Baryons in the Universe 2024

Report of Contributions

https://indico.ipmu.jp/e/baryons2024

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

Introduction/Logistics

Monday, 8 April 2024 09:00 (20 minutes)

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

The Cosmic Baryon Cycle

Monday, 8 April 2024 09:20 (25 minutes)

New observatories and advanced simulations are revolutionising our understanding of the cycling of matter into, through, and out of galaxies. In this talk I will provide an overview of the normal matter in collapsed structures, their chemical make-up and dust content. I will present fresh clues of the cosmic evolution of cold gas with cosmic times as well as its spatial distribution around galaxies. Together, these results provide an increasingly accurate description of the baryon cycle which plays many crucial roles in transforming the bare pristine Universe left after the Big Bang into the rich and diverse Universe in which we live today.

Presenter: PEROUX, Celine

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

Simulating the impact of baryon physics on large-scale structure

Monday, 8 April 2024 09:45 (25 minutes)

I will present results from the FLAMINGO suite of large-volume cosmological hydrodynamical simulations on the impact of baryons on various large-scale structure observables and its implication for the 'S8 tension'. I will also discuss the crucial role that independent measurements of the intragroup medium play and I will examine the consistency between various data sets (particularly, X-ray, kSZ, and tSZ).

Presenter: MCCARTHY, Ian

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

The hot circumgalactic medium

Monday, 8 April 2024 10:10 (25 minutes)

The circumgalactic medium (CGM) plays a critical role in galaxy formation and evolution. The X-ray missions Chandra, XMM-Newton, and Suzaku opened a new window on CGM studies, allowing us to probe the warm-hot gas where most of the galactic baryons reside. In over two decades since the launch of Chandra and XMM-Newton, we have made great strides in understanding the CGM, but significant challenges remain. I'll review our progress so for, highlight new discoveries, outline the open questions, and discuss paths for future progress.

Presenter: MATHUR, Smita

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

Resolving the physics of multi-scale gaseous halos

Monday, 8 April 2024 11:05 (25 minutes)

We have certainly reached a consensus that galaxy evolution depends intricately on the cosmic baryon cycle. Inflows from the IGM meet outflows driven by feedback processes, creating the dynamic, multi-phase CGM. The physics of these gaseous halos, and the baryon cycle as a whole, are the key to understanding galaxy evolution. This is, however, a challenging regime for cosmological hydrodynamical simulations. I will discuss our recent work on three fronts: (i) developing super-Lagrangian refinement techniques to finally resolve the small-scale structure of the CGM. These new simulations have the promise to reveal the physics of the 'cold phase' – the formation of cool, overdense clouds of gas and their observable signatures; (ii) the impact of feedback on the redistribution of baryons from halo to IGM scales, and the 'closure radius'; (iii) the structure and properties of the hot intracluster medium of galaxy clusters as revealed with the new TNG-Cluster simulation.

Presenter: NELSON, Dylan

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

The Multi-Wavelength Circumgalactic Medium

Monday, 8 April 2024 11:30 (25 minutes)

I will present observational predictions of X-rays, FRBs, and 21-cm HI for the local circumgalactic medium from a variety of simulations. [Check back for a more complete abstract later.]

Presenter: OPPENHEIMER, Benjamin

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

The Milky Way warm-hot circumgalactic medium as seen by eROSITA

Monday, 8 April 2024 11:55 (20 minutes)

The first all-sky maps of high ionization lines observed in X-rays by eROSITA will provide an excellent probe for the study of the hot phase (T ~ 10^6 K) of the Milky Way (MW) circumgalactic medium (CGM). In this work we analyse the OVIII line detected in the eROSITA data. We fit sky maps made in narrow energy bins around the lines, with physical emission models embedded in a 3D geometry to constrain the density distribution of the hot gas around our Galaxy, with a focus on mid and high (absolute) Galactic latitudes. By filtering out the eROSITA bubbles and other foreground sources, we find that an oblate geometry of the hot gas (T ≡ 0.15 keV), flattened around the Galactic disk with scale height zh ~ 1 – 3 kpc, best describes the observed eROSITA maps, with most of the observed emission resulting to be produced within a few kpc from the Sun. We find that the soft-X background emission attributed to the CGM in general does not probe the medium at distances ≫ kpc from the Sun. The additional presence of a large scale hot spherical halo, while providing a minor contribute to the X-ray emission, accounts for the high OVII absorption column densities detected with XMM, as well as most of the baryon budget of the MW CGM. The eROSITA data carry the largest amount of information and detail of OVIII CGM intensities to date, allowing to highly reduce the statistical uncertainties of the inferred physical parameters.

Presenter: LOCATELLI, Nicola

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

The impact of feedback on the distribution of baryons within and outside haloes

Monday, 8 April 2024 14:00 (25 minutes)

Simulations indicate that stellar and AGN feedback processes significantly influence star formation and the distribution of baryons in the Universe. Despite this consensus, there is no agreement on the exact model for these processes. The Simba suite of hydrodynamical cosmological simulations (box size 74 Mpc, gas mass resolution 1.82X10^7 M_sun) includes variants with various stellar/AGN feedback models, providing an ideal testbed for assessing the impact of different processes on key observables. I will present the predictions of the different Simba runs on the distribution of baryons within and around haloes, as a function of halo mass and redshift. My results show a distinctive signature of AGN-driven jets on the slope of the gas density profile of groups and clusters. I will also show preliminary results on the impact of baryonic physics on the concentration-mass relationship of dark matter density profiles in the IllustrisTNG and MillenniumTNG simulations. Thanks to the large box size of the MillenniumTNG simulation (740 Mpc), the results probe an expansive range of halo masses (10^9.5 – 10^15 M_sun), over a wide redshift range (0<z<7).

Presenter: SORINI, Daniele

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

Virialization of the CGM and some of its implications

Monday, 8 April 2024 14:25 (25 minutes)

I will review basic results on the virialization of the CGM, a key phase transition determining when the gas is expected to be hot vs. cold. The presentation will highlight recent insights from modeling cooling flows in galaxy-scale halos and the concept of outside-in virialization, in which the inner CGM is the last part of a halo to sustain a hot phase. Time permitting, I will summarize results on the connections between CGM virialization and the properties of central galaxies, including star formation variability, galactic winds, and the formation of thin disks, as well as predictions for CGM observables.

Presenter: FAUCHER-GIGUERE, Claude-Andre

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

An alternative origin for high-equivalent width UV absorbers in the CGM

Monday, 8 April 2024 14:50 (20 minutes)

A basic ansatz employed by studies of circumgalactic low/mid-ion absorbers is that they trace ‘clouds’ or ‘mist’ with minute filling fractions, embedded in a hot T ~ T_vir volume-filling medium. I will present evidence from cosmological and idealized simulations that this ansatz may be incorrect for absorbers with high equivalent widths (EW >~1 A). Such high EW absorbers instead trace a T « T_vir volume-filling CGM phase which is supersonically turbulent, akin to a star-forming cloud. I will discuss unique signatures of this alternative physical origin for CGM absorbers, which can be used to identify it in observations, and its implications for inference of CGM properties from UV absorption spectra.

Presenter: STERN, Jonathan

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

The Hot Phases of the CGM: Past, Present, and Future

Monday, 8 April 2024 15:40 (25 minutes)

The circumgalactic medium (CGM) plays a pivotal role in every aspect of the formation and evolution of galaxies from the highest redshifts to the present day. While UV observations have made significant progress in mapping the warm gas around galaxies, the bulk of the baryons reside in the CGM in the form of tenuous, hot, X-ray-emitting gas. This hot gas can only be studied with X-ray observatories. The X-ray phase of the CGM contains a substantial fraction of baryons and also retains the imprint of physical processes such as energetic feedback from supernovae and supermassive black holes. In this presentation, I will overview our current understanding of the hot X-ray-emitting CGM based on a wide range of observational data and will briefly discuss the prospects of observing the hot phases of the CGM.

