


Rubin LSST Dark Energy Science Collaboration

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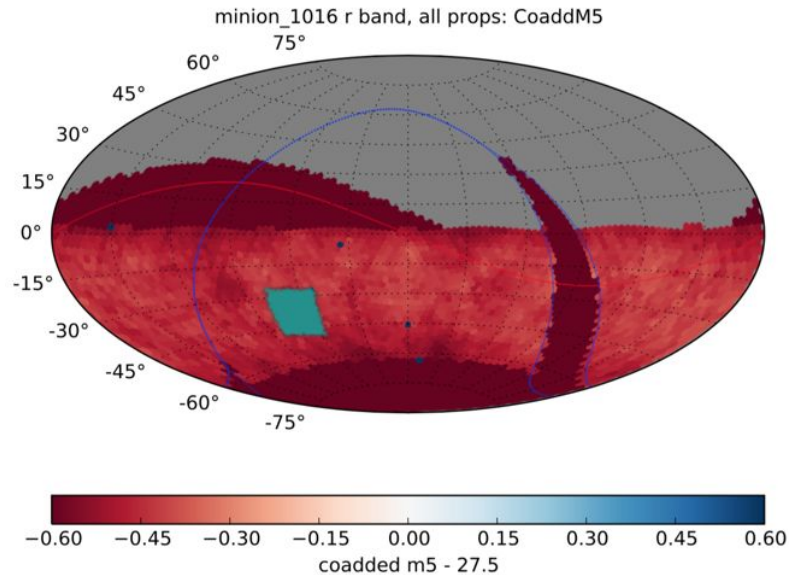
An aerial photograph of the Vera C. Rubin Observatory under construction on Cerro Pachon. The observatory's large, white, angular structure is the central focus, perched on a rocky ridge. In the background, another mountain peak features a smaller, traditional observatory dome. The sky is a deep twilight blue, with a bright star or planet visible. The foreground shows construction equipment and materials on a dirt road.

Vera C. Rubin Observatory: Currently under construction on Cerro Pachon at nearly 9,000 feet in the foothills of the Chilean Andes

Exploring the physics of the dark Universe (and much more!)

- The ten-year Rubin Observatory Legacy Survey of Space and Time (LSST) will observe half of the sky and record 37 billion stars and galaxies
- 10 million alerts, 20 TB of data, every night!
- First light: Valentine's Day 2024 (with error bars!)
- Year 1 Data Release (DR2): October 2025 - January 2026

The Legacy Survey of Space and Time



Main survey: $\sim 18,000$ sq deg of southern sky, “Deep Drilling Fields”, 10 sq deg each, plus further “mini-surveys” to support special science cases

- Worldwide “Alerts” released nightly (with minimal info)
- Annual data releases: Images, Object and Source tables (including galaxy model measurements and forced photometry light curves), released to LSST data rights community

Dark Energy Science Collaboration



Collaboration Meeting, Chicago 2022



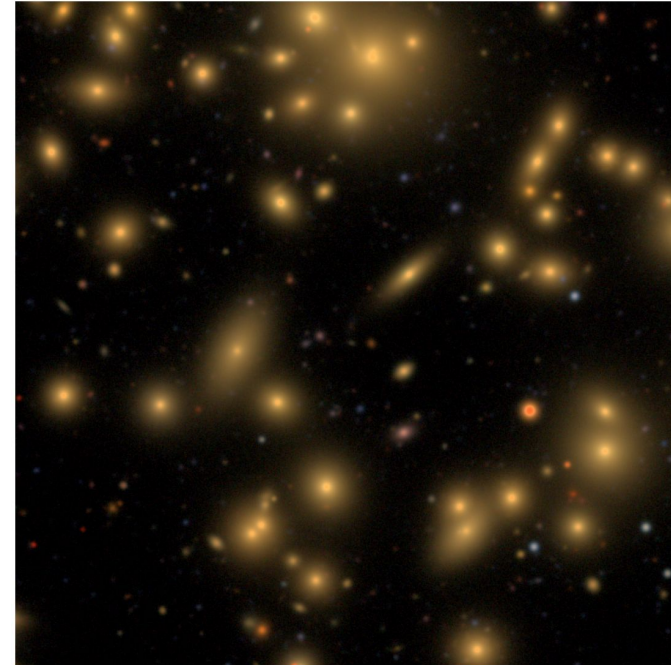
More than 1200 members!



