 minutes)

The standard Lambda Cold Dark Matter (ÎCDM) model of cosmology provides a good fit to a wide range of astrophysical and cosmological observations that have probed nearly all the epochs and scales of the Universe. However, in the recent years various tensions and anomalies are seriously questioning the validity of this baseline scenario, motivating both the need to test its underlying assumptions and the opportunity to probe new physics with increasing accuracy. In this talk I will focus on both possibilities and analyze different extensions toÂ ÎCDM that involve a rich phenomenology beyond our current paradigm of the Universe. I will test both the agreement of observations in extended cosmological models and their consistency with the underlying theoretical assumptions, discussing different hints for new physics and pointing out some interesting challenges for the (near) future.

Presenter: Dr GIARÈ, William (Galileo Galilei Institute for theoretical physics)

Contribution ID: **82** Type: **not specified**

Boltzmann solvers in the era of cosmological tensions: symbolic implementation of extensions in PyCosmo

Sunday, 11 September 2022 16:00 (10 minutes)

In this talk, we will show how the cosmology code PyCosmo, developed by the Cosmology Group at ETH Zurich, can be easily extended to beyond ΛCDM models. We will present how we added dark energy with a constant equation of state and massive neutrinos to the Boltzmann solver of PyCosmo. The possibility to easily extend the equation system is a core feature of PyCosmo, enabled by the SymPy symbolic representation of the equations and is of crucial importance when tensions in the cosmological model indicate the possibility of new physics beyond the standard model. The symbolic expressions are translated into efficient C/C++ code by the sympy2c library. We will show how we compare our results for the different models with CLASS, both in terms of accuracy and computational speed. We find a comparable runtime and good agreement for all models, to better than 0.1% when using high-precision settings.

Presenter: Ms MOSER, Beatrice (ETH Zurich)

Contribution ID: **83** Type: **not specified**

Quantifying the S8 tension with the Redshift Space Distortion data set

Sunday, 11 September 2022 16:10 (10 minutes)

One problem of the ÎCDM model is the tension between the S8 found in Cosmic Microwave Background (CMB) experiments and the smaller one obtained from large-scale observations in the late Universe. The ÏƒS8 quantifies the relatively high level of clustering. Bayesian Analysis of the Redshift Space Distortion (RSD) selected data set yields S8 = 0.700+0.038 â0.037. The fit has 3Ï tension with the Planck 2018 results. With the Gaussian processes method a model-independent reconstruction of the growth history of matter in-homogeneity is studied. The fit yields S8 = 0.707+0.085 â0.085, 0.701+0.089 â0.089, and 0.731+0.063 â0.062 for different kernels. The tension reduces and is smaller than 1.5 Ï. With future measurements the tension may be reduced, but the possibility the tension is real is a plausible situation.

Presenter: Dr BENISTY, David (Ben Gurion U. of Negev)

Contribution ID: **84** Type: **not specified**

Challenging LCDM and the isotropy of the local Universe with galaxy clusters

Sunday, 11 September 2022 16:10 (10 minutes)

The hypothesis that the late Universe is isotropic and homogeneous is a cornerstone of the standard cosmological model. The cosmic expansion rate H0 (i.e. Hubble constant) is assumed to be spatially constant, while coherent matter flow motions (bulk flows) are believed to be negligible at cosmic scales. Any deviation from this consensus can put the validity of the standard cosmological model under question. Scaling relations of galaxy clusters are a powerful probe of cosmic isotropy. By measuring many different cluster properties (that do or do not depend on cosmology), several scaling relations with different cosmological sensitivities can be built. Nearly independent tests of cosmic isotropy and large bulk flows are then feasible. We use up to 570 clusters with measured properties at X-ray, microwave, and infrared wavelengths to construct ten different cluster scaling relations and test the isotropy of the local Universe. Through rigorous and robust tests and by combining all available information, we detect an apparent 9% spatial variation in the local H0, at a >5.5 sigma level. The observed anisotropy has a nearly dipole form. Alternatively, our findings could also be attributed to a 900 km/s cluster bulk flow, which seems to extend out to at least 500 Mpc. Both of these scenarios strongly challenge LCDM. Future tests with more distant clusters and new cluster measurements will provide further insights on these exciting findings.

