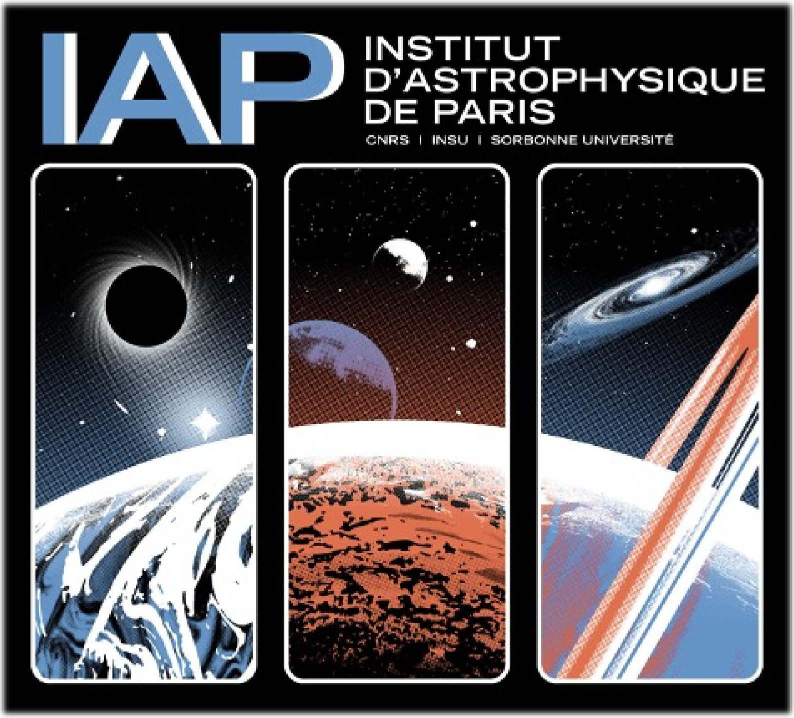
PhD day



Friday, 23 May 2025, 9:00 - 17:45

Sorbonne Université (Jussieu)

Amphitheater Durand

Esclangon building

Organizers: Clément Prévotat, Étienne Ligout, Albert Bonnefous & Emeric Seraille.

Program

9:00	*Introduction*	
9:10	Anwar El Rhirhayi	From particles to galaxies: fluctuations, collisions and large deviations
9:25	Iryna Chemerynska	JWST's GLIMPSE at the extremely faint galaxies at z=9-15
9:40	Etienne Ligout	Stability of circular orbits of compact binaries at fourth post-Newtonian order
9:55	Eunhee Ko	Dynamical Heating by Superbubbles and the Cusp-Core Transformation
10:10	Emilie Pernet	Next-generation spectral models for high-redshift galaxies observed with JWST
10:25	Nathan Belrhali	Mapping inflationary fields with plane waves
10:40	*Coffee break*	
11:00	Mouad Gnaoui	Modelling the prompt emission of gamma-ray bursts in the SVOM era
11:15	Aline Vitrier	Towards constraining cosmological parameters from SPT-3G observations of 25% of the sky
11:30	Albert Bonnefous	The cosmic matter dipole discrepancy
11:45	Emma Bruyère	Gravitational waves beyond geometric optics
12:00	Mathieu Venet	The influence of key stellar evolution parameters on binary neutrons stars
12:15	Sofia Flores Morales	Stellar Dynamics and Closure Theory
12:30	*Lunch buffet*	
14:00	Alice Maurel	Study of TRAPPIST-1 b and c from JWST emission observations
14:15	Nimatou Diallo	Feedback in galaxies: the role of cosmic rays
14:30	Emeric Seraille	Dipolar dark matter theory reproducing the MOND phenomenology based on a Yang-Mills graviphoton
14:45	Romane Cologni	Mapping molecular gas in Super Spiral Galaxies
15:00	Angèle Syty	Characterization of detector performance for the Ariel mission using classical and machine learning methods
15:15	Tristan Hoellinger	Lightening black-box models in field-based, implicit-likelihood inference
15:25	Theo Vrignaud	Characterisation of exocomets in UV spectroscopy: results from the Beta Pic system
15:40	*Coffee break*	
16:05	Arthur Poisson	A look through the dark ages of cosmological inflation via the scalar-induced Gravitational wave background
16:20	Rosa Malandrino	A catalog of high significance cosmic voids in the Local Universe
16:35	Clément Prévotat	Probing the transition between Galactic and Extragalactic cosmic rays with a multi-messenger approach
16:50	Kratika Mazde	Biverse, Bohm, and Bounces
17:05	Mayeul Aubin	sCOLA: towards fully parallel, fast and reliable cosmological N-body simulations for Bayesian inference
17:20	Florian Destriez	A new population of giant planets around M dwarfs with Gaia

