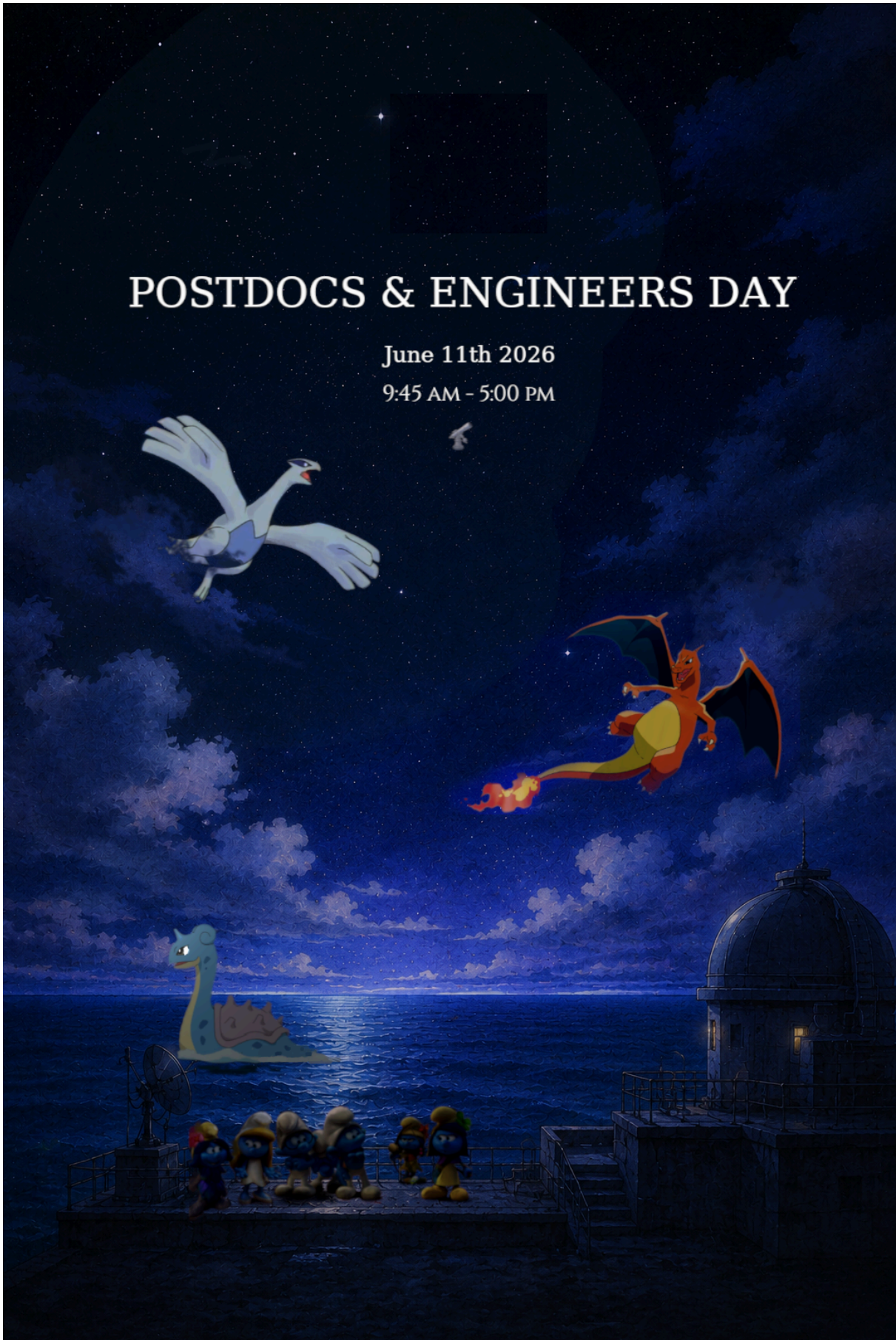


P&E day

POSTDOCS & ENGINEERS DAY

June 11th 2026

9:45 AM - 5:00 PM



Program

- **09:45–10:30** — Opening word by K. Kotera & introduction fire-slides
- **10:30–10:45** — Unveiling faint galaxies at the Epoch of Reionization and beyond: insights from JWST observations and SPHINX simulations (Marcie Mun)
- **10:45–11:00** — Identifying Lyman-Continuum leakers across cosmic time (Meriam Ezzati)
- **11:00–11:30** — **Coffee break**
- **11:30–11:45** — NewCluster: a high-resolution zoom-in simulation of a galaxy cluster (San Han)
- **11:45–12:00** — Tracing enrichment from Binary Neutron Star Mergers in RAMSES Simulations (Arturo Núñez-Castiñeyra)
- **12:00–12:15** — Exploring the afterlife of radio galaxies with numerical simulations (Georgia Stewart)
- **12:15–12:30** — Studying planet formation and demographics with Roman and Euclid (Efstathia Natalia Reksini)
- **12:30–14:00** — **Lunch**
- **14:00–14:15** — Bouncing cosmologies from quantum gravity (Lisa Mickel)
- **14:15–14:30** — Tensions in Cosmology (Ali Rida Khalife)
- **14:30–14:45** — Through a dark crystal: CMB polarization as a tool to constrain the optical properties of the Universe (Margherita Lembo)
- **14:45–15:00** — On the diverse origins of star formation quenching and gas stripping of galaxies in groups (Jinsu Rhee)
- **15:00–15:15** — Hydrodynamical Simulations for the Effective Field Theory of Dark Energy (Wangzheng Zhang)
- **15:15–15:30** — Tracing Galaxy Group Evolution with COSMOS-Web SFHs (Rafael C. Arango Toro)
- **15:30–16:00** — **Coffee break**
- **16:00–16:15** — Effect of Half-Wave Plate (HWP) Non-Idealities in CMB Polarisation Leakage (Miguel Gomes)

- **16:15–16:30** — From Quasar Spectra to Cosmic Maps: Cosmology with the Lyman-Alpha Forest (Hiram K. Herrera-Alcantar)
- **16:30–16:45** — From parallelization on CPU to parallelisation on GPU: Use Kokkos in cosmological numerical simulations (Guillaume Tcherniatinsky)
- **16:45–16:55** — Concluding remarks

Talk details

Opening word & introduction fire-slides

- **Speaker:** K. Kotera
- **Time:** 09:45–10:30

Unveiling faint galaxies at the Epoch of Reionization and beyond: insights from JWST observations and SPHINX simulations

- **Speaker:** Marcie Mun
- **Time:** 10:30–10:45