Presenter: BOGDAN, Akos

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

Understanding baryons through galaxy groups and clusters in FLAMINGO

Monday, 8 April 2024 16:05 (20 minutes)

We use FLAMINGO, the biggest full hydro cosmological simulation ever, to study the most massive objects in the universe and do a direct comparison with observations. FLAMINGO hosts many tens of thousands of galaxy groups and clusters, in their full cosmological environment, making it an ideal testing ground to do a statistically relevant comparison with observations. Using a new forward modelling pipeline for X-rays, including photo-ionization models from CLOUDY, we can accurately model the emission from clusters and their surroundings in a wide mass-range. We construct X-ray scaling relations and study how they are impacted by halo- and stellar mass, cool-core fractions, relaxed-ness, projection effects, and redshift. Furthermore, because FLAMINGO has 9 observationally motivated feedback variations, we show the impact of AGN and stellar feedback on group and cluster radial thermodynamic profiles. The feedback variations allow us to understand the distribution of baryons. For all FLAMINGO haloes, we also compute their density, entropy, temperature and pressure profiles. We compare those with observations, and fit them to estimate the hydrostatic bias, which we can now do for tens of thousands of galaxy groups and thousands of massive clusters, and as a function of cluster properties. With the unprecedented size of the FLAMINGO simulations, we can do all these things for statistically relevant sample sizes, enabling a real comparison with observations at all masses, and even on a lightcone.

Presenter: BRASPENNING, Joey

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

Unveiling Hidden Biases in the Baryonic Universe of Galaxy Groups

Monday, 8 April 2024 16:25 (20 minutes)

"Mapping the distribution of baryonic mass on large scales, specifically within group-sized halos, is vital to clarify how much of the missing baryons is locked up within halos and filaments. Thermal feedback, predominantly driven by AGNs residing in central galaxies, has been proposed to explain the observed amount and distribution of hot gas and overall baryonic content. However, the precise injection of AGN energy into the environment, including the timing, location, and magnitude, remains an ongoing debate in observational studies. Theoretical models, while successful in reproducing various observables such as the galaxy stellar mass function and hot gas content in massive clusters, still diverge in predicting the baryonic mass at smaller scales. Different feedback implementations lead to divergent outcomes, ranging from gas-rich groups with excessively hot environments to completely gas-depleted systems. Resolving these uncertainties will shed light on one of the fundamental weaknesses in our understanding of galaxy formation and evolution.

In this study, we present the first direct comparison between synthetic mock eROSITA observations derived from the Magneticum simulation and the real eRASS and eFEDS observational samples by eROSITA at varying depths. By employing a consistent methodology on both synthetic and real datasets, we investigate the distribution of hot gas in detected groups and clusters, as well as undetected systems, using a stacking analysis. Additionally, we explore the distinguishing characteristics between central and satellite galaxies within these environments, providing insights into the models implemented in state-of-art cosmological simulations.

Our findings contribute to a comprehensive understanding of AGN feedback, hot gas distribution, and the intricate interplay between theoretical simulations and real observations."

Presenter: MARINI, Ilaria

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

Unveiling the properties of the hot gas in Galaxy Groups from the CGM to the IGrM

Monday, 8 April 2024 16:45 (20 minutes)

Low-mass galaxy groups are the most common environments for galaxies in the Universe, and they provide a crucial link between cosmology and galaxy evolution. However, their hot gas and baryon content are poorly constrained by current X-ray observations due to their low surface brightness. In this talk, I will demonstrate the efficiency of spectral stacking as a method to overcome these limitations for galaxy groups coming from the major spectroscopic surveys, such as the SDSS, GAMA and DESI, and then observed by eROSITA All Sky Survey. I will focus on the temperature, density, and entropy profiles within mass ranges from 1e13 to 1e14 solar masses, where estimations from individual data are challenging. The stacking results from eRASS1 will be compared with predictions from mock observations based on hydro-dynamical simulations like Magneticum and IllustrisTNG. This approach not only extends the study of gas properties in clusters to scales comparable to our own Local Group, but also expands and validates existing X-ray scaling relations on the low-mass end. Furthermore, it traces the influence of AGN feedback on baryon distribution in groups, providing insights into their internal dynamics.

Presenter: TOPTUN, Victoria

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

Probing the hot CGM by combining eROSITA with DESI and 4MOST

Monday, 8 April 2024 17:05 (25 minutes)

In this presentation, in a first part, I review the current measurements of the hot CGM carried out on eROSITA using the galaxy samples from SDSS and GAMA. Then I discuss the potential of combining the next-level spectroscopic surveys (4MOST and DESI) with the latest eROSITA observations to measure the properties of hot CGM.
In a second part, I discuss the challenges encountered in modelling hot CGM observations and how to solve them with a forward modelling approach leveraging hydro-dynamical simulations.

Presenter: COMPARAT, Johan

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

Backlighting the baryons with the CMB

Tuesday, 9 April 2024 09:00 (25 minutes)

Many baryon properties such as density, temperature, bulk velocity and more are imprinted on the CMB as secondary anisotropies. I will review these numerous effects, including the thermal and kinematic Sunyaev-Zel'dovich effects, the patchy screening, highlighting their differences and complementarity. Combined with imprints of the gravitational potential on the CMB, such as lensing, integrated Sachs-Wolfe and moving lens effect, they will provide a multifaceted picture of the gas thermodynamics in galaxy halos, with implications for galaxy formation and galaxy lensing. I will present new developments in statistical methods to measure them and to distinguish them from each other and from other foreground emission. These have enabled recent first detections (e.g., patchy screening) and promise to enable more with existing and upcoming datasets.

Presenter: SCHAAN, Emmanuel

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

Direct measurement of feedback and baryon effects in lensing with the CMB

Tuesday, 9 April 2024 09:25 (20 minutes)

The CMB provides and clean and direct way to measure the gas distribution in the outskirts of galaxies and clusters, and therefore measure the effect of feedback. Combining pressure (from tSZ), density (from kSZ) and lensing data, we can reconstruct the full thermodynamic properties of the halo and test hydrodynamical simulations. Moreover, direct measurements of gas density are able to calibrate baryon effects in weak lensing. I will discuss current measurements with BOSS and ACT, and if permitted by the collaborations, ongoing work with the latest ACT and DESI data, which represent a large improvement over the BOSS measurements and the current state-of-the-art.

Presenter: FERRARO, Simone

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

Exploration of cosmic baryons using pairwise kinematic SZ power spectrum measurements

Tuesday, 9 April 2024 09:45 (20 minutes)

"The measurement of the Kinematic Sunyaev-Zel'dovich (KSZ) effect is increasingly gaining prominence for the exploration of baryons in the universe. The KSZ effect, an result of the motion of free electron gas, is independent of the gas temperature. Therefore, it is sensitive to the Warm-Hot Intergalactic Medium (WHIM) in the temperature range of 10^5 K < T < 10^7 K, which is neither hot enough to be detected in X-ray observations (T < 10^8 K) nor cold enough to form stars or galaxies (T > 10^3 K). Additionally, measuring the so-called pairwise kSZ – the cross-correlation with galaxy or galaxy cluster samples – enables large-scale, temperature-independent baryon exploration on cosmological scales.

While real-space measurements are predominant in pairwise kSZ, this study presents the first measurement of the pairwise kSZ power spectrum in Fourier space, using CMB data from Planck and galaxy data from BOSS. We also examine in detail the optical depth, a proportional coefficient in the pairwise kSZ power spectrum, to provide constraints on the gas distribution around galaxies. Finally, we discuss the prospects of precision baryon observations in cosmology using future observations, such as CMB-S4, DESI, and PFS, which are expected to achieve high precision with S/N ~100."

Presenter: SUGIYAMA, Naonori

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

Impact of baryonic physics on small scale anisotropies

Tuesday, 9 April 2024 10:05 (20 minutes)

"The Cosmic Microwave data at very small scales are known to probe not only primordial CMB fluctuations but also many extragalactic components such as tSZ, kSZ, CIB, points sources.
I will show how to use the cosmological dependent SZ signatures (tSZ and kSZ) at small scales coherently in a combined analysis of Planck and SPT experiments to retrieve not only cosmological parameters but also reionisation history and hot gas properties. I will focus on on how the assumptions on the gas distribution (pressure profile, scaling relations) impact the results and how we can retrieve the gas properties or marginalise over them in forthcoming observations such as LiteBIRD or CMB-HD."