From particles to galaxies: fluctuations, collisions and large deviations

The long-term evolution of galaxies and stellar systems relies on collective interactions that, although tiny at the individual scale, produce significant macroscopic effects. In this presentation, we will begin by introducing the Landau equation, describing the average evolution of the velocity distribution under the effect of grazing and frequent collisions. To make this dynamic more tangible, we will illustrate it through a stochastic formulation inspired by Langevin, allowing for the direct simulation of collective noise. Finally, we will address the issue of atypical fluctuations via the principle of large deviations, which allows quantifying the occurrence of rare and potentially structuring events in the evolution of galactic systems.

Supervisor: Jean-Baptiste Fouvry

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JWST's GLIMPSE at the extremely faint galaxies at $z = 9 - 15$

In this talk, I will present our latest findings from the JWST Cycle 2 GLIMPSE program, a deep NIRCam imaging campaign targeting the lensing cluster AS1063. These observations have revealed 72 galaxy candidates at $9 < z < 15$ with absolute magnitudes ranging from $M_{UV} = -18$ to -13 mag, which is about three magnitudes fainter, on average, than those in prior JWST studies. Using comprehensive lensing simulations, we derived the UV luminosity function at $z > 9$, finding a slow evolution of the faint-end slope. I will also present results on the cosmic star formation rate (SFR) density, which we find to be significantly shallower than predictions from most theoretical models. By integrating SFRD down to $M_{UV} = -13$, we also determined that galaxies fainter than $M_{UV} = -16$ contribute more than 50% of the total cosmic SFR density at redshift 12. During the talk, I will discuss which physical mechanisms could drive the observed excess in SFRD at high redshifts.

Supervisor: Hakim Atek

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Stability of circular orbits of compact binaries at fourth post-Newtonian order

In the Newtonian theory of gravity, all circular orbits remain stable under a small perturbation. This is not so in general relativity, where there is an Innermost Stable Circular Orbit (ISCO). However, in the case of the two-body problem, and crucially for a compact binary system, the location of the ISCO can not be determined exactly. A popular approach to circumvent this issue is to resort to the post-Newtonian (PN) expansion. Iterating on the PN order thus provides us with an approximate expression for the ISCO.
In the literature, the ISCO has been determined up to the 3PN order. In the work I present here, we (with Luc Blanchet and David Langlois) have been able to extend this analysis to the next, 4PN order. The main challenge of this order is the appearance of non-local in time interactions: the state of the binary system depends on the entire history of the two bodies, not just on the present state.

Supervisors: Luc Blanchet & David Langlois

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Dynamical Heating by Superbubbles and the Cusp-Core Transformation

Recent JWST observations have revealed superbubbles (SBs) cavity-shell structures distributed across the galactic disk—formed by successive supernova explosions. The potential fluctuations generated by SBs can dynamically heat galactic systems. Using the orbit-averaged Fokker-Planck equation, we investigate the role of SB-driven stochastic heating in the context of cusp-core transformation. This formalism describes the cumulative impact of weak, local encounters induced by stochastic noise sources. By modeling the expansion and collapse of SBs, along with their inhomogeneous spatial distribution, we derive diffusion coefficients linked to the power spectrum of SB-induced fluctuations. Furthermore, we find simple analytic scaling relations that provide an intuitive understanding of how diffusion efficiency depends on noise source and system parameters.

