

# LSST@Europe 8

28 September – 2 October 2026  
Budapest, Hungary

## ABSTRACT BOOK



**LSST**  
Discovery  
Alliance



NATIONAL RESEARCH, DEVELOPMENT  
AND INNOVATION OFFICE  
HUNGARY

PROJECT FINANCED  
FROM THE NRDI FUND



**LSST@EUROPE 8**  
**28 September– 02 October 2026**

**Ensana Thermal Margaret Island**  
**Hungary**

Abstract Book of the LSST – Europe 8 Conference  
held in Budapest Hungary

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Cover: Night Sky at the Rubin Observatory, Chile

# PREFACE

We are pleased to welcome you to LSST@Europe8, the next installment of the LSST European conferences, held in Budapest, Hungary, from September 28 to October 2, 2026.

Previous conferences have shown us the importance of such an event, as professional achievements, interesting and often surprising ideas shape our community and our research work in the field.

We were eagerly preparing for this conference in Budapest, drawing on the organizational experience we have gained in previous years in the United Kingdom, Serbia, France, Italy, Croatia, the Canary Islands, La Palma, and Poland.

In previous years, we heard so much about the observatory that was already under construction and the plans for its operation. Last year all of this became reality as the first results obtained from the Data Preview 1 (DP1) were presented in papers and at the conference in Poland as well. This made the actual launch of this ambitious project increasingly tangible.

By the time of the Budapest conference, however, this sky survey program and the alert stream will be fully operational and functional, and it is very exciting that the Data Preview 2 (DP2) data package created with the LSSTCam camera, will be available.

During the conference, we would like to provide an opportunity to discuss the following topics:

- the current status of the observatory
- the potential of the DP1 and DP2 data and the LSST alert stream
- LSST DP2 and DR1 data, data storage centers, and how to access them
- topics related to in-kind contributions
- cooperation between European and international groups

We look forward to welcoming you to Budapest for what promises to be an inspiring and fruitful meeting.

**Róbert Szabó**  
chairman

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Nóra Takács (*HUN-REN CSFK Konkoly Observatory*)

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**TALKS**

## LSST Project

Plenary session

**Mon Sep 28 9:30 – 12:30**

**Chairs:** *Róbert Szabó & Željko Ivezić*

93. 281\_95\_1 **INVITED**

1. [LSST project](#)

## Rubin Observatory Status Update

Bob Blum<sup>1</sup>

<sup>1</sup> NSF–Doe Vera C. Rubin Observatory/NSF Noirlab, 950 N. Cherry Ave., 85719, Tucson, Arizona, USA

I will present a current status of the observatory. Rubin has completed an intense period of optimization in early operations as we approach the one-year anniversary of Construction Completeness and the start of Operations. The survey began in June, and our staff have been working since July to recover from a once-in-a-lifetime (we hope) winter storm. I will give the latest news as we approach “back on sky!”

79. **INVITED**  
1. LSST Project

## Rubin Observatory and LSST: early science

Željko Ivezić<sup>1</sup>

<sup>1</sup>University of Washington, USA

The Vera C. Rubin Observatory's Legacy Survey of Space and Time (LSST), started on June 30, 2026. I will summarize Rubin's early data, including Data Preview 2, and discuss the remaining fine-tuning of the Observatory.

100. **INVITED**

1. LSST Project

## Current LSST Survey Strategy

Lynne Jones<sup>1</sup>

<sup>1</sup>University of Washington, USA

I will describe the current LSST survey strategy, covering its goals and a high-level view of their implementation in the Feature Based Scheduler. I will also talk briefly about the current simulations and what these tell us about expectations for the LSST.

101. **INVITED**

1. LSST Project

## Data Preview 2 Processing and Products

Colin Slater<sup>1</sup>

<sup>1</sup>University of Washington, USA

With Early DP2 available now and the full DP2 release coming soon, I'll describe the how Data Management ran the production process, along with giving a tour of the data products and particularly what's new since DP1.

84. **INVITED**  
1. LSST Project

## Scaling Rubin: Data Preview 2, prompt products, and MultiModal Science

Neven Caplar<sup>1</sup>

<sup>1</sup>University of Washington, USA

LSDB is an open-source framework for analyzing astronomical catalogs at the billion-to-trillion-object scale, built on the HATS (Hierarchical Adaptive Tiling Scheme) format. Part of LINCC Frameworks, a program supported by Schmidt Sciences, LSDB targets the analysis challenges of the Rubin era: multi-billion-source cross-matching and time-domain science over massive light-curve collections.

I will report on recent work importing Rubin DP2 catalogs as HATS collections and serving them on the Rubin Science Platform and external IDACs, along with early science results. I will also present the ingestion of the alert archive into a world-public, queryable HATS store, preparation for the Prompt Products Database service, and our integration with SCiMMA for real-time bulk cross-matching of alerts. Alongside this, our support for MultiModal astronomical datasets through the MultiModal Universe extends LSDB beyond tabular data to include images and spectra.

Looking ahead, I will discuss plans for serving direct-image prompt products from Rubin, for Gaia DR4, Euclid, and Schmidt Observatories datasets, and for expansion of MultiModal support. Together, these establish LSDB as a general-purpose analysis layer for datasets in the Rubin era.

83.205\_90\_1 INVITED

1. LSST Project

## LSST survey strategy: how we started, how it may change

Federica Bianco<sup>1</sup><sup>1</sup> University of Delaware

LSST has begun. The LSST survey strategy is designed by the scientific community and assembled by the Survey Cadence Optimization Committee (SCOC) through a recommendation to the Observatory Director. This community-driven process has been ongoing for over a decade and will continue throughout operations; the strategy is designed to be flexible and can be updated in response to emerging scientific priorities, environmental changes, and system performance. The initial survey strategy design was completed in 2024 (PSTN-056), but an improved understanding of the Observatory system—and particularly the engineering time required throughout the life of the survey—necessitates updates. The SCOC has produced a recommendation for the start of LSST (PSTN-057). However, as system performance and our understanding of it improve, we expect updates to occur rapidly in the first years of the survey, and the community's creativity in suggesting modifications and diligence in assessing them are central to this process. I will describe which parameters of the LSST survey strategy are most likely to be modified and guide the community on how to contribute to the survey design.

75.244\_86\_1

[1. LSST project](#)

## Entering the LSST Era from the Summit: Early Operations at Vera C. Rubin Observatory

Marina S. Pavlovic<sup>1</sup>, Bruno C. Quint<sup>1</sup>, David Sanmartin<sup>1</sup>, Freddy Munos Arancibia<sup>1</sup>, Tiago Ribeiro<sup>1</sup>, Kevin Fanning<sup>2</sup>, HyeYun Park<sup>3</sup>, Erik Dennihy<sup>1</sup>, Elana Urbach<sup>4</sup>, and Brian Stalder<sup>1</sup>

<sup>1</sup> NSF DOE Vera C. Rubin Observatory/NoirLAB, Juan Cisternas 1500, 1500000 La Serena, Chile

<sup>2</sup> SLAC National Accelerator Laboratory, 2575 Sand Hill Road, Menlo Park, California 94025

<sup>3</sup> Duke University, 2080 Duke University Road, Durham, NC 27708

<sup>4</sup> Harvard University, Department of Physics, Massachusetts Hall, Cambridge, MA 02138

**Keywords:** Early operations, Summit, System integration, Testing, Engineering, Communication

As the Vera C. Rubin Observatory moved from commissioning toward the LSST era, the summit has become the place where years of design, integration, and testing are transformed into nightly operations. This talk will present a progress report from the perspective of a Summit Support Scientist, focusing on the practical work required to bring a complex, highly automated observatory into routine use.

I will describe the transition from engineering and commissioning activities to early operational workflows, including the coordination of the telescope, dome, camera, scheduler, observing scripts, and summit teams. Special attention will be given to the lessons learned while operating an unprecedented system in real conditions: validating procedures, responding to faults, improving efficiency, supporting observing nights, and building confidence in the systems that will enable LSST science.

Beyond technical progress, this talk will highlight the human and operational side of entering the LSST era from the summit. Early operations require not only sophisticated hardware and software, but also clear communication, rapid troubleshooting, shared responsibility, and close collaboration between engineers, scientists, operators, and support teams. From the mountain, the beginning of LSST is not a single milestone, but an evolving process of learning how to operate one of the most ambitious survey facilities ever built.

This contribution will offer a ground-level view of Rubin's early operations: what has been achieved, what challenges remain, and how the summit experience is shaping the path toward efficient, reliable, and science-ready survey operations.

28. 165\_52\_1

1. LSST Project

2. Transients, Variable Stars

## Correcting atmospheric effects on LSST's photometry with AuxTel's spectroscopy

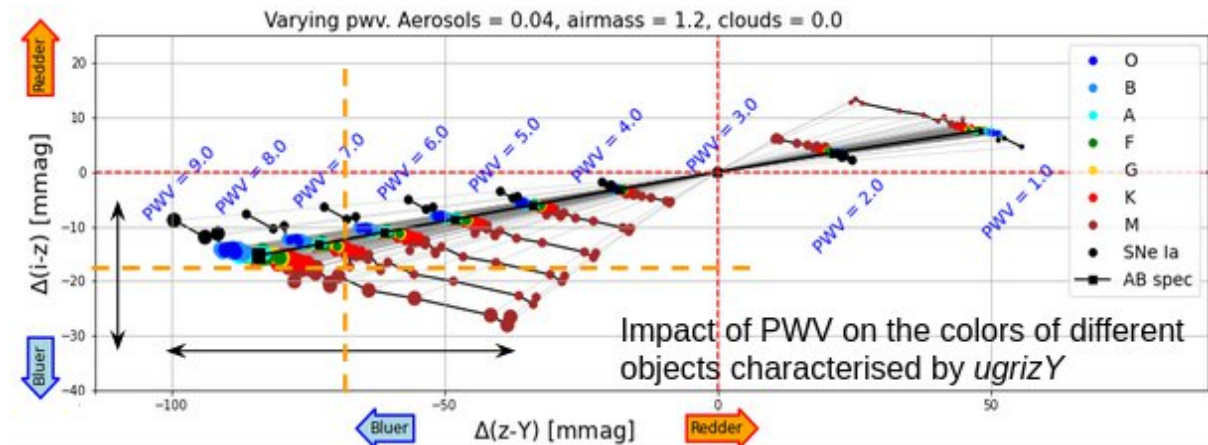
Martín Rodríguez Monroy<sup>1</sup>, Marc Moniez<sup>2</sup>, Sylvie Dagoret-Campagne<sup>2</sup>, Jérémy Neveu<sup>2</sup>

<sup>1</sup> Konkoly Observatory, Budapest, Hungary

<sup>2</sup> Laboratoire de Physique des 2 Infinis Irène Joliot-Curie, Orsay, France

**Keywords:** AuxTel, colour corrections, photometry

The Large Survey of Space and Time (LSST) has just started to carry out a massive survey which will provide data with such a statistical power that the systematic uncertainty will be dominant. Photometric precision is particularly important for obtaining cosmological information from supernovae and to compute photometric redshifts. One of the main sources of photometric uncertainty is related to the variations on atmospheric transmission. To deal with atmospheric effects, LSST counts with a companion telescope, the Auxiliary Telescope (AuxTel), whose purpose is to measure the atmospheric transparency and to derive colour corrections based on spectroscopic observations. In this contribution we will present our latest results from the methodology currently in development to derive colour corrections from AuxTel data. Our objective is to calibrate LSST's photometry with a precision of the order of 1mmag.



**Figure 1:** Impact of precipitable water vapor on the photometry of different stellar types.

## Dark Energy SC

Plenary session

**Mon Sep 28 13:30 – 15:00**

**Chair:** *Gautham Narayan*

43.182\_39\_1

[1. Dark Energy](#)

### **LSST Dark Energy Science Collaboration: preparation for cosmological studies with Rubin data**

Nora Elisa Chisari<sup>1,2</sup>, LSST Dark Energy Science Collaboration

<sup>1</sup> Institute for Theoretical Physics, Utrecht University, Utrecht, The Netherlands

<sup>2</sup> Leiden Observatory, Leiden University, Leiden, The Netherlands

**Keywords:** data previews, cosmology, combined probes

I will give an overview of the LSST Dark Energy Science collaboration, its mission and its organization. This will be followed by a summary of our ongoing major activities. First, I will report on our recent analyses of DP1 data, including photometric redshift results. The imminent arrival of the DP2 data set has set us on a path towards declaring several “key projects”, collaboration-wide efforts to make the most of this data as an exercise to brace ourselves for DR1. I will explain how these key projects have been chosen and organized, the steps we are taking in pursuing them and the results that can be expected from our DP2 analyses. I will also highlight the accessibility of our pipelines and remark on the remaining challenging aspects of the DP2 analyses in the near future.

29.165\_53\_1  
1. Dark Energy

## From DES to DESC: new methods for correcting observational systematics in LSST

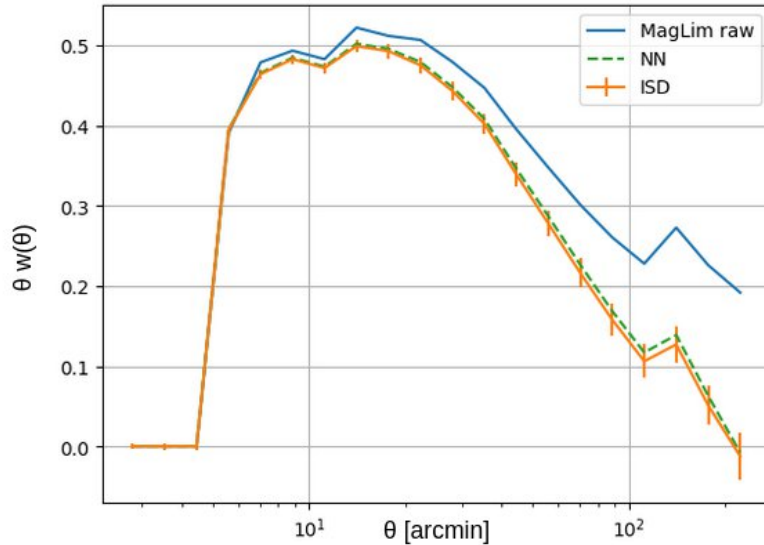
Martín Rodríguez Monroy<sup>1</sup>, Hendrik Hildebrandt<sup>2</sup>, Angus Wright<sup>2</sup>

<sup>1</sup> Konkoly Observatory, Budapest, Hungary

<sup>2</sup> German Centre for Cosmological Lensing, Ruhr-Universität Bochum, Bochum, Germany

**Keywords:** observational systematics, galaxy clustering, neural nets

One of the main cosmological probes that LSST-DESC will use to obtain cosmological constraints is the combination of galaxy clustering, cosmic shear and galaxy-galaxy lensing, resulting in the so-called 3x2pt probe. Given the astonishing amount of data that LSST will provide, statistical errors will shrink even lower than in previous stage surveys, such as DES, so systematic errors will become the main sources of uncertainty. Therefore, it will be essential to know in detail the different sources of systematic effects and to correct for them appropriately to avoid significant biases on the results. In this sense, galaxy clustering measurements are not an exception to this problem, with observational systematics being of particular relevance. In this contribution we present new methodologies for treating observational systematics in galaxy clustering, from Partial-Least Squares to a Neural Net method. These methodologies have been tested in DES-Y6 data and now are being prepared to be incorporated into DESC infrastructure.



**Figure 1:** Impact of observational systematics on the galaxy clustering correlation function and correction with a neural net.

32.170\_25\_1

1. Dark Energy

2. Galaxies

3. Informatics and Statistics

## Physical properties and redshift distributions of KiDS-1000 galaxies with pop-cosmos

Anik Halder<sup>1</sup>, Hiranya Peiris<sup>1</sup>, Stephen Thorp<sup>1</sup>, Boris Leistedt<sup>2</sup>, Daniel Mortlock<sup>2</sup>, Gurjeet Jagwani<sup>1</sup>, Madalina Tudorache<sup>1</sup>, Sinan Deger<sup>1</sup>, Benedict Van den Bussche<sup>1</sup>, Joel Leja<sup>3</sup>, Angus Wright<sup>4</sup>

<sup>1</sup> Institute of Astronomy, University of Cambridge, Cambridge, UK

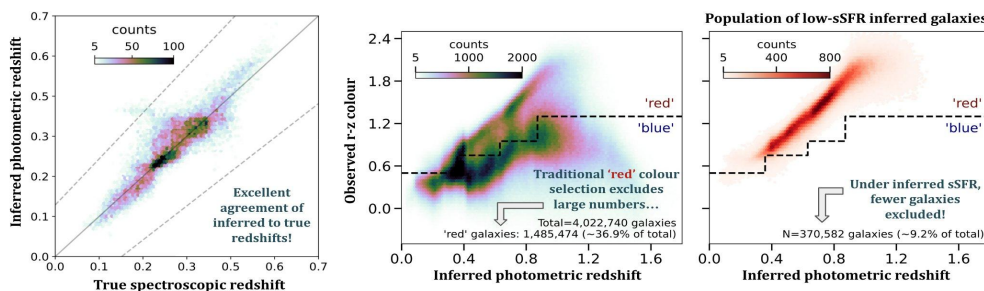
<sup>2</sup> Department of Physics, Imperial College London, London, UK

<sup>3</sup> Department of Astronomy and Astrophysics, Pennsylvania State University, USA

<sup>4</sup> Astronomical Institute (AIRUB), Ruhr University Bochum, Bochum, Germany

**Keywords:** weak lensing, photometric redshifts, galaxies

Accurate redshift calibration and physically motivated source sample selection are central challenges for precision weak lensing cosmology. Here I present our recent work on forward modelling redshift distributions and inferring physical properties of weak lensing galaxies in the Kilo-Degree Survey (KiDS-1000) using a generative galaxy population model [1, 2], carried out on Stage III data as a pathfinder for Rubin Legacy Survey of Space and Time (LSST) data. The framework enabling this is **pop-cosmos**, a data-driven galaxy population model allowing principled Bayesian inference of redshifts and physical properties for millions of KiDS-1000 source galaxies. Validation against spectroscopic samples demonstrates low bias and scatter in the inferred photometric redshifts (Figure 1, left). Access to inferred specific star-formation rates (sSFR) enables physically-motivated selection of star-forming source galaxies to mitigate intrinsic alignment (IA) systematics: compared to traditional colour cuts which exclude  $\sim 37\%$  of galaxies (Figure 1, middle), the sSFR-based selection retains  $\sim 91\%$  of the sample (Figure 1, right). We additionally develop a forward-modelling framework to infer KiDS-1000 redshift distributions [2]. By applying a KiDS data and survey selection model to synthetic **pop-cosmos** photometry, we characterise redshift distributions in each of five tomographic bins, bypassing spectroscopic reweighting used in conventional methods. These results demonstrate how **pop-cosmos** delivers accurate redshift distributions and galaxy properties, crucial for connecting galaxy evolution physics and weak lensing cosmology with Rubin LSST.



**Figure 1:** *Left:* Inferred vs. spectroscopic redshifts for  $\sim 45,000$  KiDS galaxies crossmatched to DESI BGS spectroscopic galaxies. *Middle:*  $\sim 4$  million KiDS galaxies in observed  $r-z$  colour vs. redshift; traditional colour cut (dashed) excludes  $\sim 37\%$  of the sample. *Right:* Under inferred sSFR, only  $\sim 9.2\%$  excluded.

[1] Halder et al. 2026, *pop-cosmos: Redshifts and physical properties of KiDS-1000 galaxies*, arXiv:2602.03930

[2] Leistedt et al. 2026, *pop-cosmos: Forward modeling KiDS-1000 redshift distributions using realistic galaxy populations*, arXiv:2602.03935

97. **INVITED**<sup>1</sup> Transients and Variable Stars**Searching for stellar and extragalactic variability in LSST DP2 data**

Hands-on session

**Mon Sept 29 16:00 – 17:30**Oleksandra Razim<sup>1</sup><sup>1</sup> University of Nova Gorica, Vipavska 13, SI-5000 Nova Gorica, Slovenia

The LSST Early Data Preview 2 (DP2) dataset, released in summer 2026, includes the first observational data made with LSST Camera in the period from April 2025 till January 2026. Roughly seven months of observations covered about 3000 square degrees of the Southern Sky, with some fields observed with hundreds of pointings. While this dataset gives us only a taste of the future LSST returns, it already contains observations of over 200 million of variable objects. This hands-on session is dedicated to the usage of RSP platform for accessing LSST DP2 and to the analysis of data quality and populations of variable objects of different types, with a special accent on periodic and transient events, and on efficiently pre-filtering the dataset to lower the computational cost of the further analysis.

## TVS & SMWLV

Plenary session

**Tue Sep 29 9:00 – 10:30**

**Chair:** *Tomislav Jurkić*

49.196\_47\_1 **INVITED!**

1. Transients, Variable Stars

### **Variable Stars from Space and Ground: The Gaia–LSST Synergy**

Laurent Eyer<sup>1</sup>

<sup>1</sup> Department Of Astronomy, University Of Geneva, Versoix, Chemin Pegasi 51, 1290, Switzerland

The Gaia spacecraft has observed bright and faint sources (down to about  $G \approx 21$ ) over the entire celestial sphere during more than 10 years of operation. In addition to the alert stream, the data have been analysed and delivered to the community through successive data releases.