Presenter: DOUSPIS, Marian

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

An SZ view of baryons in cosmic web

Tuesday, 9 April 2024 10:55 (25 minutes)

The Large scale Structure of the Universe is organised in a cosmic web made of nodes, filaments, walls and voids, and is well traced by the distribution of galaxies. This filamentary structure, detected in galaxy surveys, contains the majority of baryons in the form of hot and warm gas components. The use of the Sunyaev-Zeldovich (SZ) signal measured by the Planck satellite over the whole sky is used to study these large structures of the Universe. In particular by combining the SZ signal which probes the gas and the distribution of galaxies, we can address the challenging task of characterising the LSS, its composition and the interplay between baryons.

Presenter: AGHANIM, Nabila

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

Simulating Sunyaev-Zel'dovich Effects with Baryon Pasting

Tuesday, 9 April 2024 11:20 (20 minutes)

"The inverse Compton scattering of cosmic microwave background (CMB) photons with hot cosmic gas induces spectral distortions of CMB. This effect leads to the secondary anisotropy of CMB temperature and is referred to as the Sunyaev-Zel'dovich (SZ) effect. The SZ effect is a sensitive probe into the cosmic gas distribution and has been employed to constrain cosmological models and address cluster astrophysics. For the statistical analysis of measurements of SZ effects, mock simulations are employed to estimate the covariance matrix of the SZ statistics and evaluate the systematic uncertainties. However, simulations of cosmic gas evolution is computationally expensive, and thus, fast generation of mock SZ observations is critical for the statistical analysis.
We present a fast methodology ""Baryon Pasting"" to produce mock observations of the SZ effects based on the dark matter only N-body simulations coupled with the analytic intracluster medium model. As validation of our methods, we have produced 108 all-sky maps. Our method can produce a mock map within a few hours, even for all-sky coverage with a parallel computational environment. The power spectra measured from mock SZ maps are consistent with the halo model prediction. We also discuss the ongoing project to create a suite of mock multi-wavelength observations, including SZ effects, with supercomputer Fugaku."

Presenter: OSATO, Ken

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

Probing the Ionized Gas Thermodynamics in Distant Galaxies with the Sunyaev-Zel'dovich Effect

Tuesday, 9 April 2024 11:40 (20 minutes)

"The Cosmic Microwave Background (CMB) data not only provide powerful constraints on the early Universe physics, but also information from the late Universe, as the CMB photons interact with matter while propagating through cosmic time. One of such powerful probes of late-time physics is the Sunyaev-Zel'dovich (SZ) Effect—inverse-Compton scattering of the CMB photons off free electrons in galaxies and clusters. Its two main constituents are the kinematic SZ effect (kSZ), where electrons have a non-zero line-of-sight (LOS) velocity and which probes the electron momentum, and the thermal SZ effect (tSZ), where electrons have high temperatures, and which probes the electron integrated pressure. These two effects provide complementary information, which can be combined with probes of total mass to constrain the thermodynamic profile of the ionized gas residing in distant galaxies and study baryonic feedback, a poorly understood set of high-energy processes affecting galaxy formation.

In this talk, I will present several ongoing SZ–LSS cross-correlations with the Atacama Cosmology Telescope (ACT) data, including the tSZ–DES Maglim galaxies to constrain their pressure profile, as well as tSZ and projected-fields kSZ with the unWISE galaxy catalog to probe gas pressure and density, respectively. The projected-fields kSZ estimator squares the temperature field to avoid the cancellation of the signal due to electron velocity. I will also discuss various ways to mitigate the Cosmic Infrared Background (CIB) contamination, a large foreground to SZ cross-correlations."

Presenter: KUSIAK, Aleksandra

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

Non-thermal pressure in galaxy clusters: methods, models, constraints

Tuesday, 9 April 2024 14:00 (25 minutes)

I will discuss the role of non-thermal pressure support as a major source of the difference between the hydrostatic and the total "true" halo mass in galaxy clusters. I will present new models and methods to constrain the non-thermal pressure, highlighting the role of the next generation of X-ray observatories, like XRISM and Athena, in constructing a consistent picture of the formation and composition in mass and energy of galaxy clusters.

Presenter: ETTORI, Stefano

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

New Cluster Weak Lensing Mass Constraints and their Implications for Cluster Baryonic Scaling Relations

Tuesday, 9 April 2024 14:25 (25 minutes)

Cluster mass calibration using the DES weak lensing dataset as well as weak lensing informed cluster abundance analyses of ICM selected cluster samples from SPT, RASS and eROSITA offer new accuracy and precision for cluster mass measurements that can be used to improve studies of cluster baryonic scaling relations. We present new measurements of the ICM mass versus halo mass relation and their comparison to state of the art hydrodynamical simulations. These indicate increases of the ICM mass fraction with cluster mass that extend to the highest mass clusters studied. Through comparison of observed and simulated scaling relations one can constrain the range of baryonic impacts on the matter power spectrum by assigning a credibility to each set of hydro simulations. This effort should enable the extension of cosmic shear analyses to smaller scales by improving theoretical priors on the matter power spectrum. We highlight the implications of our new cluster measurements.

Presenter: MOHR, Joe

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

Hot galactic atmospheres as laboratories of baryon cycling and enrichment

Tuesday, 9 April 2024 14:50 (20 minutes)

Most galaxies comparable to or larger than the mass of the Milky Way host hot, X-ray-emitting atmospheres and central radio sources. Hot atmospheres and radio jets and lobes are the ingredients of radio-mechanical active galactic nucleus (AGN) feedback. Nearby massive elliptical galaxies are excellent laboratories for the study of AGN feedback and its role in the redistribution of baryons in the Universe, as well as for the study of chemical enrichment. We will present the results of systematic X-ray spectral imaging studies of a large sample of around 100 Chandra-observed nearby giant elliptical galaxies, complemented with 60 more distant clusters, focusing on the physics of AGN feedback and chemical enrichment. The presented results form an essential anchor for numerical simulations.

Presenter: WERNER, Norbert

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

Probing the impacts of radio-mode feedback on the properties of the CGM

Tuesday, 9 April 2024 15:40 (20 minutes)

Radio-mode feedback from supermassive black holes is expected to impact the evolution of massive galaxies, suppressing star formation and maintaining the heat content of their circumgalactic medium (CGM). However, the effects of this feedback on the cool CGM remain poorly understood. In this talk, I will present our recent study of probing the cool CGM traced by MgII absorption lines around radio galaxies. To this end, we assemble a large statistical sample of approximately 25,000 radio galaxies with background quasars by utilizing the largest spectroscopic dataset from the Dark Energy Spectroscopic Instrument (DESI) survey and a wealth of radio sources detected by two radio surveys, LOFAR and VLASS. Such a large sample enables us to characterize the properties of the CGM around radio galaxies, including absorption line strengths, gas spatial distribution, and gas kinematics. These properties are then compared with those of control galaxy samples without radio emission. I will discuss how our novel measurements can constrain the impact of radio-mode feedback on the baryon distribution in the universe.

Presenter: CHANG, Yu-Ling

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

X-ray Observation of Cosmic Baryons

Tuesday, 9 April 2024 16:00 (25 minutes)

"Baryons are still missing at all scales in the Universe, from galaxies to the intergalactic medium at large-scale-structure scales.
While theory unanimously and since two decades strongly suggests that they should be hiding in hot and tenuous material in the diffuse IGM (the so-called WHIM) and galaxy halos (so called CGM), observations have been struggling in confirming it. This is probably because of the limited power of the previous generation of high-resolution X-ray spectrometers. The situation is bound to change in the near-to-medium future, with the advent of observatories like XRISM and Athena or dedicated mission like LEM, Arcus or HUBS.
Here I will review the current observational evidence for both baryons in the WHIM and the CGM of galaxies, and outline the large discovery space that will opened in the near-to-not-too-far future in this important field, by the upcoming UV and X-ray missions."

Presenter: NICASTRO, Fabrizio

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

The eROSITA All-Sky Survey: First results on galaxy clusters and superclusters

Tuesday, 9 April 2024 16:25 (20 minutes)

The first eROSITA All-Sky Survey (eRASS1) was completed in June 2020. The eRASS1 data, catalog, and science results in the western Galactic hemisphere will be released in early 2024. In this talk, I will briefly overview the most recent results on galaxy clusters and superclusters from eRASS1.