Supervisor: Christophe Pichon

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Next-generation spectral models for high-redshift galaxies observed with JWST

Significant progress has been made in spectral modelling of young, star-forming galaxies, driven by the advent of high-redshift observations with the James Webb Space Telescope (JWST). A novel approach combining the GALSEVN stellar population synthesis code with the CLOUDY photoionization code offers a promising framework to account for binary-star evolution in galaxy spectral models. While early results suggested improved interpretations of stellar and nebular emission in metal-poor galaxies, these gains remain to be fully validated. Meanwhile, JWST has revealed interstellar spectral features at high redshift, which differ markedly from those in lower-redshift galaxies, posing new challenges for existing models. To address these, we are constructing a comprehensive grid of spectral models spanning a broader parameter space than previously explored. Key parameters include stellar and gas metallicities, hydrogen density, C/O and N/O abundance ratios, ionization parameter, dust-to-metal ratio, and the fraction of binary stars. This next-generation model grid will enable more flexible and robust analyses of the stellar and interstellar properties of primordial galaxies, offering new insights into the conditions of the reionization era.

Supervisor: Stephane Charlot

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Mapping inflationary fields with plane waves

Inflation is an accelerated expansion era introduced at the beginning of universe timeline to address causality problems of the FLRW model. It can be realized with a scalar field theory minimally coupled to gravity. This scalar field has a background classical part that drives the accelerated expansion, and quantum fluctuations that, stretched by this expansion, give rise to large scale structures. These fluctuations can be mathematically described as quantum massive fields that propagate in a curved time-dependent space-time. This complicated time-dependent propagation can be decomposed over plane waves by an integral transformation, introducing a convenient dual space for expressing physical quantities in inflation.

Supervisor: Sébastien Renaux-Petel

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Modelling the prompt emission of gamma-ray bursts in the SVOM era

There is ongoing debate about the physical mechanisms driving the prompt emission in Gamma-Ray Bursts (GRBs). In the leading scenario, electrons are accelerated by shocks within an ultra-relativistic outflow, emitting synchrotron radiation that is blue-shifted into the soft gamma-ray range. The predictions from the simplest version of this model is in tension with observations. Upcoming multi-wavelength data from missions such as SVOM and the Einstein Probe offer a new opportunity to deepen our understanding of these processes and refine theoretical models. In this context, I will present my work on the role of lepton pair production and annihilation in the emission region, and how these processes may impact the emerging spectrum. In particular, I explore their relevance to the spectral feature observed at a few tens of MeV in GRB 221009A, the most luminous GRB ever detected.

Supervisor: Frédéric Daigne

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Towards constraining cosmological parameters from SPT-3G observations of 25 % of the sky

Ground based telescopes designed to observe the cosmic microwave background (CMB) aim to improve our knowledge of the universe composition and evolution. Information from the E and B modes of polarization and from the temperature at small angular scales will be crucial to address contemporary tensions of cosmology. The South Pole Telescope (SPT) observes the CMB with its 10m primary mirror from the South Pole and its third generation camera SPT-3G started collecting data in 2018. The Wide field is one of the three regions observed by SPT-3G and extends the survey area to cover 25% of the sky in total. This field is divided in nine subfields spread in the south hemisphere around the galactic plane with a declination ranging from -20deg to -80deg. These features represent new challenges to be taken into account in the analysis. In this talk, I will discuss the analysis strategy of this field. I will show the tests we performed to ensure that the loss of information due to analyzing the subfields independently is negligible on cosmological parameters. I will also present how the Wide field complements the two other fields observed by SPT and how it allows to test models beyond LCDM, namely those proposed to solve the Hubble tension.

Supervisors: Silvia Galli & Karim Benabed

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The cosmic matter dipole discrepancy

In 1984 was proposed [1] a new method to measure our relative velocity to far away sources, which assuming cosmological principle should agree with the measure of our velocity with respect to the CMB. At this time, there was no catalogue of cosmological objects big enough to measure this accurately, but recent surveys [2] have pointed at a non negligible discrepency between these two measures. This cosmic matter dipole problem has potentially huge implication in cosmology and could put into question the assumption of isotropy in the cosmological principle. However, before making such ambitious assumption, many other systematics effects not taken into account could potentially explain this phenomena. In the begining of my PhD, I worked on the effect of weak lensing on the number count of cosmological sources to see if it could participate in explaining this discrepancy.

