Vera C. Rubin Observatory: Ushering a New Era of TDA

Federica Bianco

Rubin Legacy Survey of Space and Time
Construction Project Deputy Project Scientist

University of Delaware
Department of Physics and Astronomy
Biden School of Public Policy and Administration
Data Science Institute

This is a living land acknowledgement developed in consultation with tribal leadership of Poutaxet, what is now known as the “Delaware Bay,” including: the Lenape Indian Tribe of Delaware, the Nanticoke Indian Tribe, and the Nanticoke Lenni-Lenape Tribal Nation in 2021. We thank these leaders for their generosity.

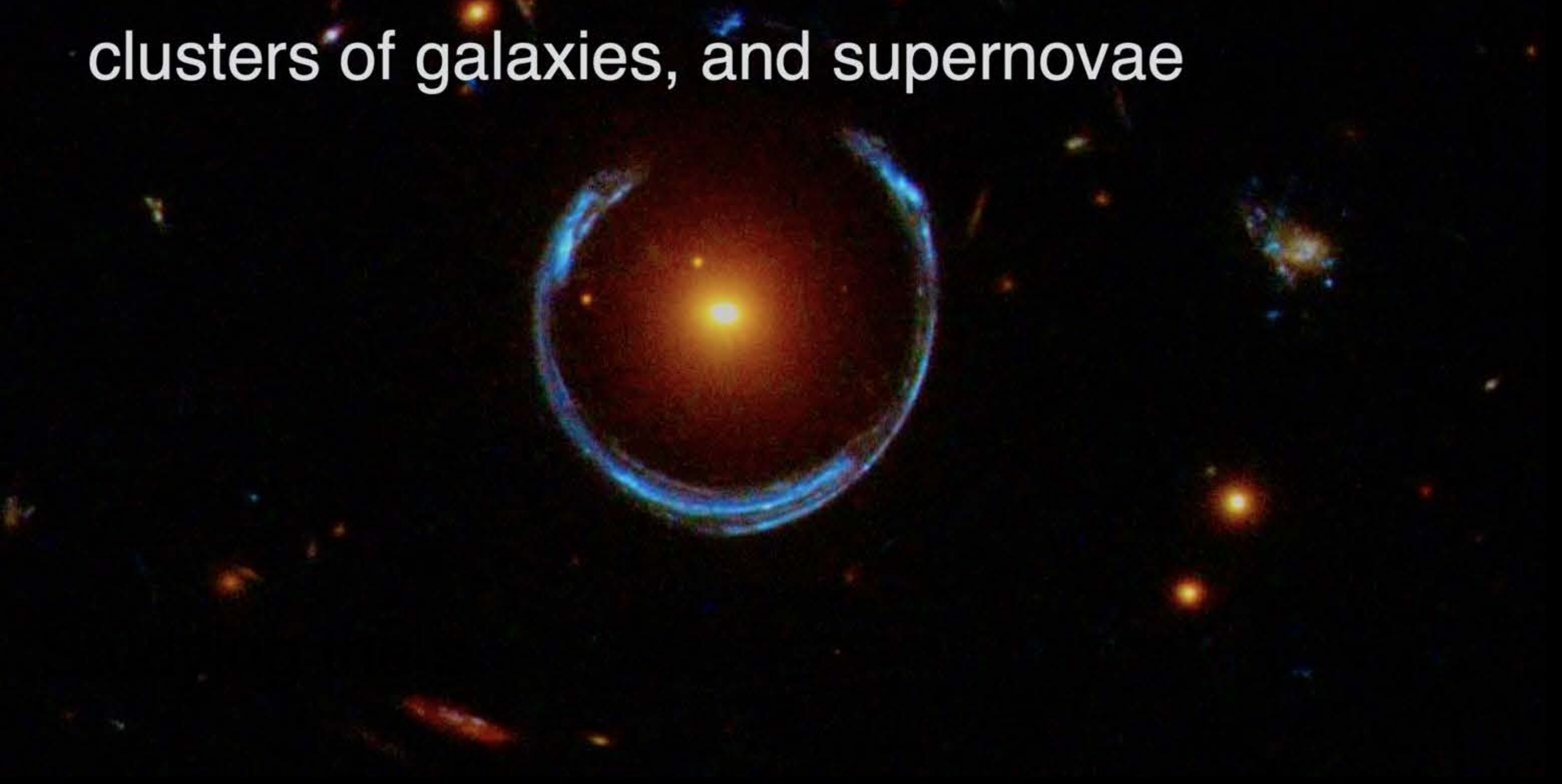
The University of Delaware occupies lands vital to the web of life for Lenni Lenape and Nanticoke, who share their ancestry, history, and future in this region. UD has financially benefited from this regional occupation as well as from Indigenous territories that were expropriated through the United States land grant system. European colonizers and later the United States forced Nanticoke and Lenni Lenape westward and northward, where they formed nations in present-day Oklahoma, Wisconsin, and Ontario, Canada. Others never left their homelands or returned from exile when they could. We express our appreciation for ongoing Indigenous stewardship of the ecologies and traditions of this region. While the harms to Indigenous people and their homelands are beyond repair, we commit to building right relationships going forward by collaborating with tribal leadership on actionable institutional steps.

slides available at

https://slides.com/federicabianco/kahn22

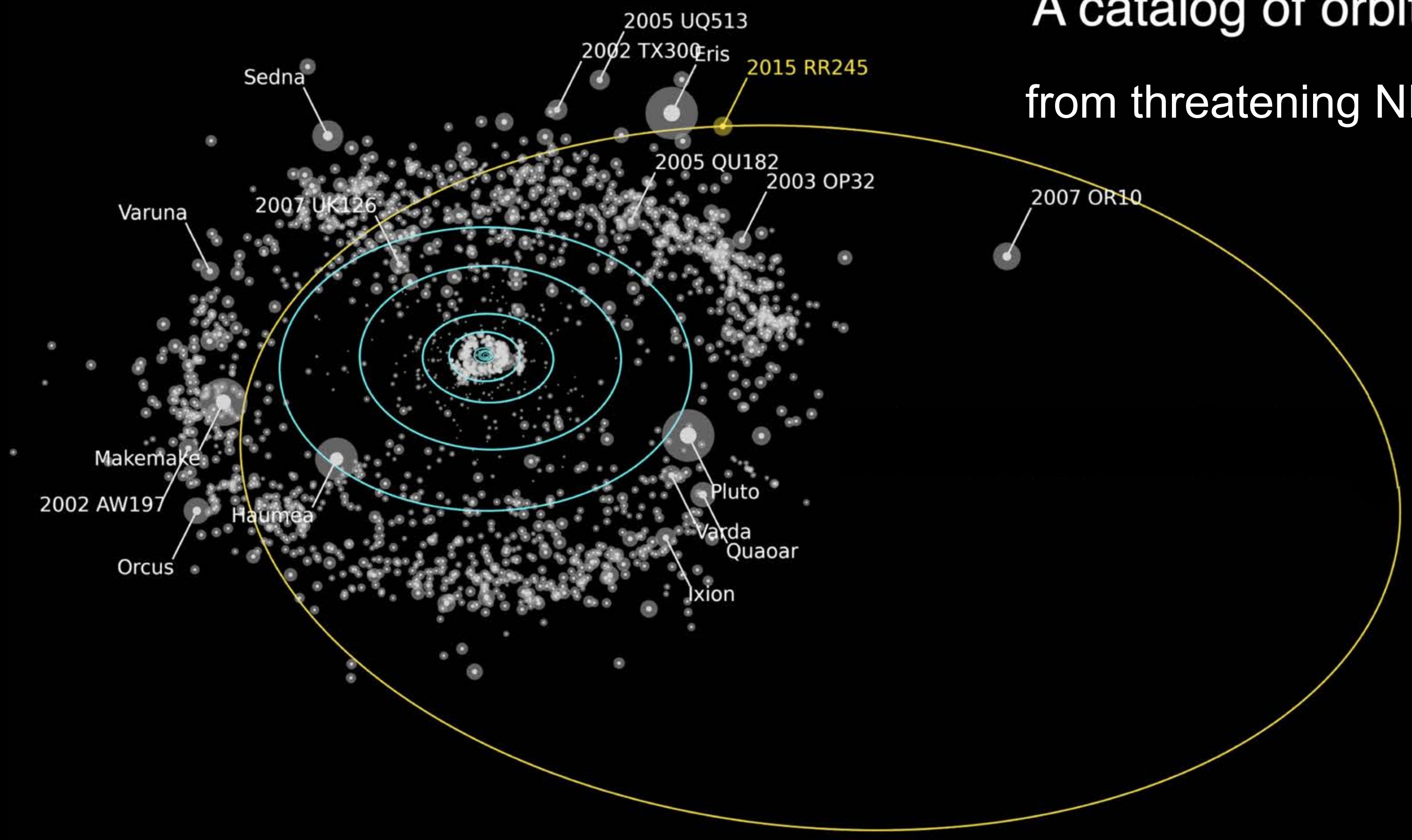
Probing Dark Energy and Dark Matter

Exquisite measurements of strong and weak lensing, large-scale structure, clusters of galaxies, and supernovae



LSST Science Drivers

Taking an inventory of the solar system



A catalog of orbits for 6 million bodies

from threatening NEO to the distant Oort Cloud

LSST Science Drivers

Mapping the Milky Way (and Local Volume)

17B stars characterized in shape, color, and variability.