Dark Energy Science Collaboration

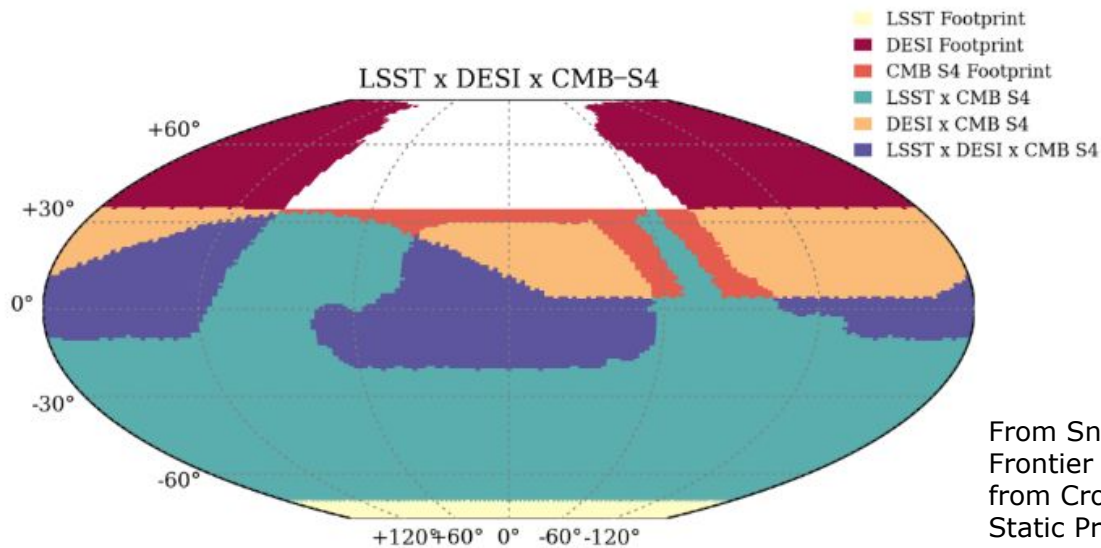


- **Our scientific aim:** Explore the Dark Universe
 - Dark energy, dark matter, neutrinos and signatures of inflation
- **Our objectives:** (<https://lsstdesc.org/>)
 - Accurate cosmology
 - A vibrant & inclusive scientific community
 - Meeting LSST's data challenge
 - Learning continuously from each other
- **Our approach:**
 - Combine five cosmological probes: clusters, weak & strong lensing, SNe, clustering
- **Our challenges:**
 - Systematics, ... and more systematics



Cluster of galaxies from the DESC Data Challenge 2 (DC2) catalog, generated on the Rubin Science Platform; Image credit: Jeff Carlin, DM Science Verification Team

What can we gain by “joining forces”?



- Let's take a look at joint project between the **Dark Energy Survey** and **SPT/ACT/Planck ...**
- Interrogate list of **Scientific Papers** by the DES members of the DES Collaboration

What can we gain by “joining forces”?

- Joint analysis of DES Year 3 data and CMB lensing from SPT and Planck I: Construction of CMB Lensing Maps and modeling choices ([arXiv:2203.12439](https://arxiv.org/abs/2203.12439))
- Joint analysis of DES Year 3 data and CMB lensing from SPT and Planck II: Cross-correlation measurements and cosmological constraints ([arXiv:2203.12440](https://arxiv.org/abs/2203.12440))
- Joint analysis of DES Year 3 data and CMB lensing from SPT and Planck III: Combined cosmological constraints ([arXiv:2206.10824](https://arxiv.org/abs/2206.10824))
- Superclustering with the Atacama Cosmology Telescope and Dark Energy Survey: I. Evidence for thermal energy anisotropy using oriented stacking ([arXiv:2107.05523](https://arxiv.org/abs/2107.05523))

What can we gain by “joining forces”?

- Cross-correlation of DES Y3 lensing and ACT/*Planck* thermal Sunyaev Zel'dovich Effect I: Measurements, systematics tests, and feedback model constraints ([arXiv:2108.01600](https://arxiv.org/abs/2108.01600))
- The mass and galaxy distribution around SZ-selected clusters ([arXiv:2105.05914](https://arxiv.org/abs/2105.05914))
- Cosmological Constraints from DES Y1 Cluster Abundances and SPT Multi-wavelength data ([arXiv:2010.13800](https://arxiv.org/abs/2010.13800))
- Exploring the contamination of the DES-Y1 Cluster Sample with SPT-SZ selected clusters ([arXiv:2101.04984](https://arxiv.org/abs/2101.04984))
- The Atacama Cosmology Telescope: A Catalog of > 4000 Sunyaev-Zel'dovich Galaxy Clusters ([arXiv:2009.11043](https://arxiv.org/abs/2009.11043))
- The SPTpol Extended Cluster Survey ([arXiv:1910.04121](https://arxiv.org/abs/1910.04121))

What can we gain by “joining forces”?