The catalogue of variable stars has grown from a few thousand objects in Data Release 1 to more than 10 million in Data Release 3. Through these successive releases, not only have the time baselines become longer, but additional variability classes and increasingly sophisticated processing have been introduced, including Gaia's multi-instrument observations (astrometry, photometry, and spectroscopy, including radial velocities).

The LSST survey from the ground will go deeper, reaching a single-visit depth of  $r \approx 24.5$ , and will observe an estimated 17 billion stars over its 10-year survey (for the baseline survey).

These two major surveys have long been recognised as highly complementary. Gaia with its space-based observations are not free from limitations, LSST is of course subject to the usual atmospheric perturbations. Still, there is a significant overlap between Gaia and LSST in terms of survey properties and scientific goals. In this contribution, we explore some of the synergies between these two surveys for the study of variable stars, including the added value from their different photometric systems, different sampling/cadence, and the potential for a major step forward in the physical understanding and classification of variable sources.

80. **INVITED**

## 1. Transients and Variable Stars

**Pulsating stars as precision distance indicators in the Rubin LSST era**Anupam Bhardwaj<sup>1</sup><sup>1</sup>IUCAA, Pune, India

The cosmic distance scale anchored with classical pulsating stars, such as Cepheids, RR Lyrae, and Mira variables forms the foundation of modern cosmology providing the spatial and temporal scales of our Universe. The Rubin-LSST will deliver an unprecedented decade-long, multi-band time-domain survey of the southern sky, discovering and characterising millions of variable stars by reaching the faintest Galactic populations and distant Local Group galaxies. Achieving a homogeneous and high-precision distance scale in the LSST era requires robust absolute luminosity calibrations for pulsating stars in the Milky Way and the Large Magellanic Cloud as anchor galaxies. In this talk, I will present recent results from the Zwicky Transient Facility and globular cluster program that provide improved calibrations of the period–luminosity relations for RR Lyrae, Mira, Anomalous Cepheid, Type II Cepheid, and SX Phoenicis variables. I will also discuss preliminary results from DECam observations of Mira variables in the LSST  $z$  and  $y$  bands in the Large Magellanic Cloud. Finally, I will highlight exploratory studies of RR Lyrae stars using Rubin-LSST Data Preview 1 and early alert streams, outlining the opportunities with future LSST data releases for the cosmic distance scale.

**90. INVITED**

1. Transients and variable stars

**An AI for Time-Domain Discovery in the LSST Era**C. R. Bom<sup>1,2</sup>

<sup>1</sup> Artificial Intelligence Laboratory for Physics, Centro Brasileiro de Pesquisas Físicas, Rua Dr. Xavier Sigaud 150, CEP 22290-180, Rio de Janeiro, RJ, Brazil

<sup>2</sup> Laboratório Interinstitucional de e-Astronomia - LIneA, Avenida Pastor Martin Luther King Jr., 126 Nova América Offices, Rio de Janeiro, RJ 20765-000, Brazil

The Rubin Observatory will transform time-domain astronomy not simply through data volume, but by changing how discovery is organized. For LSST, the challenge is increasingly to move from static alert classification toward continuous, uncertainty-aware interpretation of an evolving sky, where scientific priorities and follow-up decisions become part of the inference process itself. I will present the emerging AI roadmap of the LSST Transients and Variable Stars Science Collaboration. The goal is to move toward AI systems that can learn from heterogeneous and incomplete observations, recognize both known phenomena and unexpected behavior, update their interpretation as new information arrives, and help determine which observations can deliver the greatest scientific return. This requires moving beyond isolated predictive models toward integrated, auditable AI workflows that connect scientific inference, decision-making, follow-up, and human expertise. As an outlook, I will discuss Whisper, a platform being developed to explore this vision operationally. Whisper combines real-time analysis of the alert stream with contextual reasoning, adaptive prioritization, and rapid physical inference, aiming to support the discovery and characterization of rare and fast-evolving transients while keeping scientists in the loop.

80. **INVITED**

## 1. Transients and Variable Stars

**Mapping dark matter with stellar streams in the Rubin era**Vasily Belokurov<sup>1</sup><sup>1</sup> Institute of Astronomy, Madingley Rd, Cambridge, CB3 0HA, UK

Stellar streams have become powerful tools for mapping the Milky Way's gravitational field, revealing its mass, shape, time dependence and perturbations. The next frontier is to take these methods beyond the Milky Way. Rubin will uncover streams around large samples of nearby galaxies, opening a new regime for dark-matter measurements. I will review what makes streams such sensitive dynamical probes, discuss the challenges of discovering and modelling unresolved streams in external galaxies, and show how imaging combined with targeted spectroscopy can constrain halo mass, density profiles, shape and orientation. These measurements offer a new view of the interplay between dark matter, baryons and galaxy assembly.

## Strong Lensing

Splinter session

Tue Sep 29 11:00 – 12:30

Chair: *Aprajita Verma*

63. 228\_68\_1

1. Strong Lensing

2. Transients, Variable Stars

3. Follow up

### Discovering strongly lensed supernovae: from ZTF to LSST

Alice Townsend<sup>1</sup>

<sup>1</sup> University of Birmingham, Birmingham, UK

**Keywords:** strong lensing, supernovae, cosmology

Strongly lensed transients, particularly type Ia supernovae, are emerging as powerful cosmological probes. Their standardisable luminosities enable precise measurements of lensing magnification and time delays, providing direct constraints on the Hubble constant ( $H_0$ ). I will present results from our work on identifying these rare events in the Zwicky Transient Facility (ZTF), highlighting the detection methods we developed, the lensed supernovae we discovered, and the practical lessons learned about searching for strongly lensed transients in ground-based time-domain surveys.

I will also present our time-delay analysis of the strongly lensed superluminous supernova SN Winny. Using a coordinated multi-facility follow-up campaign, we obtained densely sampled spectroscopy and resolved photometry of the system. I will describe how these heterogeneous data were processed and combined to model the lens, measure the time delays, and infer constraints on  $H_0$ . This case study illustrates both the scientific potential of lensed transients and the observational effort required to exploit them for precision cosmology.

These results directly inform our strategy for the Vera C. Rubin Observatory's Legacy Survey of Space and Time (LSST), whose greater depth is expected to yield a substantially larger sample of strongly lensed supernovae. We are now adapting our detection and prioritisation tools for LSST broker alert streams, with a focus on real-time candidate selection for follow-up. By refining these pipelines and follow-up strategies, we aim to maximise LSST's discovery potential and enable robust cosmological measurements from the next generation of strongly lensed transients.

17.139\_13\_1

1. Strong Lensing

2. Transients and Variable Stars

3. Follow up

## Detectability of Gravitationally Lensed Kilonovae in the Rubin LSST

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**Keywords:** gravitational lensing: strong, transients

Identification and characterisation of Kilonovae (KNe) can be instrumental in improving our understanding of cosmology and astrophysics. However, their detection poses unique challenges due to rarity and faintness. Upcoming telescopes, with their deep imaging capabilities and wide field-of-views, will provide a unique opportunity to observe these rare and faint transients. The Rubin Legacy Survey of Space and Time (LSST) will generate a deluge of data, making it essential to deploy fast, efficient methods for identifying genuine KNe, especially when they are gravitationally lensed. To address this, we simulate realistic populations of both unlensed and lensed KNe in the six LSST bands.

Comparing with the Type Ia Supernovae, we find that the KNe color evolution is morerapid and the two separate out when their colors are compared at two epochs. Since the mergers of compact binaries are probable progenitors of KNe, the KNe properties may be affected by the delay time distribution (DTD) of the mergers, which is dictated by the minimum delay time and power-law slope. For longer minimum delay time and shallower slopes, we find an increased rate of detectable Kne in LSST.

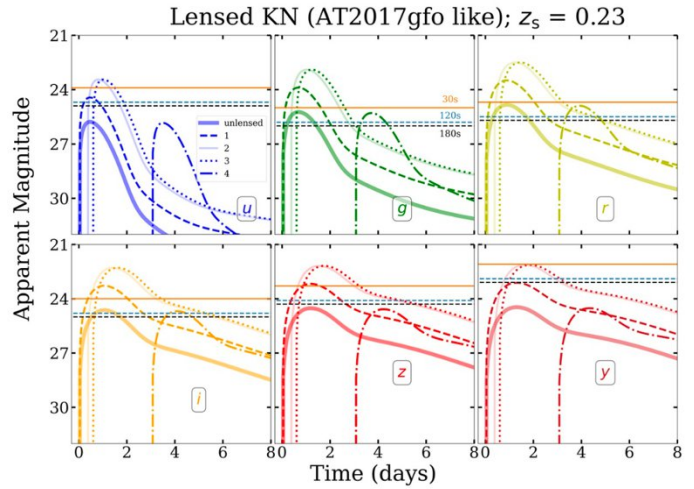


Figure 1: Light Curves of quadruply lensed Kne in different LSST bands. Different linestyles show light curves of unlensed four images.

In Ganguly and More (2026) [1], we generate the first statistically realistic lensed Kne population for different DTDs and find that the rate of detectable lensed KNe increases for DTDs with longer minimum delay time for a fixed slope. We further note that an AT2017gfo-like event at a redshift of 0.5 (1.0) needs magnification of at least 5 (44) to be detectable in LSST. In Figure 1, we show an example light curve of quadruply lensed KN, where the peak brightness of lensed lightcurves is higher than different exposure-limited magnitude in the Rubin LSST.

Reference: [1] Ganguly, A., & More, A. 2026, arXiv e-prints, arXiv:2604.15443. [\[Link\]](#)

46.187\_43\_1

[1. Strong Lensing](#)

## The Rubin Static Strong Lensing Data Challenge: Towards Automated Discovery and Modelling at LSST Scale

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**Keywords:** strong gravitational lensing, LSST, Rubin Observatory, automated discovery, lens modelling

Strong gravitational lensing provides a unique window into the distribution of dark and luminous matter in galaxies and serves as a powerful cosmological probe. The advent of the Vera C. Rubin Observatory and its Legacy Survey of Space and Time (LSST) will dramatically increase the volume and complexity of imaging data, offering unprecedented opportunities for lens discovery and analysis. However, strong gravitational lenses are orders of magnitude rarer than ordinary galaxies, demanding specialized, high-purity detection algorithms that scale efficiently to LSST-sized datasets.

To address this challenge, we present the Rubin Static Strong Lensing Data Challenge (RSLDC), a Strong-Lensing-Science-Collaboration initiative designed to benchmark automated lens discovery and modelling tasks. The RSLDC establishes a reproducible framework for comparing algorithms trained on mock one-year LSST imaging and adapted real Hyper Suprime-Cam (HSC) imaging. In total, 21 teams participated in the classification challenge, with five teams also entering the regression challenge.

The top ten teams each achieved precision exceeding 0.99. Combining predictions across all teams, only 83 out of 50,000 lenses were missed by every model; of these, four are recovered by an ensemble classifier trained on the submitted predictions. The regression results show that a single architecture is able to model some lens parameters robustly. This effort represents a significant step toward scalable automated strong-lens analysis in the LSST era.

19.141\_20\_2

[1. Strong Lensing](#)[2. Galaxies](#)[3. LSST Project](#)

## From instrumental systematics to strong-lensing science: assessing the impact of stray light and PSF variations in Rubin LSST

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**Keywords:** Strong lensing, dark matter, stray light, LSST, telescope performance

The Vera C. Rubin Observatory will enable the discovery of large samples of strong gravitational lenses, opening new opportunities for statistical studies of galaxy mass distributions and detailed lens modelling. The scientific exploitation of these systems depends on the ability to identify and accurately model faint lensed features in multi epoch imaging. Instrumental systematics affecting individual LSSTCam visits may therefore propagate into the final coadds and impact both lens detection and the inference of physical parameters. Recent on-sky commissioning observations of LSSTCam have revealed a variety of stray and scattered light artifacts and provided a detailed characterization of their occurrence, morphology, and instrumental origin. While these efforts are essential for understanding and mitigating the artifacts, their impact on strong- lensing analyses remains largely unexplored, as for many other science cases. In addition, the multi epoch nature of the LSST introduce also the time variant, the same sky region is observed in different periods of the year and in different conditions. Changes in seeing, telescope orientation and in its thermal state can introduce visit-to-visit PSF variations, providing a second source of systematic uncertainty for lens and source modeling. Variation that wouldn't be present if the same amount of data was acquired traditionally. We present a simulation framework aimed at quantifying the impact of these effects on strong lensing observations. We will construct a large catalog of realistic galaxy-scale lenses by combining candidate lens galaxies from Rubin observations with synthetic arcs produced by background sources and generate LSST- Cam like multi-epoch observations. For a representative subset of systems, we will simulate approximately 100 visits per lens while introducing controlled PSF variations and stray light artifacts in a fraction of the individual exposures. We will then assess their impact on strong lens detection and on the recovery of the physical parameters of the lens models, using uncontaminated simulations as a reference. Then the same procedure will be applied but using an increasing fraction of visits affected by stray light or by bigger PSF distortions, up to the moment when both the modeling and the detection starts to fail. This study will quantify the tolerance of strong lensing analyses within LSST to instrumental systematics and identify the levels of stray light contamination and PSF variability at which the scientific performance of Rubin strong lensing analyses is significantly degraded. The resulting hybrid lens catalog will also provide a reusable dataset for future investigations and training of classifiers and automatic lens detectors.

# Transients and Variable Stars

Splinter session

Tue Sep 29 11:00 – 15:30

**Chairs:** Markus Hundertmark & Marcella Marconi

26.163\_19\_1

1. Transients, Variable Stars
2. Stars Milky Way Local Volume
3. Synergies with other missions

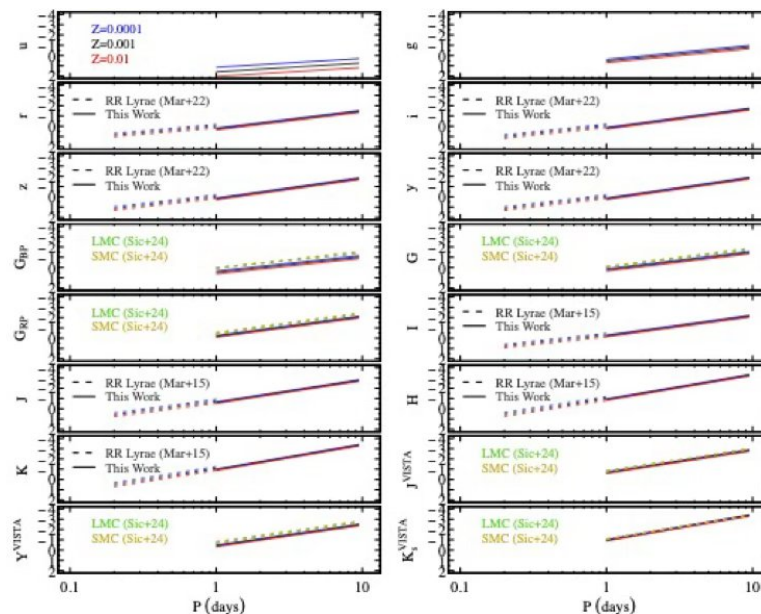
## A new self-consistent Pop II theoretical distance scale in the Rubin-LSST era

Marcella Marconi<sup>1</sup>, Roberto Molinaro<sup>1</sup>, Giulia De Somma<sup>1</sup>, Mami Deka<sup>1</sup>, Ilaria Musella<sup>1</sup>

<sup>1</sup> INAF-Osservatorio Astronomico di Capodimonte, Naples, Italy

**Keywords:** pulsating stars, distance scale, old stellar population

Nonlinear convective pulsation models allow us to predict all the relevant pulsation observables including bolometric light curves, for each selected pulsation mode, that can be transformed into a variety of photometric bands. Mean magnitudes and colours can then be derived and in turn a full set of theoretical Period-Luminosity, Period-Luminosity-Color and Period-Wesenheit relationships for several classes of pulsating stars typically adopted as standard candles in the calibration of the cosmic distance scale, e.g. Classical, Type II, Anomalous Cepheids, RR Lyrae.



**Figure 1:** An example of predicted Period-Luminosity relationships for RR Lyrae and Type II Cepheids in the Rubin-LSST filters (adapted from Marconi et al. 2025 A&A).

In this Lecture I will illustrate recent results based on the modelling of both RR Lyrae and Type II Cepheids that tracing old stellar populations represent a valuable alternative to the more used Classical Cepheids in calibrating the cosmic distance scale. Their role is indeed becoming increasingly attractive in the hot debate on the Hubble constant value, the so-called Hubble constant tension. The presented pulsation relations in a variety of photometric filters for both RR Lyrae and Type II Cepheids confirm a substantial consistency between the two classes of old pulsators and a good agreement with observational counterparts, thus representing a new theoretical tool to calibrate the Tip of the RGB in galaxies of any morphological types and in turn a variety of secondary distance indicators. Some implications of the predicted relations in the Rubin-LSST filters for the Hubble constant debate are finally discussed.

36. 173\_27\_1

[1. Transients, Variable Stars](#)[2. Stars Milky Way Local Volume](#)

## Tools for the simulation of Pulsating Stars (ITA\_INA\_ S8 Inkind)

Ilaria Musella<sup>1</sup>

<sup>1</sup> INAF Osservatorio Astronomico Di Capodimonte, Salita Moiariello 16, Napoli, 80131, Italy

We present the work carried out within the framework of the in-kind contribution ITA\_INA\_S8, “Tools for the simulation of Pulsating Stars” (deliverable software).

One of the key deliverables of this contribution is the creation of the most extensive and detailed model database to date. Featuring an unprecedentedly fine step in input stellar parameters, it allows for a wide and homogeneous sampling of observed periodicities, color and luminosity ranges, and chemical abundances of Cepheid and RR Lyrae stars. These models are being produced using both the Stellingwerf and MESA codes, providing the community with the first extended theoretical database that simultaneously varies chemical compositions, super-adiabatic convection efficiency, and luminosity ranges for each assumed stellar mass—a highly computationally intensive objective.

In this framework, we are developing interactive software tools to interpolate within these databases, and not only, enabling the derivation of light curve properties and their associated stellar parameters even in the case of periods not exactly matching the model grid points.. Furthermore, we present an interactive tool designed to transform the models into all existing filter systems, allowing users to simulate, for example, variable stars within the LSST filters.

Recently, the Radial Basis Function interpolation model has been enhanced to allow the mixing length parameter to vary across the grid. This interpolation now operates across six dimensions (Period, Mass, Luminosity, Effective temperature, Mass-Luminosity relation and mixing-length) with highly promising results.

8. 118\_28\_1

1. Transients, Variable Stars

2. Synergies with other missions

3. Stars Milky Way Local Volume

## RR Lyrae Light Curve Characterization in the LSST Era: Template-Based Period Refinement and Cross-Survey Calibration

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<sup>1</sup> Centro de Estudios de Física del Cosmos de Aragón (CEFCA), Plaza San Juan 1, 44001 Teruel, Spain

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**Keywords:** stars: variables, surveys: J-PLUS/J-VAR, techniques: photometric

In this work, we present a template-driven framework for the analysis of 315 RR Lyrae stars (refer Figure 1), built from a combination of multi-epoch, 7-band Javalambre VARibility Survey Data Release 1 (J-VAR DR1) photometry and the *Gaia* DR3 catalog of variable stars, and calibrated using SDSS-based RR Lyrae templates in the  $u$ ,  $g$ ,  $r$ ,  $i$ ,  $z$  system. SDSS template fitting is used to refine periods and estimate amplitudes from sparsely sampled light curves, improving phase reconstruction and reducing aliasing in period determination.

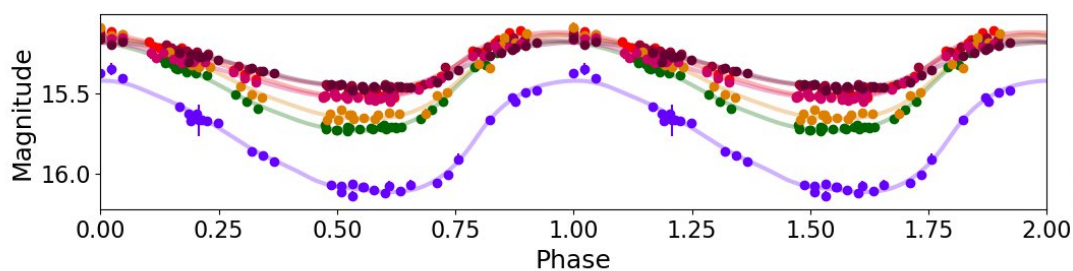


Figure 1:

Fig. RR Lyrae Light Curve with Template-Based Fit

We further extend this methodology to single-epoch, 12-band Javalambre Photometric Local Universe Survey Data Release 3 (J-PLUS DR3), combined with *Gaia* DR3 variable star data, providing multi-band coverage in the  $u$ ,  $g$ ,  $r$ ,  $i$ ,  $z$  system along with narrow-band filters (J0378-J0861). Using a sample of approximately 38,000 *Gaia* RR Lyrae stars, we construct data-driven templates based on Fourier decomposition and Principal Component Analysis (PCA), enabling a compact representation of light-curve morphology across the *Gaia*  $G$ ,  $BP$ ,  $RP$  bands. These templates are then applied to sparse J-VAR and J-PLUS observations to improve period recovery, amplitude consistency, and variability classification.