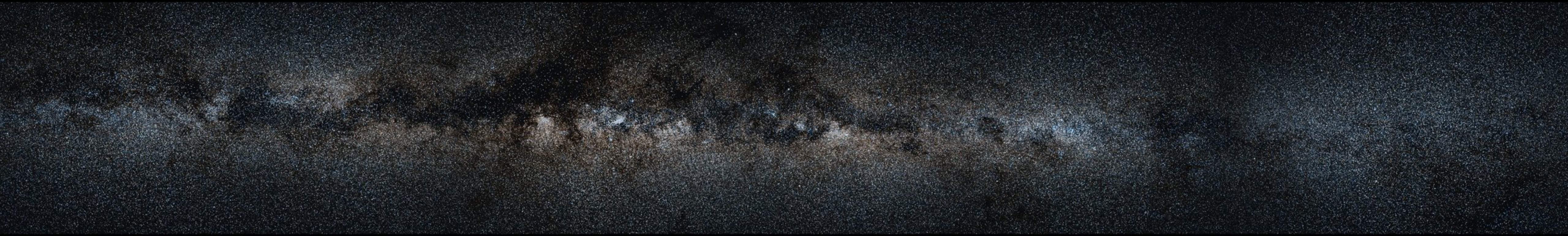
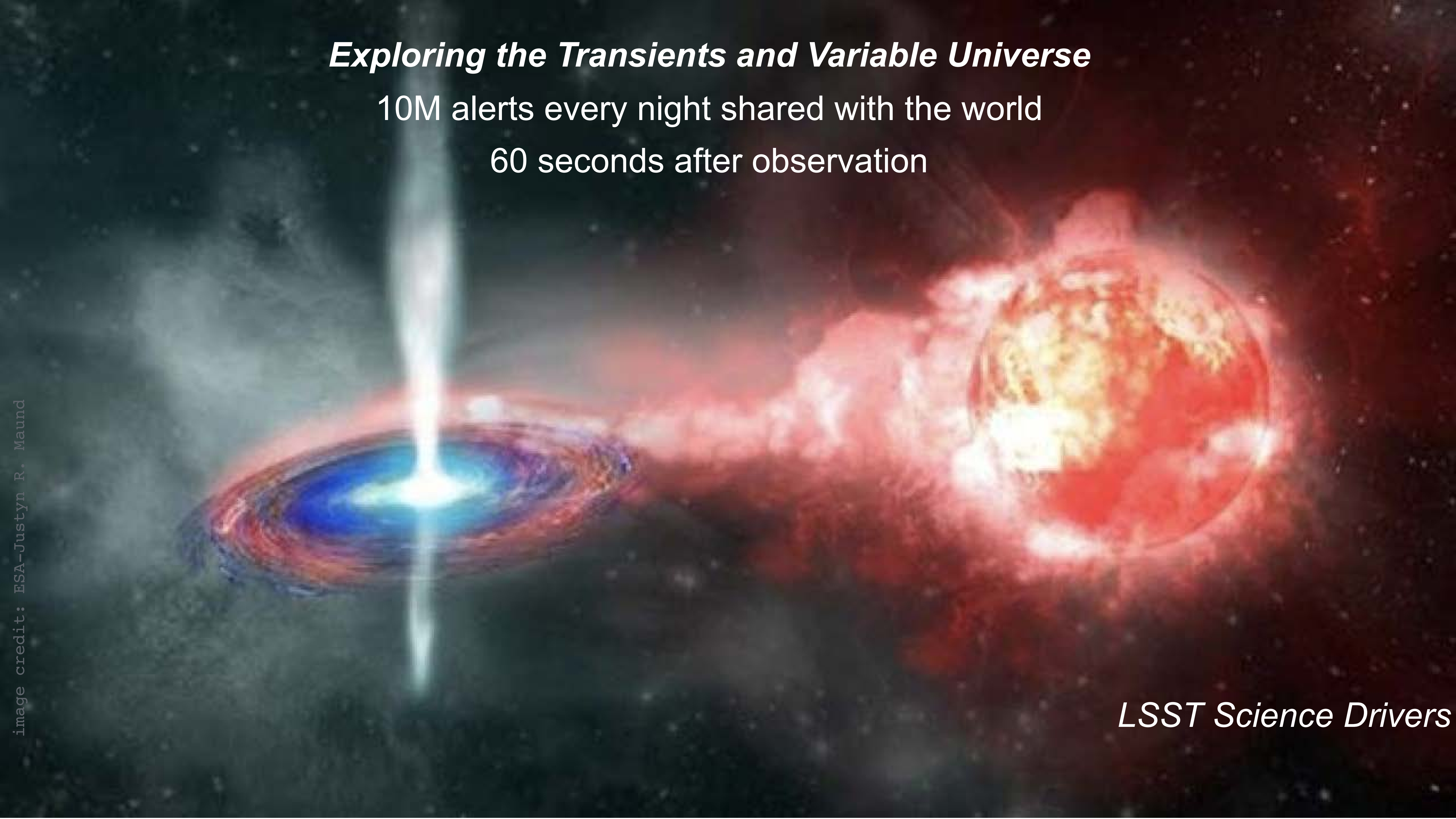


image credit ESO-Gaia

LSST Science Drivers


Exploring the Transients and Variable Universe
10M alerts every night shared with the world
60 seconds after observation
image credit: ESA-Justyn R. Maund
LSST Science Drivers

Nicole Oresme (artist unknown) Bibliothèque National de France

The Immutability of the Heavens[1]

VIRGINIA TRIMBLE

Astronomy Department, University of Maryland, College Park, MD 20742; and Physics and Astronomy Department, University of California, Irvine, CA 92687; vtrimble@astro.umd.edu

