2025 Joint ARGOS-TITAN-TOSCA workshop

Rapport sur les contributions

https://indico.in2p3.fr/e/36063

ID de Contribution: **1** Type: **Non spécifié**

Introduction

lundi 7 juillet 2025 10:00 (20 minutes)

Orateur: STARCK, Jean-Luc (CosmoStat, CEA Paris-Saclay)

ID de Contribution: **25** Type: **Non spécifié**

Learnlet for component separation of noisy data

mardi 8 juillet 2025 14:30 (25 minutes)

Orateur: Dr BONJEAN, Victor (FORTH)

Classification de Session: 21 cm data analysis

ID de Contribution: **26** Type: **Non spécifié**

Foreground cleaning strategies for HI 21 cm signal extraction

mardi 8 juillet 2025 14:55 (25 minutes)

Neutral hydrogen (HI) intensity mapping is a powerful probe of cosmological parameters, the epoch of reionization, and the dark ages. However, extracting the HI signal is challenging due to astrophysical foregrounds that are over four orders of magnitude stronger. This work evaluates various blind source separation and fitting methods for reconstructing the HI signal under different telescope beam conditions. When the beam's full-width at half-maximum (FWHM) oscillates with frequency, most methods perform poorly. However, SDecGMCA, a newly applied method for HI that simultaneously tackles blind source separation and beam deconvolution, outperforms all other methods by a significant margin. These results underscore the need for advanced methods like SDecGMCA, which jointly perform blind source separation and beam deconvolution, to effectively handle cases where the beam is more complex than a simple Gaussian degraded to the worst resolution.

Orateur: Dr GKOGKOU, Sia (FORTH)

Classification de Session: 21 cm data analysis

ID de Contribution: **27** Type: **Non spécifié**

Higher order statistics for HI intensity mapping

mardi 8 juillet 2025 15:20 (25 minutes)

Orateur: GORBATCHEV, Pauline

Classification de Session: 21 cm data analysis

ID de Contribution: **28** Type: **Non spécifié**

Deep Denoising and Signal Restoration for Astrophysical Spectral Cubes: From Simulations to Real Data

lundi 7 juillet 2025 15:20 (25 minutes)

Spectral cube data obtained from instruments such as ALMA are fundamental for understanding the structures and dynamics of astrophysical objects. However, noise, beam convolutions, and other artifacts can mask important astrophysical features. This is more evident in high-redshift observations as large cosmological distances, high levels of noise and lower resolution beams may hinder signal extraction for scientific analysis, This work compares and optimizes denoising algorithms for spectral cube data, including Principal Component Analysis, blind source separation methods like Independant Component Analysis, iterative 2D-1D wavelet transforms, and U-Net based deep learning. These are being benchmarked to establish the performance of the methods for the improvement of the signal-to-noise, flux conservation, and noise reduction while preserving spatial and spectral features on synthetic, simulated, and real data. Methods. We apply the denoising techniques to the toy spectral data of rotating galaxies, mock IFU cubes from FIRE simulations with spectral lines characteristic of ALMA, and ALMA observations of W2246-0526.

Orateur: LAHIRI, Arnab (FORTH)

ID de Contribution: **29** Type: **Non spécifié**

Plug-and-play weak lensing mass mapping with fast uncertainty quantification

lundi 7 juillet 2025 11:35 (25 minutes)

In this talk, I will present a plug-and-play (PnP) approach for estimating the dark matter distribution from weak gravitational lensing data, using noisy shear measurements. Our method is designed to provide accurate and efficient mass maps without the need to retrain deep learning models for each new galaxy survey or sky region. Instead, a single model is trained on simulated mass maps corrupted by Gaussian white noise. We show that a well-chosen data fidelity term accelerates convergence to the algorithm's fixed point. Additionally, we adapt a fast uncertainty quantification (UQ) method, based on order-2 moment networks, to the PnP framework. Unlike existing UQ approaches in this context, this method does not rely on posterior sampling, which is often computationally intensive. We benchmark our method against both model-driven and data-driven mass mapping techniques, and show that it achieves state-of-the-art reconstruction accuracy while producing smaller error bars, all with increased flexibility.

Orateur: LETERME, Hubert (ENSICAEN)

ID de Contribution: **30** Type: **Non spécifié**

Radio weak-lensing shear measurements using deep learning

lundi 7 juillet 2025 10:20 (25 minutes)

Orateur: TRIPATHI, Priyam

ID de Contribution: **31** Type: **Non spécifié**

Update

lundi 7 juillet 2025 15:45 (25 minutes)

Orateur: TSAGKATAKIS, Grigorios

ID de Contribution: **32** Type: **Non spécifié**

A Decentralized Framework for Radio-Interferometric Image Reconstruction

lundi 7 juillet 2025 11:10 (25 minutes)

A Decentralized Framework for Radio-Interferometric Image Reconstruction
Abstract The advent of large aperture arrays, such as the ones currently under construction for SKAO, allows for observing the Universe in the radio-spectrum at unprecedented resolution and sensitivity. To process the enormous amounts of data produced by these telescopes, scalable software pipelines are required. In this presentation, I will introduce a framework that allows for decentralized radio-interferometric image reconstruction, parallelizing by spatial frequency. This is achieved by creating pseudo full resolution problems for each node by using the local visibilities together with previous major cycle reconstructed images from the other nodes. I will show results when applying this proposed framework to both multiscale CLEAN and sparsity regularized convex reconstruction in the context of two partitions, for which it has shown to perform well. I will also show some additional preliminary results when scaling this method up to a larger number of partitions, discuss some of the current roadblocks, and also discuss some additional applications of separating the reconstruction by spatial frequency.