The Legacy Survey of Space and Time (LSST) at the Vera C. Rubin Observatory will deliver multi-epoch photometry in the  $ugrizy$  filter system with dense temporal sampling over a decade-long baseline. This dataset will require robust methods for RR Lyrae characterization under irregular sampling and heterogeneous observational conditions. The framework developed in this work enables direct transfer of *Gaia*- and SDSS-informed templates into the LSST photometric system, providing a pathway for cross-survey calibration, early-stage RR Lyrae identification, and improved period refinement in the LSST era, particularly for early data releases and sparsely sampled high-latitude fields.

15.137\_60\_1

[1. Transients, Variable Stars](#)[2. Brokers](#)[3. Science with prompt data products](#)

## A new pipeline for fast and robust period determination in the LSST era

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<sup>1</sup> HUN-REN Research Centre for Astronomy and Earth Sciences, Konkoly Observatory, Budapest, Hungary

**Keywords:** variable stars, period detection

Classic period determination algorithms rely on periodograms or light curve templates and operate on a single observing band. These methods can be applied when a large number of observations are available or, in the case of light curve templates, the type of the variable object is known beforehand. The forthcoming Legacy Survey of Space and Time (LSST) data releases will provide unidentified periodic variable object in numbers that are orders of magnitude larger than those of currently known objects. On the other hand, the cadence in a single observing band will not allow the period calculation for many variables in the first few years, while many classification algorithms are depending on this information. In the past decade, several studies have attempted to mitigate this problem by using all observing bands for the period determination. Although these methods are promising, they have been not implemented into a reliable pipeline capable of providing period data for detection algorithms as early as possible.

In this work, we present a comparison of different multiband period-detection algorithms (such as Quadratic Mutual Information, Analysis-of-Variance or Lomb-Scargle periodogram) to determine the period ranges over which they are applicable and assess their computational efficiency. The vast amount of data requires methods implemented with high throughput and precision; therefore, we investigate how the different methods can be coupled together into a single pipeline. We test the pipeline with ZTF and simulated LSST data. The results of this pipeline can improve the success rate of the classification algorithms developed for periodic variable targets in the first few data releases.

64.108\_76\_1

- 1. Transients and Variable Stars
- 2. Stars, Milky Way, Local Volume
- 3. Informatics and Statistics

## Data-driven Generalization of YSO light curves with multimodal representation learning

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<sup>2</sup>CSFK, MTA Centre of Excellence, Budapest, Konkoly Thege Miklós út 15-17., H-1121, Hungary

<sup>3</sup>Department of Experimental Physics, Institute of Physics, University of Szeged, Dóm tér 9, 6720 Szeged, Hungary

<sup>4</sup>Department of Astronomy, University of Geneva, Chemin Pegasi 51, 1290 Versoix, Switzerland

The Rubin Observatory is producing light curves for billions of sources, including many young stellar objects (YSOs). Characterising these sources has traditionally relied on hand-crafted features and curated label sets.

We present a general, survey-agnostic framework for the generalization of variable stars from photometric time series that operates entirely without labelled training data and produces low-dimensional representations capturing the physical properties of stellar variability directly from the observations. Our method combines two complementary views of each light curve in a multimodal architecture. Raw time-domain observations are processed by a Transformer encoder, and a generalized Lomb–Scargle periodogram is processed by a convolutional neural network. Training uses a split-half augmentation strategy, where each light curve is randomly divided into two temporal halves that serve as independent views of the same underlying variability. The two branches are trained jointly using the Variance-Invariance-Covariance Regularisation (VICReg) objective to produce embeddings that are invariant across the two halves while maintaining high information content per dimension. No labels enter the training procedure at any stage.

The embedding encodes a range of physical properties including variability amplitude, skewness, light curve asymmetry (M), periodicity (Q), and characteristic timescale, each mapped to a distinct embedding dimension. The learned representations reveal structure that goes beyond the classification labels. This allows us not only to distinguish between different types of variable stars, and to identify in-class confusion, but also helps us to better understand the variability of YSOs and their extreme morphological diversity. Our method describes the true variability behaviour of YSOs better than the most commonly used features, such as the Q&M label. We are now able to identify global brightening and dimming trends, usually lumped into stochastic by Q&M, and which now form their own coherent regions in our embedded space. While the method was developed on light curves from the Zwicky Transient Facility, the framework is directly applicable to time series produced by the Rubin Observatory.

22. 147\_72\_1

[1. Transients, Variable Stars](#)[2. Brokers](#)[3. Science with prompt data products](#)

## Rubin extragalactic transients: a first look at the first months of public alerts

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<sup>1</sup> Instituto de Astrofísica de Canarias, La Laguna, Spain

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**Keywords:** Rubin extragalactic transients, LSST brokers, supernovae

On February 24, 2026, the NSF–DOE Vera Rubin Observatory issued its first scientific alerts. Since then, our team has analyzed the first extragalactic alerts using the Legacy Survey of Space and Time ([LSST](#)) brokers and reported many transients to the Transient Name Server (TNS), from possible novae in nearby galaxies to supernovae at high redshift. We have developed tools to use several LSST brokers in combination with the key extragalactic catalogs from previous surveys. We will summarize the main results including the combination of LSST alerts with public data from other time-domain surveys like the Zwicky Transient Facility (ZTF). We will finally review briefly the main telescopes that are available for follow up of astronomical transients at the Canary Islands Observatories including the IAC-Barcelona-Madrid in-kind contributions to LSST (a fraction of the 10.4-m Gran Telescopio de Canarias observing time will be offered to the LSST community).

94. 166\_23\_2

2. Transients, Variable Stars

## Transients in the Virgo Cluster

Vinkó, J.<sup>1,2,3</sup>, Sárneczky, K.<sup>1</sup>, Horti-Dávid, Á.<sup>1,4</sup>, Regős, E.<sup>1</sup>, Wheeler, J. C.<sup>3</sup>,  
Könyves-Tóth, R.<sup>1</sup>, Bora, Zs.<sup>1,4</sup> + the Shadow collaboration

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<sup>4</sup> ELTE Graduate School of Physics

The Shadow collaboration, led by the SN group at University of Arizona (P.I. D. Sand), is pursuing the discovery of very young transients using the most recent LSST observations as templates. New wide-field (~9 sq. deg.), deep (> 22 mag) CCD frames are taken 1-2 days after the LSST observations (called as “shadowing” LSST). We target rich, nearby galaxy clusters, like Virgo, Fornax, Eridanus, etc. Transients are found using the image subtraction technique. Transients that are discovered on the Shadow frames, but not present on the previous LSST frames, are probably very young, 1-2 days old. The main observing facility is the DECam camera on the 4m Blanco telescope at Cerro Tololo, Chile. Our group at Konkoly is contributing by taking observations with the 0.6/0.9m Schmidt telescope at Piszkestető. Follow-up observations of the new transients are taken with several observing facilities worldwide, including the 10m Hobby-Eberly Telescope at McDonald Observatory. In this presentation we show some of the interesting new transients found in Virgo in 2026 and present an estimate for the expected number of new supernovae in this cluster during the upcoming years.

## 3. 107\_2\_3

1. Transients, Variable Stars

2. LSST Project

3. Science with prompt data products

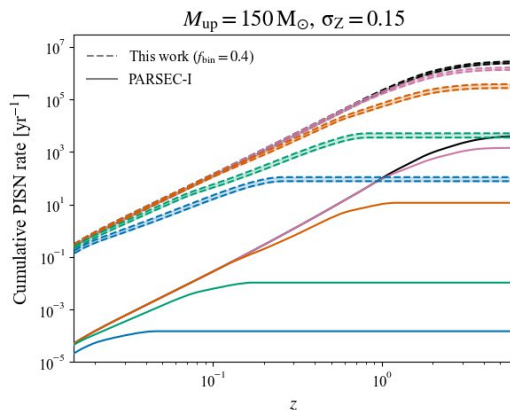
## New prospects for the observation of pair-instability supernovae

Francesco Gabrielli<sup>1</sup>, Ugolini Cristiano<sup>2</sup>, Paiella Lavinia<sup>2</sup>, Mestichelli Benedetta<sup>2</sup>, Arca Sedda Manuel<sup>2</sup>, Shepherd Kendall<sup>3</sup>, Boco Lumen<sup>4</sup>, Sgalletta Cecilia<sup>4</sup>, Costa Guglielmo<sup>3</sup>, Bressan Alessandro<sup>5</sup>, Spera Mario<sup>5</sup>

<sup>1</sup> Uppsala University, Uppsala, Sweden<sup>2</sup> GSSI, L'Aquila, Italy<sup>3</sup> University of Padua, Padova, Italy<sup>4</sup> Heidelberg University, Heidelberg, Germany<sup>5</sup> SISSA, Trieste, Italy

**Keywords:** pair-instability supernovae, LSST, binaries and dense environments

Pair-instability supernovae (PISNe) are an elusive class of transients representing the final fate of low-metallicity, very-massive stars. Despite their extreme expected luminosities, up-to 100 times higher than typical core-collapse supernovae, they have never been confidently observed. In order to solve this long-standing puzzle, a thorough study of PISN occurrence is prompted, accounting for a variety of progenitors and galactic environments.



**Figure 1:** Cumulative PISN detection rate as a function of redshift, for magnitude limits  $\mu=17, 20, 25, 30$  (blue, green, red, and pink lines), representative of instruments including LSST. I show results for a fixed choice of stellar and galaxy model assumptions (dashed lines), and for a pessimistic case (solid lines).

In this talk, I will present new prospects for the observation of PISNe with instruments such as LSST. We employ state-of-the-art PARSEC stellar tracks, and the recently-published population synthesis code SEVN, to model the evolution of single and binary PISN progenitors, both in isolation and in dense star clusters. By combining these results with an up-to-date semi-empirical determination of the metallicity-dependent star formation history, we derive a comprehensive framework for the cosmic PISN rate, for the first time accounting for binary and dynamical formation channels.

I will then describe how we derive PISN magnitudes, and simulate their observation with instruments such as LSST, in order to provide robust predictions for the PISN detection rate as a function of redshift. Moreover, I will show how varying model assumptions affects the PISN rate and the properties of the favourable PISN host galaxies. Finally, I will explain how future (or the lack of) PISN observations can enable constraints on stellar and galaxy evolution models, including the recipes for stellar-wind mass loss.

55.208\_64\_1

[1. Transients, Variable Stars](#)

## Candidate Nuclear Transients in Rubin Alerts

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**Keywords:** Galactic Nuclei, Alerts, Transients

Tidal Disruption Events (TDE) occur when a star gets too close to a supermassive black hole (SMBH) in the center of a galaxy. The black hole's gravitational pull overcomes the self-gravity of the star and tears it apart. Some of the stellar debris is accreted onto the SMBH, and the resulting emission spans the electromagnetic spectrum from optical to X-rays. Optical time domain surveys have drastically expanded the sample size and helped TDE science to transition from studying single events to population studies. The Vera Rubin Observatory is expected to increase the detection rate by at least an order of magnitude. However, identifying TDE candidates from the alert stream is a significant challenge.

Finding variable sources in the in galactic nuclei is a first step to selecting promising transients for subsequent classification. This requires an understanding of the astrometric accuracy of the alerts. We studied early alerts that are compatible with their host's core to get an understanding of how the astrometry performs in this environment. I will show how we use these results in our implementation of a nuclear transient selection within the AMPEL broker as the input to the TDE classification effort within the Transient and Variable Stars Science Collaboration. Besides that, it can also be used to identify other phenomena related to SMBH accretion, such as, for example, changing-look active galactic nuclei.

95.183\_58\_2

1. Transients, Variable Stars

2. Active Galactic Nuclei

## Refined Description of Slim Disks around Tidal Disruption Events

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**Keywords:** black hole, accretion disk, tidal disruption event

Tidal Disruption Events (TDEs) occur when a star gets too close to a black hole, and its gravitational pull tears the star apart. These events result in a bright burst of electromagnetic radiation and provide important information about the black hole's environment. When the star is disrupted, approximately half of its material forms an accretion disk around the black hole. The event is mostly detected in the optical bands, although the accretion disk's radiation lies in the X-ray regime. This phenomenon is still a subject of debate. With the Legacy Survey of Space and Time (LSST) expected to discover a vast number of new TDEs; therefore, an accurate theoretical description of these events is essential.

One of the explanations, the so-called slim disk model, states that when the fallback rate of the material exceeds the Eddington limit, a super-Eddington wind is released from the surface of the disk. The disk can sustain stability in the long term, because internal inhomogeneities reduce the effective opacity, keeping it locally sub-Eddington. The wind is optically thick, absorbing the radiation of the disk and re-emitting it at longer wavelengths.

An analytical model of TDEs based on aforementioned theory introduces a parameter describing the ratio of the wind to the disk material. The parameter largely affects the light curve of the event; therefore, its fine-tuning is crucial.

To achieve this, we present an implementation of the stationary super-Eddington slim disk model calculated for a wide parameter range of outer accretion rates and black hole accretion efficiency. This model can follow the evolution of the fallback-accretion rate and light curves of the TDEs more precisely. We used the so-called TiDE code to calculate monochromatic light curves of TDEs with our results. These light curves are compared to calculations with the old prescriptions, as well as with observations. These results demonstrate a physically consistent connection between the disk and the wind, providing an improved framework for fitting light curves of TDEs.

16.138\_36\_1

1. Transients, Variable Stars

## Modeling The Light Curve of Tidal Disruption Events with TiDE

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**Keywords:** Tidal Disruption Events, Modeling, Black holes

Tidal disruption events (TDEs) occur when a black hole disrupts a nearby star, partially or totally, by tidal force. Although the number of detections has increased significantly over the past few decades due to large sky surveys, the physical background of these events is still a mystery. Currently, several different descriptions and model codes are available (e.g., MOSFiT, TDEmass, TiDE, or REDBACK), although the predicted parameters produced by these models show large discrepancies for the same event. The LSST survey will greatly increase the number of known TDEs and TDE alerts, which could contribute to understanding the underlying physical picture.

In our poster we present the ongoing developments on TiDE and the latest results. TiDE is a public object-oriented C++ code for calculating the monochromatic light curve and continuum spectra of TDEs. It contains different models for the most significant properties of the event (such as the fallback accretion rate and the timescale of the accretion). The original version calculated the light curve by modeling an accretion disk and a super-Eddington wind, but utilizing the object-oriented structure, it is easily extensible with additional models, such as the cooling envelope description. This feature also let us combine the various theories, e.g., the cooling envelope model with realistic accretion rates. The code can be interfaced with any fitting procedure implemented in Python through the TiDEpy package. This was utilized recently in our study of the AT2022zod transient and the detectability in local systems with ZTF and LSST, whose results we also present in this poster.

24.158\_17\_1

[1. Transients, Variable Stars](#)[2. Informatics and Statistics](#)

## Continuous-Readout Imaging Can Explore the Sub-Second Optical Transient Sky

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The subminute-timescale phase space is an underexplored region of the optical transient sky. Several phenomena are expected to generate observable brightness changes on second and sub-second timescales, including cataclysmic variable stars, blazars, and potentially even counterparts to Fast Radio Bursts (FRBs). Importantly, this underexplored region of the parameter space may also contain entirely new and unexpected classes of objects. Continuous-readout mode enables millisecond-timescale observations on traditional cameras by leaving the shutter open during readout, enabling high-cadence observations on all-sky surveys. The similar technique of trailing images while slewing has been proposed for the upcoming Vera C. Rubin LSST, leading to a 10ms sampling rate. I will present the first continuous readout mode survey conducted at the Zwicky Transient Facility. We developed a deep-learning-based data analysis pipeline and will report results on  $\sim 400$  square degrees, or 525 star-hours, of data. Our Convolutional Neural Network can retrieve millisecond optical transients with a precision of 0.66% and recall of 0.78% for brightness changes of 10% and greater.

33.171\_30\_2

[1. Transients, Variable Stars](#)[2. Informatics and Statistics](#)

## Gaussian Process Framework with an Analytical Mean Function for Multiband Transient Light Curves

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**Keywords:** Transient lightcurves, Gaussian process, fitting data, TDE, SN

The LSST survey is set to deliver multiband, irregularly sampled photometry for tens of millions of transient sources per year across its six filters. With a single per-filter visit cadence of weeks and spectroscopic follow-up feasible for only a small fraction of detected events, photometric inference, crucial to current classification algorithms in the current literature, must extract physical parameters directly from sparse multiband light curves. Doing so requires a model that interpolates across bands, propagates uncertainties consistently, and remains general across the diverse behavior of fast transients. Gaussian process regression in time and wavelength handles such heterogeneous photometry effectively, but existing implementations rely on a stationary kernel and a zero-mean function. This assumption is invalid for fast transients because their rise, peak, decline, and plateau phases evolve on very different timescales, whereas a stationary kernel imposes a single correlation length across the entire light curve. Consequently, this mismatch causes the over-smoothing of sharp features, biases uncertainties between observations, and yields hyperparameters that describe a statistical compromise rather than astrophysics.

This work presents a new method for multiband transient light curves built on a Gaussian process with an analytical–physical mean function that is grounded in physics without using a specific emission mechanism. The mean function consists of three components, where an analytic rise-and-decline term describes the bolometric light curve, an optional plateau term describes the late-time emission seen in Tidal Disruption Events, and a time-evolving blackbody temperature distributes the bolometric flux across wavelengths through the Planck law. Because the mean function absorbs the non-stationary evolution of the light curve directly, the remaining residuals are well behaved at a single scale, allowing a stationary Gaussian process kernel to model them adequately. Testing on real ZTF transients, simulated ELAsTiCC light curves at Rubin cadence, and the MALLORN dataset of artificial LSST light curves demonstrates that the same parameterization recovers consistent physical parameters across all three samples.

## Galaxies

Splinter session

**Tue Sep 29 13:30 – 15:30**

**Chair:** *Sugata Kaviraj*

47.190\_45\_1

[1. Galaxies](#)

### **A promising way to infer cluster masses using only ultra-deep imaging**

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Galaxy clusters are an important tool for cosmology, since the evolution of the cluster mass function depends strongly on cosmological parameters. Therefore, an accurate estimate of the cluster mass is of paramount importance. However, these mass estimates systematically differ from the true cluster mass due to the approximations assumed in each approach. With the upcoming deep wide surveys (e.g. LSST), it is of utmost importance to find a way to derive cluster masses in a more robust way. When galaxies in groups and clusters collide, stars are ejected from their galactic moorings and end up populating the space between the galaxies, forming over time a diffuse light, the intracluster light (ICL). Several properties of the ICL have been shown to correlate with cluster mass, making this light a promising tool for inferring cluster masses using deep imaging alone. In this presentation, I will demonstrate how the ICL can be leveraged to infer the total mass of galaxy clusters. I will present results based on ultra-deep imaging from the Hubble Space Telescopes and its gravitational lensing mass models establishing a relationship between ICL and total cluster mass. This approach represents a significant advancement in the precision and scale of cluster mass measurements, with important implications for cosmological constraints.

40.179\_33\_1

1. Galaxies

2. Dark Energy

## Low surface brightness galaxies in the large-scale structure

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LSST will allow to detect an unprecedented number of low surface brightness galaxies – although the completeness and biases of the gathered datasets will depend on technical factors. Even so, the relations between the observed galaxies and the cosmic web will allow to shed new light on environmental effects in the process of formation and evolution galaxies. I will present a selection of recent results of our group in Warsaw aiming to disentangle these relations and optimizing methods for the LSST data.

61.226\_70\_1

1. Galaxies

2. Informatics and Statistics

3. Science with DP2

## Optimising detection and deblending for low surface brightness science and beyond

Tom Sedgwick<sup>1</sup>, Fred Moolekamp<sup>2</sup>, Lee Kelvin<sup>2</sup>, Aaron Watkins<sup>1</sup>, Sugata Kaviraj<sup>1</sup>, Chris Collins<sup>3</sup>

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**Keywords:** techniques: image processing, methods: data analysis, surveys, galaxies: photometry, galaxies: structure, galaxies: dwarf

Source detection and deblending turn reduced LSST images into the photometric catalogues on which much downstream science will depend, from cosmic shear and dark energy to transient hosts, intracluster light and dwarf galaxies. Current detection methodology involves a difficult trade-off: strict S/N thresholds and aggressive candidate culling produce clean catalogues but miss low surface brightness galaxies, while permissive settings recover fainter sources but lead to extra detections in bright, well-resolved galaxies. Because the LSST deblender is agnostic to the legitimacy of the detections it receives, a missed faint neighbour or spurious peak can corrupt the photometry of an entire blend and lead to unfeasible source morphologies or shredded extended sources, respectively.

To search for a better optimised detection methodology, we build mock 10-year LSST deep coadds by injecting galaxies with rest-frame properties drawn from COSMOS-UltraVISTA data, over  $z < 3$  and  $\log M_*/M_\odot > 7$ , and run the detection LSST pipeline on the resulting images. Tuning S/N thresholds and candidate-culling rules gives only marginal gains in completeness and purity, showing that peak finding alone has limited discriminatory power across the diversity of astrophysical sources.

We therefore develop a lightweight, interpretable machine-learning layer trained on the mock catalogues and imaging. It re-examines borderline detection candidates using inexpensive features complementary to peak finding, including forced-aperture fluxes and colours, aperture-annulus contrast, and multi-band coherence. One ML step increases detectability of  $26 \leq \mu_{r,eff} < 28$  sources by an order of magnitude, while a second layer significantly reduces spurious peaks from star-forming knots, spiral arms, tidal features and diffraction spikes. Together, these gains produce a detection catalogue that is both deeper and cleaner, improving the reliability of deblender data products across the full surface-brightness range. Next steps are to further validate the approach on early LSST imaging, implement pipeline changes, before turning to complementary improvements to the deblender itself.