- Constraints on the redshift evolution of astrophysical feedback with Sunyaev-Zeldovich effect cross-correlations ([arXiv:1904.13347](#))
- A Detection of CMB-Cluster Lensing using Polarization Data from SPTpol ([arXiv:1907.08605](#))
- Mass Calibration of Optically Selected DES clusters using a Measurement of CMB-Cluster Lensing with SPTpol Data ([arXiv:1810.10998](#))
- Measurement of the Splashback Feature around SZ-selected Galaxy Clusters with DES, SPT and ACT ([arXiv:1811.06081](#))
- Dark Energy Survey Year 1 Results: the lensing imprint of cosmic voids on the Cosmic Microwave Background ([arXiv:1911.02951](#))
- Cosmological lensing ratios with DES Y1, SPT and Planck ([arXiv:1810.02212](#))

What can we gain by “joining forces”?



- Dark Energy Survey Year 1 Results: Cross-correlation between DES Y1 galaxy weak lensing and SPT+Planck CMB weak lensing ([arXiv:1810.02441](#))
- Dark Energy Survey Year 1 Results: tomographic cross-correlations between DES galaxies and CMB lensing from SPT+Planck ([arXiv:1810.02342](#))
- A joint SZ-Xray-optical analysis of the dynamical state of 288 massive galaxy clusters ([arXiv:2004.01721](#))
- DES Year 1 Results: Joint Analysis of Galaxy Clustering, Galaxy Lensing, and CMB Lensing Two-point Functions ([arXiv:1810.02322](#))
- A Measurement of CMB Cluster Lensing with SPT and DES Year 1 Data ([arXiv:1708.01360](#))
- Optical-SZE Scaling Relations for DES Optically Selected Clusters within the SPT-SZ Survey ([arXiv:1605.08770](#))

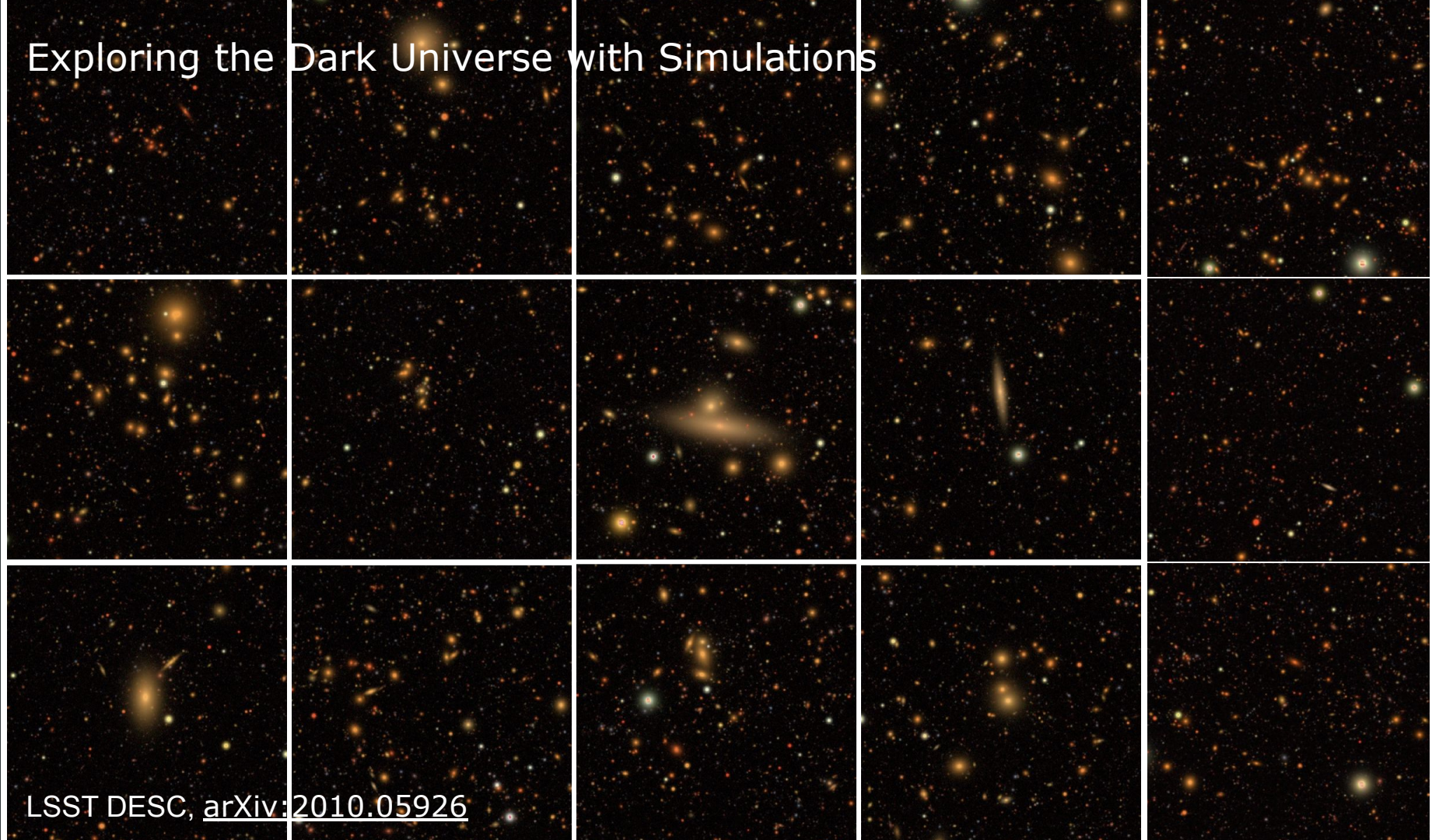
What can we gain by “joining forces”?