Presenter: Dr MIGKAS, Konstantinos (University of Bonn)

Contribution ID: **85** Type: **not specified**

Tensions in Cosmological Probes and Quasar Cosmology

Sunday, 11 September 2022 13:10 (20 minutes)

In the current era of precision cosmology, the emergence of crucial tensions in the determination of the universe expansion has led to a twofold need to determine a criterion for combining different probes in a physically meaningful way, and to extend the mapping of the expansion of the universe to include data at redshifts not currently covered. In this talk, I will present recent compatibility estimates of cosmological data and illustrate the possibility of using Quasar as cosmological probes, which can extend the Hubble diagram of SNe to a higher redshift range (= 2.4 - 7.5) in which the predictions of cosmological models can be distinguished. The LCDM model and some of its extensions and tensions are tested and possible incompatibility between BAO, SNe and QSO data are explored.

Presenter: Dr BENETTI, Micol (University of Naples)

Contribution ID: **86** Type: **not specified**

Can intermediate time scales modified gravity theories solve the s8 and H0 tensions ?

Sunday, 11 September 2022 16:20 (10 minutes)

Most of the attempts to reconcile the s8 and H0 tensions are focusing on extensions to LCDM that can be considered as either late or early times modifications of general relativity with limited success as to be able to evade constraints from local and deep probes at once. In this work we focus on models that rather act in the intermediate redshifts to try to escape constraints from the current cosmological common observables in early and late times. Using MGCLASS II we shall examine which parameterisations, within the above conditions, could succeed in alleviating the tensions and to which cost in terms of model fitting with respect to LCDM.

Presenter: Dr SAKR, Ziad (IRAP Toulouse)

Contribution ID: **87** Type: **not specified**

Resolving Hubble Tension with New Gravitational Scalar Tensor Theories

Sunday, 11 September 2022 16:30 (10 minutes)

We investigate the cosmological applications of new gravitational scalar-tensor theories and analyze them in the context of H0 tension. In these theories the Lagrangian contains the Ricci scalar and its first and second derivatives, in a specific combination that makes them free of ghosts. In the Einstein frame they are proved to be a subclass of bi-scalar extensions of general relativity. Extracting the dark energy sector containing both the scalar degrees of freedom, we study two specific models capable of alleviating the H0 tension. We find that the evolution of the Hubble function is sensitive to the value of the model parameter. We show that the effect of the additional terms, coming from these theories, is negligible at high redshifts, consequently they match with ΛCDM cosmology. However as time passes the deviation increases and thus at low redshifts the Hubble parameter acquires increased values in a controlled way. In particular, we show that for two specific choices of the biscalar construction, alleviation of the tension is possible, resulting to H0 ≈ 74 km/s/Mpc for particular parameter values. We also find that the effective dark energy equation of state parameter depicts phantom evolution, thus serving as a mechanism for Hubble tension alleviation. We further confront our models with the Cosmic Chromometer data.

Presenter: Dr BANERJEE, Shreya (Friedrich Alexander University, Erlangen, Germany)

Contribution ID: **88** Type: **not specified**

The last 10 billion years of cosmic structure growth

Sunday, 11 September 2022 16:30 (10 minutes)

The current constraints on the growth of perturbations are subject of debate. Cosmic shear observations show a lower value than that predicted by Planck. For instance, KiDS finds results 3\sigma away from Planck's value and data from DESY1 also points in the same direction. In this talk I will show a data driven reconstruction of the structure growth history from a combination of 6 different data sets that include galaxy clustering, weak lensing and CMB lensing (with DESY1 and KiDS-1000 among them). I will show that these data constrain the amplitude of fluctuations in the range 0.2 \lesssim z \lesssim 2 and give consistent growth histories. Furthermore, I will show that in the range 0.2 \lesssim z \lesssim 0.7 current data prefer a lower value than that predicted by Planck and that it is mostly driven by cosmic shear observations. I will also discuss the possible implications that this result may have on Modified Gravity. Finally, I will present a public repository of large-scale structure data that will be soon released and will allow consistent multi-survey analysis as the one presented in this talk.

Presenter: Mr GARCIA GARCIA, Carlos (University of Oxford)

Contribution ID: **89** Type: **not specified**

The H0 tension alleviated through ultra-light primordial black holes: an information insight through gravitational waves

Sunday, 11 September 2022 16:40 (10 minutes)