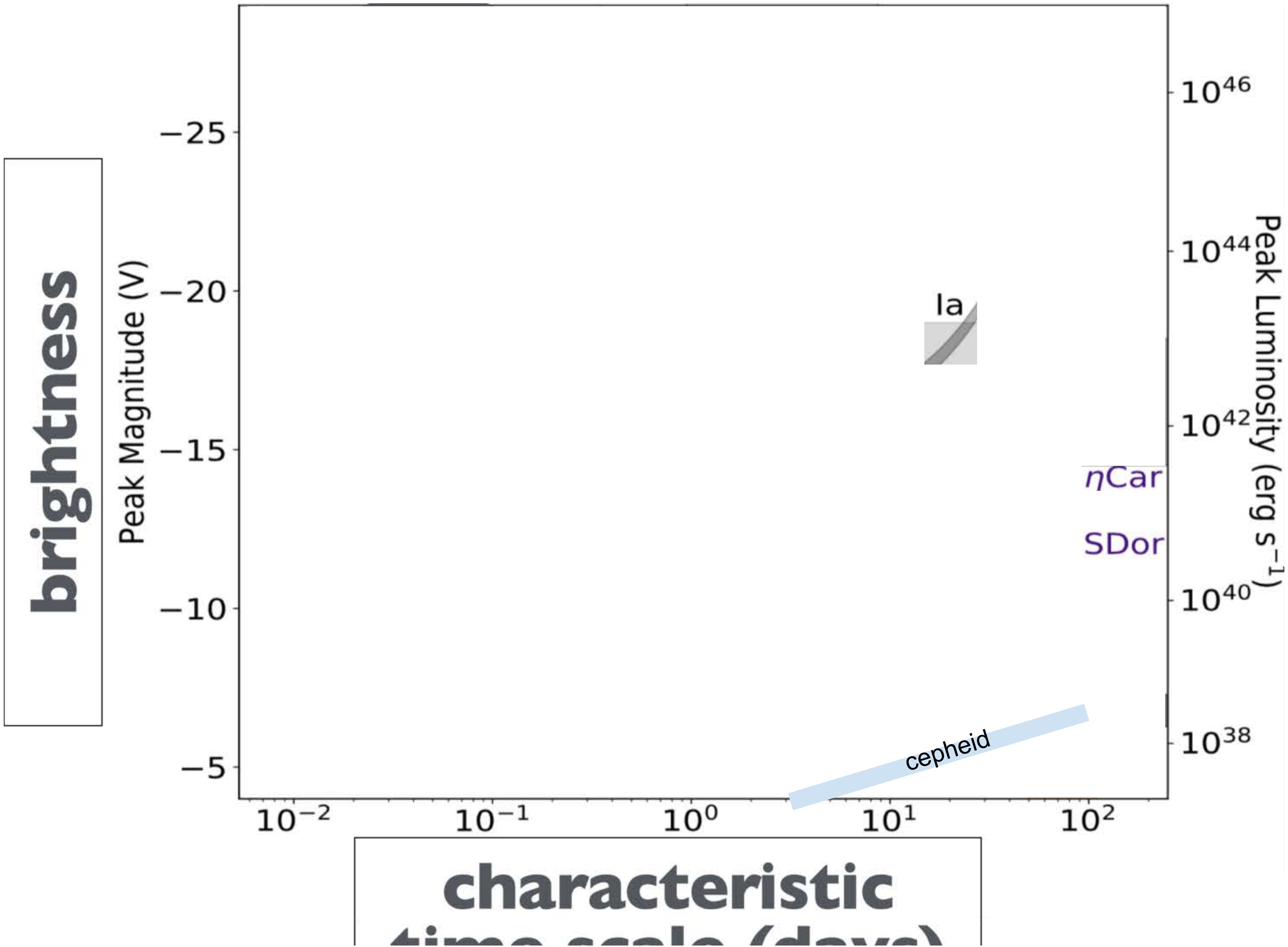
Received and accepted 1999 September 2

The immutability of the heavens was an important aspect of this synthesis, with a distinction being drawn between Earthly ("secular") affairs, which could change any old way, and the affairs of the heavenly and angelic spheres, in which only cyclic changes occurred, like the seasons, phases of the Moon, and motions of the wandering planets. The connection between eclipses and phases of the Moon was well enough understood for them to fall within this allowed, sacred calendar.

From Flammarion's Astronomie Populaire (1880): in Scania, Denmark

Workshop of Diebold Lauber unknown artist, ca.1450

TED talk - Andrew Connely


brightness
Peak Magnitude (V)
−25
−20
−15
−10
−5
Peak Luminosity (erg s−1)
10^46
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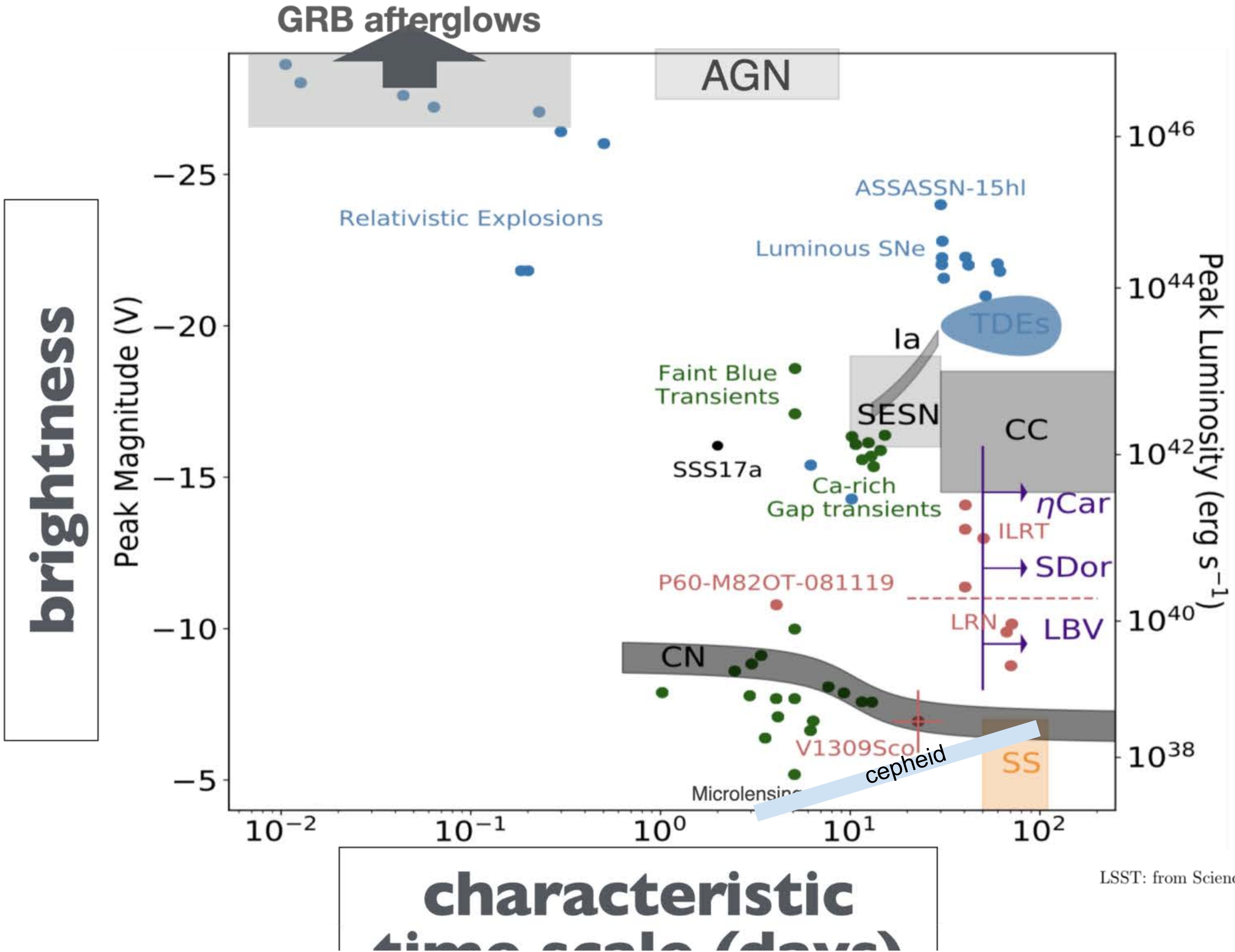
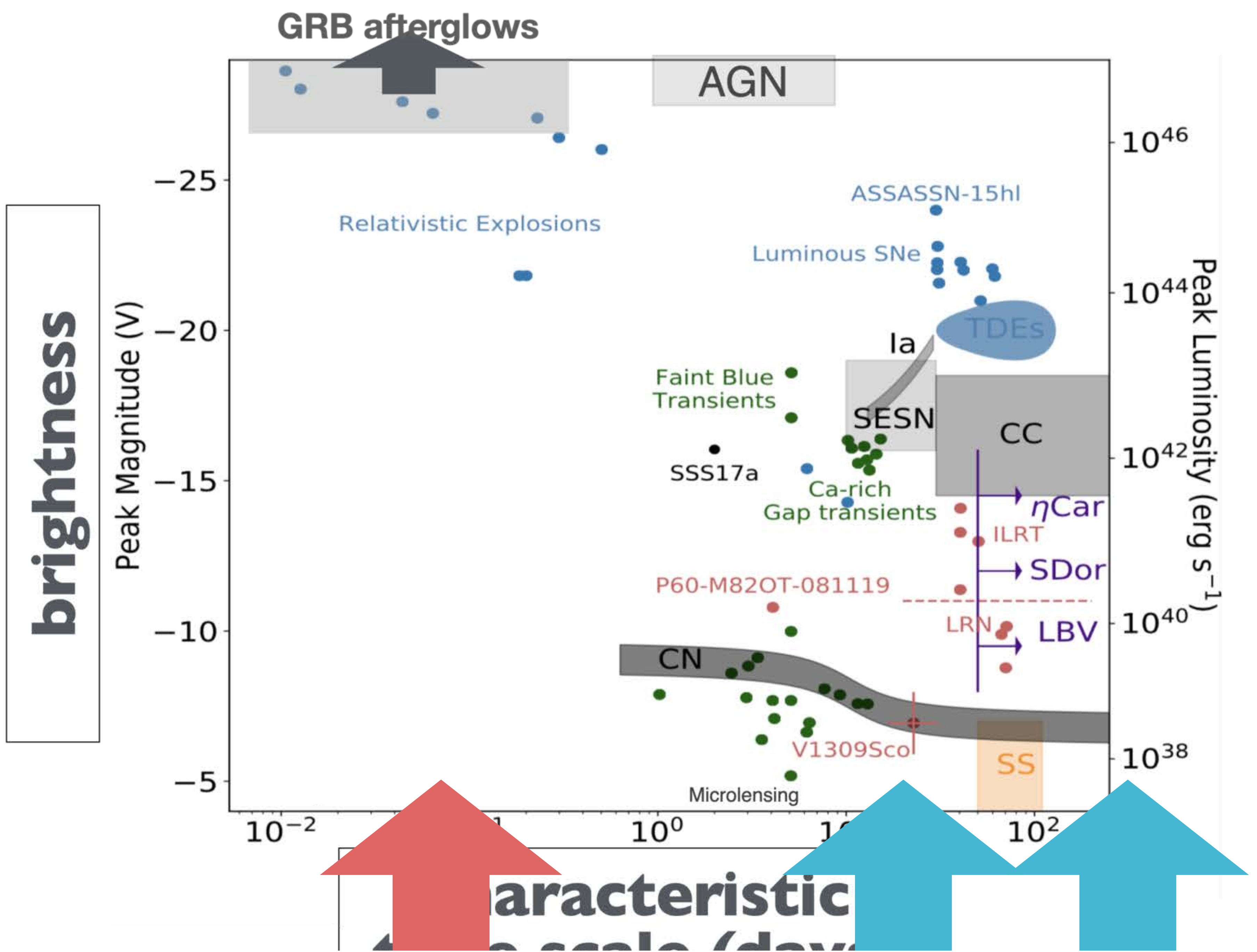
10^0
10^1
10^2
characteristic