- Dark Energy Survey Year 1 Results: Methodology and Projections for Joint Analysis of Galaxy Clustering, Galaxy Lensing, and CMB Lensing Two-point Functions ([arXiv:1802.05257](https://arxiv.org/abs/1802.05257))
- Detection of the kinematic Sunyaev-Zel'dovich effect with DES Year 1 and SPT ([arXiv:1603.03904](https://arxiv.org/abs/1603.03904))
- Cross-correlation of gravitational lensing from DES Science Verification data with SPT and Planck lensing ([arXiv:1512.04535](https://arxiv.org/abs/1512.04535))
- Joint Measurement of Lensing-Galaxy Correlations Using SPT and DES SV Data ([arXiv:1602.07384](https://arxiv.org/abs/1602.07384))
- Constraints on the Richness-Mass Relation and the Optical-SZE Positional Offset Distribution for SZE-Selected Clusters ([arXiv:1506.07814](https://arxiv.org/abs/1506.07814))
- CMB lensing tomography with the DES Science Verification galaxies ([arXiv:1507.05551](https://arxiv.org/abs/1507.05551))

How can we get started?

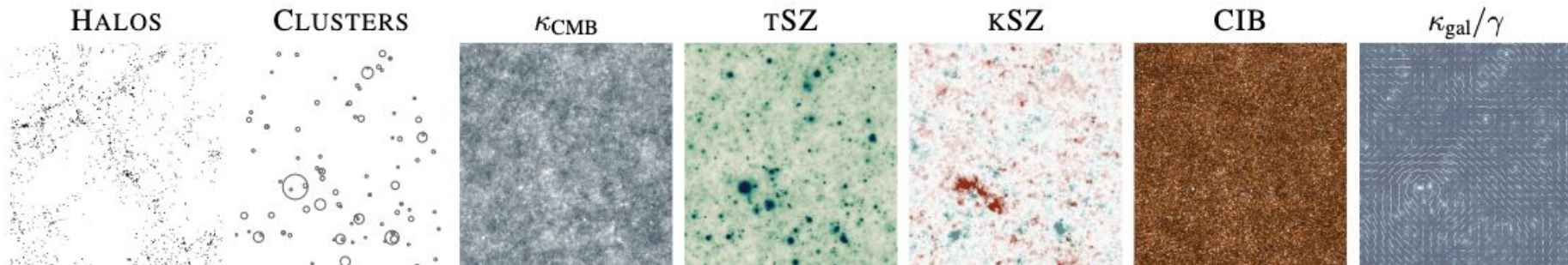


Exploring the Dark Universe with Simulations



How can we get started?

- **Snowmass White Paper** ([Baxter et al](#)) provides concrete ideas!
 - Joint simulations for multi-wavelength cross-correlation analyses
 - Build joint modeling and analysis capabilities
- **LSST DESC External Synergies Working Group**
 - Helps to formulate MOUs (as long as no data is exchanged this should be straightforward)
 - Can help kick-start joint projects



Summary

- Construction of the Rubin Observatory is making excellent progress
- LSST DESC is preparing for data arrival and DR2 for late 2025
- During the time of LSST Y1 data analysis effort, CMB-S4 is taking shape
- Exciting scientific opportunities for joint projects
- Start preparing!