50.197\_55\_1

1. Galaxies

2. Science with DP2

## A new class of extreme galaxies found in the Virgo Cluster using Rubin First Look images

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Recent deep imaging surveys have discovered a new type of galaxy known as “almost-dark” galaxies. These galaxies are much fainter than Ultra-Diffuse Galaxies, yet they have similarly large extensions. Almost-dark galaxies have negligible baryonic effect on their dark matter halos, keeping halo profiles unchanged and allowing for the testing of different dark matter models by comparing these observed profiles to the models’ predictions. In this talk, I present the almost-dark galaxy TTT J1237327+143535, discovered with the Two-Meter Twin Telescope at the Teide Observatory. This galaxy has a central surface brightness of 28 mag arcsec<sup>-2</sup> in the g-band and an effective radius of 1 kpc at the distance of the Virgo Cluster. Together with four similar systems identified in the Rubin First Look color images, this object suggests the existence of a previously unrecognized population of galaxies in the Virgo Cluster. New Rubin data releases and the LSST 10-year coadds are expected to reveal large samples of this new galaxy population, which can help answer questions on the nature of dark matter.

30.167\_35\_1

1. Science with DP1

2. Galaxies

3. Informatics and Statistics

## pop-cosmos: Scaleable SED fitting for LSST with a generative galaxy population model prior

Madalina Tudorache<sup>1</sup>, Sinan Deger<sup>1</sup>, Anik Halder<sup>1</sup>, Gurjeet Jagwani<sup>1</sup>, Boris Leistedt<sup>2</sup>, Joel Leja<sup>3</sup>, Daniel Mortlock<sup>2</sup>, Hiranya Peiris<sup>1</sup>, Benedict van den Bussche<sup>1</sup>

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**Keywords:** galaxies: photometry – galaxies: statistics

Upcoming surveys like the Legacy Survey of Space and Time (LSST) on the Vera C. Rubin Observatory will produce observations of billions of galaxies, creating an urgent need for scalable, reproducible methods to extract physical properties such as redshifts and stellar masses. We introduce pop-cosmos, a forward-modelling framework for photometric survey data that approaches this challenge by treating galaxies as draws from a population-level prior over physical parameters -- including redshift, stellar mass, star formation history, and dust properties. This prior is mapped to observed colours and brightness using neural emulators that stand in for otherwise prohibitively expensive astrophysical models.

To calibrate the population prior, we use simulation-based inference, training a diffusion model to reproduce the statistical properties of deep multi-wavelength observations from the Cosmic Evolution Survey (COSMOS2020). This allows the framework to learn realistic galaxy population structure directly from data, without relying on hand-tuned assumptions. We present results applying pop-cosmos to LSST DP1 data, demonstrating both stellar population parameter inference and redshift estimation, with full MCMC posteriors obtained in seconds per galaxy on a GPU.

53. 203\_56\_1

1. Galaxies

## The relationship between morphology, density and location in the cosmic web from massive to dwarf galaxies

Ilin Lazar<sup>1</sup>, Sugata Kaviraj<sup>1</sup>, Aaron E. Watkins<sup>1</sup>, Christopher J. Conselice<sup>2</sup>, Darshan Kakkad<sup>1</sup>, Thomas M. Sedgwick<sup>1</sup>, Garreth Martin<sup>3</sup> and Sophie Koudmani<sup>1</sup>

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**Keywords:** galaxies: evolution -- galaxies: formation -- galaxies:dwarf

We study how morphology relates to environment from massive to dwarf galaxies using, for the first time, a mass-complete sample of  $\sim 13,000$  galaxies, in the stellar-mass and redshift ranges  $10^8 M_{\text{Sun}} < M_{\text{star}} < 10^{11.5} M_{\text{Sun}}$  and  $0.2 < z < 0.4$ , respectively. Our galaxies span an array of environments from large groups to the field, but do not reside in rich clusters. By combining HST-derived visual morphological classifications with local density and galaxy distances from nodes and filaments, we quantify how early-type and late-type galaxies (ETGs and LTGs) differ with respect to these environmental parameters. The overall fraction of ETGs decreases from  $\sim 65\%$  at  $M_{\text{star}} \sim 10^{11} M_{\text{Sun}}$  to  $\sim 20\%$  at  $M_{\text{star}} \sim 10^8 M_{\text{Sun}}$ . Regardless of morphological type, galaxies with lower stellar mass lie further away from nodes and the cores of filaments than their more massive counterparts. While, at  $M_{\text{star}} > 10^9 M_{\text{Sun}}$ , ETGs reside further away from nodes and filaments than LTGs, this segregation weakens as stellar mass decreases, with ETGs and LTGs exhibiting similar locations at  $M_{\text{star}} < 10^9 M_{\text{Sun}}$ . The diminishing difference between ETGs and LTGs at lower stellar mass is likely driven by the fact that filaments have a finite extent and lower stellar mass galaxies, regardless of morphological type, lie further away from filament cores and are confined to a smaller region of the filament. For high mass galaxies (where ETGs and LTGs show strong environmental segregation), greater proximity to nodes likely inhibits coherent angular momentum acquisition, while residing closer to filament cores increases the likelihood of interactions and mergers. Both make it easier to create dispersion-dominated systems, resulting in a sharp rise of the ETG fraction, in the high mass regime, close to nodes (and, to a lesser extent, filaments). Taken together with the recent literature, our results show that galaxy evolution is increasingly driven by internal processes as stellar mass decreases.

## Active Galactic Nuclei

Splinter session

Tue Sep 29 16:00 – 17:30

Chair: *Matthew Temple*

9.121\_8\_1

[1. Active Galactic Nuclei](#)

### The LSST AGN Science Collaboration: European Opportunities in the Rubin Data Era

W. Niel Brandt<sup>1</sup>, Matthew J. Temple<sup>2</sup>, The LSST AGN Science Collaboration

<sup>1</sup> Penn State University, University Park, USA

<sup>2</sup> Durham University, Durham, UK

**Keywords:** Active Galactic Nuclei, Supermassive Black Holes, Rubin Observatory, LSST

The LSST Active Galactic Nuclei Science Collaboration (AGN SC), comprising approximately 320 members worldwide - including about 95 based in Europe - aims to lead many of the large-scale investigations of growing supermassive black holes in AGNs enabled by the Rubin Observatory. I will briefly summarize the history, goals, membership, and organizational structure of the AGN SC. I will then highlight recent activities, including ongoing projects and publications; the acquisition and analysis of ancillary data sets (e.g., in the Deep-Drilling Fields); the execution of data challenges; contributions to survey cadence optimization; regular collaboration meetings; service on key Rubin working groups; and outreach to both the scientific community and the general public. Finally, I will emphasize the AGN SC's plans for early Rubin data and describe how interested members of the European astronomical community can become involved.

## 5.111\_6\_1

1. Active Galactic Nuclei

2. Galaxies

3. Science with prompt data products

**Revealing AGN host galaxy properties in the LSST DDFs**Shenli Tang<sup>1</sup>, Manda Banerji<sup>1</sup>, Elham Saremi<sup>1</sup><sup>1</sup> School of Physics and Astronomy, University of Southampton, Highfield Campus, Southampton SO17 1BJ, UK

The host galaxy properties of AGNs are the key to understand the co-evolutionary scenario between the supermassive black holes (SMBHs) and their environment. While revealing them under the contamination of the point source remains a challenging task. In this work, we focus on the XMM-LSS field, which is one of the primary deep drilling fields (DDF) of LSST. This field is covered by Subaru HSC-SSP, a path-finder survey of LSST, and also VISTA VIDEO. At the University of Southampton, as part of the LSST in-kind contribution programme, we developed the LSST–VISTA Fusion Pipeline to reprocess VIDEO data in an LSST-compatible framework. Combined with HSC data processed with the LSST pipeline, this provides eight-band imaging across grizyJHKs in the XMM-LSS field, enabling consistent multiband image analysis. The depth and image quality of these data allow us to study AGN host galaxies directly at the image level for sources at  $z < 1$ .

Starting from the X-ray-, IR-, and SED-selected AGN catalog in this field (Zou et al. 2022), we obtained images of  $\sim 2600$  AGN candidates at  $z < 1$ . We perform 2D imaging analysis techniques to remove the point source from the image using GaLight. This is possible, also thanks to the precise PSF models generated by the LSST pipeline. We then measure the pure AGN host galaxy flux from the decomposed images and proceed with the SED fitting using CIGALE. We highlight that this method does not assume any AGN SEDs, and the AGN flux is purely measured from the morphology. It also provides an independent test of reliability of the AGN selection from the morphological point of view-i.e., whether the candidate is point-source-like in image. In this presentation, I will show our preliminary results of the stellar mass of these AGN host galaxies, the reliability rate of various AGN-selection methods, and the dwarf AGN host galaxy candidates. Finally, we generate a dwarf AGN SED template from our image decomposition results, which is largely uncertain in previous works.

This work shows the potential of revealing AGN host-galaxy properties using LSST-like images, thus paving the way for imaging analyses in the LSST era.

45.186\_42\_1

1. Active Galactic Nuclei

2. Science with DP1

## Closing the loop: AGILE DR1 comparison to LSST DP1

Viitanen, Akke<sup>1,2,3</sup>, Bongiorno, Angela<sup>2</sup>, Saccheo, Ivano<sup>4</sup>

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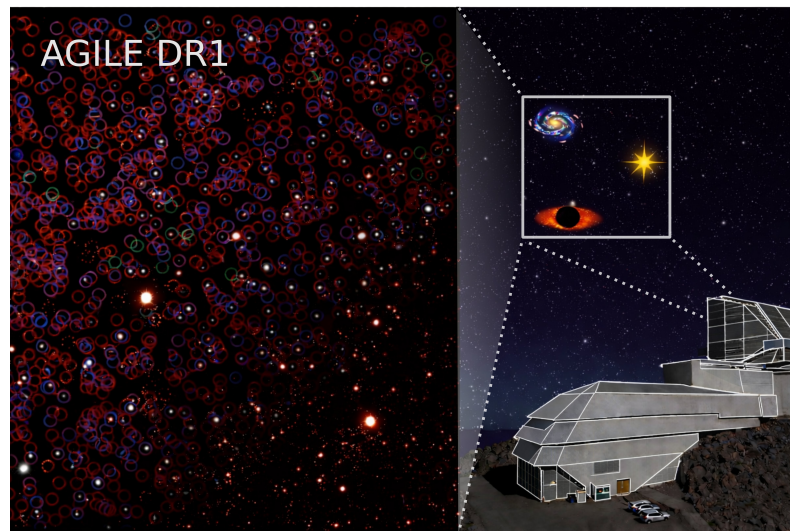
<sup>3</sup> University of Helsinki, Helsinki, Finland

<sup>4</sup> University of Bristol, Bristol, UK

**Keywords:** AGN, simulations, DP1

Contemporary large-scale surveys such as the Vera C. Rubin Observatory Legacy Survey of Space and Time (LSST) and *Euclid* present an unprecedented discovery potential for studying active galactic nuclei (AGNs). However, the major challenge is the accurate identification and classification of AGNs from photometry or variability data alone.

Here, I attempt to close the loop between AGILE simulations and LSST observations. AGILE (AGNs In the LSST Era; Viitanen et al., 2026) is an end-to-end simulation pipeline capable of simulating catalogs of AGNs, galaxies, and stars, and LSST-like images and photometric catalogs. The AGILE DR1 dataset (3yrs/1deg<sup>2</sup> of simulated data in the COSMOS field) is comparable in depth and area to the LSST DP1 in the ECDFS. Therefore, it presents a perfect opportunity to interpret the data. In this talk, I will present the preliminary results from comparing AGILE DR1 to LSST DP1 and discuss what can be already learned from these first LSST data.



**Figure 1:** AGILE (AGNs In the LSST Era) is a realistic end-to-end simulation pipeline and a part of the Italian in-kind contribution. It is designed to simulate the AGNs, galaxies, and stars in LSST at the level of mock catalogs, images, and photometric catalogs. AGILE DR1 – the first data release – is comparable in scope to LSST DP1. In my talk, I will discuss the results of the direct comparison between the two.

27.164\_21\_1

1. Active Galactic Nuclei

2. Informatics and Statistics

## Multi-Head ALNP: An Attentive Latent Neural Process for AGN light curve reconstruction and parameters inference

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Historically, to study the geometry of the innermost region of an Active Galactic Nucleus (AGN), we used a technique known as Reverberation Mapping (RM). Recent observational evidence suggests that the standard picture of the AGN accretion disk is incomplete, indicating that the disk is systematically larger than predicted by the classical Shakura–Sunyaev model, a discrepancy commonly referred to as the “disk size problem”.

Traditional RM techniques have been the primary tool for studying this phenomenon, but they perform poorly on the sparse and irregularly sampled light curves typical of astronomical observations. Furthermore, the number of sources with dedicated RM campaigns is small. A definite answer as to why we observe the disk size problem, still unclear.

The advent of next-generation surveys, such as the Legacy Survey of Space and Time (LSST), will provide higher-cadence observations for millions of AGNs. While this will dramatically increase the available data, it also demands scalable and computationally efficient analysis techniques capable of processing the unprecedented data volume.

In this context, we present a Multi-Head ALNP, a Latent Attentive Neural Process designed to simultaneously reconstruct AGN light curves and infer their underlying physical parameters. By combining these tasks within a single framework, the model addresses both the challenges posed by sparse, irregularly sampled observations and the computational demands of the LSST era.

51. 200\_49\_1

1. Active Galactic Nuclei

## Variability-selected AGN in dwarf galaxies: the incidence of AGN in dwarf and massive galaxies is similar

Sugata Kaviraj<sup>1</sup>, Demetra De Cicco<sup>2</sup>, Ilin Lazar<sup>1</sup>, Brian Bichang'a<sup>1</sup>, Aaron Watkins<sup>1</sup>, Garreth Martin<sup>3</sup> and Sophie Koudmani<sup>1</sup>

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**Keywords:** galaxies: evolution -- galaxies: formation -- galaxies: interactions -- galaxies:dwarf -- galaxies: active

The incidence and role of AGN in the evolution of dwarf galaxies is a key unresolved problem. We use the VST-COSMOS survey to identify, via their optical broadband variability, 30 AGN in nearby ( $z < 0.4$ ) dwarf ( $10^8 \text{ M}_{\text{Sun}} < M_{\text{star}} < 10^{10} \text{ M}_{\text{Sun}}$ ) galaxies. VST-COSMOS offers a  $1 \text{ deg}^2$  survey footprint, a single visit depth of 24.6 mag and 68 r-band visits spanning an eleven-year temporal baseline. Given its LSST-like single-visit depth and temporal baseline, our study provides a preview of the novel AGN science that will soon be possible in dwarf galaxies with LSST.

Compared to a control sample matched in stellar mass and redshift, our dwarf-hosted AGN population shows an elevated fraction of early-type galaxies but a similar fraction of interacting objects, suggesting that interactions do not play a significant role in triggering these AGN. The dwarf hosts do not show strong differences in their distances to nodes, filaments and massive galaxies compared to the controls, which indicates that AGN triggering, at least in this sample, is not strongly correlated with environment.

Finally, by combining the true number of galaxies, the detectability of AGN and the measured numbers of variable sources in dwarf and massive ( $M > 10^{10} \text{ M}_{\text{Sun}}$ ) galaxies, we estimate the relative frequency of AGN in these two mass regimes. Contrary to the prevailing view, which is largely based on shallower surveys, we find that the incidence of AGN is similar (within less than a factor of two) in dwarf and massive galaxies, with tentative evidence for an increasing AGN fraction with stellar mass among dwarfs.

## Stars, Milky Way, and Local Volume

Splinter session

Tue Sep 29 16:00 – 17:30

Chair: *Tom J. Wilson*

58.218\_66\_1

1. Transients, Variable Stars

2. Stars Milky Way Local Volume

### Bridging the Gap to Rubin-LSST: multi-band ugrizY characterization of high-fidelity variable stars in the Galactic bulge

Massimo Dall'Ora<sup>1</sup>, Mahtab Gholami<sup>1</sup>, Julio Olivares Carvajal<sup>1</sup>, Silvio Leccia<sup>1</sup>, Alonso Luna<sup>2</sup>, V. Braga<sup>3</sup>, A. Calamida<sup>4,1</sup>

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**Keywords:** Galactic bulge, variable stars

As the Vera C. Rubin Observatory begins full-scale operations, the need for high-cadence, multi-band benchmarks in crowded fields is critical. We present the results of a decadal photometric survey of the Galactic Bulge using the Dark Energy Camera (DECam), providing a strategic bridge to future LSST Science. Our study leverages a massive ugrizY archive spanning over 10 years, with individual light curves sampled up to 1,000 epochs, spanning the same LSST baseline with a sampling 10 times denser.

We compared our results with OGLE-IV and demonstrated an 83% recovery rate of the already known variables while 38% of the objects in our catalogue are new discoveries. A systematic manual vetting of our first inspected field resulted in a final catalog of 6,320 high-quality variable candidates, while other tens of thousands of objects do show clear signs of variability, but without obvious periodic behaviour.

A primary highlight of this work is the expansion of the OGLE-IV variables to the ugrizY photometric system. When focusing on the RR Lyrae stars, these data serve as a vital tracer for distance, reddening, and metallicity, providing a 5- filter “ground truth” for modeling Galactic stellar populations in the LSST era. In conclusion, this catalog offers an unprecedented look at pulsating variables in the Bulge, refining the period-luminosity-metallicity relations required for the next generation of Galactic structure studies. Finally, the unclassified objects in our catalogue will build a solid benchmark, for the „unknown unknowns” science.

38.176\_31\_1

[1. Stars Milky Way Local Volume](#)

## SPICE4LSST: Incompleteness and Crowding Errors for LSST data releases

Giada Pastorelli<sup>1</sup>, Leo Girardi<sup>1</sup>, Massimo Dall’Ora<sup>2</sup>, Marcella Di Criscienzo<sup>3</sup>, Simone Zaggia<sup>1</sup>

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**Keywords:** stellar crowding, photometry, stellar populations

I will present a status update on an ongoing project designed to quantify the incompleteness and photometric errors caused by stellar crowding in LSST data releases. The classical approach of performing artificial star tests (ASTs) for every observed pointing is not computationally feasible due to the sheer scale of LSST data. As such, this remains an unplanned component of the data releases, yet it is critical for many science applications, including deriving star formation histories of Milky Way substructures, using pulsating stars as population tracers and distance indicators.

To address this, we are developing a pipeline that performs and analyzes ASTs for selected, representative fields covering a wide range of stellar densities and luminosity functions. By leveraging the behavior of crowding errors as a function of seeing inferred from LSST-TRILEGAL simulations, and using deep HST data as control fields, we are developing interpolation algorithms to provide the expected incompleteness and photometric errors for any given sky location observed by Rubin LSST.

This pipeline is currently being tested using visit and deep coadd images from LSST Data Preview 1 in preparation for Data Preview 2. The software developed within this project will be integrated into the Rubin Science Platform, and the resulting data products will be made fully available to the community.

13.135\_51\_1

1. Stars Milky Way Local Volume

2. Science with DP1

3. Science with DP2

## Photo-D with the LSST: First Stellar Photometric Distances, Faint Blue Star Deficits in DP1 and Future Photo-D Stellar Distance Catalogs

Lovro Palaversa<sup>1</sup>, Ema Donev, Željko Ivezić, Lovorka Gajović

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We investigated the utility of Rubin's Data Preview 1 (DP1) for estimating stellar number density profiles across the Milky Way halo by using ugrizy photometry released in DP1 to estimate distance and metallicity for blue main sequence stars brighter than  $r = 24$  in three  $\sim 1.1$  sq. deg. fields at southern Galactic latitudes.

Compared to TRILEGAL simulations of the Galaxy's stellar content, we found a likely deficit of blue main sequence turn-off stars with  $22 < r < 24$ . We interpreted this discrepancy as a signature of a steeper halo number density profile at galactocentric distances 10 – 50 kpc than the canonical  $\sim 1/r^3$  profile assumed in TRILEGAL simulations.

This interpretation is consistent with earlier suggestions based on observations of more luminous, but much less numerous, evolved stellar populations, along with a few pencil beam surveys of blue main sequence stars in the northern sky. These results bode well for the future Galactic halo exploration with Rubin's Legacy Survey of Space and Time.

In addition to the DP1 results above, I'll also give a short overview of what we expect to deliver in the photo-D stellar distances catalog, starting with the DP2 and subsequent data releases.

21.146\_14\_1

1. Science with prompt data products
2. Transients, Variable Stars
3. Stars Milky Way Local Volume

## **A Scientific exploration only possible with Rubin-LSST: Search for hidden baryons through interstellar scintillation**

Marc Monier<sup>1</sup>,

<sup>1</sup> IJCLab CNRS, Orsay Bp34, IJCLab Batiment 200, Rue Ampère, 91898, France

Cold molecular hydrogen (H<sub>2</sub>) could be the ultimate component of the Milky Way's hidden baryonic matter. I will present a new method for searching for this transparent matter in the galactic disk and halo by exploiting its diffraction and refraction effects on the light from background stars with small angular sizes — and thus high magnitudes ( $V > 20$ ). The light from these background stars can undergo stochastic fluctuations on the order of a few percent on a timescale of a few minutes, measurable only with the LSST.