[1] Ellis and Baldwin, 1984
[2] Secrest et al. 2022

Supervisor: Roya Mohayaee

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Gravitational waves beyond geometric optics

We are studying the effects of a black hole on the path of a gravitational wave. We usually study the propagation of a gravitational waves in two different regimes. In the geometric optics limit or in the wave optics limit. In our case, we want to study an in-between regime where the wavelength is large with respect to the Schwarzschild radius but small with respect to the impact parameter. Our approach will be similar to the geometric optics one but with some correction terms in the wave form.
For a simpler approach, we are first studying the case of a scalar field and we will then incorporate the tensor structure to our work. We considered the case of a Schwarzschild black hole and will use the Newmann-Penrose formalism to derive the equations.

Supervisor: Cyril Pitrou

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The influence of key stellar evolution parameters on binary neutrons stars

Binary neutron stars (BNS) are rare and compact systems composed of two neutron stars. Through their evolution and eventual merger, they play a crucial role in our understanding of high-energy astrophysical phenomena, including short gamma-ray bursts and the following synthesis of heavy elements via the r-process.

However, the scarcity of observational data limits our ability to obtain statistically significant samples of both galactic and extra-galactic BNS populations, which are essential to constrain their formation channels as well as their merger rates. Population synthesis codes serve as powerful tools to bridge this gap. They model the evolutionary properties of BNS populations and enable comparisons with a wide range of observational datasets, offering valuable insights into the underlying astrophysical processes.

In this talk, I will explore how key stellar parameters influence the dominant formation channels of binary neutron stars (BNS), and how population synthesis codes can be used to investigate this vast parameter space.

Supervisor: Irina Dvorkin

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Stellar Dynamics and Closure Theory

Stars orbiting a supermassive black hole in the center of galaxies undergo very efficient diffusion in their orbital orientations: this is "Vector Resonant Relaxation." Such a dynamics is intrinsically nonlinear, stochastic, and correlated, hence bearing deep similarities with turbulence in fluid mechanics or plasma physics. In this talk, I will show how generic methods stemming from statistical closure theory, namely, the "Martin-Siggia-Rose formalism", can be used to characterize the correlations describing the redistribution of orbital orientations. In particular, I will explicitly compare the associated prediction for the two-point and three-point correlation functions with measures from numerical simulations.

Supervisor: Jean-Baptiste Fouvry

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Study of TRAPPIST-1 b and c from JWST emission observa- tions

The TRAPPIST-1 system, with its seven rocky transiting planets around a M-dwarf, is a choice target for terrestrial planets characterization. Thus, each planet of the system has been observed by JWST during the first cycles. However, the stellar surface inhomogeneities create features in transit spectra difficult to disentangle from potential planetary atmospheric features, and transmission has not permitted to detect an atmosphere yet. Observations of the secondary eclipse allow to avoid this problem. Here we present the emission observations of the TRAPPIST-1 inner planets, and their interpretation using 1-D and 3-D atmospheric simulations.

Supervisors: Jean-Philippe Beaulieu, Pierre Drossart & Martin Turbet

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Feedback in galaxies: the role of cosmic rays

Cosmic rays are high-energy particles that interact with galactic plasma through magnetic fields. They represent a significant energy component in galaxies, and simulations have shown that they can profoundly influence galactic dynamics, making them a key feedback mechanism.
However, this impact is strongly dependent on how cosmic rays propagate—an aspect that remains poorly constrained. To improve the connection between theoretical models and observations, it is essential to model their energy distribution with greater accuracy.
To this end, we have developed a new cosmic ray module, now integrated into the RAMSES simulation code, which incorporates their full spectral energy distribution. In this presentation, I will outline the numerical framework of this implementation and share test results illustrating cosmic ray evolution across various physical processes.

