

Introduction to early science with Rubin/LSST

Graham Smith

Project Scientist, LSST:UK



National Astronomy Meeting, Durham, July 7th, 2025

Rubin/LSST science is person-power limited on an unprecedented scale!



- Apply for data rights – Bob Mann’s talk
- Access data – Roy William’s talk (Lasair), James Mullaney’s talk (DP0)
- Join one or more Science Collaborations (SCs) – this talk
 - access scientific and technical expertise
 - contribute your own scientific and technical expertise
 - connect with new collaborators
 - create exciting new opportunities for you and your team
- Get involved, stay connected, help other people
 - join the Junior Associates Network – lunch session tomorrow
 - volunteer (all career stages) for the LSST:UK Science Working Group – imminent re-launch!
- *Credit for most slides: Gautham Narayan, Federica Bianco, SC Co-chairs*

Huge scale drives new ways of collaborating...

LSST's science pillars and scaling challenges

Inventory the Solar System

~10k asteroids → ~10M with LSST

Map the Milky Way

~100M stars → 17B with LSST

Probe Dark Matter & Dark Energy

~100M galaxies → 30B with LSST

Explore the Transient Sky

~10k supernovae → ~10M with LSST

20 TB, with 10M time-domain alerts**, per night!

*From killer asteroids to the most distant
Universe:*

20 orders of magnitude in distance scales

60 orders of magnitude in energy scales

**The LSST Science Collaborations aim
to leverage unprecedented data volume
for multiple science goals.**

Data access

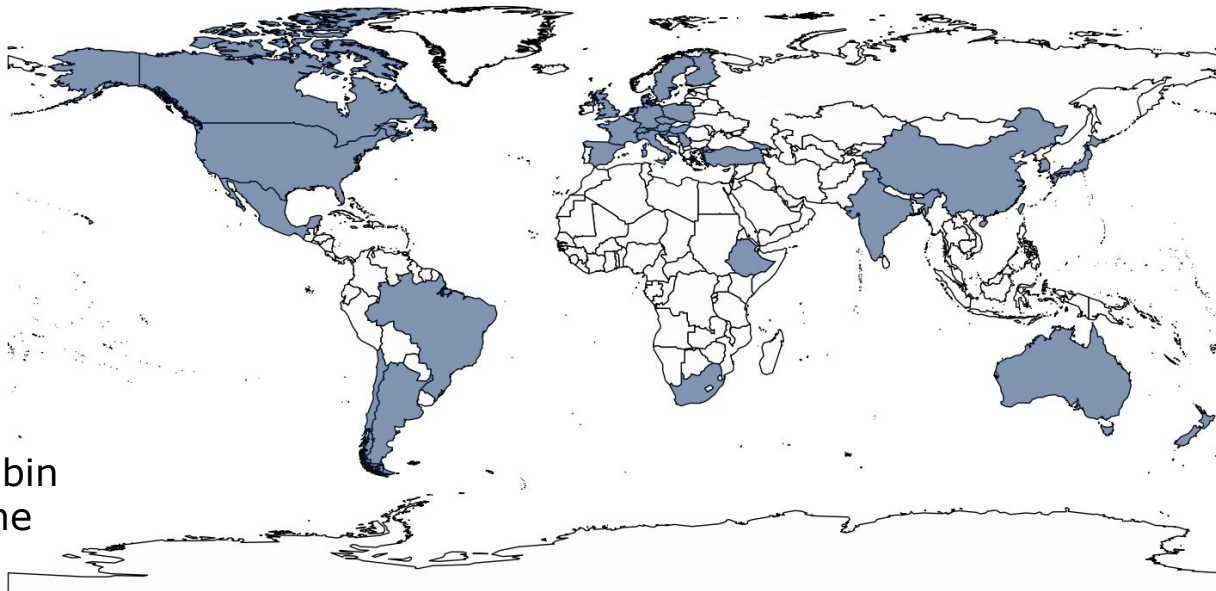


- Alerts:
 - ~1 minute after readout, world readable – see Roy William’s talk
- Data previews (and releases):
 - ~annual, data rights holders – see Jame Mullaney’s talk
- Custom and single-visit data products:
 - >80 hours, data rights holders – a lot easier as part of a Science Collaboration

What the Science Collaborations are

SCs Federation Charter

- Independent, self-organized groups of scientists based on research focus
- > 2000 members, no membership fees & no institutional affiliation requirements. **Students are encouraged to join!**
- Preparing for science with Rubin Obs, and coordinating with the project on strategies, data products, etc.
- Learn more at: www.lsst.org/scientists/science-collaborations



Credit: Federica Bianco

The Rubin Science Collaborations (SCs)

LSST science belongs to the you!