I will show that a mini-survey campaign lasting a few hours with the Vera Rubin Observatory telescope, consisting in filming a single field (in the Large Magellanic Cloud or the Small Magellanic Cloud) at a rate of a few images per minute, offers a unique opportunity to detect (or rule out) interstellar scintillation caused by transparent turbulent clouds in the halo.

96.212\_62\_1

- 1. Stars Milky Way Local Volume
- 2. Transients, Variable Stars
- 3. Informatics and Statistics

## Predicting the metallicity of RR Lyrae stars in LSST based on their pulsational properties and machine learning

Gustavo E. Medina<sup>1,2</sup>, Yazan Bakhshwin<sup>1,3</sup>, Nina Hernitschek<sup>4</sup>, Ting S. Li<sup>1,2</sup>, Sergey Koposov<sup>5</sup>

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**Keywords:** Computational methods, Milky Way Galaxy, RR Lyrae variable stars, Spectroscopy, Surveys

RR Lyrae stars are low-mass pulsating variables that serve as precise distance indicators and tracers of old stellar populations across the Local Group. Since their metallicity shapes their pulsational properties (e.g., their periods, light curve morphology, and the presence of multiple pulsation modes), determining their iron abundances ( $[Fe/H]$ ) is key both to their reliability as distance and population tracers and to our understanding of stellar pulsation theory. Yet, spectroscopic  $[Fe/H]$  measurements remain challenging for these stars due to their short-period variability and the difficulty of obtaining spectra for complete RR Lyrae samples across the Galaxy.

Well-established correlations between  $[Fe/H]$  and pulsational observables, including their periods and the Fourier decomposition parameters of their light curve, allow the estimation of  $[Fe/H]$  from photometry alone, an approach that scales naturally to the large RR Lyrae samples expected from modern photometric surveys. The Vera Rubin Observatory is now delivering multi-band time-series photometry of unprecedented depth across the Southern sky through its Legacy Survey of Space and Time (LSST), which will enable the photometric characterization of the first complete sample of RR Lyrae stars reaching the Galaxy's outermost regions.

In this contribution, we present supervised machine learning models for the prediction of photometric metallicities of both fundamental-mode (RRab) and first-overtone (RRc) RR Lyrae stars, trained on multi-band light curves from Gaia DR3, ZTF, early LSST data, and spectroscopic  $[Fe/H]$  measurements from the Dark Energy Spectroscopic Instrument (DESI). Using pulsation periods and Fourier parameters as input features, we quantify their performance and robustness as a function of light curve properties. We will discuss the application of the best-performing models to LSST DP1/DP2 data to deliver a first homogeneous catalogue of LSST-based RR Lyrae metallicities across the Galactic halo, demonstrating the power of multi-survey synergies for stellar population science in the era of LSST.

## Solar System SC & GX & AGN

Plenary session

Wed Sep 30 9:00 – 10:30

Chair: *Lovro Palaversa*

52. 200\_50\_1 **INVITED!**

1. [Galaxies](#)

### The Rubin-LSST Galaxies Science Collaboration: activities and highlights

Sugata Kaviraj<sup>1</sup>, Simona Mei<sup>2</sup>

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**Keywords:** galaxies: evolution -- galaxies: formation

The [Rubin-LSST Galaxies Science Collaboration](#) is one of the original nine LSST Science Collaborations founded in 2006. Its aims, as described in this [Roadmap](#), are to conduct a wide range of extragalactic research programs with LSST data and assist the LSST Project in developing critical data and software products that will enable astronomers from all over the world to conduct cutting-edge research programs of their own. I will describe the current activities of the Collaboration, present highlights of our recent work and discuss the Collaboration's scientific priorities using the upcoming Data Previews and LSST DR1.

81. **INVITED**

## 1. Galaxies

**LSST as a low surface brightness discovery survey**Aaron Watkins<sup>1</sup><sup>1</sup>University of Hertfordshire, UK

The low surface brightness (LSB) regime remains an extremely important but still largely unexplored area of astronomical research, with past LSB surveys focusing predominantly on nearby individual galaxies, groups, or clusters. While LSST was designed as a cosmology, variability, local Universe, and solar system survey, its vast breadth and expected depth invite exploitation of its data for use in the LSB regime as well. Indeed, it is capable of becoming, by the end of its 10-year run, the most important LSB survey ever conducted. However, LSB observing and data processing requirements are strict and quite specific--systematics such as flat-fielding errors must be minimized across the entire field of view, scattered light must be prevented or its impact reduced, and telluric night sky emission must be modelled and removed in such a way as to preserve the astrophysically interesting LSB flux in every image--which sometimes can conflict with the requirements of, for example, weak lensing science. Still, given the enormous reach of its expected discovery space, LSB has recently become an important alternative science goal for LSST, and so efforts have been and are being made to ensure that this regime is accessible. From hardware adjustments to the telescope mount assembly and dome, to software adjustments to the image reduction pipeline and detection or deblending software, this talk provides a broad overview of these efforts to showcase the positive current status and future challenges of LSB within the LSST ecosystem.

35.172\_26\_1 **INVITED!**

1. Active Galactic Nuclei

## Advancing Rubin-Era AGN Science through European In-Kind Contributions

Andjelka B. Kovačević<sup>1</sup>, Dragana Ilić<sup>1</sup>, Matthew Temple<sup>2</sup>

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**Keywords:** active galactic nuclei, time domain astronomy, data analysis methods

The LSST will deliver unprecedented AGN time-domain data, probing accretion physics, black hole demographics, and transient phenomena at scales inaccessible to current surveys. Translating this data volume into science requires robust, scalable analysis infrastructure — an area where European in-kind contributions to the LSST AGN Science Collaboration (LSST AGN SC) are making visible and targeted impact.

We review the current landscape of European-led efforts within the LSST AGN Science Collaboration, encompassing light-curve characterisation, nonlinear periodicity detection, multi-band coherence analysis, and anomaly-driven discovery. We assess the readiness of these pipelines, and the open challenges that will define AGN time-domain science through early operations and beyond.

## Galaxies & AGN

Splinter session

Wed Sep 30 11:00 – 12:30

Chair: *Sugata Kaviraj*

88. **INVITED**

1. Galaxies

### **The Extragalactic ML Toolkit: Overcoming the LSST's Data Deluge with Community-Driven Algorithms**

Ilin Lazar<sup>1</sup>

<sup>1</sup> Centre for Astrophysics Research, University of Hertfordshire, Hatfield, AL10 9AB, UK

The Vera C. Rubin Observatory's Legacy Survey of Space and Time (LSST) is poised to revolutionize extragalactic astronomy, generating an unprecedented volume of data that will catalog billions of galaxies and millions of Active Galactic Nuclei (AGN) over ten years. In this data-rich regime, traditional analysis methods will quickly become a computational bottleneck, making the adoption of advanced machine learning (ML) techniques not just advantageous, but essential. Given that LSST will probe unprecedented depths throughout its 10-year programme and given that we face a critical scarcity of training sets for faint object populations we will also need viable techniques to process these data.

In this talk, I will emphasize the growing necessity of unsupervised and self-supervised ML algorithms to successfully explore the Low Surface Brightness (LSB) and dwarf galaxy regimes without relying on biased or highly limited prior catalogues and training sets.

Finally, I will briefly review the current landscape of community-built ML frameworks focusing on their application to key extragalactic challenges. This includes scalable infrastructure for probabilistic photometric redshift estimation, modern algorithms for automated structural and morphological galaxy classification, robust deblending techniques for crowded fields, and advanced alert brokers capable of filtering millions of transient alerts for early AGN identification.

74.246\_85\_1

[1. Galaxies](#)

## Quantifying detection and morphological biases for Low Surface Brightness Galaxies (LSBGs) in the LSST era

Anirban Dutta<sup>1</sup>, Agnieszka Pollo, Anna Durkalec, Nandini Hazra, Cory Hoo, John Peterson

<sup>1</sup>National Centre for Nuclear Research (NCBJ), Pasteura 7, Warszawa, 02-093 Poland

The faint nature of Low Surface Brightness Galaxies (LSBGs) makes their detection and morphological measurement highly sensitive to observational systematics. How exactly these systematics affect LSBG detection and measurement remains poorly explored. One way to quantify these biases for the upcoming Rubin Observatory LSST, is to map how ground-based recovery compares against high-resolution, deep, space-based data. To investigate this, we simulate  $> 26$  magnitude depth LSST images of the Perseus cluster using Euclid VIS images as the "truth" in PhoSim. We stack several 30-second simulated exposures, apply various background subtraction methods, and run source detection to identify LSBGs. We find that  $\sim 35\%$  of LSBGs detected in Euclid are not recovered in the simulated LSST images. We compare the recovered magnitudes as well as morphological parameters such as axis ratio, Sérsic index, and effective radius in order to assess biases and propose either calibration strategies or low-surface-brightness optimized measurement techniques for future LSST analyses.

71. 242\_82\_1

1. Active Galactic Nuclei

2. Stars, Milky Way, Local Volume

## Milky Way Near Twins: Evolutionary diagnostics for search and NGC 3521 as the example

Vavilova Iryna<sup>1</sup>, Kompaniets Olena<sup>1</sup>, Vasylykivskiy Yevhen<sup>2</sup>, Konovalenko, Oleksandr<sup>2</sup>, Pastoven Olena<sup>1</sup>, Izviekova Inna<sup>1,3</sup>, Junais<sup>5</sup>, Dmytrenko Artem<sup>1</sup>, Dobrycheva Daria<sup>1</sup>, Fedorov Petro<sup>4</sup>, Khramtsov Vladyslav<sup>1,4</sup>, Sergijenko Olga<sup>1</sup>, Vasylenko Anatoliy<sup>1</sup>

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<sup>5</sup> Instituto de Astrofísica de Canarias (IAC), Tenerife, Spain

**Keywords:** Milky Way, Milky Way analogues, NGC3521

Milky Way analogues (MWAs) are usually identified through structural, kinematic, and global physical parameters. However, a more complete search for MW-like systems should also account for key environmental and evolutionary properties of the Milky Way (MW), including its relatively isolated location in the local cosmic web, absent or weak nuclear activity, and low-mass central supermassive black hole. In this context, the integrated spectral energy distribution (SED) offers an additional physically motivated diagnostic: galaxies evolving on a similar cosmological scale are expected to show broadly consistent SED shapes, star-formation rates, stellar masses, and dust properties, within the natural scatter of MWA parameters.

We present a homogeneous aperture-photometry-based SED of NGC 3521, one of the nearest and best-known MW near-twin candidates, extending from the ultraviolet to the radio decimeter domain. The SED combines measurements from GALEX, SDSS, WISE, Spitzer/MIPS, Herschel/PACS and SPIRE, VLA imaging, and new low-frequency observations obtained with the Ukrainian T-shaped Radio Telescope, UTR-2. The UTR-2 data, acquired in January–February 2022, provide a constraint on the decimeter emission and an upper limit in the 24–32 MHz band. The full UV-to-radio SED was modeled with CIGALE, including a dedicated radio\_extra module developed to account for emission and absorption effects in the meter and decimeter radio regimes.

The final SED contains 27 photometric points. The preferred model yields a stellar mass of  $M_{\star} \simeq 6.0 \times 10^{10} M_{\odot}$ , a star-formation rate of  $\text{SFR} \simeq 1.65 M_{\odot} \text{ yr}^{-1}$ , a dust mass of  $M_{\text{dust}} \simeq 1.3 \times 10^8 M_{\odot}$ . By comparing the modeled SED of NGC 3521 with that of the MW, we find a strong similarity in the global SED shape, with the most noticeable residual offsets in the far-UV and around the far-IR dust peak. This close agreement supports the use of integrated SED shape as a complementary criterion for identifying and validating Milky Way analogues. Such an approach is particularly relevant for the LSST era, where large optical time-domain datasets will enable systematic searches for MW-like galaxies, while multi-wavelength SED constraints can help distinguish genuinely close analogues from structurally similar but physically different systems.

14. 134\_15\_1

[1. Active Galactic Nuclei](#)

## Differential Chromatic Refraction with LSST

Matthew Temple<sup>1</sup><sup>1</sup> Durham University, South Road, Dh1 3Le, Durham, UK

As the Earth's atmosphere acts as a prism, different wavelengths of light from each source are observed at slightly different positions on the night sky. A standard SED is assumed to remove this effect in the Rubin pipelines, but the residual astrometric shifts due to this "differential chromatic refraction" (DCR) effect encode information about the sub-band distribution of flux within Rubin's filters, ie. deviations from the standard SED. I will present results from a project to model to effect of DCR on galaxies and AGN observed within the Rubin Observatory's Legacy Survey of Space of Time and understand how we can improve the estimation of photometric redshifts by incorporating additional information from DCR.

56. 209\_59\_4

1. Active Galactic Nuclei

## A multi-wavelength approach to high-redshift quasar detection and identification

Julie Beck<sup>1</sup>, Katherine Kauma<sup>1</sup>, Richard McMahon<sup>1</sup>

<sup>1</sup> Institute of Astronomy, University of Cambridge

**Keywords:** High-redshift quasars, Supermassive Black Holes, Galaxy evolution

High-redshift quasars at  $4 < z < 7$  offer a unique testing ground for theories on Supermassive Black Hole formation and evolution as well as galaxy co-evolution. To constrain these processes, a statistically significant number of quasar detections are needed. LSST is expected to uncover around 10 – 20 million quasars over its 10-year duration [1] and will provide time-domain and photometric observations in 6 different wavebands (u,g,r,i,z,y) covering approximately 30000 deg<sup>2</sup>. A major challenge will be the identification of new quasars, hence the focus of our project on creating a multi-wavelength framework incorporating spectroscopic data as well as infrared from VISTA and X-Ray observations to allow for an efficient quasar selection procedure.

We present our work that combines LSST observations with quasar data from different surveys as well as spectroscopic observation using the spectrograph VISTA/4MOST (<https://www.4most.eu/cms/home/>) upon its first internal data release (expected September 2026). Near-Infrared observations of the Southern hemisphere are provided by the VISTA Hemisphere Survey (VHS) DR5 (<https://www.eso.org/qi/catalog/show/290>), containing around 20000 deg<sup>2</sup> of extra-galactic observations. CSC 2.1 (<https://cxc.cfa.harvard.edu/csc/>) and XMM DR14 (<http://xmmssc.irap.omp.eu/>) complement our data in the X-Ray, with Gaia DR4 (<https://www.cosmos.esa.int/web/gaia/dr4>) providing monthly multi-epoch time-domain optical observations taken from 2014 to 2020 spanning a period of 66 months.

Our pipeline incorporates crossmatching via XMatch (<http://cdsxmatch.u-strasbg.fr/>), with the reliability of the match being validated using the likelihood ratio method presented by Sutherland and Saunders [2]. It considers not only the separation between objects but also accounts for aspects such as magnitude and background density. This approach has been validated using the Kilo-Degree Survey (KiDS) DR5 (<https://kids.strw.leidenuniv.nl>), whose footprint overlaps with both VHS and XMM, and will be applied to LSST DP2 upon its release to correctly categorise known high-redshift quasars, before extending this work to the detection of new high-redshift quasars.

To conclude, we present a multi-wavelength approach to high-redshift quasar identification across a multitude of wavebands as well as spectroscopic and photometric data, allowing for a swift categorisation of sources in LSST DP2. We further plan to extend this work to the search for new quasars, with first results expected in September 2026.

### References:

- [1] Guodong Li *et al*, 2026, *ApJ*, 1000, 165
- [2] Sutherland W., Saunders W., 1992, *Monthly Notices of the Royal Astronomical Society*, 259

## Solar System & Informatics and Statistics

Splinter session

Wed Sep 30 11:00 – 12:30

Chair: Gyula M. Szabó

12. 130\_11\_1

1. Solar System

2. Informatics and Statistics

### Preparing for the LSST: Small Hildas and Trojans as Tracers of Early Solar System Mixing

Nóra Takács<sup>1,2,3</sup> Csaba Kiss<sup>1,2,3</sup> Róbert Szakáts<sup>1,2</sup> Emese Plachy<sup>1,2</sup> Csilla E. Kalup<sup>1,2,3</sup> Gyula M. Szabó<sup>1,4,5</sup> László Molnár<sup>1,2</sup> Krisztián Sárneczky<sup>1,2</sup> Róbert Szabó<sup>1,2</sup> Attila Bódi<sup>6</sup> András Pál<sup>1,2,3</sup>

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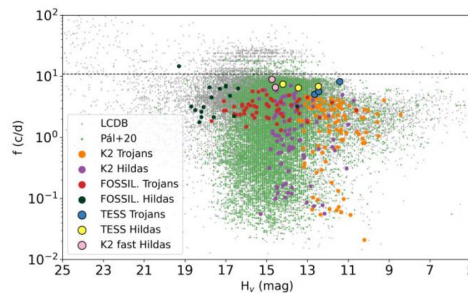
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**Keywords:** Hilda, Jupiter, Trojan, Asteroids, Main Belt, Evolution, Solar System

Jovian Trojans and Hilda asteroids are dynamically linked to Jupiter and represent important remnants of the early Solar System. Their orbital properties, rotation rates and surface compositions provide key constraints on giant planet migration and the mixing of small body populations during the Solar System's early evolution. Recent studies based mainly on TESS and K2 observations identified several unusually fast-rotating Hilda and Trojan asteroids with spin periods as short as 3–4 hours, significantly shorter than the previously known ~5-hour limit for medium-sized objects (Takács et al. 2025; Kiss et al. 2025). These fast rotations suggest either higher bulk densities or significant internal cohesion, indicating that some of these objects may be denser interlopers originating from the outer main belt rather than primordial icy bodies.



**Figure 1:** Rotational properties of inner Solar System asteroids. The dashed horizontal line marks the rotational breakup limit (a 2.2-hour period) from Pravec & Harris (2000). Different colours represent data from various sources, as shown in the legend. The fast-rotating asteroids are highlighted with large yellow and blue symbols, and the two fast rotators from K2 are marked with pink dots.

LSST will enable the detection of significantly fainter and therefore smaller Hilda and Trojan asteroids, extending current studies from the ~10 km size range down to km-scale objects. This will make it possible to investigate the poorly explored end of their size distribution and better constrain their internal structure and collisional evolution. In addition, repeated multi-band observations will provide reliable colour measurements, allowing statistical taxonomic classification into C-, P-, and D-type objects. Since C-type asteroids are expected to be denser and may represent material mixed in from the outer main belt, LSST colours will help determine the mixing fraction of these populations within both the Hilda and Trojan groups. Although accurate rotation period determination from sparse LSST sampling will remain challenging, the combination of size distribution, colour information, and rotational constraints will provide powerful new insight into the origin and evolution of Hilda and Trojan asteroids, as well as the early dynamical evolution of the Solar System.

37.175\_29\_2

[1. Solar System](#)[2. Informatics and Statistics](#)

## Improving the Detection of Faint, Fast-Moving Asteroids with Machine Learning

Karlo Mrakovčić<sup>1</sup>, Chester Lee<sup>2,3</sup>, Tom McConnell<sup>3</sup>, Mario Jurić<sup>2,3</sup>

<sup>1</sup> Faculty of Physics, University of Rijeka, Rijeka, Croatia

<sup>2</sup> University of Washington, Seattle, USA

<sup>3</sup> DIRAC Institute, Seattle, USA

The Vera C. Rubin Observatory's LSST will generate an unprecedented stream of difference-image detections for transient and moving-object science. For faint fast moving Solar System bodies, like NEOs, motion during an exposure spreads flux into low-surface-brightness streaks, making detection that is optimised for point sources less efficient. Lowering the detection threshold recovers more objects but sharply inflates the number of false positives. We present an end-to-end test of a machine learning layer that recovers faint trailed sources missed by the standard Rubin detection path while keeping the false positive load manageable.

The pipeline operates on LSSTCam difference images. We trained by injecting synthetic asteroid trails with controlled SNR, length, and orientation using realistic trail rendering, and score recovery by footprint overlap against the LSST Stack detections. A residual squeeze-and-excitation U-Net predicts pixel level trail probability maps from the difference image, a local noise estimate, and detection-mask information; candidate regions are then classified by another CNN layer using morphology, probability concentration, local difference-image flux, and line-coherence features.

On a 50-detector injected test set, the standard  $5\sigma$  Stack detector recovers less than half of the injected trails. Adding the ML layer lifts recovery up to about two thirds, recovering close to half of the trailed objects the  $5\sigma$  point source detector misses. The NN detector is more complete than the  $4\sigma$  point source detector while producing about one-third fewer false positives. Detection completeness scales smoothly with trail SNR and length, with the largest gains on the faintest, longest streaks.

These results show machine learning can complement the Rubin detection pipeline for fast moving objects in prompt difference image processing. We are applying the method to real LSSTCam difference images and benchmarking it against the Rubin difference image source catalog.