"As it was recently argued, the Hawking evaporation of ultra-light primordial black holes (PBH) domi- nating the early universe can increase the effective number of extra neutrino species ΔNeff, which is proportional to the initial PBH abundance and the total number of extra degrees of freedom produced from Hawking evaporation on the top of the Standard Model (SM) ones. Hence, by increasing ΔNeff, one can alleviate the Hubble tension problem. These light PBHs can form a gas of Poisson
distributed compact objects which can induce at second order in cosmological perturbation theory a gravitational-wave (GW) background. Consequently, in this work, by avoiding overproduction of the above mentioned scalar induced GW background we derive model-independent constraints on the initial PBH abundance, ΩPBH,f as a function of their mass, mPBH and translate these constraints to constraints on ΔNeff finding at the end extremely small masses for PBHs, namely below the
Planck mass, which is excluded. By accounting as well for the fact that for extra degrees of freedom produced from Hawking evaporation at energies $T \gg 100$MeV, $\Delta N_{\rm eff} \ll 1$ we find an extremely small upper bound on ΩPBH,f below the lowest value required for early PBH domination. At the end, we conclude that the scenario of early ultra-light PBH domination is excluded pointing out that in order to alleviate the Hubble tension through the portal of Hawking evaporation of ultra-light PBHs, one
should introduce a high number of light relativistic degrees of freedom with feeble couplings to the SM in order to recompensate for the low initial PBH abundances."

Presenter: Dr PAPANIKOLAOU, Theodoros (National Observatory of Athens)

Contribution ID: **90** Type: **not specified**

Alleviating H0 tension in entropic cosmology

Sunday, 11 September 2022 16:40 (10 minutes)

Presenter: Dr LYMPERIS, Andreas (University of Patras)

Contribution ID: **91** Type: **not specified**

A new constraint on Early Dark Energy using the profile likelihood

Sunday, 11 September 2022 16:50 (10 minutes)

A dark energy-like component in the early universe, known as early dark energy (EDE), is a proposed solution to the Hubble tension. Currently, there is no consensus in the literature as to whether EDE can simultaneously solve the Hubble tension and provide an adequate fit to the data from the cosmic microwave background (CMB) and large-scale structure of the universe. In this talk, I will give a brief overview on the status of EDE and describe the disagreement about EDE in the literature. To explore the origin of this disagreement, we deconstruct the current constraints on EDE We use two different methods, a grid sampling and a profile likelihood, and find evidence that the current constraints on EDE might suffer from (prior) volume effects upon marginalization and are possibly biased towards small values of the EDE fraction. Using the profile likelihood, we construct a new constraint that is not subject to volume effects.

Presenter: Ms HEROLD, Laura (Max Planck Institute for Astrophysics, Munich)

Contribution ID: **92** Type: **not specified**

As good as it gets – solving the H0-tension Ã la Ellis & Stoeger

Sunday, 11 September 2022 16:50 (10 minutes)

Cosmological models were essential to interpret the sparse observations we could collect in the first decades of modern cosmology. Our current LCDM standard model was established when an increasing amount of multiple data sets corroborated the prior assumptions of homogeneity and isotropy on largest scales. Now, several oddities and tensions emerge when evaluating more data of even better quality within this framework. Some call the tensions a crisis, I call them an opportunity to gain a deeper understanding. In this talk, I will present the opportunity to solve the H0-tension as a mere fitting problem that matches a continuous cosmological model to a set of granular observations living on perturbation level, based on Ellis & Stoeger 1987. The H0-fitting problem then amounts to two fits of LCDM, one at early, one at late cosmic times. Highly non-linear, evolved structures in a limited volume complicate the fit at late times and can easily cause deviating parameters compared to the fit at early times when structures are small perturbations on top of the background and our observations cover a much larger volume. This approach not only explains the H0-tension but also sets a clear roadmap how to obtain a background cosmology in which all observations can consistently live without tension. Based on the current status-quo in observations, I will outline how to employ existing and upcoming data to arrive at this goal within the next years. Further details can be found in https //arxiv.org/abs/2203.11219 (invited paper submitted to the Focus Issue on the Hubble Constant Tension in CQG)

Presenter: Dr WAGNER, Jenny

Contribution ID: **93** Type: **not specified**

Tensions in the deceleration parameter the effect of peculiar velocities in the time-like and null q

Sunday, 11 September 2022 17:00 (10 minutes)

In this talk I will introduce and discuss the concepts of bulk flows and peculiar velocities, the importance of which has progressively been shown to be more significant in modern cosmology. Alongside this, I will also discuss recent theoretical developments of a new way of expanding luminosity distances in terms of null geodesics, allowing us to obtain null analogues of the well-known expansion and deceleration parameters. I will wrap up by connecting both topics and analyzing the effect of peculiar velocities in the null deceleration parameter, as well as open a discussion on the impacts of such results on the existence of dark energy.