Supervisor: Yohan Dubois

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Dipolar dark matter theory reproducing the MOND phenomenology based on a Yang-Mills graviphoton

Despite the great success and relative simplicity of the standard ΛCDM model, certain phenomena remain unexplained, such as the striking correlation between galaxy rotation curves and the observed baryon density. This is the original motivation for the development of MOND. However, most theories attempting to reproduce MOND have to rely on ad hoc free functions, preventing them from being considered fundamental.
In this presentation I will introduce a new theory that reproduces MOND phenomenology, built on a fundamental Yang-Mills gauge field based on SU(2), with a gravitational coupling constant that emerges in a low-acceleration regime, below the MOND acceleration scale, in an effective theory approach. Using a mechanism of gravitational polarization within the dark matter medium, I will discuss how certain solutions of this theory naturally recover the deep MOND regime without introducing arbitrary functions in the action. Within this new framework, we can connect the observed MOND effect to the existence of a new sector of particle physics, which fundamentally involves a violation of local Lorentz invariance.

Supervisors: Cédric Deffayet & Luc Blanchet

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Mapping molecular gas in Super Spiral Galaxies

The population of galaxies in the high-mass range ($M > 10^{11}$ M_{sun}) is almost entirely represented by quenched early-type galaxies. Except for 6% of the most luminous galaxies observed by Ogle et al. (2016, 2019) at redshift $z < 0.3$, that are indeed massive super spiral galaxies (SSG). These objets are of great interest because they question our knowledge on galaxy evolution and challenge mass-quenching scenarios. They have preserved their rotation-supported disc shape as well as a standard to high star formation rate (SFR) throughout their growth process, although we know growth can severely affect both these aspects ; either by disrupting the gas and stellar dynamics (mergers, collisions) or by depriving the galaxy of its gas content (RAM pressure stripping, tidal effects, AGN feedback). As such, SSGs constitute a relevant population to study failed quenching in galaxies. Learning more about their star forming gas content is necessary to better understand star formation in such objects. In this contribution, I will present preliminary results from molecular gas observations (NOEMA/IRAM) of a small sample of SSGs at redshift$z$ $[0.01; 0.25]$, which allows us to map the distribution of their cold gas reservoir and for one of them, measure the resolved star formation efficiency.

Supervisor: Damien Le Borgne

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Characterization of detector performance for the Ariel mission using classical and machine learning methods

Ariel is a European Space Agency (ESA) mission that aims to study the atmospheres of a large and diverse sample of transiting exoplanets (Tinetti et al. 2021). Scheduled for launch in 2029 to the L2 Lagrange point. Ariel will observe exoplanets in visible and near-infrared wavelengths (0.5–7.8 µm) via low-resolution spectroscopy. Ariel will use various spectroscopic techniques, including transmission and emission spectroscopy during transits and eclipses, as well as phase curve observations. This will enable detailed studies of atmospheric composition, clouds, hazes, and thermal structure. To achieve its science objectives, the Ariel consortium must ensure that the noise budget is resilient to various sources of systematics, including those from the detector, the instrument, or the science scene itself.
In this contribution, the work will be presented as a part of the Ariel Simulators Software, Management and Documentation (S2MD) Working Group, on studying the combined effect of different sets of systematics. This work is based on the use of the ExoSim2.0 simulator (Mugnai et al, 2025) to produce simulated Ariel observations. Artificial intelligence methods are used to analyze calibration data acquired in the laboratory prior to satellite launch, particularly to characterize non-nominal pixels. This work confirms the resilience of the Ariel instrument design against the set of systematics investigated here.

Supervisors: Jean-Philippe Beaulieu, Orphée Faucoz & Pierre Drossart

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Lightening black-box models in field-based, implicit-likelihood inference