- **Abstract:** Cosmic reionization was likely driven by a population of faint, low-mass galaxies that have been poorly constrained observationally. JWST surveys exploiting strong gravitational lensing from galaxy clusters - such as UNCOVER, GLIMPSE, and VENUS - are now revealing this population in unprecedented detail. In addition, these lensed observations provide a robust dataset to validate theoretical predictions from cosmological simulations (e.g., SPHINX, MEGATRON) specifically designed to model high-redshift galaxy formation. In this talk, I will share some recent results on constraining one of the key galaxy scaling relations, i.e., the star-forming main sequence, at the Epoch of Reionization with JWST observations and SPHINX simulations down to low stellar masses. In addition, I will discuss the importance of paired analysis of real and mock observations from simulations, showing some early results of matching observed and simulated galaxies in redshift and broad-band photometry.

Identifying Lyman-Continuum leakers across cosmic time

- **Speaker:** Meriam Ezzati
- **Time:** 10:45–11:00

- **Abstract:** In order to understand the contribution of galaxies to cosmic reionization, estimating the Lyman-continuum (LyC) photon escape fraction is fundamental. Since direct detections in high-redshift galaxies are impossible, we generally rely on low-redshift analogues to calibrate and predict LyC escape from indirect indicators and extend these relations to high redshift. However, traditional single-parameter indicators such as O32, EW([OIII]), or the UV slope often exhibit significant scatter and lack universality across varying physical conditions. In this talk, I will present an analysis combining high-redshift hydrodynamic simulations (SPHINX20) with multi-epoch observational samples to evaluate the reliability of common LyC diagnostics. Using correlation and information-theory-based analyses, we identify a robust set of non-redundant observables and show that their joint application significantly outperforms any individual indicator. By grounding indicator selection in simulations and cross-validating with observations, this work provides a physically motivated framework for identifying the galaxies that contributed to cosmic reionization.