Presenter: Dr SANTIAGO, Jessica (Aristotle University of Thessaloniki)

Contribution ID: **94** Type: **not specified**

Can we alleviate the tensions using ANN

Sunday, 11 September 2022 17:00 (10 minutes)

The prospect of nonparametric reconstructions of cosmological parameters from observational data sets has been a popular topic in the literature for a number of years. This has mainly taken the form of a technique based on Gaussian processes but this approach is exposed to several foundational issues ranging from overfitting to kernel consistency problems. In this talk, I will discuss the possibility of using artificial neural networks (ANN) to reconstruct late time expansion and large scale structure cosmological parameters.

Presenter: Dr DIALEKTOPOULOS, Konstantinos (Aristotle University of Thessaloniki)

Contribution ID: **95** Type: **not specified**

Impact of redshift systematics and intrinsic alignment modelling on the S8-tension

Sunday, 11 September 2022 17:10 (10 minutes)

Intrinsic alignment (IA) modelling and photometric redshift estimation are two of the main sources of systematic uncertainty in weak lensing surveys. We investigate the impact of redshift errors and their interplay with different IA models. Generally, errors on the mean δ_z and on the width σ_z of the redshift bins can both lead to biases in cosmological constraints. We find that such biases can, however, only be partially resolved by marginalizing over δ_z and σ_z. For Stage-III surveys, δ_z and σ_z cannot be well constrained due to limited statistics. The resulting biases are thus sensitive to prior volume effects. For Stage-IV surveys, we observe that marginalizing over the redshift parameters has an impact and reduces the bias. We derive requirements on the uncertainty of σ_z and δ_z for both Stage-III and Stage-IV surveys. We assume that the redshift systematic errors on S_8 should be less than half of the statistical errors, and the median bias should be smaller than 0.25σ. We find that the uncertainty on δ_z has to be
$lesssim 0.025$ for the NLA IA model with a Stage-III survey. We find no requirement threshold for σ_z since the requirements are met even for our maximum prior width of 0.3. For the TATT IA model, the uncertainty on δ_z has to be
$lesssim 0.02$ and the uncertainty on σ_z has to be
$lesssim 0.2$. Current redshift precision of Stage-III surveys is therefore high enough to meet these requirements. For Stage-IV surveys, systematic effects will be more important due to the higher statistical precision. In this case, the uncertainty on δ_z has to be
$lesssim 0.005$ and the uncertainty on σ_z should be
$lesssim 0.1$, with no significant dependence on the IA model. This required high precision will be a challenge for the redshift calibration of these future surveys. Finally, we investigate whether the interplay between redshift systematics and IA modelling can explain the S_8-tension between cosmic shear results and CMB measurements. We find that this is unlikely to explain the current S_8-tension. We also discuss how noise bias for a Stage-III survey can lead to biases of up to -0.5σ on S_8.

Presenter: Mr FISCHBACHER, Silvan (ETH Zurich)

Contribution ID: **96** Type: **not specified**

Assessing tensions in CMB Polarization data by extending the Minkowski Functional framework

Sunday, 11 September 2022 17:10 (10 minutes)

Minkowski Functionals are high-order statistics that can be extracted from spherical maps such as the CMB, providing additional information to that in the angular power spectrum. The expected value of these functionals can be very accurately predicted for Gaussian isotropic maps, which turn them into an excellent tool to look for Non-Gaussianities and violations of the Cosmological Principle in a model-independent way. They have been widely applied to scalar maps such as CMB temperature and lensing, but they can not be directly applied to spin maps such as CMB polarization. In this talk, I will extend the formalism of Minkowski Functionals to CMB polarization (and generally, to spin fields) in two different ways that keep full information of the spin field. I will briefly introduce the theoretical predictions for the Minkowski Functionals in these extensions and present a Python package developed in our group that can be used to compute them in scalar and spin maps. This framework and software will soon be extended to include other high-order statistics such as peak statistics. Finally, I will present the results of applying this framework to Planck polarization data and explain how present and future CMB data can be used to assess the Cosmological Principle and to disentangle primordial and foreground-induced Non-Gaussianities. I will also explain how Minkowski Functionals can be used to assess anomalies such as the power asymmetry of the CMB temperature and how polarization can help in this task. This talk is based on several ongoing projects developed with Domenico Marinucci, Nicola Vittorio, Marina Migliaccio, Alessandro Carones, Giuseppe Puglisi, and Giacomo Galloni.