8 Science Collaborations ([linked here](#))

[Rubin LSST SCs Charter](#)



Active Galactic Nuclei SC
Matthew Temple, Neil Brandt



Stars, Milky Way, and Local Volume SC
Peregrine McGehee, Kristen Dage



Dark Energy SC
Renee Hlozek, Tesla Jeltema



Strong Lensing SC
Simon Birrer, Anupreeta More



Galaxies SC
Sugata Kavirai/Simona Mei



Informatics and Statistics SC
Ashley Villar, Francois Lanusse
(but stand for their election!)



Solar System SC
Meg Schwamb, Colin Chandler

How are the SCs preparing for Rubin Data?

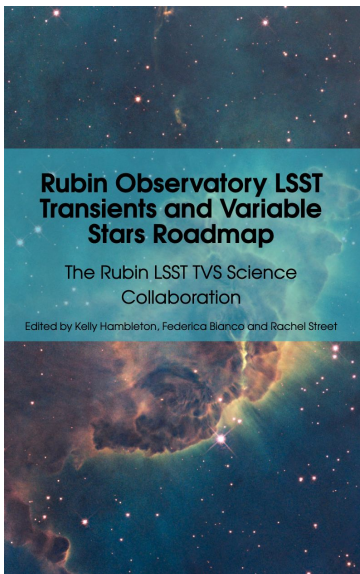
The scope and potential for science with the Rubin Observatory LSST is as enormous as the unprecedented volume and complexity of the LSST data products.

Correspondingly, the technologies, methodologies, policies, and collaborative strategies for research with LSST are preparing to meet this challenge by:

- building analysis software infrastructure
- assembling preparatory data sets
- pioneering sophisticated new algorithms
- establishing inter-collaboration ties
- investigating synergies with other facilities

One early science goal we have is to find intrinsically rare, exotic transients & variables

Microlensing
Eclipsing Binary Stars
Cataclysmic Variables
Neutron Star Binaries
Black Hole Binaries
Supernovae
Intermediate-Luminosity Optical Transients
Light Echoes of eruptions and explosions

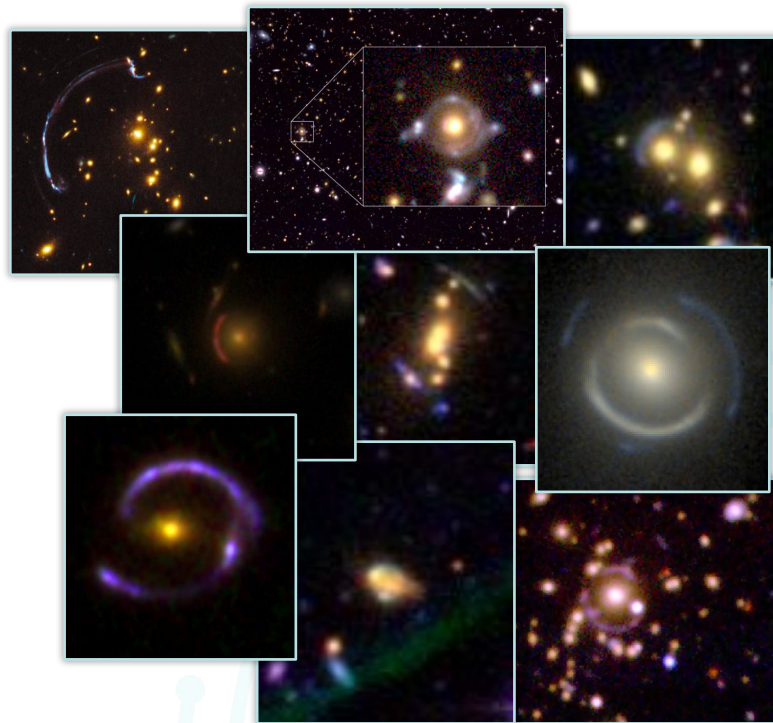


Tidal Disruption Events
EM counterparts of GW events
Young stellar objects
Pulsating Stars
Cepheids and RR Lyrae Stars
Long Period Variables
Brown Dwarfs
GRB
Blazars
Transiting Exoplanets
Alert Brokers
SETI