circa 1900



LSST: from Science Drivers to Reference Design and Anticipated Data Products

Ivezić et al 2019


GRB afterglows
AGN
Relativistic Explosions
ASSASSN-15hl
Luminous SNe
TDEs
Ia
Faint Blue
Transients
SESN
CC
SSS17a
Ca-rich
Gap transients
ηCar
ILRT
SDor
P60-M82OT-081119
LRN
LBV
CN
V1309Sco
SS
Microlensing
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Peak Luminosity (erg s⁻¹)
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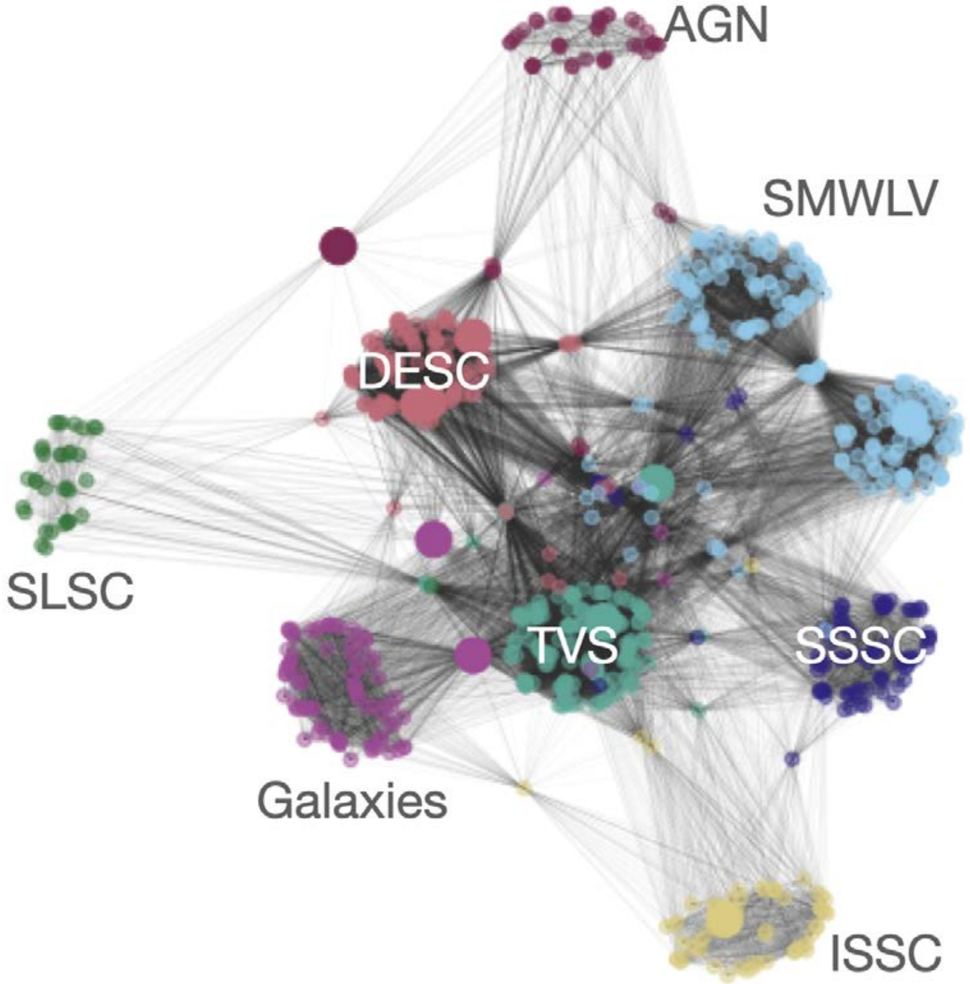
Rubin LSST Science Collaborations