NewCluster: a high-resolution zoom-in simulation of a galaxy cluster

- **Speaker:** San Han
- **Time:** 11:30–11:45
- **Abstract:** We will introduce NewCluster, a novel high-resolution zoom-in cosmological simulation designed to reproduce a galaxy cluster and its surrounding environment within a modern galaxy evolution framework. The simulation targets a volume encompassing 4.1σ overdensity region that is expected to evolve into a galaxy cluster with a virial mass comparable to that of the Virgo Cluster ($5 \times 10^{14} M_{\odot}$). The simulation has a good stellar mass resolution of $2 \times 10^4 M_{\odot}$, and the best spatial resolution of 68 pc. The simulation includes a state-of-the-art feedback and chemical enrichment model for stellar components, as well as a dual-mode, spin-induced AGN feedback scheme that has been implemented in previous high-resolution simulations but is being applied for the first time at low redshift in a high-density environment. Chemical evolution is tracked for ten elements, along with four dust species spanning two chemical compositions and two size bins. The dust model is evolved on-the-fly, including formation, growth, and destruction. We implement a Monte Carlo-based tracer particle scheme to overcome the limitations of the Eulerian

hydrodynamic approach, enabling accurate tracking of baryon cycles within galaxies. The simulation reached $z=0.4$ by May of 2026, corresponding to the final major merger phase between the two main progenitor clusters. We will present early results of the NewCluster simulation, including the latest scaling relations of galaxies and preliminary scientific results from the simulation data.

Tracing enrichment from Binary Neutron Star Mergers in RAMSES Simulations

- **Speaker:** Arturo Núñez-Castiñeyra
- **Time:** 11:45–12:00
- **Abstract:** The origin and distribution of r-process elements remain key open questions in galaxy formation and chemical evolution. Binary neutron star mergers are now widely recognized as a major production site of heavy r-process nuclei, yet significant uncertainties remain regarding how these elements are injected, transported, and mixed within the interstellar medium, and how these processes shape the abundance patterns observed in stars.

Here at IAP, we are developing a framework within the RAMSES code to model the enrichment of galaxies by binary neutron star mergers. The implementation aims to follow the formation of compact binaries, their delay times and natal kicks, and the subsequent injection of r-process material into the surrounding gas. Particular attention is given to the spatial and temporal decoupling between the birth sites of neutron star binaries and their eventual merger locations. I will introduce the scientific motivation behind the project and discuss the numerical challenges associated with modeling rare enrichment events in cosmological simulations. These preliminary experiments establish the foundation for future studies aimed at connecting neutron star merger physics with observed stellar abundance patterns, such as the evolution of $[\text{Eu}/\text{Fe}]$ as a function of metallicity.

Exploring the afterlife of radio galaxies with numerical simulations

- **Speaker:** Georgia Stewart
- **Time:** 12:00–12:15

- **Abstract:** Radio galaxies are powered by jets launched from Active Galactic Nuclei, which inflate large lobes of radio-emitting plasma in their surrounding environment. After the jets switch off, these systems enter a remnant phase in which the lobes fade and evolve without continued energy injection. Identifying these remnants is difficult because their observable properties can overlap significantly with still-active radio galaxies, and they are expected to make up only a small fraction of the overall population. This makes it challenging to build large, reliable samples, yet doing so is important for understanding the feedback and duty cycles of galactic jets. Numerical simulations provide a way to study this evolution in a controlled framework, allowing the life cycle of radio galaxies to be followed under quasi-realistic environmental conditions. In this talk, I will present insights into the dynamical and spectral evolution of simulated remnant radio galaxies drawn from a large suite of three-dimensional hydrodynamic simulations that follow both active and remnant phases. These simulations are post-processed to produce synthetic radio observations, enabling direct comparison with observational surveys. The aim is to characterise how the physical and observational properties of these systems evolve after jet shutdown, and to develop a theoretical framework for interpreting remnant sources in current and future low-frequency radio surveys.

Studying planet formation and demographics with Roman and Euclid

- **Speaker:** Efstathia Natalia Reksini
- **Time:** 12:15–12:30
- **Abstract:** Gravitational microlensing has proven to be a powerful technique for probing exoplanet populations even in the darkest corners of our Galaxy, as long as sufficiently bright background sources are sampled. The detection depends on the chance alignment between two distant stars and the observer. Due to the difficulty in predicting the time and the location of an event, the number of exoplanet detections via this technique remains modest, but this is about to change. The Nancy Grace Roman Space Telescope is expected to detect more than 1,400 bound planets and hundreds of free-floating planet candidates via microlensing, promising a real breakthrough in our understanding of our Galaxy's planetary population.