Co-chairs: Simon Birrer, simon.birrer@stonybrook.edu
Anupreeta More, anupreeta@iucaa.in

- Time delay **cosmography**: lensed QSO, SNe, GWs
- Mass and structure of **dark matter halos**: 10^5 strong lenses spanning galaxies, groups and clusters
- Quasar **microlensing**: accretion disk structure of 10^3 lensed AGN and IMF of lensing galaxies
- **Gravitational telescopes**: resolved properties of high-redshift galaxies
- Physics of lensed **explosive transients** (SNe, TDEs, KNe, GWs, GRB afterglows)

One early science goal: to discover and do science with Rubin/LSST's first lensed transients

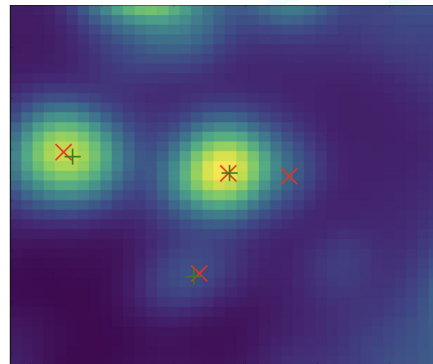
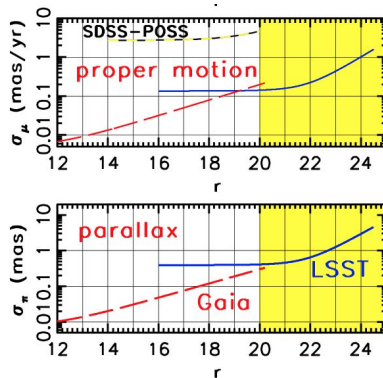


Presented on behalf of SMWLV by Tom J. Wilson

<https://rubin-smwlv.github.io/>

One (okay, a few...) early science goal(s) we have is to...

- Understand feasibility and accuracy of detecting extragalactic globular clusters
- Implement AI/ML techniques for a globular cluster classification tool (Star Clusters)
- Quantifying if/how LSST extends *Gaia* data (GSISM, Solar Neighborhood)
- Understanding second-order effects of crowded fields (Crowded Fields TF, GSISM, ...)





Colin Orion Chandler & Meg Schwamb
SSSC Co-Chairs



Active Objects Working Group (Lead: Henry Hsieh)



Community Software/Infrastructure Development Working Group
(Lead: Tim Lister)



Carrie Holt & Maria Chernyavskaya
Early Career Representatives



Inner Solar System Working Group (Lead: Siegfried Eggel)



NEOs (Near Earth Objects) and Interstellar Objects Working Group
(Lead: Sarah Greenstreet)



Agata Rożek & Gal Sarid
Publication Coordinators



Laura Inno
Cross Science
Collaborations
EDI Committee



Outer Solar System Working Group (Lead: Pedro Bernardinelli)



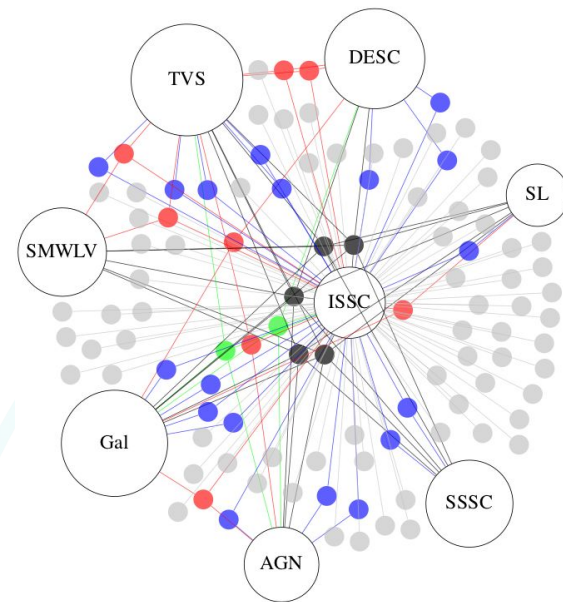
Technosignatures Think Tank (Lead: Jim Davenport)





ISSC is actively evolving! Now is the perfect time to get involved: <https://issc.science.lsst.org/>