Presenter: LIU, Ang

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

Probing kinematics of ICM/CGM with microcalorimeter-based X-ray missions

Tuesday, 9 April 2024 16:45 (25 minutes)

Current and future microcalorimeter-based X-ray missions (e.g., XRISM, LEM, ATHENA) will have transformative impacts on the study of hot gaseous atmospheres across galactic scales: spanning the circumgalactic medium (CGM) to the intra-group/cluster medium (IGrM/ICM). Notably, these missions will offer high-resolution (eV-scale) spectroscopic data, enabling detailed analysis of the gas motions in the CGM/IGrM/ICM. In the first part of this talk I will present a recent study using the new TNG-Cluster simulation suit to explore the X-ray inferred kinematics of the ICM based on a simulated sample of Perseus-like clusters. I will discuss the predictions from TNG-Cluster for upcoming XRISM observations as well as the comparison with the existing Hitomi observations of the Perseus cluster. In the second part, I will talk about a future X-ray mission concept named Line Emission Mapper (LEM), which has been proposed to NASA as an Astrophysics Probe mission for the 2030s. In particular, using high-resolution TNG50 simulation I will discuss the prospects of the LEM All-sky survey in probing kinematic structures of the eROSITA bubbles in the Milky Way.

Presenter: TRUONG, Nhut

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

Baryon Pasting Project

Tuesday, 9 April 2024 17:10 (25 minutes)

We are entering the golden age of multi-wavelength astronomical surveys. In the 2020s, a plethora of multi-band surveys (such as Rubin-LSST, DESI, Simons Observatory, CMB-S4, and eROSITA, to name a few) are underway or planned to provide unprecedented insights into the cosmic structure formation and the fundamental physics of the cosmos. One of the key challenges of this cosmic frontier lies in understanding the halo-galaxy-gas connection and the roles of still poorly understood galaxy formation physics and its impact on cosmology. In this talk, I will present the Baryon Pasting project, which aims to create a physically-motivated, computationally efficient model for large multi-wavelength cosmological surveys. I will discuss the current status, challenges, and future prospects towards forward-modeling multi-wavelength cosmological surveys and enabling cross-survey, cross-correlation cosmology.

Presenter: DAISUKE, Nagai

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

X-ray signatures of WHIM

Wednesday, 10 April 2024 09:00 (25 minutes)

While X-rays from massive virialized halos are routinely observed, the detection of low density warm-hot intergalactic medium is much more difficult. We discuss specific spectral signatures of WHIM and the possible strategies of finding them with perspective X-ray observatories.

Presenter: CHURAZOV, Eugene

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

Detection of the 10^6.7 Kelvin Intergalactic Medium in Long Cosmic Filaments

Wednesday, 10 April 2024 09:25 (20 minutes)

The warm/hot intergalactic medium (WHIM) within cosmic filaments is one of the least well-characterized baryon repositories in the local Universe. The extremely weak signals in either X-rays or the Sunyaev-Zeldovich effect challenge its robust detection. We utilize SRG/eROSITA All-Sky Survey data to examine WHIM emission properties in > 20 Mpc long cosmic filaments. We detect a 9.2σ significance of X-ray emission spatially coincident with cosmic filaments traced by galaxy distribution. After correcting for undetected source contributions, the WHIM detection remains significant at > 4σ. We stack a broadband 100-eV resolution spectrum of cosmic filaments and measure a mean WHIM gas temperature of 10^6.7 Kelvin, suggesting that the phase we detect is in the highest temperature among the entire WHIM phases predicted by numerical simulations.

Presenter: ZHANG, Xiaoyuan

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

Spectroscopy of the Cosmic Web: a view beyond collisional ionisation equilibrium with future X-ray telescopes

Wednesday, 10 April 2024 09:45 (20 minutes)

The physical properties of the faint and extremely tenuous plasma in the far outskirts of galaxy clusters, the circumgalactic media of normal galaxies, and filaments of the cosmic web, remain one of the biggest unknowns in our story of large-scale structure evolution. Modeling the spectral features due to emission and absorption from this very diffuse plasma poses unique challenges, as both collisional and photo-ionization processes must be accounted for. In this talk I will present scenarios when the photo-ionization by galaxy cluster photons needs to be accounted for in addition to the photo-ionization by the cosmic UV/X-ray background, when inferring the properties of cosmic web filaments, like e.g. their column densities. I will also present whether the cosmic web filaments, simulated with the cosmological hydrodynamical simulations Hydrangea, can be observed in absorption against diffuse extended sources, in particular the cool-core galaxy clusters. I report the significance of the detection of filaments in OVII and OVIII with Athena X-IFU and LEM. I discuss the lower limit on the column densities that can still be observed with these instruments and provide a guide of where to look for filaments on the sky.

Presenter: STOFANOVA, Lydia

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

The baryonic content of multi-scale filaments

Wednesday, 10 April 2024 10:05 (20 minutes)

I will present a characterisation of gas in and around filaments at different scales of the Universe using several simulations from the TNG suite. I will show that, at Mpc-scales, the cosmic filaments at the basis of the cosmic skeleton are essentially made of gas in the warm-hot intergalactic medium (WHIM), the 'missing baryon' gas phase that is still partially elusive in current observations. Cosmic filament cores are isothermal, baryon depleted, and their pressure is ~1000 times lower than typical values of galaxy clusters. At smaller scales, the filamentary structures in the circum-galactic medium (CGM) of galaxies show different properties and gas content. These filaments are multi-phase and populated by low mass satellite galaxies, whose cold gas content plays a crucial role in galaxy evolution. Finally, I will present preliminary results concerning the observation these small-scale filaments in recent galaxy surveys.

Presenter: GALÁRRAGA-ESPINOSA, Daniela

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

The hot phase of the circumgalactic medium of the Milky Way and around galaxies

Wednesday, 10 April 2024 10:55 (25 minutes)

The growth of galaxies in the local Universe critically depends on the physical conditions of the hot phase of the interstellar and the circumgalactic medium and on its interplay (via outflows and re-condensation) with the other phases.
I will review the recent progress on our knowledge of the hot phase of the circumgalactic medium of the Milky Way, as well as of Milky Way like galaxies, allowed by the analysis of the eROSITA data.

Presenter: PONTI, Gabriele

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

Probing Gas Dynamics in the Intracluster Medium: Current Status and Future Perspectives

Wednesday, 10 April 2024 11:20 (20 minutes)

Hot, volume-filling gas in the intracluster medium (ICM) is continuously perturbed by matter accretion along cosmic filaments, mergers, and AGN feedback. Measuring velocities of gas motions is important for understanding energy partition during large-scale structure evolution, astrophysical processes that drive the evolution of galaxies within the ICM, and plasma physics. In my talk, I will review recent updates from indirect methods, namely, through the analysis of X-ray surface brightness fluctuations and how they compare with predictions from cosmological simulations. Selected challenges in interpreting the observed properties of gas motions will be discussed. Finally, I will review exciting opportunities with high-resolution X-ray spectroscopy, particularly with the recently launched XRISM satellite and more distant future missions like LEM.

Presenter: ZHURAVLEVA, Irina

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

Constraining the role of stellar feedback in the baryonic cycle from cosmic noon to z~6

Friday, 12 April 2024 14:45 (20 minutes)

This talk will focus on the new era of observing the high-redshift universe enabled by ground-based all-sky surveys and the James Webb Space Telescope (JWST). Specifically, the investigation of the intergalactic medium (IGM)/circumgalactic medium (CGM) and its correlation with local environments from cosmic noon and the reionization epoch (EoR) will be presented, highlighting the synergies between JWST and ground-based telescopes such as DESI I-II, VLT, and ALMA. I will present the CGM/IGM-galaxy correlation study using data from one JWST GO program, 'A Spectroscopic Survey of Biased Halos in the Reionization Era (ASPIRE),' and VLT/Xshooter. The results tentatively indicate that the ionization state of the patchy IGM/CGM at EoR has significant field variation and may strongly affect the assembly of young star-forming galaxies. The relative abundances probed by different ions in the CGM suggest that we may be witnessing the contribution of the first generation Population III stars to the CGM at the end of the reionization epoch. I will also present the results from exploring the correlation between the gaseous halo and galaxies at cosmic noon using DESI (and early DESI-II data) and photometry data in the COSMOS field. The cool and warm gas traced by MgII and CIV absorbers, and their correlation with galaxy counterparts and large-scale structure. It is found that the covering fraction of strong MgII-selected galaxies shows significant evolution in main-sequence galaxies and marginal evolution in all galaxy populations within 250 kpc at $1 < z < 2.2$. In summary, this talk suggests that the environment may play a significant role in CGM/IGM gas metal origin at $2 < z < 6$. At $z > 6$, the IGM/CGM physical metal abundances are strongly affected by local galaxies stellar feedback and star formation history.