78. 233\_89\_1

1. Solar System

## Forced-Photometry Service for Faint Solar System Objects on the Rubin Science Platform

László Szigeti<sup>1</sup>

<sup>1</sup>ELTE, Gothard Astrophysical Observatory, Szombathely, Hungary

With the Vera C. Rubin Observatory's Legacy Survey of Space and Time (LSST) now underway, the survey is discovering and cataloguing vast numbers of solar system objects. Its Solar System Processing pipeline detects and links moving objects visit by visit, but many science cases call for targeted measurements it does not directly provide: re-measuring the brightness of a known object at a chosen epoch, or recovering sources that fall below the single-visit detection threshold. Both require forced photometry at a predicted position. We present `ssoforcedphot`, an open-source Python service developed within the LSST Solar System Science Collaboration (SSSC) that automates this task end-to-end on the Rubin Science Platform (RSP) — from a target name to photometry in one command. The pipeline chains three services that can also be used independently: (1) ephemeris prediction from JPL Horizons or IMCCE *Miriade* at the Rubin site code (X05), including positional error ellipses; (2) image search against Rubin ObsCore via TAP or the Butler, using per-epoch point queries or track-based sky polygons; and (3) forced PSF and multi-aperture photometry built on the LSST Science Pipelines, with source detection and deblending inside the error ellipse. For fast-moving objects, an optional refinement step re-queries the ephemeris at exact observation times. A standalone mode additionally performs forced photometry at arbitrary user-supplied coordinates, with no ephemeris required. Results — calibrated fluxes and magnitudes, diagnostic plots, FITS cutouts, and JSON/CSV tables — are accessible from a CLI, a Python API, or an interactive Panel web UI. The tool is freely available at [github.com/lst-sssc/ssoforcedphot](https://github.com/lst-sssc/ssoforcedphot).

## 2. 105\_1\_1

1. Stars Milky Way Local Volume

2. Informatics and Statistics

**Not just a catalogue combination method, or How to use probabilistic macauff cross-matches to remove junk objects from your data sample, clean your objects' measurements, find interesting new objects, and more!**Tom J. Wilson<sup>1</sup>, Tim Naylor<sup>1</sup><sup>1</sup> School of Physics, University of Exeter, Stocker Road, Exeter EX4 4QL, UK**Keywords:** astrometry, photometric catalogue, anomalies

Catalogue cross-matching, the determination of counterpart associations between detections made in differing photometric datasets, is often a footnote in the literature. Usually a single sentence, if mentioned at all, the most common cross-match is the simplest: the nearest neighbour search. Driven by the fact that we are, in essence, mapping constellations between the points on the sky each telescope survey observed, the smallest on-sky separation of all catalogue 2 detections for object A in catalogue 1 will be declared its match.

In the era of LSST (the Vera C. Rubin Observatory's Legacy Survey of Space and Time), and an order-of-magnitude increase in survey size, this method will quickly become untenable, resulting in a flood of false-positive matches to very faint interloper objects when matching LSST to any survey that came before it. To overcome this problem almost all LSST-related astronomical research will have to turn to probabilistic cross-matching methods. Being developed as part of the LSST:UK in-kind program to Rubin, macauff offers numerous advantages tailored to solving the problem of the catalogue cross-match in the era of LSST. First, probabilistic cross-matches use the precision with which the object was measured to be in its quoted sky position to shrink the lengthscale over which potential counterparts are considered, which reduces false positives. Second, it uses the colour information available from the catalogue's photometry to further reject interlopers. Finally, uniquely, macauff uses the full Astrometric Uncertainty Function (AUF) to include additional sources of uncertainty in an object's true position, such as can be caused by proper motion or crowding, which results in an up to 100% *increase* in returned matches (yes, twice as many!) at LSST densities. In this talk I will briefly describe macauff, the framework in which we derive our probabilistic cross-matches, and these advantages over simpler, more naive match methods.

I will then highlight the further features and scientific use cases unlocked by using the LSST:UK cross-match service and macauff to obtain your counterpart associations. For example, modelling the contributions to object location uncertainty from blended contaminants means we can provide astronomers with information on the level to which their *photometry* is compromised, in addition their astrometry suffering perturbations. This information can be used to both remove biases from measured fluxes and allow for a clean set of detections to be selected. As another use case, cross-matching on position and brightness grounds opens up the "likelihood ratio" phase space, through which users can both eliminate data that will introduce noise into their analyses and find anomalous objects more or less instantaneously and for free as part of the counterpart-association stage of their investigations.

## Synergies, AGN & TVS

Plenary session

Thu Oct 1 9:00 – 10:30

Chair: *Dragana Ilić*

86. **INVITED**

1. **AGN**

### Searching for AGN populations in alert streams with Machine Learning: lessons from ZTF for the LSST era

Paula Sánchez Saez<sup>1</sup>

<sup>1</sup>ESO

Brightness variations of active galactic nuclei (AGNs) provide key insights into their emission mechanisms and an alternative way to identify candidates missed by traditional selection techniques. Over the past years, the Zwicky Transient Facility (ZTF) has served as an ideal testbed for the alert-based study of AGNs and supermassive black hole (SMBH) transients with machine learning. Now, with the Rubin Observatory Legacy Survey of Space and Time (LSST) underway and its alert stream ramping up toward an unprecedented scale, these lessons are becoming directly relevant for the LSST era. In this talk, I will summarize what we have learned from ZTF about the use of alerts to search for AGN populations, and how this experience is guiding the development of our LSST models. I will focus on the variability- and color-based alert classifier developed within the ALeRCE broker (one of the official LSST community brokers) trained on ZTF data to distinguish transient, persistently variable, and non-variable sources. This model has allowed us to identify changing-look AGNs (CLAGNs), low-mass and low-Eddington-rate AGNs, and other elusive populations. Finally, I will present our recent work extending the classifier to new classes, such as nuclear transients, and the tests we are carrying out to prepare it for the early LSST alerts.

41.180\_34\_1 **INVITED!**

1. Synergies with other missions
2. Follow-up
3. Dark Energy

## LSST synergies with the ESO 4m Multi-Object Spectroscopic Telescope

Chris Frohmaier<sup>1</sup>

<sup>1</sup> Institute of Cosmology and Gravitation, University of Portsmouth, Portsmouth, UK

**Keywords:** Surveys, Supernovae, Cosmology, Galaxies, Active Galactic Nuclei

The Legacy Survey of Space and Time (LSST) at the Vera C. Rubin Observatory will bring about a revolutionary shift in how we study the time-domain Universe by issuing millions of transients alerts each night observed to an unparalleled depth. However, the true astrophysical and cosmological potential of this massive dataset can only be fully realised with large scale spectroscopic follow-up facilities.

In this presentation, we highlight the powerful synergy between LSST and the 4m Multi-Object Spectroscopic Telescope (4MOST), using the Time-Domain Extragalactic Survey (TiDES) as the blueprint for next-generation transient follow-up. TiDES exploits the wide-field, high-multiplex capabilities of 4MOST to target live transients, their host galaxies, and Active Galactic Nuclei. We will present the end-to-end framework for obtaining spectra and demonstrate the real-time follow-up of LSST alerts from the community broker platforms. Excitingly, we will also report on an important milestone for TiDES: observing its first set of LSST discovered supernovae.

Other 4MOST surveys also have strong synergies with LSST and each of these will be presented in this talk. The Wide-Area VISTA Extragalactic Survey (WAVES) will target 4 of the LSST Deep Drilling Fields to construct a panchromatic legacy dataset of around 1.6 million galaxies. The 4MOST Cosmology Redshift Survey will secure 5.4 million galaxy redshifts in the Southern hemisphere to map the distribution of Bright Galaxies and Luminous Red Galaxies. 4HS (4MOST Hemisphere Survey of the Nearby Universe) will obtain spectroscopy for 6 million galaxies in the local Universe ( $z < 0.15$ ) to provide the definitive local galaxy reference sample for LSST - and in doing so, map the local velocity field to enable a peculiar velocity analysis using LSST transients. Finally, the 4MOST Strong Lensing Spectroscopic Legacy Survey (4SLSL) will use LSST as the discovery platform for lensed galaxies to secure 10,000 pairs of redshifts.

## 10.124\_9\_2

1. Transients, Variable Stars

2. Science with prompt data products

## The Lasair Broker for Rubin Alerts

Roy Williams<sup>1</sup>, Gareth Francis<sup>1</sup>, Andy Lawrence<sup>1</sup>, Stephen Smartt<sup>2</sup>, Ken Smith<sup>2</sup>, Heloise Stevance<sup>2</sup>, Dave Young<sup>3</sup>

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<sup>3</sup> Queens University, Belfast, UK

Lasair is the UK Community Broker for transient alerts from the Legacy Survey of Space and Time from the Vera C. Rubin Observatory. Lasair offers users a set of components that can be used to build filters to concentrate their desired alerts. The set allows filtering on the diaObject attributes, novel light-curve features, intelligent sky context, user-made watchlists of special sky objects and regions of the sky, dynamic cross-matching with catalogues of known astronomical sources (*Sherlock*), and classifications and annotations from other users and other brokers. Filters can be shared with other users, copied, and modified. Lasair offers real-time machine-to-machine notifications of filtered transient alerts. Everything is fully documented and there is a [Lasair blog](#).

It is easy to start using Lasair, just go to the website (<https://lasair.lsst.ac.uk/>) and click on Quick Start. The website allows input of SQL clauses to build a filter from database attributes and components, made simple by auto-complete. Once a filter is built and tested, it can be made *active*, meaning that it runs in real time as alerts are ingested, with the results and lightcurves available as machine-readable Kafka. Email is also supported.

Users can build components for filters as watchlists and watchmaps, and they can create *annotations* for objects of interest, which may be used by others if designated public. Annotations include possible TDEs, classifications from other brokers, and a real-bogus classifier. Users can also create their own tags and comments for objects of interest, allowing Lasair to be used by a group as a follow-up marshal.

44.185\_41\_1

1. Brokers

2. Interactive session, hands-on session, tutorials

3. Transients, Variable Stars

## **The Fink broker, personalized filtering for the Rubin alert stream**

Emille Ishida<sup>1</sup>

<sup>1</sup> CNRS/LPCS, Aubiere Cedex, 4 Avenue Blaise Pascal, 63178, France

To fully harness the scientific potential of Rubin data, we require analysis methods capable of dealing with large data volumes that can identify promising transients within minutes for follow-up coordination. In this talk I will present Fink, a Rubin community broker developed to face these challenges. Fink is based on high-end technology and designed for fast and efficient analysis of big data streams. More importantly, it has been designed to answer specific science questions which are unique to different science cases. I will describe how the filters within Fink are constructed and what are the steps necessary to prepare a science module given specific requirements, which can be from simple cuts to complex machine learning models. I will also describe the lessons learned from ZTF and first outcomes from Rubin data.

91. **INVITED**

## 1. Transients and variable stars

**Transients and Variable Stars Science Collaboration: a very diverse range of scientific topics when the Vera C. Rubin Observatory Legacy Survey of Space and Time will start**Rosaria Bonito<sup>1</sup><sup>1</sup>INAF, Osservatorio Astronomico di Palermo

With the first early science results from the Vera C. Rubin Observatory Legacy Survey of Space and Time (LSST), following the First Look milestone, the Data Preview 2, and the start of the operations in 2026, I will discuss the progress on several scientific topics of the Transients and Variable Stars (TVS) Science Collaboration, focusing on the activities of the subgroups and Task Forces of TVS and emphasizing the results and work in progress of the international community.

## Brokers & Data centers

Plenary session

Thu Oct 1 11:00 – 12:30

Chair: *Knut Olsen*

69.238\_78\_1

[1. Data centers](#)

### Introducing the LSST:UK Independent Data Access Centre

George Beckett<sup>1</sup>,

<sup>1</sup>University of Edinburgh, United Kingdom

Central to UK plans for Rubin science is the setup and operation of a full, Independent Data Access Centre, to serve the full range of Rubin Observatory data products to the international community. Alongside this, we are hosting a Rubin Community Broker service -- which we call Lasair -- to receive and process the Observatory's real-time alert stream for various transient-astronomy applications.

In this talk, we will describe the function and scope of the UK-based IDAC, including experience with key IDAC services, such as: the Rubin Science Platform; Qserv; and the Data Butler. We will describe the key capabilities that the UK IDAC provides, including various derived data products for UK-priority science cases, and co-location with the Lasair community broker. We will also describe the infrastructure on which the UK IDAC operates and how we plan to effectively and efficiently scale the hosting infrastructure to address the growing demand for astronomy over the 10+ years of the survey.

The UK IDAC is, at the time of writing, one of thirteen IDACs and Processing Science Centres, spread across the Americas, Europe and Australasia. In the run-up to the Data Release 1, it is important that the various IDAC providers collaborate to harmonise their various deployment plans and to maximise the potential for scientific discovery. LSST:UK is fully committed to the IDAC Coordination Group, which has begun to develop a common roadmap towards IDAC operations. We describe LSST:UK involvement in several collaborative ventures which should help ensure the IDAC network is ready for Rubin science.

68.234\_75\_1

1. Data Centers

2. Interactive session, hands-on session, tutorials

## Progress on the LSST lite-IDAC@PIC

Carretero, Jorge<sup>1,4</sup>, Tallada-Crespí, Pau<sup>1,4</sup>, Van den Bogaart, Sílvia<sup>2,4</sup>, Luelmo, Alex<sup>2,4</sup>, Santamaria, Marc<sup>2,4</sup>, Delgado, Jordi<sup>1,4</sup>, Acosta, Carles<sup>2,4</sup>, Cruz, Ricard<sup>2,4</sup>, Torradeflot, Francesc<sup>1,4</sup>, Gonzalez, Elizabeth<sup>3,4</sup>, Neissner, Christian<sup>2,4</sup>, Sevilla, Ignacio<sup>1</sup>

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**Keywords:** big data, repository, interoperability, galaxy catalog

The Port d'Informació Científica (PIC) has continued to advance the development and deployment of the Spanish Lite Independent Data Access Center (Lite-IDAC), with CosmoHub as one of its main entry points for scalable catalogue access and interactive data exploration.

Over the last year, the Lite-IDAC has moved closer to becoming a practical working environment for the LSST community. Progress has been made in several areas:

- Bringing the storage and processing resources into operation, providing the basis for data access, analysis, and user workflows at PIC
- Simplifying access through an automated authentication and authorization framework based on federated identity, allowing users to access PIC resources more seamlessly using their Rubin Science Platform credentials
- Opening standard data-access paths to the data through VOSpace–WebDAV and WebDAV–HDFS gateways, making it easier to connect external tools and services to the IDAC while reducing the complexity of working with large volumes of data
- Improving CosmoHub as an interactive portal for exploring large catalogues, with a redesigned interface and API that support guided queries, visual exploration, and user-driven data selection
- Introducing new interactive analysis features, including the Canvas environment, where users can combine visualizations and text widgets, document their work, save exploration sessions, and share canvases that other users can import, modify, and reuse

This talk will present the current status of the Spanish Lite-IDAC at PIC, while also giving the LSST community a clearer picture of what users will find when accessing the IDAC. Beyond the technical updates, the presentation will describe how users can move from the Rubin Science Platform to PIC resources in a seamless way, explore catalogues through CosmoHub, and use the standard PIC computing environment, including batch processing, notebooks, and Spark-based notebooks.

By combining data access, interactive exploration, seamless access, computing resources, and interoperability services, the Lite-IDAC at PIC is evolving into a complementary environment for LSST data analysis and a practical entry point to PIC resources for the LSST community.

67. 230\_74\_1

[1. Data centers](#)

## IDAC-PL: the Polish LSST Independent Data Analysis Center — status, architecture, and early science cases

Tomasz Fruboes<sup>1</sup>, Henryk Giemza<sup>1</sup>, Krzysztof Nawrocki<sup>1</sup>, Agnieszka Pollo<sup>1</sup>

<sup>1</sup> National Centre for Nuclear Research, Warsaw, Poland

**Keywords:** LSST, IDAC, Rubin Observatory, distributed computing, in-kind contribution, DP2

The Polish LSST Independent Data Analysis Center (IDAC-PL), hosted at the National Centre for Nuclear Research in Warsaw, is one of the distributed centers contributing in-kind compute and storage to the Rubin Observatory Legacy Survey of Space and Time ecosystem. The center provides Polish researchers — and, through DESC and other collaborations, the broader Rubin community — with a local mirror of LSST data products and a hosted analysis environment integrated with the Rubin Science Platform. At the time of this talk IDAC-PL is to be operational: integration testing complete, test users from member institutes onboarded, and the DP2 release ingested.

We describe the high-level architecture chosen to satisfy the IDAC requirements: a tiered storage layout (hot working space + warm bulk + cold archival), a Kubernetes-orchestrated JupyterHub / RSP-compatible interactive layer and federated authentication with Rubin's identity-provider framework. We describe the data-ingestion path from the Rubin archive to user-facing notebooks, and the policies governing data egress and reproducibility.

We illustrate the center's capabilities through the first set of science cases now running on IDAC-PL infrastructure. Each case exercises a different combination of compute, storage, and network resources, and the resulting performance envelope informs the IDAC-PL planning for the LSST DR1 data volume.

48.194\_46\_4

[1. Science with prompt data products](#)

[2. Brokers](#)

[3. Transients, Variable Stars](#)

## Origin of Dipole Features in Rubin Alerts: A Residual effect from differential atmospheric Refraction

Sylvie Dagoret-Campagne<sup>1</sup>,

<sup>1</sup> Laboratoire de Physique des 2 Infinis Irène Joliot-Curie, Orsay, France

**Keywords:** alerts, light-curves, atmospheric-refraction, Difference Image Analysis

We investigate the origin of dipole features observed in some Rubin alert light curves, as identified in the Fink alert broker stream. These dipoles, notably present in cross-matched sources such as Gaia counterparts, are characterized by a dipole angle and an angular separation provided at the alert level.

Our analysis reveals a strong angular dependence of these features, suggestive of a systematic effect rather than an astrophysical signal. In particular, the observed behavior is consistent with expectations from atmospheric differential chromatic refraction, which can introduce chromatic centroid shifts depending on observing geometry.

We test this hypothesis by comparing the measured dipole orientations and amplitudes to the expected parallactic angle and its associated scaling with observational parameters. We present the current status of this study, including quantitative comparisons and limitations of the available alert-level information.

Finally, we discuss the implications for alert stream analysis and broker-level filtering, as well as perspectives for improving the modeling and mitigation of such effects in Rubin data products.

## 4. 109\_38\_3

[1. Data Center](#)[2. LSST Project](#)

## Supercomputer ‘Bura’ as a dedicated software processing centre for Rubin-related science

Tomislav Jurkic<sup>1</sup>

<sup>1</sup> University of Rijeka, Faculty of Physics, Rijeka, Croatia

**Keywords:** high-performance computing, big data science

Rubin/LSST is a large-scale, long-term survey expected to generate petabyte-scale data volumes, requiring substantial computational resources. As such, high-performance computing (HPC) infrastructure plays an important role in enabling and supporting Rubin/LSST science operations. With the commencement of the Rubin/LSST continuous survey, together with the availability of alert streams and Data Release 2 products, the scientific community is gaining access to real, large-scale observational datasets.

As part of the Croatian Rubin in-kind contribution, the HPC system ‘Bura’ serves as a dedicated software processing center for LSST-related activities. In this talk, we will present the main features of ‘Bura’, along with recent updates, training and user-support activities, and outline its role in supporting LSST/Rubin science. We will also present a pilot collaboration with the Solar System Science Collaboration and discuss further opportunities for establishing similar collaborations with other Rubin science collaborations. Particular emphasis is placed on potential applications of ‘Bura’ within the Rubin/LSST scientific community, primarily (but not exclusively) across the Solar System, Transients and Variable Stars, and Stars, Local Volume and Milky Way science collaborations. Finally, we will present several scientific use cases and collaborations involving ‘Bura’, currently running or planned.

## Synergies & Follow-up

Plenary session

Thu Oct 1 13:30 – 15:30

Chair: *Sara Bonito*

23.155\_16\_1

1. Transients and Variable Stars

2. Synergies with other missions

### A VST survey to support the Rubin Observatory

Vincenzo Petrecca<sup>1</sup>

<sup>1</sup> INAF-Osservatorio Astronomico di Capodimonte, Salita Moiarriello 16, 80131, Napoli, Italy

**Keywords:** transients, in-kind, synergies

The Legacy Survey of Space and Time (LSST) will provide an unprecedented view of the transient sky, but synergies with external facilities for additional photometric and multi-wavelength coverage and spectroscopic follow-up are essential to maximise its scientific return. Among those facilities, the 2.6m VLT Survey Telescope (VST), located at ESO Paranal Observatory and equipped with a 1-square degree wide-field optical camera, is perfectly designed to conduct an LSST support survey and it is the core of 4 Italian in-kind contributions. One of them consists of observing specific regions in the Deep Drilling Fields (DDFs) with an optimised rolling cadence to obtain high-cadence, well measured light curves of transient and variable sources. To further enhance synergies with additional players, we considered focusing on the Euclid Deep Field South (EDF-S) that is also receiving multiple visits by the Euclid space telescope. In preparation for full LSST operations, we launched the VST pilot project VESTA (VST-Euclid Synergies for Time-domain Astronomy). This is designed to test the observing strategy, optimise the VST automated transient detection pipelines, and merge transient search results from both ground and space. I will present preliminary results from VESTA and discuss the full potential of a synergy LSST-VST to study the transient Universe.