8 teams

>1500 members

>2000 affiliations

5 continents

Rubin LSST Science Collaborations

Active Galactic Nuclei SC

Dark Energy SC

Informatics and Statistics SC

Galaxies SC

Strong Lensing SC

Stars Milky Way Local Volume SC

Solar System SC

Transients and Variable Stars SC

federica bianco - fbianco@udel.edu

@fedhere

Rubin LSST Science Collaborations

Dark Sector Cosmology

TVS

DESC

GalaxiesSC

SLSC

SMWLV

SSSC

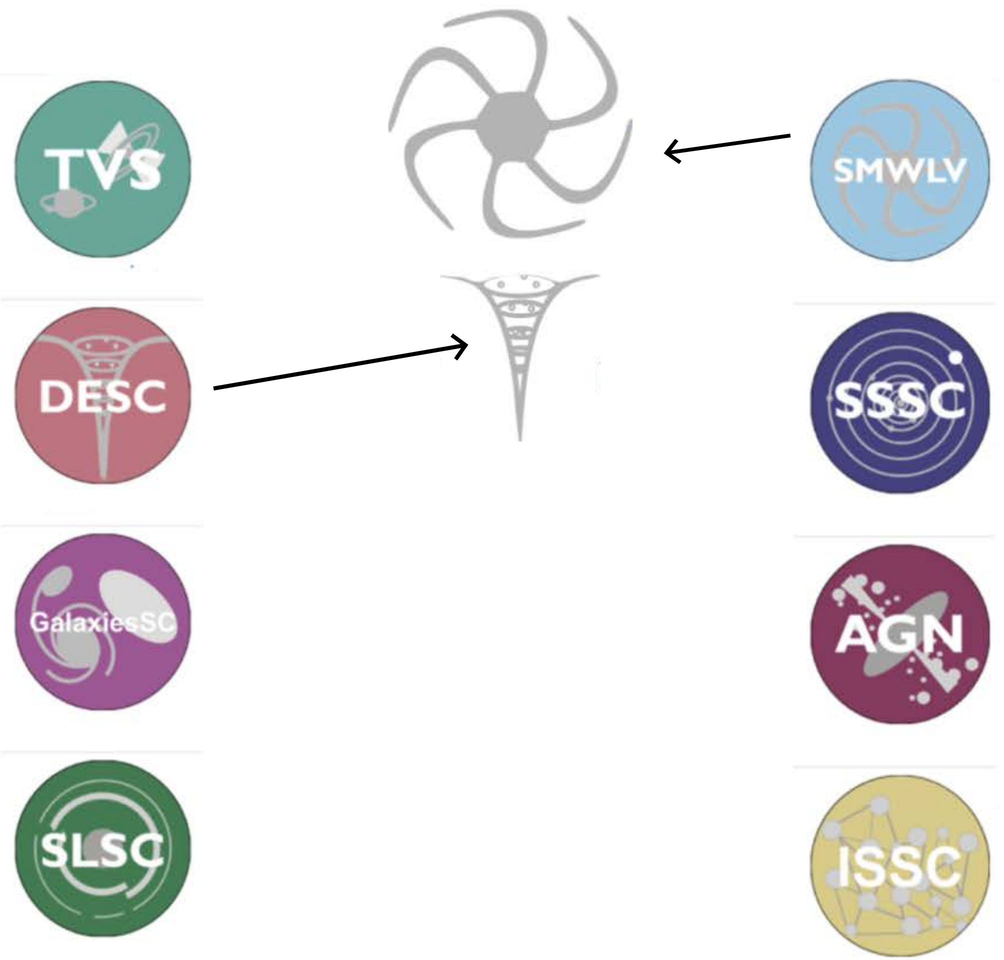
AGN

ISSC

Rubin LSST Science Collaborations

Dark Sector Cosmology

Milky Way



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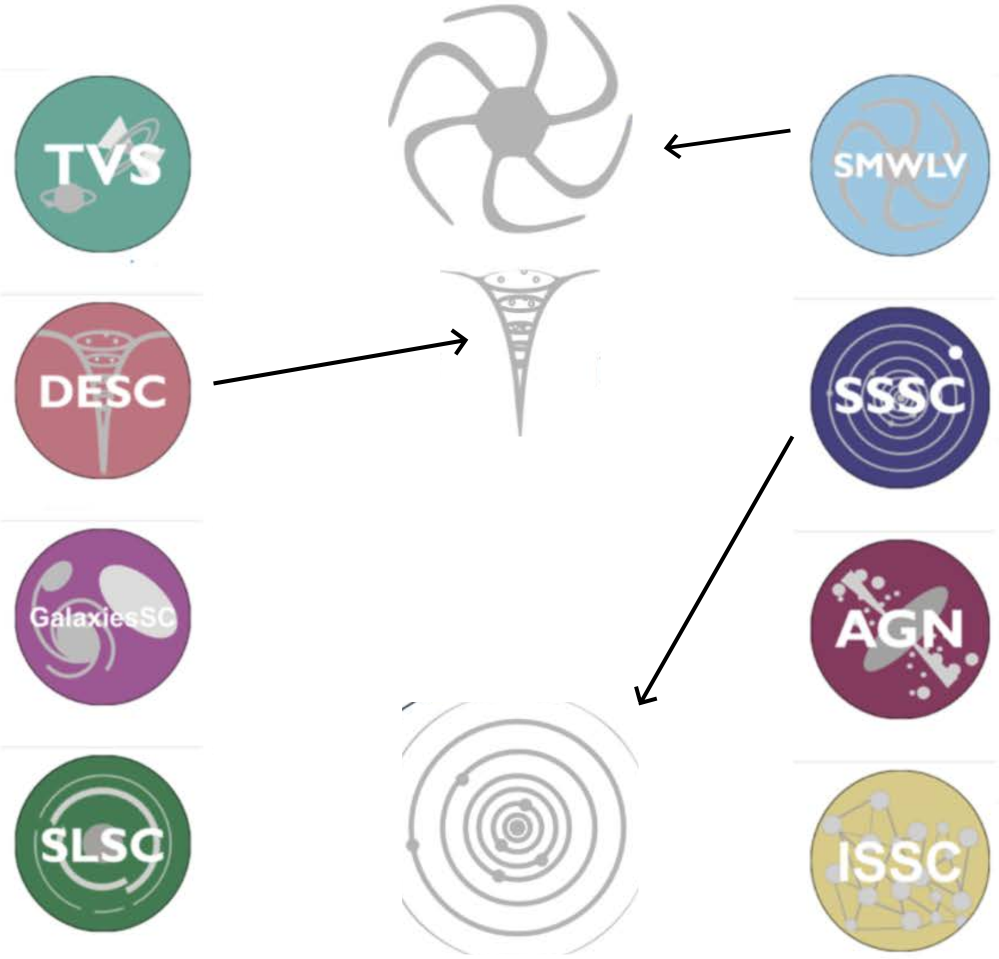
@fedhere