- Larger and more complex data than ever before
 - Accessing and processing datasets even for a conventional type of analysis is non-trivial.
 - Interpreting the data poses new challenges (e.g. blending).
=> **Specific developments in Stats/ML and Informatics to enable Rubin Science.**
- Higher standards of analysis quality and reproducibility
 - We have learned from experience that reproducing analyses is non-trivial: example of precursor reanalysis projects led by DESC
=> **Need for standards, good practices, and tools.**
- Very fast evolution of ML and Informatics
 - The rate of ML papers is “astronomical.”
 - Informatics tools used professionally to manage pipelines and big data in industry are constantly evolving.
=> **Keeping up with ever-changing landscape requires a non-trivial effort.**



Co-chairs: Simona Mei and Sugata Kaviraj - ~310 members

Our goal is to understand galaxy formation and evolution

LSST depth and area will give us an unprecedented view of our field of research especially with respect to (Robertson et al. 2017, 2019):

- Large statistics down to the faintest galaxies
- Connection between galaxy properties and their dark matter haloes
- Low-surface-brightness (LSB) features around galaxies (e.g., tidal tails, merger remnants, etc.)
- Galaxy cluster intra-cluster medium

Dark Energy Science Collaboration

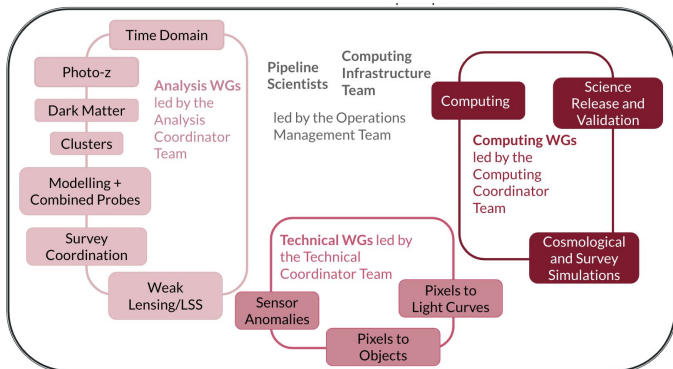
- **Our scientific aim:** Exploring the physics of the Dark Universe
 - Dark energy, dark matter, neutrinos and signatures of inflation
- **Our objectives:** (visit [DESC webpage](https://lsstdesc.org/) for more details)

Spokesperson team:
Renée Hložek (U. Toronto)
Tesla Jeltema (UC Santa Cruz)

- Producing accurate cosmology results
- Supporting a vibrant & inclusive scientific community
- Meeting LSST's big data challenge
- Learning continuously from each other

Our approach: Combining five cosmological probes: Clusters of galaxies, large-scale structure, supernovae, weak lensing and strong lensing (see [Science Overview Document](#)). Different working groups and topical teams to build pipelines and perform analysis.

1,250+ members, 250+ full members (with voting rights on policies, etc.)
For DESC membership [apply here](#)



<https://agn.science.lsst.org/>

Co-chairs: Matthew Temple, Niel Brandt – see Niel's talk tomorrow

Tens-of-millions of AGN to be discovered with LSST!

Some topics:

- Time variability studies, including searches for binary BH systems
- SMBH transients



LSST:UK Science Working Group (SWG)



- Key roles:
 - Help new LSST:UK members learn their way around the Science Collaborations
 - Provide a communication link between SCs and LSST:UK
- Two members per science collaboration are envisaged – one PI and one JA
- Non-onerous opportunity to give back / help other people
- Call for volunteers will be announced this month
- Please reach out this week or via email if you are interested / have ideas, comments, questions

Rubin/LSST science is person-power limited on an unprecedented scale!



- Apply for data rights – Bob Mann’s talk
- Access data – Roy William’s talk (Lasair), James Mullaney’s talk (DP0)
- Join one or more Science Collaborations (SCs) – this talk
 - access scientific and technical expertise
 - contribute your own scientific and technical expertise
 - connect with new collaborators
 - create exciting new opportunities for you and your team
- Get involved, stay connected, help other people
 - join the Junior Associates Network – lunch session tomorrow
 - volunteer (all career stages) for the LSST:UK Science Working Group – imminent re-launch!
- *Credit for most slides: Gautham Narayan, Federica Bianco, SC Co-chairs*