Presenter: Mr CARRON DUQUE, Javier (University of Rome Tor Vergata)

Contribution ID: **97** Type: **not specified**

Early dark energy in the light of large scale structure data

Sunday, 11 September 2022 17:20 (10 minutes)

Early dark energy (EDE) is a dark energy-like component active in the early stages of the universe and is one of many proposed ways of resolving the Hubble tension. Up to now, it is not agreed upon if EDE can solve the Hubble tension whilst fitting the cosmic microwave background and large scale structure simultaneously or not. In this talk, I will review the status of EDE in the current literature, describing the challenges that this model has to overcome. I will discuss my recent work on using an effective field theory-based approach for the full shape analysis of the power spectrum of emission line galaxies and how including higher redshift large scale structure data can constrain the validity of EDE as a solution to the Hubble tension.

Presenter: Ms GSPONER, Rafaela (Institute of Cosmology and Gravitation)

Contribution ID: **98** Type: **not specified**

Clustering effects on GWs Dark Sirens determination of Ho A simulations study

Sunday, 11 September 2022 17:20 (10 minutes)

Gravitational waves (GWs) can be used to measure the Hubble parameter. The optimal technique, a "Standard Siren", requires the identification of the electromagnetic (E/M) counterpart of the GW source. However, a significant fraction of GWs will not have E/M counterparts. Such "Dark Sirens" can still help constrain the Hubble parameter by statistical techniques. In this work, we investigate the power of this method using high-resolution, cosmological simulations that include realistic clustering effects, finding an improvement of ˜2%. In addition, we quantify the role of catalogue incompleteness, i.e. the lack of certain galaxies from our catalogues, due to observational limitations, when applying this technique.

Presenter: Mr KALOMENOPOULOS, Marios (University of Edinburgh)

Contribution ID: **99** Type: **not specified**

Update on GW standard siren cosmology

Sunday, 11 September 2022 18:30 (30 minutes)

The era of gravitational-wave cosmology has finally begun. The multi-messenger observations of GW170817 allowed it to be used as a standard siren, providing a direct measurement of the Hubble constant calibrated by the theory of general relativity. In addition to this "bright siren" approach, a "dark siren" approach has been implemented utilizing statistical correlations with host galaxies to constrain cosmological parameters. More recently, a "spectral siren" approach has been developed, which uses observed features in the statistical distribution of GW sources to constrain redshift and infer cosmology. We will summarize recent results and discuss future prospects.

Presenter: Prof. HOLZ, Daniel (University of Chicago)

Contribution ID: **100** Type: **not specified**

Tensions and anomalies: how well do we understand subtle dependencies of galaxy clustering on their properties?

Sunday, 11 September 2022 19:00 (20 minutes)

Galaxies are known to be good although biased tracers of the underlying dark matter field. This bias, mostly driven by history of hierarchical clustering and galaxy/halo assembly history, results in the dependence of galaxy clustering on their physical properties which is not easy to model. On the other hand, making use of galaxies as tracers of cosmic structure for cosmological purposes strongly relies on our understanding of the relations between a galaxy, its DM halo and large-scale environment and its evolution. In my talk I will show some recent results from my group pointing to nontrivial dependencies between galaxy properties and their environment affecting clustering measurements, thus possibly contributing to some cosmic tensions, and pointing to the necessity of new generation of models and simulations.

Presenter: Prof. POLLO, Agnieszka (National Center for Nuclear Research)

Contribution ID: **101** Type: **not specified**

Interacting vacuum and tensions

Sunday, 11 September 2022 19:20 (20 minutes)

Presenter: Dr BRUNI, Marco (University of Portsmouth)

Contribution ID: **102** Type: **not specified**

Correlations between galaxy angular momenta and initial conditions

Sunday, 11 September 2022 16:20 (10 minutes)

Galaxy angular momenta (GAM) are determined by the initial conditions (ICs) in the vicinity of the corresponding protohaloes and have a potential to improve our knowledge of cosmological ICs on Mpc scales. In this talk I will describe our observational efforts studying this correlation. Using ICs determined from SDSS galaxy positions and GAM inferred from the sense of rotation of the spiral arms of spiral galaxies, we are able to measure this correlation with detection significance of around 3ÏĪ. With similar significance we detect a correlation between the ICs and GAM inferred from ellipticities of spiral galaxies. Finally, I mention how we use GAM to probe chirality violations in the early Universe.

Presenter: Dr MOTLOCH, Pavel (CITA, University of Toronto)

Contribution ID: **103** Type: **not specified**

Conference Closure

Presenter: SARIDAKIS, Emmanuel