Stage-IV galaxy surveys have the potential to profoundly deepen our understanding of the Universe.This potential hinges on our ability to rigorously address systematic uncertainties—which, until now, was beyond reach in field-based, implicit likelihood cosmological inference. In this talk, I present the first general framework for diagnosing systematic effects in galaxy surveys prior to inferring cosmological parameters.
Our approach proceeds in two steps. First, we infer the initial matter power spectrum after recombination using SELFI (Simulator Expansion for Likelihood-Free Inference), and use it to conduct a thorough, simulation-based analysis of how systematics distort its reconstruction. This investigation relies on a single suite of N-body simulations, regardless of how many systematics are considered. Second, we perform implicit likelihood inference of cosmological parameters using a forward model of large-scale spectroscopic galaxy surveys that includes non-linear gravitational evolution (via N-body) and a range of observational systematic effects. We show how the SELFI posterior can be used to assess the impact of misspecified linear galaxy bias, selection functions, survey masks, and redshift errors on the recovered initial power spectrum. We further demonstrate that subtly flawed models can shift constraints in the the (Ω_m, σ_8) plane by more than 2σ—biases our framework can now expose and avoid. This marks a critical step towards robust cosmological inference from full forward models of galaxy surveys such as DESI, Euclid, and LSST.

Supervisors: Florent Leclercq & Guilhem Lavaux

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Characterisation of exocomets in UV spectroscopy: results from the Beta Pic system

Beta Pictoris is a young (20 Myr), nearby ($V = 3.86$) A5V star hosting one of the most iconic exoplanetary systems known to date. Its system includes an extended debris disc, two massive planets (β Pic b and c), and an exceptionally high number of exocomets, detected in spectroscopy as they transit the star. All of this, combined with its proximity, makes Beta Pic a unique laboratory for studying the final stages of planetary formation.
In this talk, I will present recent advances in our understanding of the exocomets, obtained using observations from the Hubble Space Telescope – including an on-going program in 2025. Central to this is a new method – the exocomet curve of growth; Vrignaud et al. (2024a, b, 2025) – which enables in-depth analysis of single exocomets based on their absorption signatures in UV spectral lines. For the first time, accurate constraints on the geometry of the cometary tails, on their location in the Beta Pic system, on their excitation and ionisation state, and, most importantly, on their composition, were obtained. These results provide crucial insights into the formation mechanisms of exocomets and their ability to deliver volatiles into the inner regions of planetary systems.

Supervisor: Alain Lecavelier des Étangs

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A look through the dark ages of cosmological inflation via the scalar-induced Gravitational wave background

In cosmology, the structures we observe upon the homogeneous and isotropic background are known to originate from the primordial density fluctuations produced by inflation. The current observations from the Cosmic Microwave Background (CMB) and the Large-Scale Structures (LSS) both point toward a scale-invariant spectrum for them, which corresponds to a de Sitter-like expansion. However, I will show in this talk that this only probes the early stages of the cosmological inflation and that most of the process is actually fully unconstrained. To get access to it, one must look at another kind of primordial perturbation: the gravitational waves (GW). In this talk, I will present a class of mechanisms where the inflationary dynamics undergo a very short deviation from the dS geometry, putting the quantum state of the curvature perturbation in an excited state. This will lead to a very distinctive pattern in the GW power spectrum that could be detected by LISA, offering a promising way to observe the dark ages of inflation.

Supervisor: Sébastien Renaux-Petel

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A catalog of high significance cosmic voids in the Local Universe

Cosmic voids are the largest objects emerging in the cosmic web, covering the majority of the volume of the Universe. They are a well-established probe to gather cosmological information from the large-scale structure, as well as interesting regions to study how the underdense environment affects the behavior of astrophysical objects. Unfortunately, identifying voids in a galaxy catalog is challenging for multiple reasons: observational effects such as holes in the mask or magnitude selection hinder the detection process; galaxies are biased tracers of the underlying dark matter distribution; and it is non-trivial to estimate the detection significance and parameter uncertainties for individual voids.
We use a set of constrained simulations of the large-scale structure that are consistent with the observed galaxy positions, effectively representing statistically independent realizations of the probability distribution of the cosmic web. We run the VIDE void finding algorithm on each individual simulation, and compare the detected voids to identify regions that are voids with high statistical significance. As this framework is fully Bayesian, we evaluate the probability distributions of the centers and radii of the voids. Finally, we characterize the actual shape of these regions, resulting in a template for density environments that can be used in astrophysical applications, e.g. studying the evolution of galaxies. We plan to make the resulting catalog of high-significance voids and their properties publicly available.