Presenter: ZOU, Siwei

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

IGM Preheating at Cosmic Noon as a Probe of Long-Range AGN Feedback

Wednesday, 10 April 2024 12:00 (20 minutes)

While dark matter interacts solely through gravity and is responsible for shaping the cosmic web, baryonic matter exhibits more complicated behavior and modify the structure up to megaparsec scale. Among the physics baryon gets involved, the feedback from active galactic nuclei (AGN) is essential as the observation requires its energy input to regulate the star formation, but at the same time how the AGN exert on the environment remains unclear. Our presentation will detail recent progress from The Three Hundred project's zoom-in simulations to illuminate AGN feedback mechanisms and their potency. Motivated by our recent finding on the large-scale gas heating around a protocluster in COSMOS field called COSTCO-I, we extract the mass overdensity, stellar mass and Lyman-α transmission from The Three Hundred cluster at redshift 2.5. Compared with observation, The simulation suites with a jet feedback model closely reflects COSTCO-I's observed features, indicating a important role of kinetic feedback in driving large-scale IGM heating. In The Three Hundred suites, the Lyman-α transmission values show a divergence of the distributions among the prescrptions. Such difference in Lyman-α forest among The Three Hundred suites suggests a strong dependence of Lyman-α opacity (i.e., the temperature of IGM gas) on the strength of feedback power, enabling the Lyman-α forest to be a reliable probe of AGN feedback. Future work, especially with an expanded protocluster sample from the PFS program, promises a comprehensive statistical analysis of the IGM in the vicinity of protoclusters. Such analysis will significantly enhance our comprehension of AGN feedback and its role in large-scale structure evolution.

Presenter: DONG, Chenze

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

Towards precision cosmology with FRBs

Thursday, 11 April 2024 10:00 (25 minutes)

"Fast radio bursts (FRBs) are extragalactic radio transients of typcially ~ms duration. Their extreme luminosities allow them to be observed at cosmological distances, with optical follow-up observations identifying their host galaxies at redshifts up to 1.01. The key characteristic of FRBs is their dispersion measure - a frequency dependent delay due to propagation through astrophysical plasmas. This allows FRBs to trace the total column density of ionised gas between their source and the Earth. Cosmological studies with FRBs have so-far targeted the 'missing' matter, Hubble's constant, and Galactic halos intersected along the line of sight, with proposals to also identify Helium reionisation.

This talk will review the current status of cosmological studies with FRBs, covering detections methods, host galaxy follow-up, and analysis of baryonic distributions. I will then discuss the next generation of such studies with FRBs, highlighting both the promise of the technique for performing precision measurements, and current sources of uncertainty that need to be overcome if FRBs are to fulfill this promise."

Presenter: JAMES, Clancy

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

The Comic Baryons illuminated by the Fast Radio Bursts

Thursday, 11 April 2024 10:25 (25 minutes)

Despite the, yet, unconstrained nature, the Fast Radio Bursts (FRB) became unique probes of various astrophysical and cosmological phenomena. For instance, FRBs were paramount in resolving the so-called 'missing baryons problem', yet the major questions remained regarding the relative distribution of cosmic baryons in the diffuse IGM vs CGM of the galactic halos. Unraveling the exact partition of cosmic baryons would inform the models of galaxy formation and feedback mechanisms. However, constraining the relative distribution of cosmic baryon is challenging due to the large cosmic variance induced by the unknown density field and intervening galactic halos along the FRB sightlines. In my talk, I will discuss how this issue can be mitigated by measuring the spectroscopic redshift distribution of foreground galaxies in front of localized FRBs in order to map out the cosmic web as well as characterise the intervening galactic halos. I will describe the FLIMFLAM, an ongoing 40-night spectroscopic survey on the Anglo-Australian Telescope (and other facilities) that will map the foregrounds of ~20-30 localized FRBs primarily detected by CRAFT/ASKAP and localized by the F^4 collaboration. I will present the analysis of the FLIMFLAM' first data release that includes 8 FRB sightlines. I will show the first direct constraints on the relative partition of cosmic baryons between the CGM and IGM, as well as the estimate on the average host galaxy contribution to the dispersion measure.

Presenter: KHRYKIN, Ilya

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

Constraining baryon retention in halos using FRBs

Thursday, 11 April 2024 11:10 (20 minutes)

Fast Radio Bursts (FRBs) are emerging as promising new probes of ionized matter in the cosmic web. FRB dispersion measures (DMs) inform us of the integrated line of sight electron density. In combination with identifying foreground structures through redshift surveys, FRB DMs can lay novel constraints on baryon distribution in the circumgalactic and intergalactic media (CGM and IGM). Hydrodynamical simulations of the universe with various feedback prescriptions have shown that dark matter halos only retain a fraction of their associated baryons within a few virial radii. In my talk, I will describe constraints that can be laid using localized FRB sightlines. Specifically, by identifying foreground halos along overdense sightlines in the NASA Extragalactic Database Local Volume Sample (NED-LVS), one can place upper limits on f_gas, the baryon fraction retained within one virial radius.

Presenter: SIMHA, Sunil

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

Decoding the cosmological baryonic fluctuation by localized fast radio bursts

Thursday, 11 April 2024 11:30 (20 minutes)

"The enigma of the missing baryons poses a prominent and unresolved problem in astronomy. Dispersion measures (DM), serving as a distinctive observable of fast radio bursts (FRBs), quantify the electron column density along each line of sight, revealing the missing baryons described in the Macquart (DM-z) relation. The scatter of this relation is anticipated to be the variation of cosmic structure. However, this is not yet statistically confirmed. Here, we present the statistical evidence of the cosmological baryonic fluctuation in the intergalactic space by measuring the foreground galaxy number densities around 12
(12) localized FRBs with WISE-PS1-STRM (WISE x SCOS) photometric redshift galaxy catalogue. The foreground galaxy number densities are determined through a comparison
with measuring random apertures with the radius of 1 Mpc. We found a positive correlation between the excess of DM contributed by the intergalactic medium (DM_IGM) and the foreground galaxy number density. The correlation is strong and statistically significant, with a median Pearson coefficient of 0.8 (0.7) and a median p-value of 0.003 (0.012) for each catalogue calculated by Monte Carlo simulations. Our findings indicate that baryonic matters in intergalactic space exceed its cosmic average along the line of sight to high galaxy-density regions, whereas there is less amount of intergalactic baryons along the line of sight to low-density regions, presenting the first statistical evidence of the cosmological fluctuation of the missing baryons with the characteristic scale of ⊠1.5 Mpc."

Presenter: HSU, Tzu-Yin

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

FRBs, Dispersion Measures and the Cosmic Web

Thursday, 11 April 2024 11:50 (20 minutes)

"The large-scale cosmic baryon distribution is sensitive to processes from gravitational collapse to AGN feedback. Characterising it may improve our understanding of the baryon cycle, matter in elusive phases, and cosmological parameters. The Cosmic Web is being probed by an increasingly diverse arsenal of tracers, and techniques from simulations to statistics. Isolating its components has been previously shown to break degeneracies, and improve cosmological parameter constraints.

Fast Radio Bursts (FRBs) are short, bright, extragalactic radio signals. Due to the dispersion they undergo as they propagate towards us, FRBs encode information about all ionised material along their sightlines. The cosmological component of an FRB's dispersion measure (DM) is affected by the exact structure of this material. DMs of different FRBs originating at the same redshift will therefore vary, and when many FRBs are averaged, a predictable DM-redshift relationship, sensitive to cosmological parameters, emerges.

FRBs are therefore under scrutiny as probes of baryonic and ionised matter fractions in the IGM; and the division of this matter between diffuse intergalactic, and structured circumgalactic phases. Exploring how FRBs might use, complement or augment our current understanding of these matter distributions is a burgeoning field, crucial for more precisely constraining cosmological parameters.