20.142\_22\_1

1. Follow-up
2. Synergies with other missions
3. Other

## BHTOM - global telescope network for time-domain follow up

Priscilla Pessi<sup>1</sup>, [Lukasz Wyrzykowski](#)<sup>1</sup>

<sup>1</sup> National Centre For Nuclear Research (NCBJ), Pasteura 7, 02-093, Warszawa, Poland

The Black Hole Target and Observation Manager (BHTOM) is a platform developed to coordinate time-domain astronomy and follow-up observations in the era of large synoptic surveys such as the Legacy Survey of Space and Time (LSST). BHTOM is designed for the long-term photometric monitoring of a wide range of astrophysical phenomena, including transients, microlensing events, quasars, variable stars, and exoplanets. In addition, the platform automatically aggregates available archival observations for selected targets from multiple external data sources, providing a unified environment for time-domain analysis and follow-up coordination.

The system integrates a heterogeneous global network of more than 160 professional and amateur telescopes, automatically collecting, processing, and standardizing observations into science-ready data products. This infrastructure provides an efficient framework for coordinating follow-up observations of alerts and targets generated by large-scale survey facilities.

In this presentation, I will introduce the BHTOM system, discuss its operational capabilities, and highlight the scientific results achieved so far. Particular emphasis will be placed on the role of BHTOM in enabling rapid and scalable photometric follow-up of LSST prompt data products and alert streams.

54. 204\_57\_1

- 1. Follow up
- 2. Strong Lensing
- 3. Transients, Variable Stars

## Spending Spectra Wisely: Adaptive Cadence Optimisation for Gravitationally Lensed Supernovae in the Rubin Era

Andrés I. Ponte Pérez<sup>1</sup>, Graham P. Smith<sup>1</sup>

<sup>1</sup> University of Birmingham, Birmingham, United Kingdom

**Keywords:** gravitational lensing: strong, supernovae, instrumentation: spectrographs

The Vera C. Rubin Observatory will discover transients in unprecedented numbers, including a growing sample of gravitationally lensed supernovae that are powerful probes of cosmology and uniquely valuable as astrophysical probes through repeated "replays" of the same explosion. Extracting their full scientific value depends on well-timed follow-up spectroscopy, yet spectrographs are a scarce and heavily contended resource. Therefore, there is a growing need to optimise both *which* targets to observe, and *when* take each spectrum.

This project focuses on the latter. Gravitationally lensed supernovae offer a unique handle on this problem: the earlier-arriving image (A) is a preview of its later-arriving counterpart (B), so observations of A can predictively schedule observations of B. This reframes follow-up from forward extrapolation into an interpolation problem, in which image A brackets the phases of image B, avoiding the large uncertainties associated with the diversity and unpredictability of supernovae, and providing a means to react to said unpredictability in cases where the supernova behaviour is unusual.

We present an adaptive cadence framework that exploits this structure. We combine machine-learning spectral predictors, which can reconstruct the full evolution of a supernova from a discrete set of observations, and a reinforcement learning algorithm, which utilises these spectral predictions to learn the optimum observing cadence for a lensed supernova, with the flexibility to adapt after each observation. This optimum cadence depends on the type of supernova being observed, the relative time delays and magnifications of each image, and the science being optimised for. The model can be tailored to maximise yield for a range of science cases: from spectroscopic time delays using supernova template matching to the recovery of key astrophysical diagnostics across SN types, including Si II velocities in Type Ia and H $\alpha$  and Fe II evolution in Type II. We further discuss the potential to utilise the evolution of spectral features across images obtained from adaptive scheduling for novel time-delay inference method, and the precision on H0 that may be achieved from this new method. Finally, we consider the overall implications for Rubin-era spectroscopic follow-up, specifically how these frameworks may be implemented for low-latency optimised follow-up of exciting candidate lensed supernovae.

**1. 104\_5\_1**

1. Synergies with other missions

2. LSST Project

3. Follow-up

## From Commissioning to Survey: The LSST–VISTA Fusion Pipeline

Elham Saremi<sup>1</sup>, Manda Banerji<sup>1</sup>, Raphael Shirley<sup>2</sup>, Richard McMahon<sup>3</sup><sup>1</sup> School of Physics and Astronomy, University of Southampton, Highfield Campus, Southampton SO17 1BJ, UK<sup>2</sup> Max-Planck-Institut für extraterrestrische Physik, Giessenbachstr. 1, 85748 Garching, Germany<sup>3</sup> Institute of Astronomy, University of Cambridge, Madingley Road, Cambridge, CB30HA, UK**Keywords:** Optical–NIR fusion, LSST, VISTA/VIRCAM

With DP1 now in hand and DP2 approaching, a practical priority is to deliver science-ready LSST datasets that connect seamlessly to the broader multiwavelength ecosystem. Legacy near-infrared imaging from VISTA/VIRCAM provides critical leverage for interpreting LSST sources in terms of their physical properties—reducing degeneracies driven by dust and older stellar populations and improving photometric redshift performance. In particular, the *Ks* band anchors stellar-mass estimates and adds wavelength coverage that naturally complements Euclid (YJH) and mid-IR datasets (e.g. Spitzer/WISE).

We present the LSST–VISTA Fusion Pipeline, a community-facing workflow that adapts the Rubin LSST Science Pipelines for joint processing of LSST and VISTA/VIRCAM imaging, delivering pixel-aligned images and consistent forced-photometry catalogues. After validation on HSC–VISTA overlap regions, as a new milestone, we have applied the pipeline end-to-end to Rubin DP1 commissioning data in ECDFS, delivering joint optical–NIR products on Rubin observations. We will outline the workflow and current DP1 fused products and discuss readiness to scale the same approach to DP2 fields as soon as the data package becomes available, enabling multiwavelength science from the earliest LSSTCam releases.

25. 159\_18\_4

1. Transients, Variable Stars

2. Galaxies

3. Dark Energy

## Applications of 1.4 GHz diagnostics in Type Ia Supernova cosmology in the LSST era

Shruti Ramaiya<sup>1</sup>, Maria Vincenzi<sup>1</sup>, Matt Jarvis<sup>1,2</sup>

<sup>1</sup> University of Oxford, Oxford, UK

<sup>2</sup> University of Western Cape, Cape Town, South Africa

The Vera C. Rubin Observatory Legacy Survey of Space and Time (LSST) will discover over one million Type Ia supernovae (SNe Ia), enabling unprecedented statistical precision in SN cosmology. In this regime, uncertainties associated with SN Ia host-galaxy environments are expected to become a dominant source of systematic. Correlations are observed between SN Ia luminosities and host properties — including stellar mass, metallicity, and star formation activity — yet a complete physical picture of these dependencies remains elusive. Realising the full cosmological potential of this dataset therefore demands robust environment; characterisation of SN Ia host environments across the full 18,000 deg<sup>2</sup> LSST footprint. A key challenge is that the far-infrared (FIR) coverage required for well-constrained SED-based star formation rate (SFR) measurements — currently the gold standard — will be limited at LSST scales.

We investigate whether 1.4 GHz radio continuum emission can provide a scalable, dust-unbiased alternative SFR tracer for SN Ia host classification. Using MeerKAT/MIGHTEE observations of Dark Energy Survey SN Ia host galaxies, we divide SN Ia hosts into three environmental populations on the SFR–stellar mass plane: low-mass, high-mass star-forming, and high-mass passive systems. We compare this radio-based SN Ia host classification against our earlier FIR-constrained SED reference analysis (Ramaiya et al. 2025) and find 84% of SN hosts retain identical region assignments when using radio versus FIR-constrained SED-derived SFRs. We further test whether radio-defined environments recover established SN Ia environmental trends in cosmological standardisation. The standardisation parameters  $\alpha$ ,  $\beta$ , and  $M$  measured within each radio-defined SN subpopulation are consistent with the FIR-based analysis within  $1.1\sigma$ , reconfirming the previously observed environmental dependence of the SN colour–luminosity relation,  $\beta$ . These results demonstrate the potential of radio continuum surveys to characterise SN Ia host environments in the absence of FIR coverage.

With wide-area radio surveys from MeerKAT and the forthcoming Square Kilometre Array expected to provide near-complete overlap with the LSST footprint, enabling environmental classification for substantially larger SN Ia samples, this work establishes radio continuum emission as a practical and physically motivated approach for environmental classification in precision SN cosmology in the LSST era.

57.211\_61\_1

1. Synergies with other missions
2. Transients, Variable Stars
3. Galaxies

## The Future of FRB Cosmology with LSST

Hugh Roxburgh<sup>1</sup>, Clancy James<sup>1</sup>

<sup>1</sup>Curtin Institute of Radio Astronomy, 1 Turner Ave, Bentley, Perth, 6102, Australia

Fast radio bursts (FRBs) have emerged as powerful probes of large-scale structure, with their dispersion measures directly encoding the free electron density – and thus the baryon distribution – along the line of sight. Upcoming dedicated FRB surveys will detect orders of magnitude more bursts over the next decade, transforming FRBs into a statistical tool for mapping diffuse gas across the cosmic web and constraining cosmological parameters such as the Hubble constant. However, this ambition places impractical demands on spectroscopic follow-up resources: constraining cosmology at the precision level may require redshifts for hundreds of thousands of FRB host galaxies. LSST offers a compelling solution, providing photometric redshifts for vast numbers of galaxies out to  $z \sim 1$ . In this talk, I will present how photometric redshifts from LSST can enable large-scale FRB cosmology, assess how redshift uncertainties propagate into parameter constraints, and discuss the role of faint foreground structures not captured by LSST in biasing our inference of the baryon distribution.

72. 245\_83\_1

[1. Synergies with other missions](#)[2. Active Galactic Nuclei](#)[3. Galaxies](#)

## Synergistic Science with Rubin and MeerKAT

Sureshkumar, Unnikrishnan<sup>1</sup>, Hilton Matt

<sup>1</sup>National Centre for Nuclear Research (NCBJ), Andrzej Soltana 7, Otwock, 05-400 Poland

Panchromatic data, by combining observations across multiple wavelengths, offer an unparalleled, comprehensive view of galaxies. This enables the determination of key physical properties and leads to discoveries not possible with single-wavelength data alone. While Rubin is preparing to make enormous discoveries in the optical wavebands, the MeerKAT radio telescope in South Africa is providing wide-field radio continuum imaging of the same sky observed by Rubin. These radio continuum observations are crucial as they provide dust extinction-free star formation rates (SFR) of galaxies, as well as the properties of Active Galactic Nuclei (AGN). In this talk, I will present a semi-automated pipeline, developed as a part of the South African in-kind contribution towards the LSST Galaxy Science Collaboration. This pipeline is designed for MeerKAT data reduction, source extraction and cross-matching them with the optical data from Rubin and, hence creating a powerful synergistic dataset. The resulting multi-wavelength catalog will be highly beneficial for diverse science cases, including accurate SFR estimation, precise source counts, and detailed radio source clustering analyses. I will also present preliminary results using existing sources extracted from MeerKAT images, cross-matched with the DECaLS optical survey, demonstrating the immediate utility of this approach.

76.144\_87\_1

1. Active Galactic Nuclei

2. Science with DP1

3. Follow-up

## **Follow-up campaign of the quasar with strong coherent variability discovered in LSST DP1**

Ilic D.<sup>1</sup>, Kovacevic A., Mestric U., Panda S., Fatovic M., De Bonis N., Stankovic-Cerovic M., Popovic L.C.

<sup>1</sup>University of Belgrade, Faculty of Mathematics, Department of Astronomy, Studentski Trg 16, Belgrade, 11000, Serbia

We present follow-up strategies of a quasar with strong coherent variability discovered in Rubin LSST DP1 through the QhX Hub of the Serbian in-kind contribution. This object at  $z = 0.198$ , identified as 3D-HST 2351 (LSST DP1 object\_id = 611255072642321324) has a coherent variability of the period of  $P = 2.76$  days. This has motivated proposals for further follow-up observations, as well as cross matching with archival data. The archival HST and JWST images reveal resolved host-scale structures including a possible nearby companion, further supporting the follow up. Here we will present the strategies for the recently approved long-slit observations with the Gemini South telescope.

**89. INVITED**

1. Solar System
2. Brokers

## **Exploring the Solar System using Rubin alert data from the Fink broker**

Hands-on session

**Thu Oct 2 16:00 – 17:30**

Julien Peloton<sup>1</sup>

<sup>1</sup> IJCLab CNRS, Orsay Bp34, IJCLab Batiment 200, Rue Ampère, 91898, France

In this session, I will cover the Solar System services deployed in the Fink broker. I will provide concrete examples on (a) how to retrieve Solar System data from Rubin observations in real-time, (b) retrieve alert data in bulk for population studies, and (c) how to act on Fink to upload your personalized analysis. I will also discuss the ongoing scientific projects in Fink, and planned services for the small body community.

Regarding technical requirements, there are none required. All data is public, and all session materials will be available after the session so that they can reproduce the demo. Optionally, participants that want to test live while I'm speaking will need to have access to internet (no need for high bandwidth), and they will need to install the Fink client on their machine (instructions at <https://github.com/astrolabsoftware/fink-client>).

## Synergies & Brokers

Plenary session

**Fri Oct 2 9:00 – 10:30**

**Chair:** *Colin Slater*

92. **INVITED**

1. LSST project

### **LSST Alert Production: now live!**

Ian Sullivan<sup>1</sup>

<sup>1</sup>University of Washington, Seattle, 3910 15<sup>th</sup> Ave NE, 98105

The Rubin Observatory began public alert distribution on February 24, 2026. Every visit is difference-imaged, and each detected variable, transient, or moving source is packaged with cutouts and a history of prior measurements, then published to community brokers within two minutes. Brokers are the route to the data today, but soon the Prompt Products Database and Rubin Science Platform will also serve the underlying catalogs and calibrated images. I will describe how the alerts are produced, what the first months of operations have taught us, and the changes coming next.

82. **INVITED**

## 1. Synergies with other missions

**Roman and Rubin Microlensing Synergize to Characterize Black Holes and Binary Stars**Natasha Abrams<sup>1</sup><sup>1</sup>University of California, Berkely, USA

Gravitational microlensing provides a unique opportunity to probe binary stars, black holes, neutron stars, white dwarfs, and brown dwarfs. Historically, microlensing events have been discovered primarily in the Galactic bulge by surveys designed solely for that purpose. As we enter the age of visible all-sky surveys, such as that of the Vera C. Rubin Observatory (Rubin), we gain the ability to probe microlensing events throughout the Galaxy. This allows us to analyze galactic structure and how the stellar and black hole mass functions and binary fractions vary across the Galaxy. Conversely, the Nancy Grace Roman Telescope (Roman) Galactic Bulge Time Domain Survey will focus with a 12.7 minute cadence in the Galactic bulge. Unlike ground-based surveys, Roman will measure the photometric and astrometric microlensing signals jointly. This will enable us to measure the masses of isolated black holes and more robustly constrain the binary star systems' masses and semi-major axes. On the individual event level, Rubin will help to provide additional color information and temporal cadence in the summer gaps when Roman cannot observe. On the statistical level, Roman will help to anchor mass distributions and binary fractions for a set of individual microlensing events towards the Galactic bulge and Rubin will allow us to probe the overall distribution throughout the Galaxy.

87. **INVITED**

## 1. Synergies with other missions

**One Sky, Two Surveys. Why Rubin and Euclid Need Each Other**Christa Gall<sup>1</sup><sup>1</sup>University of Copenhagen, Niels Bohr Institute

Rubin and Euclid are about to survey the same sky, and they see it differently. Rubin goes deep from the ground in six optical bands. Euclid works in space, with sharp galaxy shapes, near-infrared colours, and slitless spectra. However, neither survey reaches its full cosmological potential alone. Euclid needs a deep ground-based counterpart to measure weak-lensing photometric redshifts, and Rubin is that counterpart. I will present joint pixel-level processing of the two surveys. This is an ongoing project within the LSST Dark Energy Science Collaboration, together with the University of Illinois and the Danish IDAC and team at DARK, Niels Bohr Institute, University of Copenhagen. Instead of matching finished catalogues, we combine them image by image, pixel by pixel. I will show how the science scales with each data release, from a one square degree pilot on DP1, through the full Euclid Deep Field South, to joint analyses across about 1400 square degrees at LSST DR1. I will discuss where things stand today, including current Rubin image quality and the problems still open. Very few groups can bring these two surveys together. LSST is largely US-led and Euclid almost entirely European, which makes this pairing both rare and, for this audience, close to home.

85. **INVITED**

1. Follow-up

## **From time-domain alerts to discoveries: Turning the Rubin alert stream into science with GOATS**

Monika Soraisam<sup>1</sup>

<sup>1</sup>NSF Noirlab, Hilo, 670 N Aohoku Pl, 96720, USA

The Rubin Observatory's Legacy Survey of Space and Time has transformed time-domain astronomy into Big Data science, generating millions of alerts nightly. Obscured within this extensive alert stream are rare, time-critical events requiring immediate follow-up, such as Fast Blue Optical Transients, shock breakout flashes from supernovae, and kilonovae. The massive volume and rate of data pose significant challenges for rapid follow-up initiatives. To address these challenges, we have developed the Gemini Observation and Analysis of Target Systems (GOATS), which integrates essential tools for rapid response: NOIRLab's ANTARES alert broker for high-priority target filtering, the Gemini Observatory's observation planning tools, data archive, and data reduction and analysis suite. This integration allows users to easily plan, trigger, and execute time-critical observations, and then promptly retrieve, reduce, and analyze the resulting data. GOATS was successfully deployed in a live, end-to-end Rubin alert follow-up campaign led by NOIRLab, in which transients were selected directly from the real-time Rubin alert stream through ANTARES, rapid target-of-opportunity observations were triggered on Gemini as well as other NOIRLab facilities and external telescopes, and the collected data were quickly reduced and classified into supernovae of various types. I will present the results from this critical end-to-end demonstration, and also describe the current status of GOATS and the integrated services that power this system.

## LSST Project

Plenary session

**Fri Oct 2 11:00 – 12:00**

**Chair:** *Róbert Szabó*

98. **INVITED**

1. *Other*

## LSST Discovery Alliance activities

Tesla Jeltema<sup>1,2</sup>

<sup>1</sup> Department of Physics, University of California, Santa Cruz, Santa Cruz, CA 95064, USA

<sup>2</sup> Santa Cruz Institute for Particle Physics, Santa Cruz, CA 95064, USA

The LSST Discovery Alliance is a non-profit organization with over 40 member institutions dedicated to supporting the broad science and science community of NSF-DOE Rubin Observatory's Legacy Survey of Space and Time (LSST), including through private funding and interdisciplinary programs and resources. I will discuss Discovery Alliance's role within the Rubin ecosystem and highlight recent activities and opportunities.

99. **INVITED**

1. [Other](#)

## Science Collaborations summary

Tesla Jeltema<sup>1,2</sup>

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The eight LSST Science Collaborations encompass the enormous breadth of science possible with the Vera C. Rubin Observatory's Legacy Survey of Space and Time, from our Solar System to very distant galaxies. I will give a summary of the Science Collaborations and their activities, including results presented at this meeting and how to get involved.

7. 115\_7\_1

1. Broadening participation

2. Other

## Education & Public Outreach with Rubin Observatory: Sharing Rubin with the World

Clare Higgs<sup>1</sup><sup>1</sup>NSF–DOE Vera C. Rubin Observatory / NSF Noirlab

The NSF–DOE Vera C. Rubin Observatory’s Education and Public Outreach (EPO) team provides fun, intuitive, data-driven experiences for the public to engage with Rubin science and discoveries. Rubin EPO is dedicated to creating a lasting impact with the public, and strives to encourage future engagement with Rubin, astronomy and science in general. We have developed a suite of data-driven initiatives that showcase Rubin to the public and invite participation, using social media, citizen science participation, classroom learning, and more. I will provide an overview of available resources that may be used for sharing Rubin science and technology with a broad range of audiences. These include interactive data visualisations like Skyviewer and Orbitviewer, educational investigations for classrooms and lecture halls, citizen science project development support for scientists and engagement for the public, and outreach materials and images ready for use. I will also share updates on some exciting projects in the works, like our new Summit Status Dashboard, and when you can expect these additional resources to be available. Finally, I will share some qualitative and quantitative assessments of the EPO program and how this inspires our ongoing work.

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# **POSTERS**

P1.199\_54\_1

1. Galaxies

2. Dark Energy

3. Informatics and Statistics

## Gamma-Ray Bursts as Cosmic Tracers: Hemispheric Asymmetry and Overdensities

István Horváth<sup>1</sup>, Zsolt Bagoly<sup>2</sup>, István Rácz<sup>1</sup>, Lajos Balázs G.<sup>3</sup>, Viktor Tóth L.<sup>2</sup>

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<sup>3</sup>Konkoly Observatory, HUN-REN CSFK, Budapest, Hungary

Large-scale structures discovered in recent decades have raised questions about the homogeneity and isotropy assumed in standard cosmological models. We examine gamma-ray burst clustering in both Galactic hemispheres using a 3D spherical- search method designed to identify spatial overdensities. The analysis reveals only two deviations: a small southern group of 4–5 nearby GRBs, and a much larger northern concentration of about 125 GRBs, consistent with the Hercules–Corona Borealis Great Wall. No further spherical overdensities are found, suggesting that these structures do not necessarily violate the cosmological principle. LSST will discover transients of all kinds, including GRB afterglows, and GRB host galaxies. Then our analysis will be even more complete.