Rubin LSST Science Collaborations

Dark Sector Cosmology

Milky Way

Solar System



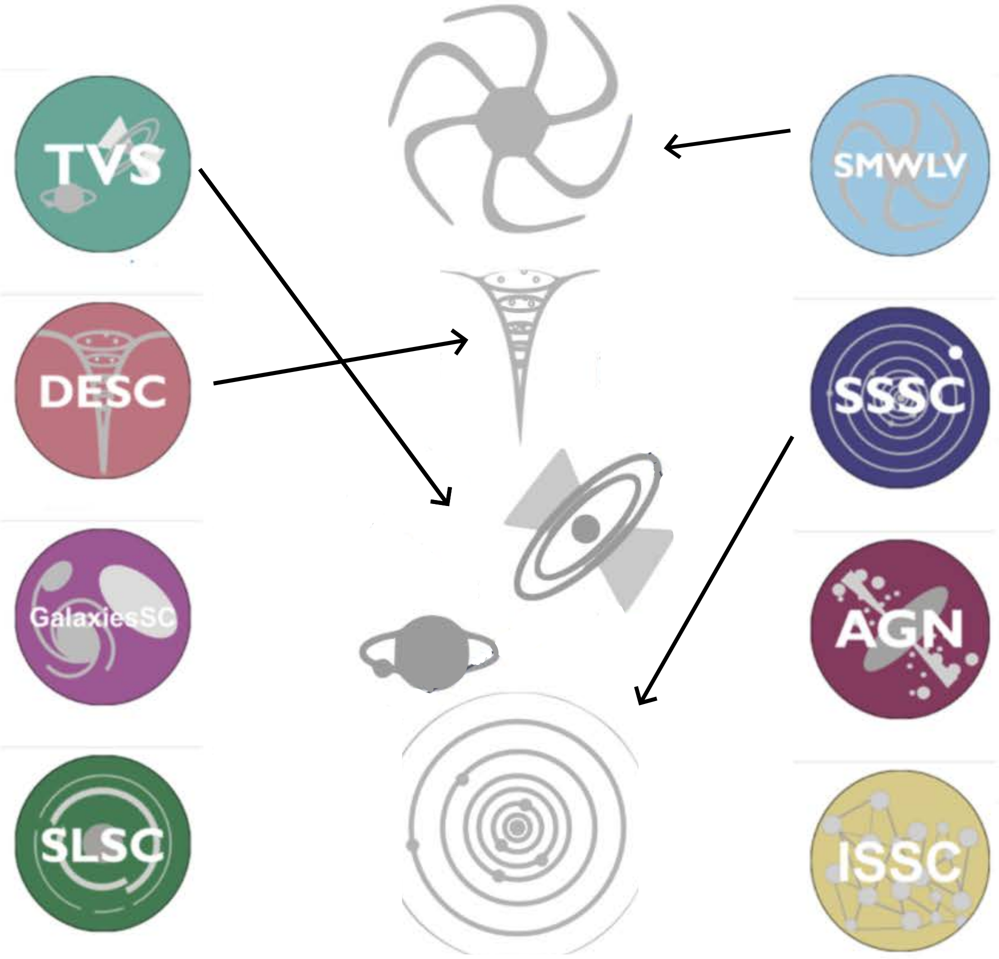
Rubin LSST Science Collaborations

Dark Sector Cosmology

Milky Way

Solar System

TDA



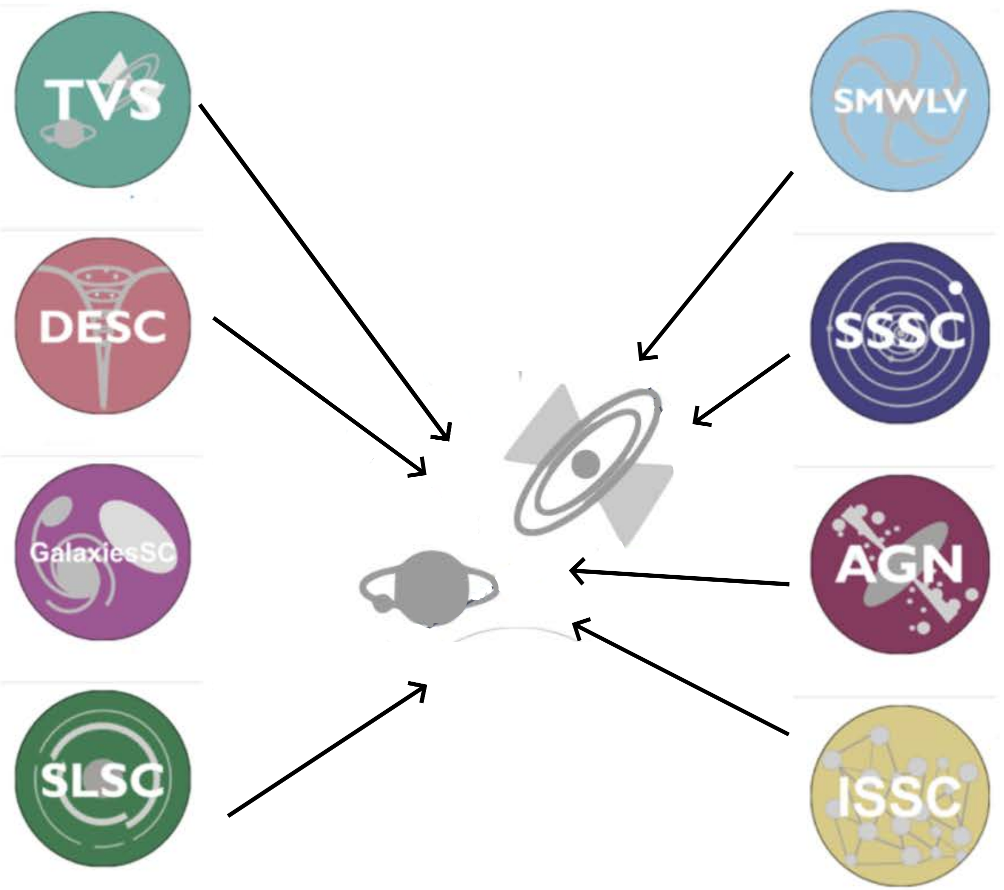
Rubin LSST Science Collaborations

Dark Sector Cosmology

Milky Way

Solar System

TDA

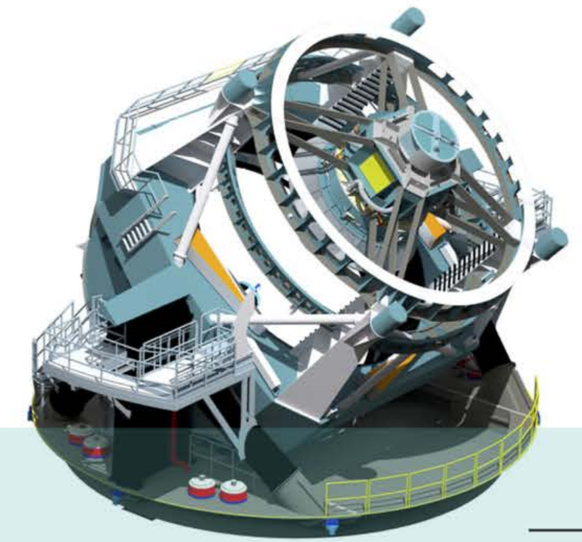


LSST time domain data products

Data Products

Raw Data: 20TB/night

Sequential 30s images covering the entire visible sky every few days



LSST — SCIENCE — PIPELINES

Prompt Data Products

Alerts: up to 10 million per night — 60s via nightly alert streams — Community Brokers

Raw & Processed Visit Images, Difference Images, Templates

Transient and variable sources from Difference Image Analysis

Solar System Objects: ~ 6 million

— 24h via Prompt Products DB

Data Release Data Products

Final 10yr Data Release:

- Images: 5.5 million x 3.2 Gpixels
- Catalog: 15PB, 37 billion objects

— via Data Releases

Rubin Data Access Centres (DACs)

USA (USDF)
Chile (CLDF)
France (FRDF)
Uniter Kingdom (UKDF)

Independent Data Access Centers (IDACs)

Access to proprietary data and the Science Platform require Rubin data rights

LSST Science Platform

Provides access to LSST Data Products and services for all science users and project staff

RUBIN SCIENCE PLATFORM

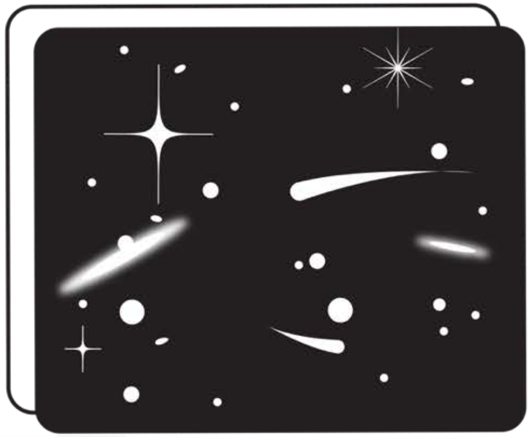
PORTAL	NOTEBOOKS	WEB APIS

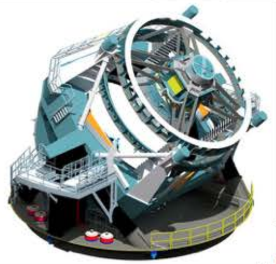
DATA RELEASES	ALERT FILTERING SERVICE	USER DATABASES	USER FILES	USER COMPUTING	SOFTWARE TOOLS

redit: Leanne Guy

Raw Data: 20TB/night

Sequential 30s images that cover the entire visible sky every few days.





lide by Leanne Guy,
SST DM Project Scientist.

Prompt Data Products

Alerts: up to 10M/night

Results of Difference Image Analysis (DIA): transient and variable sources

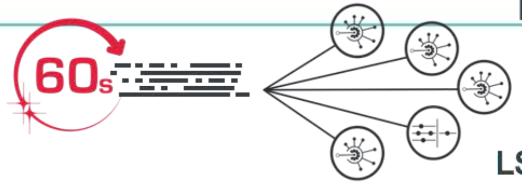
Solar System Objects: ~6M by year 10

Data Release Data Products

Final 10 year Data Release images: 5.5M x 3.2 Gpx catalogs: 37M objects, 15PB

via nightly alert streams ← **world public!**

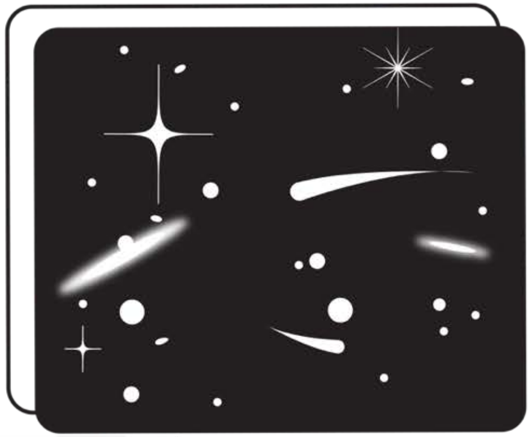
Community Brokers

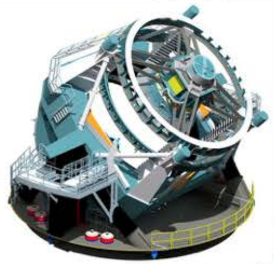


LSST Alert Filtering Service

Raw Data: 20TB/night

Sequential 30s images that cover the entire visible sky every few days.