In this talk, we will discuss the impact of cosmological large-scale structures (LSS) on FRBs. We have calculated electron densities; classified halos, filaments and voids using a dark matter density metric; and traced FRB sightlines through the IllustrisTNG simulation. When studying the numbers and impact parameters of collapsed structures intercepted by FRB sightlines, we recovered lower associated DM contributions (~90pc/cc) than those estimated in literature for purportedly galaxy-intercepting FRBs, strengthening evidence that FRBs probe environments beyond these structures. Via statistical analysis of the redshift-evolving DM contributions of halos, filaments and voids, we found evidence for homogeneity in void matter distributions which might be utilised for improved FRB-based precision cosmology.

Resulting questions include: How many void-only/low-structure FRB sightlines exist? Are they detectable with upcoming radio telescopes (e.g. the SKA)? Could they circumvent FRB-cosmology precision limitations caused by sightline-sightline DM variance? What techniques can disentangle LSS DM components in future localised FRB populations? And how effectively might existing or new techniques be used on these decomposed DMs, to break degeneracies and further improve cosmological constraints?

We hope to discuss these questions with the diverse researchers at this meeting, and learn how our results might contribute, alongside other techniques, probes, and future surveys (e.g. LSST), to the study of cosmic baryon distributions, the baryonic cycle, and cosmological parameters."

Presenter: WALKER, Charles

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

Modeling the Cosmic Dispersion Measure in the Local Volume

Thursday, 11 April 2024 12:10 (20 minutes)

"Fast radio bursts (FRBs) have recently become a promising and independent new technique to probe the cosmic baryon distribution through their dispersion measures (DM). Despite the wealth of information provided by spectroscopic surveys and constrained simulations of the D<100Mpc Local Volume, a reliable DM model is still lacking for the Local Volume.
In this presentation, I will introduce an innovative Local Volume DM model is composed of three key parts: (i) the DM of the Milky Way's Interstellar Medium, calculated using the NE2001 model; (ii) the DM of the Milky Way's halo and the intra-group medium (up to 3.4 Mpc), derived from HESTIA, a series of hydrodynamic simulations constrained by the peculiar velocities of nearby galaxies; (iii) the DM of the remaining areas within the local volume, determined using data from the NASA/IPAC Extragalactic Database. This comprehensive model will soon be available as a Python package. As the most realistic model to date for DM in the local volume, it promises to improve the constraints of DM contributions from the Intergalactic Medium (IGM) and Circumgalactic Medium (CGM) of FRBs, thereby enhancing the accuracy of cosmic baryon distribution calculations based on DM analysis of FRBs."

Presenter: HUANG, Yuxin

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

Probing the Circum-Galactic Medium with Fast Radio Bursts: Insights from the CAMELS Simulations

Thursday, 11 April 2024 14:00 (20 minutes)

Most diffuse baryons, including the circumgalactic medium (CGM) surrounding galaxies and the intergalactic medium (IGM) in the cosmic web, remain unmeasured and unconstrained. Fast Radio Bursts (FRBs) offer an unparalleled method to measure the electron dispersion measures (DMs) of ionized baryons. Their distribution can resolve the "missing" baryon problem and constrain the history of energetic feedback theorized to impart significant energy to the CGM and IGM. We analyze the Cosmology and Astrophysics in Machine Learning (CAMEL) Simulations, using three suites: IllustrisTNG, SIMBA, and Astrid, each varying 6 parameters (2 cosmological & 4 astrophysical feedback), for a total of 183 different simulation models. We find significantly different predictions between the fiducial models of the three suites, owing to their vastly different implementations of feedback. SIMBA exhibits the strongest feedback, leading to baryons becoming the most smoothed, reducing the sightline-to-sightline variance in FRB DMs between z=0-1. Astrid has the weakest feedback and the largest variance. We calculate FRB CGM measurements as a function of galaxy impact parameter, with SIMBA showing the weakest DMs due to aggressive AGN feedback, and Astrid the strongest. Within each suite, the largest differences are due to varying AGN feedback. IllustrisTNG shows the most sensitivity to supernova feedback, but this is due to the change in the AGN feedback strengths, demonstrating that black holes, not stars, are most capable of redistributing baryons in the IGM and CGM. We compare our statistics directly to recent observations, paving the way for the use of FRBs to constrain the physics of galaxy formation and evolution.

Presenter: MEDLOCK, Isabel

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

Constraining baryon feedback and cosmology with joint-probe analyses

Thursday, 11 April 2024 14:20 (25 minutes)

"Future weak lensing surveys aim to probe the matter distribution far into the non-linear regime. At these non-linear scales, weak lensing is sensitive to the effects of galaxy formation on the matter distribution, such as the redistribution of gas due to feedback from active galactic nuclei. In this talk, I will show how our models can be calibrated by including probes that are sensitive to the distribution of gas in joint-probe analyses, demonstrated on a joint analyses of cosmic shear and shear-tSZ cross-correlations between KiDS-1000 and Planck.
I will also touch on ongoing efforts within LSST DESC to build an assessment framework for models that mitigate baryon feedback."

Presenter: TROESTER, Tilman

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

A weak lensing perspective on baryons in the Universe

Friday, 12 April 2024 11:00 (20 minutes)

"In this talk, I present a weak lensing view of baryonic feedback effects.
Key to leveraging the power of weak lensing surveys is an accurate modelling of the matter power spectrum, including the baryonic content. I present a rigorous comparison of state-of-the-art modelling approaches to mitigate barons in cosmological analyses. I show new constraints on cosmological and astrophysical parameters from a joint analysis of the Dark Energy Survey cosmic shear and Atacama Cosmology Telescope kinetic Sunyaev Zel'dovich. Weak lensing surveys have consistently reported low values of the clustering amplitude (S_8) compared to that predicted by Planck primary Cosmic Microwave Background. Finally, I make the case that this tension could be due to modelling choices that underestimate the extent of baryonic feedback on the matter distribution."

Presenter: AMON, Alexandra

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

Evaluating baryonic effects in HSC Y3 cosmic shear data with a dark matter-only model

Friday, 12 April 2024 12:00 (20 minutes)

"Cosmic shear is a powerful tool for revealing matter distribution in the large-scale structure of the universe. Li et al. (2023) and Dalal et al. (2023) measured the tomographic cosmic shear correlation functions and power spectra, respectively, from the HSC-Y3 data, and then constrained the cosmological parameters from the model fitting. Although the small scale data has a high signal-to-noise ratio, accurately modeling matter distribution on these scales is still challenging due to possible contamination from baryonic physics. These baryonic effects have garnered attention as potential contributors to alleviating the S8 tension observed between weak-lensing cosmology and the cosmology inferred from Planck data. Consequently, there is a growing trend to model these baryonic effects based on hydrodynamical simulations and to account for the uncertainty by marginalizing over the associated baryonic physics parameters.
The problem is, however, that there are still uncertainties in the subgrid physics of baryonic effects employed in cosmological hydrodynamical simulations. As an alternative to pursuing an accurate or flexible baryonic physics model, our approach involves assessing the performance of a dark matter (DM)-only model prediction. Due to advancements in cosmological simulations, DM-only model predictions for the large-scale structure are considered an accurate theoretical model, next to the linear theory of structure formation. We measured the correlation functions at scales below the fiducial scale cuts, reaching the scales where large k-modes (k ~ 10 h/Mpc) significantly contribute. Using this data, we evaluate the goodness-of-fit of DM-only model predictions and find that this model can fit the cosmic shear correlation functions measured from the HSC-Y3 data, even at scales below the fiducial scale cuts. The inferred cosmological parameters, especially S8, are not significantly biased compared to those from Li et al. (2023), which marginalize over a baryonic physics parameter and apply scale cuts to discard the scales where baryonic physics could largely affect the signal. From these findings, we conclude that we do not find a clear signature of baryonic effects in the HSC-Y3 cosmic shear data, considering its associated uncertainties."

Presenter: TERASAWA, Ryo

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

X-ray - cosmic shear cross-correlations: first detection and constraints on baryonic effects

Thursday, 11 April 2024 16:05 (20 minutes)

We report a first detection, at very high significance (25σ), of the cross-correlation between cosmic shear and the diffuse X-ray background, using data from the Dark Energy Survey and the ROSAT satellite. The X-ray cross-correlation signal is sensitive to the distribution of the surrounding gas in dark matter haloes. This allows us to use our measurements to place constraints on key physical parameters that determine the impact of baryonic effects in the matter power spectrum. In particular, we determine the mass of haloes in which feedback has expelled half of their gas content on average to be $\log_{10}(M_c/M_\odot) = 13.643^{+0.081}_{-0.12}$, and the polytropic index of the gas to be $\Gamma = 1.231^{+0.015}_{-0.011}$. This represents a first step in the direct use of X-ray cross-correlations to obtain improved constraints on cosmology and the physics of the intergalactic gas.