Orateur: WANG, Sunrise

ID de Contribution: **33** Type: **Non spécifié**

Generative model for shear inference

lundi 7 juillet 2025 10:45 (25 minutes)

Orateur: CENTOFANTI, Ezequiel

ID de Contribution: **34** Type: **Non spécifié**

Inertial Non-Convex Optimization Algorithms Meet Neural Network-Based Inverse Problems

mardi 8 juillet 2025 10:00 (30 minutes)

In this talk, I will focus on non-convex minimization problems via inertial second-order (in-time) dynamics and how they can prove valuable when solving inverse problems with neural network-based methods.
I will first discuss several theoretical and practical issues fo these algorithms, including convergence, convergence rates and trap avoidance properties.
I will then turn to discussing how to bridg the worlds of optimization and that of inverse problems to provide convergence and recovery guarantees for a class of neural network-based methods (DeepInvese).
I will also a precise characterization of the network architecture to benefit from these guarantees. This provides a first step towards the theoretical understanding of the interplay between the optimization dynamics and neural networks in the inverse problem setting.

Orateur: FADILI, Jalal (ENSICAEN)

ID de Contribution: **35** Type: **Non spécifié**

Detection of Fast Radio Bursts using hybrid neural architecture

mardi 8 juillet 2025 10:30 (30 minutes)

FRBs-millisecond-duration radio pulses from distant galaxies-offer unique insights but remain challenging to detect due to overwhelming radio frequency interference. Traditional detection methods and conventional machine learning techniques struggle with extreme class imbalance and data volume challenges. Our solution treats FRB detection as an open-set anomaly detection problem, leveraging a dual-headed neural network that combines the strengths of both generative and contrastive learning paradigms. In this talk, I will present an approach to detecting Fast Radio Bursts (FRBs) using a hybrid contrastive-generative neural architecture.

Orateur: EL BOUCH, Sara (OCA)

ID de Contribution: **36** Type: **Non spécifié**

Euclid mission

mardi 8 juillet 2025 12:00 (1 heure)

Orateur: PETTORINO, Valeria (ESA)

ID de Contribution: **37** Type: **Non spécifié**

UNIONS: First Cosmic Shear Constraints from 3000 deg² of Northern Sky

mardi 8 juillet 2025 11:00 (30 minutes)

The Ultraviolet Near-Infrared Optical Northern Survey (UNIONS) is a multi-band optical survey that will cover over 4800 deg² of northern sky. Combining data from three wide-field Hawaiian telescopes (CFHT, Pan-STARRS, and Subaru), UNIONS' sky coverage and excellent image quality makes it an ideal dataset for weak lensing studies, providing cosmological constraints that are both independent of and complementary to those from Southern Hemisphere like DES and KiDS. In this talk we will present the first cosmic shear constraints from a 3000 deg² non-tomographic catalog containing 100 million galaxies, with which we expect to obtain a 6% measurement on the structure growth parameter S_8. We will discuss calibration tests of the PSF, galaxy shapes, and the redshift distribution, as well as prospects for future tomographic analyses that will provide even tighter constraints and bridge the gap between Stage III surveys and Euclid.

Orateur: DALEY, Cail (CEA)

ID de Contribution: **38** Type: **Non spécifié**

Wavelet l1norm: A Theory-Driven Approach Beyond Two-Point Inference

lundi 7 juillet 2025 14:55 (25 minutes)

Weak gravitational lensing is a key cosmological probe of the large-scale matter distribution, yet conventional two-point statistics are insufficient to capture the non-Gaussian features imprinted by nonlinear structure formation. This thesis develops a novel framework based on the wavelet $\ell 1$-norm to extract higher-order information from weak lensing convergence maps. Leveraging predictions from Large-Deviation Theory, we construct an analytical model for the one-point PDF of wavelet coefficients and use it to generate non-Gaussian maps consistent with theoretical expectations, bypassing the need for N-body simulations. The method enforces consistency with the power spectrum and is designed to incorporate inter-scale correlations and observational systematics such as baryonic effects and intrinsic alignments. Ongoing work focuses on validating the theoretical predictions through comparisons with simulation-based constraints. This framework offers a theory-driven, flexible approach for extracting maximal cosmological information from current and future weak lensing surveys.

Orateur: TINNANERI SREEKANTH, Vilasini

ID de Contribution: **39** Type: **Non spécifié**

Discussion

lundi 7 juillet 2025 12:00 (1 heure)

ID de Contribution: **40** Type: **Non spécifié**

Discussions

lundi 7 juillet 2025 16:10 (50 minutes)

ID de Contribution: **41** Type: **Non spécifié**

Mass mapping and cosmological inference with higher-order statistics

lundi 7 juillet 2025 14:30 (25 minutes)

In this talk, I will present ongoing work toward improving cosmological inference from weak lensing through a synergy of forward modeling, simulation-based inference (SBI), and higher-order statistics. First, I will discuss the impact of mass mapping algorithms on the accuracy and robustness of cosmological parameter estimation. I will then introduce a framework that combines SBI with the BNT (backward normalizing transform) to directly infer cosmological parameters from noisy shear fields, allowing for flexible, likelihood-free inference while capturing non-Gaussian features, and show the impact of unmodelled baryonic effects on the inferred parameters. Finally, I will highlight the role of theory-informed higher-order statistics, specifically the wavelet l1-norm, and their validation against suites of cosmological simulations, on the level of cosmological contours. These tools together form a robust framework for extracting maximal cosmological information from current and next-generation weak lensing surveys, including Euclid and UNIONS.

Orateur: TERSENOV, Andreas