Observing a microlensing event alone cannot always guarantee a precise mass measurement of the planet and its host star. High-angular-resolution follow-up observations of the target in the decade that follows the source–lens alignment have proven to be a very efficient way to derive precise mass and separation measurements for planetary systems. With this motivation, ESA's space telescope Euclid conducted a 29-hour set of observations of the upcoming Roman fields in late March 2025. This is the largest high-resolution Galactic Bulge survey dedicated to microlensing to this day.

Here I will present an overview of the Euclid Galactic Bulge Survey and its data products. I will also introduce the first microlensing systems that we have been working on and explain how Euclid can help us derive the physical parameters of these systems.

Bouncing cosmologies from quantum gravity

- **Speaker:** Lisa Mickel
- **Time:** 14:00–14:15
- **Abstract:** In this talk we will explore the resolution of the big bang singularity from quantum effects. We shall start with an overview of the need for quantum gravity and motivate its application to cosmology. Then, we will look at two approaches that replace the big bang with a quantum induced bouncing universe. First, we will consider minisuperspace models, which should be understood as a low energy approximation to an unknown, full quantum gravity theory. We will see how the singularity is resolved in such models and how the quantum background can impact the evolution of cosmological perturbations. Secondly, we will take a quick look at a possible approach to a full theory of quantum gravity and see how the singularity resolution can be described in such models.

Tensions in Cosmology

- **Speaker:** Ali Rida Khalife
- **Time:** 14:15–14:30
- **Abstract:** Modern Cosmology has become a precise discipline thanks to immense improvements in Cosmic Microwave Background (CMB) and Large Scale Structure (LSS) observations, in addition to an ameliorated theoretical description of cosmological models. However, this precision

uncovered tensions between datasets that challenge the standard model of Cosmology, Λ CDM. In this talk, I present a brief overview of current tensions, focusing mainly on the Hubble Tension and the rising potential tension between CMB and Baryon Acoustic Oscillations measurements from the Dark Energy Spectroscopic Instrument (DESI). In addition to showing the most up-to-date status of these tensions, I describe one of the models presented to address these tensions.

Through a dark crystal: CMB polarization as a tool to constrain the optical properties of the Universe

- **Speaker:** Margherita Lembo
- **Time:** 14:30–14:45
- **Abstract:** I will present the formalism developed in [PRL 127, 011301 (2021)] to describe the in-vacuo conversion between polarization states of propagating radiation, the generalized Faraday effect (GFE), in a cosmological context. GFE can be seen as a tracer of new isotropy- and/or parity-violating physics, and provides a unified framework encompassing cosmic birefringence (rotation of the linear polarization plane) as well as the partial conversion of linear into circular polarization. The framework recasts GFE parameters as components of an effective "cosmic susceptibility tensor", analogous to light propagating through a chiral medium, the dark crystal.
Shortly, I will also mention two applications. First [JCAP 03 (2023) 018], a comprehensive study of Lorentz violation signatures in electrodynamics on CMB anisotropies. Second [JCAP 03 (2025) 009], a sensitivity forecast for next-generation CMB experiments to constrain new physics beyond the standard model through circular polarization generation.

On the diverse origins of star formation quenching and gas stripping of galaxies in groups

- **Speaker:** Jinsu Rhee
- **Time:** 14:45–15:00
- **Abstract:** The role of environments in galaxy evolution has been widely studied, and it is now well established that galaxies tend to become red and dead in denser environments. Star formation quenching accompanied by gas removal through ram pressure stripping and starvation in cluster-scale

halos has long been considered the primary mechanism responsible for the large population of passive galaxies in high-density regions. However, the evolution of galaxies in smaller virialized systems, namely galaxy groups, remains much less explored. The lower virial masses of groups imply weaker environmental effects, while group galaxies are themselves generally lower in mass and therefore more vulnerable to external influences. This combination leads to evolutionary pathways that differ significantly from those of galaxies in massive clusters, indicating that environmental effects are not self-similar across halo mass scales. In this talk, we investigate the diverse physical processes responsible for star formation quenching and gas stripping in galaxy groups using NewHorizon and NewHorizon2 simulations. We show that some satellite galaxies exhibit periodic star formation histories closely linked to their orbital motion. Moreover, beyond the conventional picture of ram pressure stripping by hot halo gas, satellites can also experience stochastic gas stripping driven by interactions with surrounding structures and components. These examples highlight the complexity and diversity of environmental processes acting in galaxy groups and provide a new perspective on galaxy evolution in intermediate-density environments.