Presenter: FERREIRA, Tassia

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

Constraining baryonification using inter and intra cluster measurements combined

Thursday, 11 April 2024 16:25 (20 minutes)

Baryonification is a strong candidate for modeling the baryonic feedback on matter power spectrum. The gold of this model is that it provides an inclusive picture of both the intra-cluster physics, namely the cluster component profiles, and the inter-cluster physics, namely the 2pt function statistics of cosmic shear. We plan to both test the validity of this picture and constrain the baryonification parameters one step further using DES Y3 cosmic shear 2pt data product and X-ray measurements on the electron density profile of the clusters. In this talk I will present the Fisher forecast on such combined likelihoods and show the improvement on the baryonic parameters constraints contributed by cluster measurements.

Presenter: CHEN, Angela

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

Cluster Cosmology from mm observations: impact of baryonic physics.

Thursday, 11 April 2024 16:45 (20 minutes)

"Galaxy clusters are the most massive gravitationally bound objects in the Universe. They are powerful cosmological probe, being able to constrain the matter distribution in the recent Universe.
In the cluster cosmological analysis, the measurement of cluster mass is a key ingredient. Nevertheless, cluster masses cannot be measured directly. We rely therefore on scaling relations, linking cluster masses to the survey observables, such as the galaxies inside the clusters, the pressure, temperature and luminosity profiles. The modelling of these relations rely therefore on the knowledge of baryons distribution in the dark matter gravitation well and of the astrophysical processes that might impact this distribution.
In this talk, I focus on clusters detected in the mm wavelength, using observations of the Planck satellite and combining them with detections from the South Pole Telescope.
Analysing results from cluster number counts and gas fraction, I will show the impact on the cosmological analysis of the mass estimation and of all the assumptions performed when describing the gas distribution inside galaxy clusters."

Presenter: SALVATI, Laura

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

FRB-Weak Lensing Cross Correlations

Thursday, 11 April 2024 17:05 (20 minutes)

Weak lensing convergence maps offer a line-of-sight probe of the matter power spectrum, but cosmological inference from the total matter auto-power spectrum is contaminated by baryonic effects which limit the use of small scales. Fast radio bursts (FRBs) offer a line-of-sight probe of baryons at z ~ 1 which offer a path towards independently measuring these baryonic effects at the field level. We propose to correlate weak lensing mass maps with dispersion measure maps produced by large samples of localized FRBs as a way to disentangle astrophysics from cosmology. We find that compared to the total matter power spectrum, the cross power is more sensitive to feedback by a factor of a few. With fiducial Euclid parameters, it should be detectable with a single year of observing FRBs with a next-generation instrument such as CHORD or the DSA- 2000; we can constrain feedback models with 5 years of operation. Finally, we propose a method of "nulling" the baryonic contribution to the matter auto-power spectrum. At l = 2000, the "nulled" power spectrum is several times less sensitive to feedback than the shear auto power spectrum alone.

Presenter: LEUNG, Calvin

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

Baryons reducing clustering: a movement of mass

Friday, 12 April 2024 09:00 (25 minutes)

Galaxy formation reduces the clustering of matter on scales k >~0.1 h/Mpc, primarily through AGN and supernova feedback. Several sophisticated models exist to model this effect as a function of cosmology, feedback strength and/or a number of free parameters. In this talk, I will demonstrate that we can understand the suppression of matter clustering to a very high degree as simply mass being removed from clustered regions, without considering halo profiles, and without free parameters. This also explains the strong correlation between power suppression and observed baryon fractions in large groups. The result is a model that directly links observables to the mass removed from different regions and a suppressed power spectrum signal to ~1% accuracy.

Presenter: VAN DAALEN, Marcel

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

Mapping Baryon Physics and Three-dimensional Lya Forest onto Dark Matter Fields

Friday, 12 April 2024 09:25 (20 minutes)

We have developed a new physically motivated supervised machine-learning method, HYDRO-BAM, to reproduce the 3-dimensional Lya forest field in real and redshift space, which learns from a reference hydro simulation including the effects of star formation and feedback. Our new method saves about seven orders of magnitude in computing time, and is accurate up to k ~ 1 h/Mpc in the one- to three-point (bispectra) statistics of the reconstructed fields. Our results show that an accurate analysis of the Lya forest requires considering the complex baryonic thermodynamical large-scale structure relations, i.e, the hierarchical non-linear non-local bias between dark matter overdensity, total gas density, neutral hydrogen, and gas temperature. We then implement the findings from the aforementioned studies into the augmented non-local Fluctuating Gunn-Peterson Approximation which outperforms previous analytical methods to predict the Lya forest at the field level. Our method paves the path to establish the best setup for the construction of mocks probing the IGM in the statistical analysis of large forthcoming missions such as DESI, Euclid, J-PAS, PFS, and WEAVE.

Presenter: NAGAMINE, Kentaro

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

Unified Appraoch to Hydrodynamical Marginalization using Generative Surrogate Models

Friday, 12 April 2024 09:45 (20 minutes)

Presenter: HOROWITZ, Benjamin

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

A field-level emulator for modeling baryonic effects across hydrodynamic simulations

Friday, 12 April 2024 10:05 (25 minutes)

We develop a new and simple method to model baryonic effects at the field level relevant for weak lensing analyses. We analyze thousands of state-of-the-art hydrodynamic simulations from the CAMELS project, each with different cosmology and strength of feedback, and we find that the cross-correlation coefficient between full hydrodynamic and N-body simulations is very close to 1 down to k=10h/Mpc. This suggests that modeling baryonic effects at the field level down to these scales only requires N-body simulations plus a correction to the mode's amplitude given by: (P_hydro(k)/P_nbody(k))^0.5. We build an emulator for this quantity, using Gaussian processes, that is flexible enough to reproduce results from thousands of hydrodynamic simulations that have different cosmologies, astrophysics, subgrid physics, volumes, resolutions, and at different redshifts. Our emulator is accurate at the percent level and exhibits a range of validation superior to previous studies. This method and our emulator enable field-level simulation-based inference analyses and accounting for baryonic effects in weak lensing analyses.

Presenter: DAI, Biwei

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

Constraining baryonic impact in cosmological analyses with baryonification

Thursday, 11 April 2024 15:40 (25 minutes)

I will present the baryonification as a method to accurately model baryonic processes in a cosmological context, and show how we can exploit multi-wavelength observations to constrain both cosmology and astrophysics.

Presenter: ARICÒ, Giovanni

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

Can baryonic effects alleviate the 8 tension in weak gravitational lensing surveys?

Friday, 12 April 2024 11:20 (20 minutes)

"Upcoming large-scale structure (LSS) surveys will measure the matter power spectrum to approximately percent level accuracy with the aim of searching for evidence for new physics beyond the standard model of cosmology. In order to avoid biasing our conclusions, the theoretical predictions need to be at least as accurate as the measurements for a given choice of cosmological parameters. However, recent theoretical work has shown that complex physical processes associated with galaxy formation (particularly energetic feedback processes associated with stars and especially supermassive black holes) can alter the predictions by many times larger than the required accuracy.

In this talk, I will introduce SP(k), an analytical model for the effects of baryon physics on the nonlinear matter power spectrum based on the ANTILLES large suite of hydrodynamical simulations. Using this model, I will show that the effects of baryons on the matter power spectrum can be understood at approaching the percent level in terms of the mean baryon fraction of haloes, at scales of up to < 10 h/Mpc and redshifts up to = 3.

Through the application of the SP(k) model, I will investigate the compatibility of baryon budget measurements, derived from the latest weak gravitational lensing and X-ray data, with recent findings. These include the cross-correlation between cosmic shear and the diffuse X-ray background from Ferreira et al. (2023), as well as the proposals by Amon & Efstathiou (2022) and Preston et al. (2023), suggesting more aggressive feedback beyond typical simulations to reconcile primary CMB (+BAO+CMB lensing) measurements with low-redshift LSS measurements."