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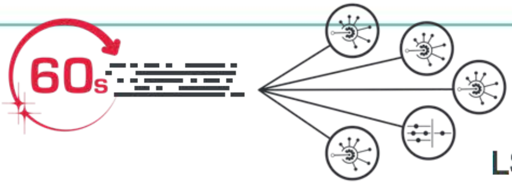
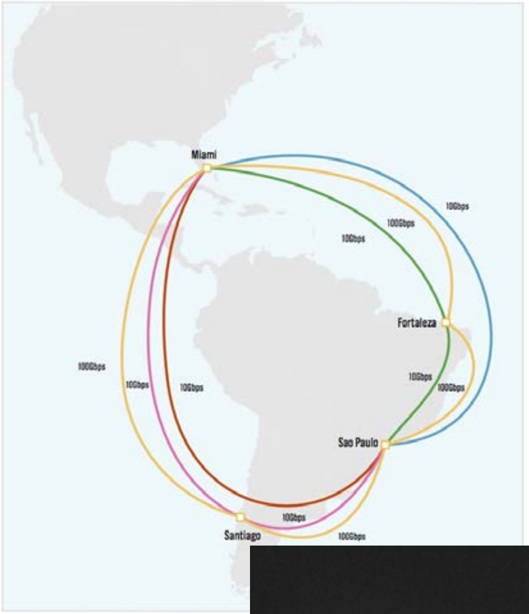
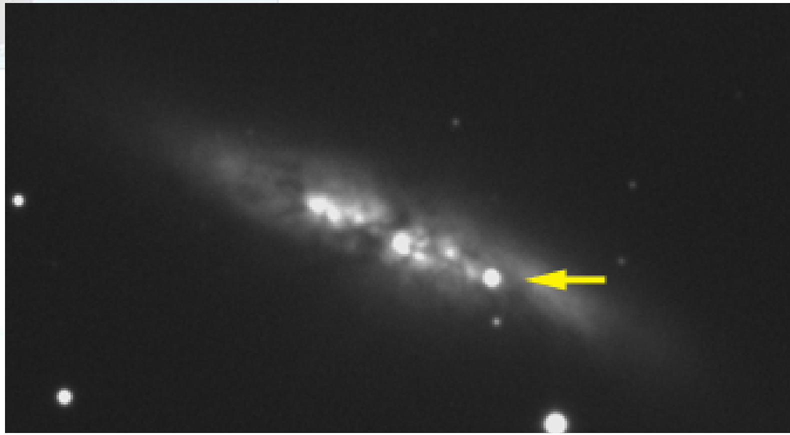
Community Brokers



LSST Alert Filtering Service





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Rubin Observatory LSST

https://www.youtube.com/embed/CP_ueZFHc4g?enablejsapi=1

Science-Driven Optimization of the LSST Observing Strategy

Prepared by the LSST Science Collaborations, with support from the LSST Project.

Marshall et al 2017

Periodic Variable Type	Examples of target science	Amplitude	Timescale
RR Lyrae	Galactic structure, distance ladder, RR Lyrae properties	large	day
Cepheids	Distance ladder, cepheid properties	large	day
Long Period Variables	Distance ladder, LPV properties	large	weeks
Short period pulsators	Instability strip, white dwarf interior properties, evolution	small	min
Periodic binaries	Eclipses, physical properties of stars, distances, ages, evolution, apsidal precession, mass transfer induced period changes, Applegate effect	small	hr-day
Rotational Modulation	Gyrochronology, stellar activity	small	days
Young stellar populations	Star and planet formation, accretion physics	small	min-days

5 Variable Objects

Chapter editors: *Ashish Mahabal, Lucianne Walkowicz.*

Contributing authors: *Michael B. Lund, Stephen Ridgway, Keaton J. Bell, Patrick Hartigan, C. Johns-Krull, Peregrine McGehee, Shashi Kanbur*

6 Eruptive and Explosive Transients

Chapter editors: *Eric C. Bellm, Federica B. Bianco*

Contributing Authors:

Iair Arcavi, Laura Chomiuk, Zoheyr Doctor, Wen-fai Fong, Zoltan Haiman, Vassiliki Kalogera, Ashish Mahabal, Raffaella Margutti, Tom Matheson, Stephen Ridgway, Ohad Shemmer, Nathan Smith, Paula Szkody, Virginia Trimble, Stefano Valenti, Bevin Ashley Zauderer

7 The Magellanic Clouds

Chapter Editors: *David Nidever, Knut Olsen*

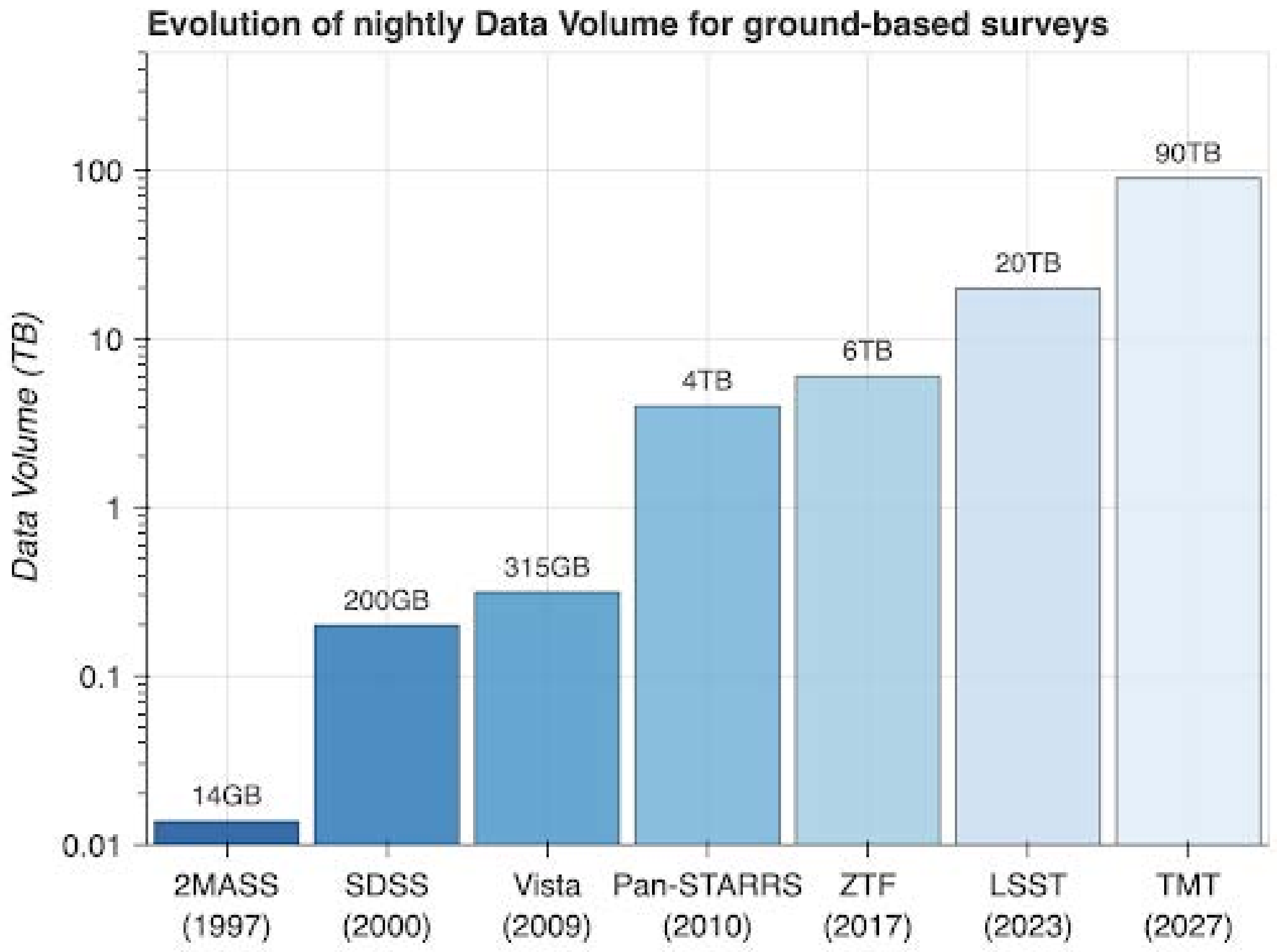
Transient Type	Science drivers	Amplitude	Time Scale	Event Rate
Flare stars	Flare frequency, energy, stellar age, space weather	large	min	very common
X-ray Novae	Interacting binaries, stellar evolution, SN progenitors, nuclear physics	large	weeks	rare
Cataclysmic variables (6.6.3)	Interacting binaries, stellar evolution, compact objects	large	min - days	common
LBV variability (6.6.5)	Late stages stellar evolution, Mass loss, SN progenitors	large	weeks-years	rare