## Infrared Variability Identification of AGN

Jannis Necker<sup>1</sup>, Sjoert van Velzen<sup>1</sup>

<sup>1</sup> Leiden Observatory, Leiden, Netherlands

**Keywords:** Active Galactic Nuclei, Infrared, Variability

Active Galactic Nuclei (AGN) are accreting supermassive black holes (SMBH) in the center of galaxies. Their intrinsic continuum variability is best described by a random walk. In the optical, this variability is typically around 10%. It carries information about the accretion disk itself and the surrounding environment but can also mimic other transient phenomena in Galactic Nuclei, such as Tidal Disruption Events (TDEs). For both reasons, it is important to identify as many AGN as possible in the LSST footprint to enable AGN science as well as flag them in transient searches.

Dust surrounding an accreting SMBH efficiently absorbs the incident radiation and re-radiates it in the infrared. The Widefield Infrared Survey Explorer (WISE) monitored the sky in the relevant wavelength range for more than a decade, producing sparsely sampled lightcurves with a six-months cadence. Analysing them for variability, we can find AGN that have previously not been identified through a commonly used infrared color selection. Using a boosted decision tree trained on variability features calculated from the light curves, we are able to recover a few percent of a part of the AGN population, that was previously unidentified in the infrared. As part of our in-kind contribution, this will help identify known AGN in the alert stream from the Vera Rubin Observatory.

P3. 110\_79\_1

1. Transients and Variable Stars

## High Velocity Features in Type Ia Supernovae -- A puzzle still waiting to be solved after 26 years

Zsófia Bora<sup>1, 2</sup>, József Vinkó<sup>1, 3, 2, 4</sup>, John Craig Wheeler<sup>4</sup>, Réka Könyves-Tóth<sup>1, 3</sup>

<sup>1</sup>HUN-REN Research Centre for Astronomy and Earth Sciences Konkoly Thege Miklós Astronomical Institute, Budapest, Hungary

<sup>2</sup>ELTE Eötvös Loránd University, Institute of Physics and Astronomy, Budapest, Hungary <sup>3</sup>Department of Experimental Physics, Institute of Physics, University of Szeged, Szeged, Hungary

<sup>4</sup>Department of Astronomy, University of Texas at Austin, Austin, United States

**Keywords:** supernovae, transients, early discovery

High velocity (25-30000 km/s) features (HVF) are absorption features of Ca II, and sometimes Si II that can be seen in the early spectra of Type Ia supernovae (SNe Ia) at velocities significantly higher than that of the photosphere. First discovered in the spectrum of SN1994D in 1999, they have since been proven to be ubiquitous in SNe Ia. However, their exact origin remains unclear to this day. They appear to form in a higher velocity layer above the photosphere and show varying strengths and velocity evolution from object to object. We used 15 years of early-phase optical/near-infrared spectra obtained by the Hobby-Eberly Telescope (HET) of 57 supernovae to determine the velocity, strength and evolution of these features.

We confirm a connection between the light-curve width and the strength (and velocity) of the HVFs, with slow decliners (i.e. brighter SNe Ia) showing stronger (and faster) high velocity lines. We investigate how velocity determination from the gaussian fitting of spectral lines compares to velocities gained from the modelling of spectra and show a systematic difference between the two methods.

Through our investigation, we conclude that HVFs are most likely a consequence of the explosion mechanism itself, of which we favor a double detonation scenario. Early discovery of supernovae exhibiting these features – by for example future projects like LSST – however is needed to confidently exclude other possible scenarios of HVF formation.

## Type Ia Supernovae in the Coma Cluster

Ágoston Horti-Dávid<sup>1,2</sup>, József Vinkó<sup>2,3,1,4</sup>, Krisztián Sárneczky<sup>2</sup>, Réka Könyves-Tóth<sup>2,3</sup>, László L. Kiss<sup>2</sup>, Zsófia Bora<sup>1,2</sup>, András Péter Joó<sup>1,2</sup>, Levente Kriskovics<sup>2</sup>, András Pál<sup>2</sup>, Bálint Seli<sup>1,2</sup>, Ádám Sódor<sup>2</sup>, Róbert Szakáts<sup>2</sup>, J. Craig Wheeler<sup>4</sup>

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**Keywords:** Transients, Supernovae, Coma Cluster, SN type Ia, Distance measurement, Hubble constant

The Coma galaxy cluster has long been used as a cosmic laboratory. This is no coincidence, as it is one of the closest large galaxy clusters to us after the Virgo cluster. Its distance is large enough for the Hubble flow to dominate, but still close enough to be studied in detail.

In our research, we attempted to determine the Coma galaxy cluster's distance as precisely as possible using Type Ia supernovae that were discovered within it. We used several publicly available photometric data sets from the ZTF, ATLAS and YSE surveys, as well as the SALT3 code for multi-colour light curve fitting, to make the distance measurements. We also used our own photometric measurements from the 60 cm Schmidt and 80 cm RC telescopes at the Piszkéstető Observatory. Using all this data, we were able to measure the distance to the Coma cluster more precisely than before. Furthermore, we were able to determine the cluster's average redshift with high accuracy using SDSS spectroscopic data. We also determined the Hubble constant based on our own results.

P5.

1. Informatics and Statistics

2. Transients and Variable Stars

## **Nightly Analysis of Light Curves with Neural Processes (NightLANP) to enable probabilistic inference, classification, and anomaly detection**

Shiddhart Chaini<sup>1</sup><sup>1</sup>University of Delaware, USA

The sparse multiband light curves from large-sky surveys like LSST are crucial for informing follow-up observations and enabling the discovery of novel astronomical events. However, a challenge is the analysis of these light curves, with their long observational gaps and differing cadences over filters. While Gaussian Process (GP) regression is a common method for interpolation, it requires specifying a kernel a priori, making a strong assumption about the object's temporal nature that may not hold for diverse transients. However, the sheer volume of LSST light curves enables a data-driven approach. Neural Processes (NPs) are a family of models that learn distributions over functions, combining the probabilistic framework of GPs with the scalability and flexibility of neural networks. We recently released NightLANP, a package for fast nightly light curve modelling of light curves. I will talk about our results on simulations, scaling them up to real LSST data, and how it helps downstream tasks such as classification and anomaly detection, to help search for transients in this new era of time-domain astronomy.

## Testing Dynamical Dark Energy Beyond $\Lambda$ CDM with Rubin LSST: A Growth–Geometry Consistency Forecast Using Weak Lensing and Redshift-Space Distortions

Aida Barati<sup>1</sup>

<sup>1</sup>Faculty of Physics, University of Isfahan, Isfahan, Iran

**Keywords:** Rubin LSST, Dynamical Dark Energy, Redshift-Space Distortions

The physical origin of cosmic acceleration remains one of the most fundamental open questions in modern cosmology. While the  $\Lambda$ CDM model provides an excellent description of current observations, possible deviations from a cosmological constant through a time-varying dark energy component represent a critical avenue for testing physics beyond the standard cosmological paradigm. In this work, we investigate the capability of the Vera C. Rubin Observatory Legacy Survey of Space and Time (Rubin LSST) to distinguish dynamical dark energy models from  $\Lambda$ CDM through a growth–geometry consistency analysis. We adopt the Chevallier–Polarski–Linder (CPL) parameterization and perform a joint cosmological forecast combining weak gravitational lensing from Rubin LSST with redshift-space distortion measurements from complementary spectroscopic surveys. Weak lensing provides a probe of the integrated matter distribution and cosmic geometry, while redshift-space distortions independently constrain the growth rate of large-scale structure. By combining these complementary observables, we construct a consistency framework between the expansion history and structure formation, enabling a more sensitive test of evolving dark energy scenarios. Using Rubin LSST Year-10 survey specifications, we forecast the expected constraints on the CPL dark energy parameters ( $w_0, w_a$ ) and quantify the improvement provided by the joint analysis. We find that combining weak lensing and redshift-space distortions significantly enhances the dark energy Figure of Merit compared with individual probes and reduces parameter uncertainties by approximately 30–40%, substantially tightening the allowed parameter space for evolving dark energy models. Our results demonstrate the power of Rubin LSST multi-probe cosmology to test departures from  $\Lambda$ CDM by connecting cosmic geometry with the growth of structure. This study highlights the potential of future large-scale structure observations to reveal signatures of new physics in the dark sector and to provide stringent consistency tests of the standard cosmological model.

P7.171\_40\_2

1. Informatics and Statistics

## Uncertainty Aware Gradient-Boosted Trees for Noisy and Incomplete Astronomical Data

Vysakh Anilkumar<sup>1</sup>, Sjoert van Velzen<sup>1</sup>

<sup>1</sup> Leiden Observatory, Leiden, Netherlands

**Keywords:** gradient boosting, decision trees, xgboost, probabilistic machine learning

The Vera C. Rubin Observatory will deliver tabular catalogs of tens of billions of sources, each described by hundreds of measured attributes, together with millions of real time alerts every night. For most of the science built on these catalogs the working data product is a table of extracted features, and the analysis of such tables is led by gradient boosted trees and random forests, which remain among the most accurate, fastest, and most interpretable methods for tabular data at survey scale. They already underpin photometric redshift estimation, star and galaxy separation, the classification of transients and variable stars, stellar parameter estimation, and the identification of solar system objects. Every measured quantity in these catalogs carries an error bar, and many features are poorly constrained or entirely absent for faint sources and for objects seen only in the first few epochs of an alert. A growing body of work shows that accounting for these measurement uncertainties measurably improves classification and regression on astronomical feature tables. Standard gradient boosted trees instead treat each value as exact and each gap as a quantity to be imputed, leaving this information unused for the faint and incompletely observed sources that dominate the survey.

We present PXGBoost, a probabilistic extension of gradient boosted trees that propagates measurement uncertainty through the model itself. Each source is represented as a Gaussian distribution over its feature values, so that at every split it flows down both branches with weights given by the normal cumulative distribution function of the feature relative to the threshold. Well measured features behave like ordinary deterministic splits, while uncertain or missing features route ambiguously and contribute proportionally less. Label confidence enters in the same way, softening the training targets throughout the boosting loop. The method generalises the probabilistic random forest to the boosting regime, keeping the established split gain formulation with every sum replaced by an uncertainty weighted sum, and is implemented in pure NumPy behind a scikit learn compatible interface.

We validate PXGBoost on transient classification with real survey light curve parameters and benchmark it against standard gradient boosting and the probabilistic random forest, finding that feature and label uncertainty improve robustness on faint and partially observed sources, with feature attribution confirming that the reliance of the model on each feature scales with how well it is measured. Because it operates on generic feature tables, PXGBoost applies across the uncertainty dominated tabular tasks at the heart of Rubin science, from photometric redshifts and source classification to the real time typing of transients, wherever calibrated and uncertainty aware probabilities are needed to act on noisy and incomplete data.

P8. 242\_81\_1

1. Active Galactic Nuclei

2. Galaxies

## Isolated AGNs in the Local Universe: X-ray Properties and the Role of Environment in Nuclear Activity

Vavilova Iryna<sup>1</sup>, Kompaniiets Olena<sup>1</sup>, Vasylenko Anatoliy<sup>1</sup>

<sup>1</sup> Main Astronomical Observatory of the National Academy of Sciences of Ukraine, Kyiv, Ukraine

**Keywords:** Isolated AGNs, X-ray, Cosmic Web environment

Isolated galaxies hosting active galactic nuclei (isolated AGNs) offer the unique laboratory to assess how nuclear activity behaves when external interactions are minimised and the large-scale environment is explicitly quantified. We combine a homogeneous analysis of X-ray properties for isolated AGN with a Cosmic-Web-oriented reconstruction of the local density field for isolated galaxies in the nearby Universe. For a sample of 2MIG isolated galaxies with AGN at  $z < 0.05$ , we systematise multi-mission X-ray observations from Swift, NuSTAR, XMM–Newton, Chandra, and INTEGRAL, deriving general spectral properties, preferred models, and supermassive black-hole mass estimates. We investigated the best spectral models of 25 isolated AGNs, including 10 recently fitted in this work. The intrinsic luminosities  $\log L_{210\text{keV}}$  do not exceed  $\sim 43$ . Our results indicate that the isolation of galaxies in the nearby Universe does not significantly affect nuclear activity. Independently, we quantify the environments of isolated barred galaxies in the Local Volume using projected and 3D Voronoi-based density estimators, supplemented by k-nearest-neighbour metrics. For a northern-sky sample of 311 isolated barred systems at  $z < 0.05$ , we classify their locations in the Cosmic Web and compare the distributions of local density across BPT diagram based on SDSS DR17 spectra. We find no statistically significant segregation of star-forming, composite, LINER, or Seyfert galaxies by local density, supporting a scenario in which internal secular processes play the dominant role in sustaining low-to-moderate nuclear activity in isolated galaxies. These results define an observational baseline for the large-survey era. Deep, homogeneous observations from facilities such as the LSST will enable more detailed reconstruction of the Cosmic Web and local-density field, allowing isolation- and density-based selections of AGN hosts to be extended to larger samples and used to test how AGN incidence and nuclear properties depend on Cosmic Web environment.

P10.220\_71\_1

1. Synergies with other missions

2. Dark Energy

## Cosmology from the CMB - LSST cross-correlations: new observables and prospects

José Bermejo-Climent<sup>1</sup><sup>1</sup> Konkoly Observatory, HUN-REN CSFK, Budapest, Hungary

LSST observations will be optimal to perform cross-correlations analyses with the CMB, given their overlap with other experiments such as SO. When doing cosmology in 2D, it is also possible to extract complementary information to the clustering and cosmic shear probes, through a recently proposed observable called "angular redshift fluctuations" (ARF). In particular, with the Quaia catalog, it was shown in Bermejo-Climent et al. (2026) the capacity of ARF to improve by  $\sim 20\text{-}30\%$  the constraints on primordial non-Gaussianity (PNG). The methodology is currently being applied to DESI data and has shown a potential interest for PNG, since ARF are more independent on observational systematics than 2D clustering. In this talk, I will discuss about the possible applications of this methodology to LSST data and present forecasts on cosmological parameter constraints for upcoming datasets.

P12. 221\_67\_1

1. Dark Energy

2. Synergies with other missions

## A Simulation-Based Framework for ISW and CMB–Large-Scale Structure Cross-Correlation Studies

Mina Ghodsi Yengejeh<sup>1</sup>, András Kovács<sup>1</sup>, István Szapudi<sup>2</sup>, István Csabai<sup>3</sup>

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The Integrated Sachs–Wolfe (ISW) effect is a unique probe of cosmic acceleration, linking the growth of large-scale structure to secondary anisotropies in the cosmic microwave background (CMB). We present a simulation-based framework for generating and analyzing ISW signals across a broad range of cosmological models using the Gower Street simulation suite. While developed for ISW studies, the pipeline is designed more generally for CMB–large-scale structure cross-correlation analyses, providing realistic mock observables, theoretical validation, and a flexible platform for testing cosmological models beyond  $\Lambda$ CDM. Such simulation-based approaches are becoming increasingly important as forthcoming surveys deliver remarkable measurements of large-scale structure and its connection to the CMB. In particular, this framework enables the development and validation of cross-correlation analyses relevant to future data from the Vera C. Rubin Observatory LSST, Euclid, strengthening the synergy between simulations and large-scale structure surveys in the era of precision cosmology.

P13. 153\_77\_1

[1. Transients and Variable Stars](#)[2. Informatics and Statistics](#)

## Machine learning in variable star classification and source identification in crowded fields

Tamás Szklenár<sup>‡</sup>, Róbert Szabó<sup>1</sup>

<sup>1</sup>Konkoly Observatory, Research Centre for Astronomy and Earth Sciences, Hungarian Research Network (HUN-REN), Konkoly Thege Miklós út 15-17, 1121 Budapest, Hungary

Machine learning plays a new and important role in reliable and fast classification of pulsating variable stars. Our team developed various methods for this, where not just the light curve shape determines the possible type of the given variable star, but additional numerical informations and different filters can be used together as well. This way the classification is not just incomparably faster than work done by human labor, but it processes all data objectively and, based on the results it produces, performs as well as or better than trained professionals. These methods require a great deal of preparation, one of these is the selection of targets, the cross-matching between different datasets. In the era of LSST, crowded-fields and faint object will make this especially difficult, this is why we started to create variable star databases with the cross-matching of different sky-surveys.

P14.127\_10\_1

1. Transients, Variable Stars

2. Stars Milky Way Local Volume

## How many stars are variable?

László Szabados<sup>1</sup>

<sup>1</sup>HUN-REN CSFK Konkoly Observatory, Budapest, Hungary

The number of known variable stars is growing at an astonishing rate. After a brief overview of the projects that have facilitated this, I will present my survey of the brightest naked-eye stars from the point of view of variability. The results are almost incredible.

P15.

1. LSST Project

## LSST Rising

Gyula M. Szabó<sup>1</sup>, Róbert Szabó<sup>2</sup>

<sup>1</sup>ELTE Gothard Astrophysical Observatory, Szombathely, Hungary

<sup>2</sup>HUN-REN CSFK Konkoly Observatory, Budapest, Hungary

In this musical piece, a member of the collaboration captured the excitement of anticipation through the expressive tools of music. The piece, titled **LSST Rising**, was composed a few days before the official launch of the Legacy Survey of Space and Time of the Vera C. Rubin Observatory.

The work explores the musical potential of the acronym LSST as a four-note thematic cell, representing *la–so–so–ti*. The exposition develops the LSST cell through successive entries, followed by a scalar figure (dome). The usual modulatory section has been replaced by a gradual intensification from minor-mode instability towards the major tonic, depicting the progressive emergence of the LSST survey. A major-Phrygian flavor supports Latino moments. In the final section, repeated echoes of the thematic material progressively challenge tonal anchoring before resolving into the tonic, spanning the entire range of the keyboard.

P16. 268\_92\_1.pdf

1. Galaxies

2. Science with DP2

3. LSST project

## Detecting Faint diffuse galaxies in the Rubin-LSST era

Kanak Saha<sup>1</sup>, Dipanjan Mitra<sup>1</sup>

<sup>1</sup>Inter-university Centre for Astronomy and Astrophysics, Pune, Seminar A2, IUCAA, University Campus, India

Faint diffuse or ultra-diffuse galaxies are smooth, featureless, extended objects in the sky; these often do not contain a set of bright pixels or core but become visible when viewed as a whole. Traditional automated methods work well for point sources, but often fails for extremely diffuse, low-SNR galaxies in large surveys. As a result, their origin and physical properties are not well understood. Since Rubin-LSST with its unprecedented sensitivity will provide a unique opportunity to investigate them, it is timely to develop alternate algorithm to detect them. As part of an in-kind contribution, the speaker will discuss about the development of an ongoing algorithm and its efficiency in detecting such diffuse galaxies. If time permits, the speaker will show the serendipitous detection of an extremely LSB galaxy in the Rubin-LSST DP2 data.

P17.285\_94\_1

1. Stars, Milky Way, Local Volume

2. Science with DP2

## PhotoD with LSST: Stellar Photometric Distances Out to the Edge of the Galaxy

Lovorka Gajović<sup>1</sup>, Lovro Palaversa<sup>1</sup>

<sup>1</sup> Ruđer Bošković Institute, Bijenička Cesta 54, 10000, Zagreb, Croatia

If one wishes to study kinematics, formation or evolution history of the Milky Way, accurate distances to the stars are needed to construct a three-dimensional map of the Galaxy. Recent sky survey data demonstrated that broadband near-UV to near-IR stellar photometry can be used to estimate star distances, metallicity, and interstellar dust extinction along the line of sight. Anticipating photometric catalogs with tens of billions of stars from Rubin's Legacy Survey of Space and Time (LSST), we present a Bayesian model and pipeline that can handle LSST-sized datasets. Likelihood computations utilize MIST/Dartmouth isochrones and priors are derived from TRILEGAL-based simulated LSST catalogs from P. Dal Tio et al. Our pipeline, named photoD (in analogy with photo-z, photometric redshifts of galaxies), had an initial computation speed of about 10 ms per star on a single CPU core using an optimized grid search method. In this talk, I will also present the improvements we included since the first published version. Utilizing GPU-s and significantly improving the code lowered the overall execution time by two orders of magnitude. Neural networks were also used to improve this performance further (paper by K. Mrakovcic et al.) PhotoD was validated using both simulated catalogs and SDSS and Gaia photometry. The final LSST-based photometric distance catalog will increase the number of stars and distance by an order of magnitude compared to current largest catalogues, mostly based on Gaia data.

P18.245\_84\_1

1. Galaxies

## Tracing the environment of Low Surface Brightness Galaxies in the LSST era

Sureshkumar, Unnikrishnan<sup>1</sup>

<sup>1</sup>National Centre for Nuclear Research (NCBJ), Andrzej Soltana 7, Otwock, 05-400 Poland

Low surface brightness galaxies (LSBGs) are believed to account for a significant fraction of the total number density of galaxies and play a crucial role in galaxy evolution. However, their connection to their local environment remains poorly understood, despite the well-established influence of the environment on the evolution of galaxies. Rubin LSST is expected to reveal an unprecedentedly large population of LSBGs, making it an appropriate time for dedicated LSBG science. In this talk, I will present our recent results on the spatial clustering of LSBGs using two-point correlation functions. I will also discuss the environmental correlations of various LSBG properties, such as color and effective radius, with the help of marked correlation function measurements. Our results are based on LSBG samples identified in the Dark Energy Survey. These findings contribute significantly to the advancement of low surface brightness science using the Rubin LSST.