Presenter: SALCIDO, Jaime

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

New methods to probe baryons with LSS and CMB on cosmological scales

Friday, 12 April 2024 11:40 (20 minutes)

Baryon fluctuations carry valuable cosmological and astrophysical information. On large scales, cross-correlations between matter and baryon (or electron) fluctuations probe initial conditions, interactions and dynamics during early Universe, such as primordial isocurvature, a smoking-gun signature of inflationary models. On scales corresponding to inter- and circum-galactic media, precise measurements of free electron abundance might give hints on the strength of baryonic feedback which push the gas away from the halo centers; improving our current understanding of galaxy formation, further elucidating the 'missing baryon' problem, for example, or on the influence of baryons on matter perturbations beyond halo scales, with implications for the so-called sigma8 tension. The small-scale baryon isocurvature can also be a probe of initial conditions. Furthermore, optical depth is a tracer of the reionization history. In particular, at redshifts 2<z<4 accessible to upcoming galaxy surveys, the mean ionization fraction probes the ionization of the second electron in helium. In this talk I will introduce multiple new methods to probe baryon fluctuations from upcoming galaxy and intensity mapping surveys alone (Hotinli and Holder; to appear) as well as new methods that utilize the LSS and CMB cross-correlations (e.g. Hotinli, Hotinli et al, Caliskan et al. 2023 and Kumar-Anil et al, upcoming). I will also showcase new work on probing helium reionization with CMB and LSS (Caliskan et al. 2023, Anil-Kumar et. al and Madden et. al., upcoming).

Presenter: HOTINLI, Selim

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

Interactions of galaxies and their gas reservoirs from local halos to the cosmic web

Friday, 12 April 2024 14:00 (25 minutes)

The interconnectedness among galaxies, their circumgalactic media (CGM), and the intergalactic medium (IGM) that permeates the cosmic web has come in ever sharper focus, as it is now clear that star formation and the enrichment of heavy elements critically depends on the exchange of matter and energy from one to the other. I will present results from the observational perspective highlighting these dependencies from galaxy to halo to cosmic web scales leveraging ultraviolet, optical, and 21 cm tracers of star formation and multi-phase gas reservoirs. On the largest scales, my team developed the Monte Carlo Physarum Machine (MCPM), inspired by the physarum polycephalum slime mold organism, to reconstruct the cosmic web from discrete galaxy tracers. We have combined these reconstructions with both QSO spectra and fast radio bursts to characterize how the ionized plasma of the IGM depends on large-scale structure environment. On halo scales, I will demonstrate how the star formation, cold gas in the ISM (from 21cm HI measurements), and CGM gas contents (from the UV) depend on the mass of the host group or cluster halo and the location of the galaxy within the halo. Finally, I will give a first look at results from the SDSS-V eROSITA clusters follow-up program that combines the widest and deepest X-ray perspective ever on the hotter phase that is ultimately responsible for quenching in the most massive halos, enabling us to study both quenching and cooler gas reservoirs on group and cluster scales over a large swath of cosmic time.

Presenter: BURCHETT, Joe

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

Baryonic cycle around galaxies revealed by JWST and ALMA at z=2–6

Friday, 12 April 2024 14:25 (20 minutes)

I will provide some new results of about the properties of the interstellar and circumgalactic of galaxies using JWST, ALMA, Keck/KCWI and VLT/MUSE at z=2-5. The properties include the metallicity (e.g., mass-metallicity relation, signature of solar-metallicity in very low-mass galaxies, new tracers such as SIII or so), kinematics (e.g., recycled inflow, IGM metal enrichment), and morphology (e.g., multi-spiral arms at z>3). We will also discuss the environmental dependence of these properties and further study the implications of these results by detailed comparisons with cosmological simulations. Note some results have been published using public JWST data.

Presenter: CAI, Zheng

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

The baryonic content and gas accretion rate of high-redshift galaxies

Wednesday, 10 April 2024 11:40 (20 minutes)

The weakness of the hyperfine HI 21cm line, the main tracer of the HI content of galaxies, has meant that we know little about the atomic gas content of high-redshift galaxies and its redshift evolution. In this talk, I will describe new HI 21cm studies of star-forming galaxies at z~0.7-1.5 that, via stacking their HI 21cm emission signals, have resulted in the first measurements of the average atomic gas mass of high-z galaxies and the dependence of the atomic gas mass on the stellar mass, the M_HI-M_star scaling relation. I will also describe the use of this scaling relation to determine the gas accretion rate and the total baryonic content of star-forming galaxies at these redshifts, and the evolution of these quantities over the last 9 billion years.

Presenter: KANEKAR, Nissim

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

Unveiling the formation of multi-phase cosmic gas and heavy elements with multi-tracer intensity mapping

Friday, 12 April 2024 15:35 (20 minutes)

Intensity mapping (IM) is a highly promising approach for the census of cosmic baryons out to Cosmic Dawn. Through low-resolution tomography of many unresolved sources, IM can efficiently map large cosmological volumes in aggregate line or continuum emission, thereby probing the physics of cosmic gas in different phases and environments traced by these emission signals. Understanding and accurately modeling the production mechanisms of IM signals from galactic/intergalactic hydrogen gas and heavy elements is crucial to fulfill the promise of IM in astrophysics and cosmology. I will discuss the recent progress in simulations of IM in the context of multi-tracer analysis, where a multitude of IM signals (e.g., lines like HI 21cm, CO, Ly-alpha, [CII], [OIII], and continuum like the cosmic infrared background) probing a wide range of baryonic processes are self-consistently simulated and jointly studied. In particular, I will focus on our efforts on using both parametric and generative AI approaches to combine the advantages of high-resolution cosmological zoom simulations and semi-numerical models, in order to efficiently and accurately simulate how IM signals trace cosmic baryons. Taking the star formation and metal enrichment histories of galaxies as examples, I will show the importance of augmenting semi-numerical models with sub-grid astrophysical prescriptions motivated by high-resolution simulations when predicting IM signals for precise astrophysical and cosmological inference. I will conclude with an outlook for building a fully Bayesian framework for modeling and analyzing data from multi-tracer IM and other probes.

Presenter: SUN, Guochao

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

AGN Feedback Effects on the Low Redshift Lyman-α Forest

Friday, 12 April 2024 15:55 (20 minutes)

The low redshift Lyman-α (Lyα) forest (z ⊠ 2) presents a challenge for both observers and theorists. Observationally, it is difficult to collect data due to the need for high resolution space-based FUV spectrographs. The observational data we do have for the forest (which lies largely below z=0.5) challenges predictions from cosmological hydrodynamic simulations. In order to resolve theory and observation in this context, a better understanding of the mechanisms that alter the thermal state of the intergalactic medium (IGM) is necessary. In particular, galactic feedback mechanisms are likely to play a role in resolving the theorized and observed low-z Lyα forest, especially that from active galactic nuclei (AGN), a feedback mechanism that is still largely unconstrained. Using the Cosmology and Astrophysics with Machine Learning Simulations (CAMELS) suite, we explore variations of the AGN and stellar feedback models in the IllustrisTNG and Simba sub-grid models. We find that both AGN and stellar feedback in Simba play a role in setting the Lyα forest column density distribution function, the Doppler width distribution, and the flux power spectrum. Simba's AGN jet feedback mode is able to efficiently transport both energy and gas out to the diffuse IGM to shape the Lyman-α forest statistics. We find that stellar feedback plays a prominent role in regulating supermassive black hole growth and feedback, highlighting the importance of constraining stellar and AGN feedback simultaneously. In IllustrisTNG, the AGN feedback variations explored in CAMELS do not affect the Lyα forest, but varying the stellar feedback model does produce subtle changes. Our results imply that the low-z Lyα forest can be sensitive to changes in the ultraviolet background, stellar and AGN feedback, and that AGN jet feedback in particular can have a strong effect on the thermal state of the IGM.

Presenter: TILLMAN, Megan

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

Modelling baryons for cosmological inferences

Thursday, 11 April 2024 14:45 (25 minutes)

Optimal exploitation of future cosmic probes will rely on a detailed understanding of the connection between dark and visible matter in the universe. In this talk I will discuss several physical approaches to model these connections. By combining with suites of gravity-only simulations, this framework delivers predictions for the observed properties of galaxies and gas as a function of cosmological parameters, which will enable high-precision cosmological inferences.

Presenter: ANGULO, Raul