Hydrodynamical Simulations for the Effective Field Theory of Dark Energy

- **Speaker:** Wangzheng Zhang
- **Time:** 15:00–15:15
- **Abstract:** Large-scale structure surveys can serve as cosmological laboratories for testing modified gravity theories, which provide viable explanations for the accelerated expansion of the late-time universe. Testing these theories using upcoming survey data requires accurate predictions of structure formation on galaxy scales. To be finished...

Tracing Galaxy Group Evolution with COSMOS-Web SFHs

- **Speaker:** Rafael C. Arango Toro
- **Time:** 15:15–15:30
- **Abstract:** Galaxy groups provide a key intermediate environment between the field and massive clusters, where environmental processes begin to significantly affect star formation and drive galaxy quenching. Thanks to

the deep and relatively large COSMOS2025/COSMOS-Web datasets, these effects can now be investigated consistently across cosmic time.

In this talk, I will present recent results focusing specifically on the richest galaxy groups, analysing how quenching depends on group-centric radius and redshift. Our results show a clear increase of quenching towards the inner regions of groups, while its redshift evolution suggests a transition from a more mixed and heterogeneous behavior at earlier times to a more uniformly suppressed star formation at later epochs.

This analysis is embedded within a broader framework based on non-parametric star formation histories, which provide a consistent way to connect physical parameter inference from COSMOS2025 photometry with population-level evolutionary tracks in the stellar mass–SFR plane.

Effect of Half-Wave Plate (HWP) Non-Idealities in CMB Polarisation Leakage

- **Speaker:** Miguel Gomes
- **Time:** 16:00–16:15
- **Abstract:** Future satellite missions focusing on the tensor-to-scalar ratio r will likely include a rotating half-wave plate (rHWP) device in order to precisely recover the B-mode polarisation signal. However, non-idealities in the HWP induce systematic effects, namely Temperature-to-Polarisation leakage. Building on the modeling approach in Patanchon [2023], we simulate LiteBIRD scanning with a realistic rHWP model and quantify the resulting leakage amplitude, comparing it to the expected variance of the primordial B-mode signal.

From Quasar Spectra to Cosmic Maps: Cosmology with the Lyman-Alpha Forest

- **Speaker:** Hiram K. Herrera-Alcantar
- **Time:** 16:15–16:30
- **Abstract:** The Lyman-alpha forest, a series of absorption features observed in the spectra of distant sources, provides a unique view of the intergalactic medium and the large-scale structure of the Universe at high redshift. In this talk, I will introduce the Lyman-alpha forest and discuss its role as a cosmological probe, particularly for measuring the Baryon Acoustic Oscillation (BAO) scale and constraining the expansion history of the

Universe. I will present recent results from the Dark Energy Spectroscopic Instrument (DESI), which has delivered the most precise Lyman-alpha forest measurements to date, extending cosmological studies to redshifts beyond those accessible with galaxy surveys. Finally, I will discuss my work at IAP on Lyman-alpha tomography, an emerging technique that reconstructs three-dimensional maps of the intergalactic medium and offers new opportunities to study the cosmic web and the evolution of large-scale structure.

From parallelization on CPU to parallelisation on GPU: Use Kokkos in cosmological numerical simulations

- **Speaker:** Guillaume Tcherniatinsky
- **Time:** 16:30–16:45
- **Abstract:** As technology evolves, national clusters and simply our good old Infinity home cluster hosts not only CPUs, but also GPUs. However, making the best use of these technologies means porting code to GPU and can be discouraging and tedious, as it requires architecture specific code that differs for every type of GPU (CUDA, OpenMP target, SYCL...). In this talk, I will show how the Kokkos framework in C++ can be used to write generic code that can be used on any GPU architecture as well as CPU. I will show examples in my work in astrophysical simulations and discuss the benefits and drawbacks of GPUs compared to CPUs in the light of my projects.