Supervisors: Benjamin Wandelt & Guilhem Lavaux

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Probing the transition between Galactic and Extragalactic cosmic rays with a multi-messenger approach

Since their discovery in 1912, significant efforts have been devoted to uncovering the origin of cosmic rays (CR). It is now accepted that most detected CR with energies below $\sim 10^{15}$ eV originate within our Galaxy, while those exceeding $\sim 10^{18}$ eV are of extragalactic origin. However, the source of CR in the intermediate energy range remains an open question.
New experiments have opened observational windows in PeV energies, both in neutrinos (GVD and KM3NeT) and gamma rays (LHAASO), complementing CR measurements in this energy range and offering new insights in the origin of CR. In this work we explore the transition between Galactic and extragalactic CR using a multi-messenger approach. Using the CRPropa code, we model the distribution of extragalactic CR in the Milky Way and compute the spectra of gamma rays and neutrinos produced during their propagation. This study is part of the science case of GRAND, a next generation observatory of ultra-high-energy neutrinos, cosmic rays, and gamma rays ; the current prototype (GP300) will be fully operational in 2026 and will study the CR flux in this transition region.

Supervisors: Rafael Alves Batista & Kumiko Kotera

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Biverse, Bohm, and Bounces

General Relativity predicts its own breakdown at the most extreme scales, and thus arises the need for a more fundamental theory. In the pursuit of such a theory, we turn to quantum cosmology. We explore an approach based on affine quantization of a flat Friedmann–Lemaître–Robertson–Walker spacetime coupled to a perfect fluid, which serves as an internal clock. Within the framework of the minisuperspace model, we derive non-singular bouncing solutions using the trajectory approach. We examine the case in which the quantum state of the universe is given by a superposition; specifically we focus on the case of a biverse. Our results demonstrate that the quantization of the cosmological background can yield distinct observable consequences, underscoring the need for a quantum theory of gravity.

Supervisor: Patrick Peter

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sCOLA: towards fully parallel, fast and reliable cosmological N-body simulations for Bayesian inference

Current and future observatories of the cosmic web, such as Euclid or DESI, will deliver tremendous amount of data, mapping bilions of galaxies throughout the whole observable universe. In order to fully harness the information acquired, we need fast and reliable simulators of the formation of large-scale structures that go beyond the linear scales into the non-linear regime. The sCOLA approach aims to provide a framework to tile properly the observable universe volume into sub-boxes that can be simulated independently, offering complete parallelism while remaining sufficiently accurate for precise cosmological parameters inference. In this talk, I will introduce this sCOLA paradigm and present my work on its improvements.

Supervisors: Florent Leclercq & Guilhem Lavaux

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A new population of giant planets around M dwarfs with Gaia

M-type stars, the most common in the universe, are a major focus for surveys because they are well-suited for detecting low-mass planets in the habitable zone. Despite their importance in the formation and evolution of low-mass planets, little is known about giant planets (GPs) in M star systems. Detecting long period GPs (with semi-major axis typically greater than 1 au) is difficult with transit methods and challenging with radial velocities (RV) due to the faintness and relatively high activity level of M stars. This significant limitation can be effectively addressed by combining RV and high-contrast imaging (HCI) with Gaia-Hipparcos absolute astrometry. In this context, I used the GaiaPMEX tool presented in Kiefer et al. (2024) to detect GPs around all M stars closer than 15 pc with Gaia Data Release 3 data. GaiaPMEX uses astrometric data from Gaia and Hipparcos data when available to build a two-dimension confidence map to constrain the mass and the semi-major axis of the companion. When combining these maps with RV and HCI detection limits, we can rule out binary companions, as well as identifying and characterizing planetary companions. I built a catalog of M dwarfs within 15 pc and using GaiaPMEX, I performed a systematic search for GPs to produce a list of hundreds of planetary candidates. I will present the results of this survey which allows the study of a new population of long period GPs and in particular, to derive the radial distribution of GPs around M dwarfs beyond 1au.

Supervisors: Anne-Marie Lagrange, Guillaume Hébrard & Flavien Kiefer

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