LSST Data Volume: a change of perspective

Rubin Transients by the number

~1000 images per night

10M alerts per night (5sigma changes)



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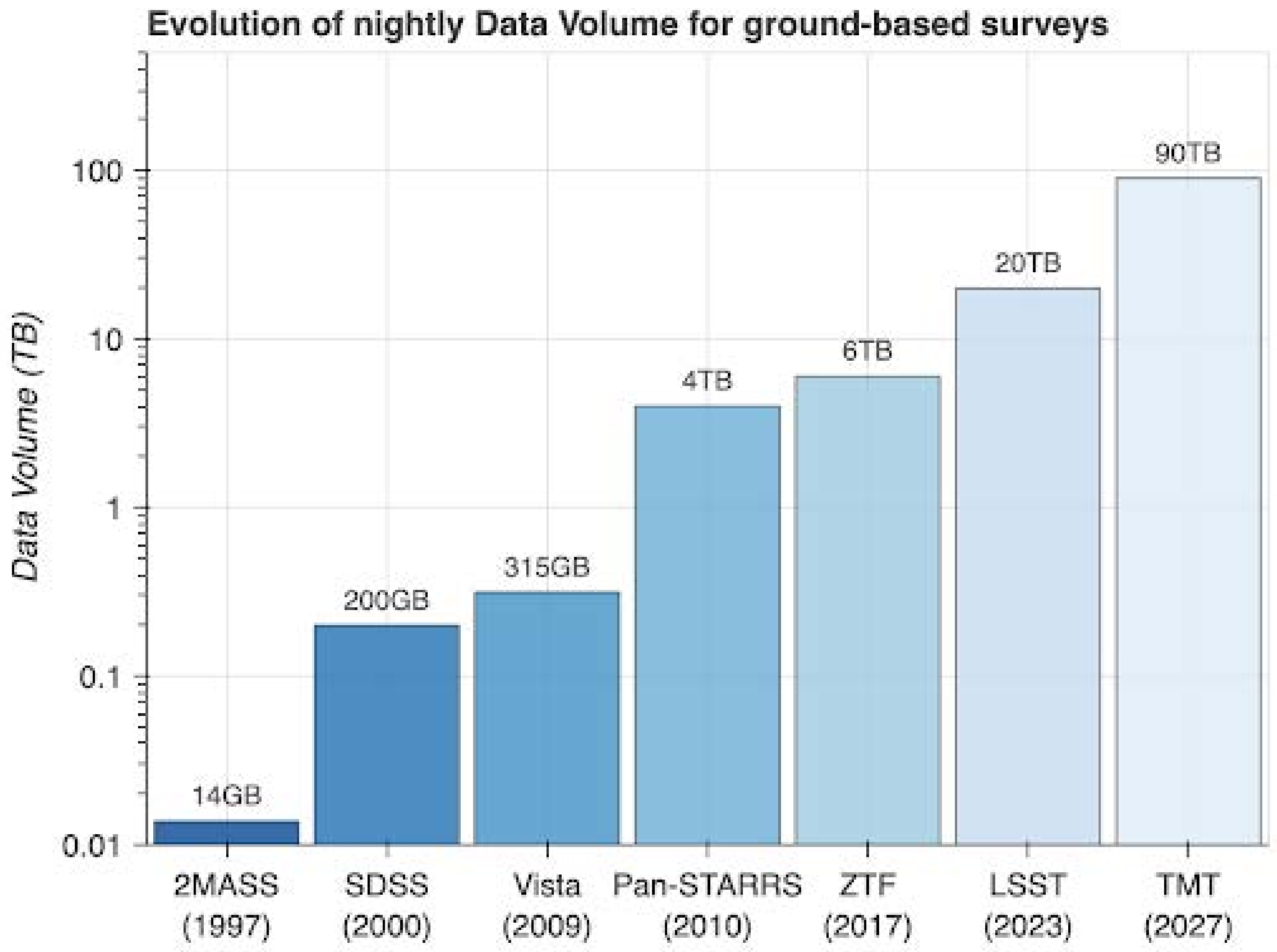
17B stars Ivezic+18



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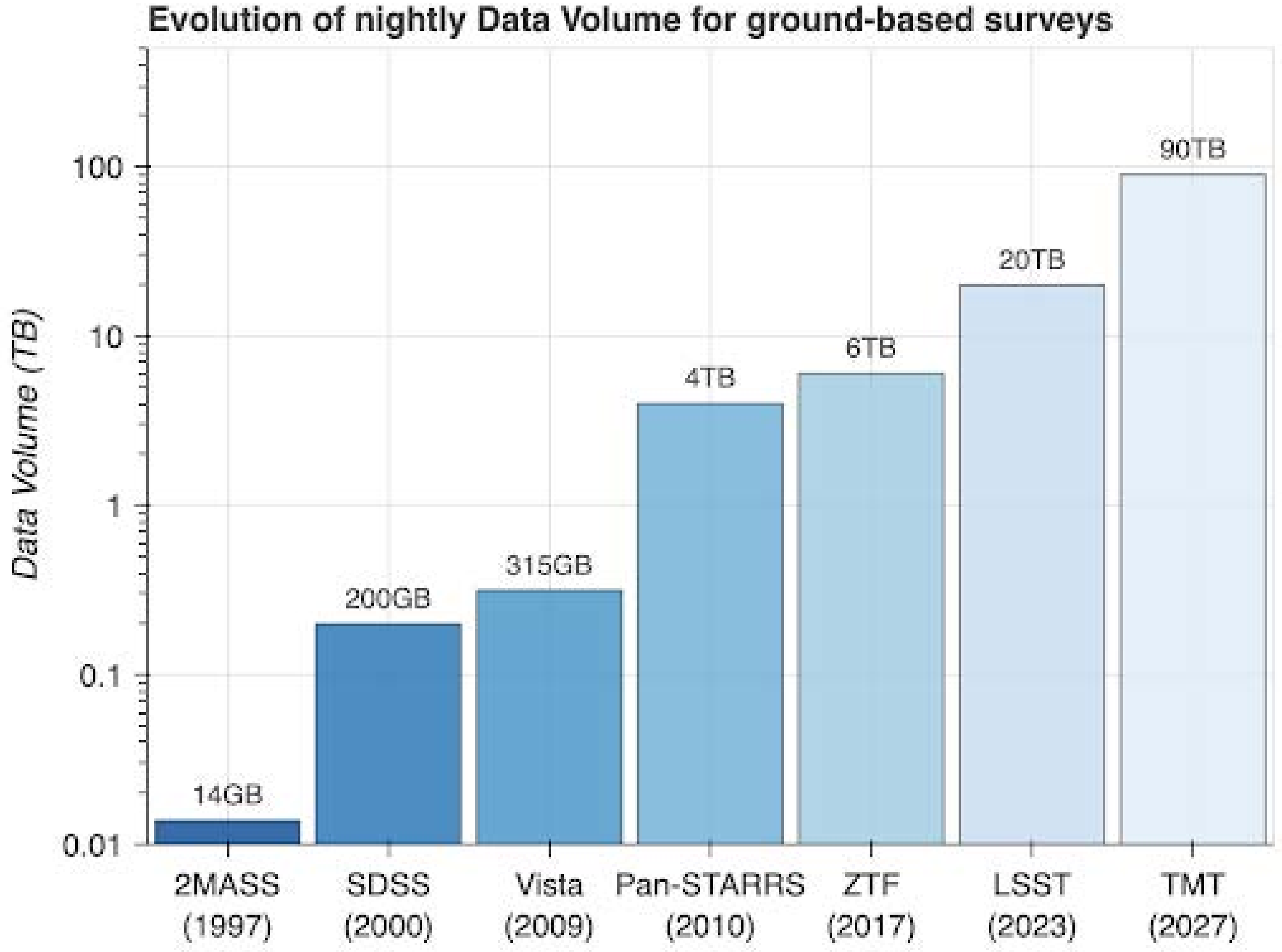
~10 million QSO Mary Loli+21



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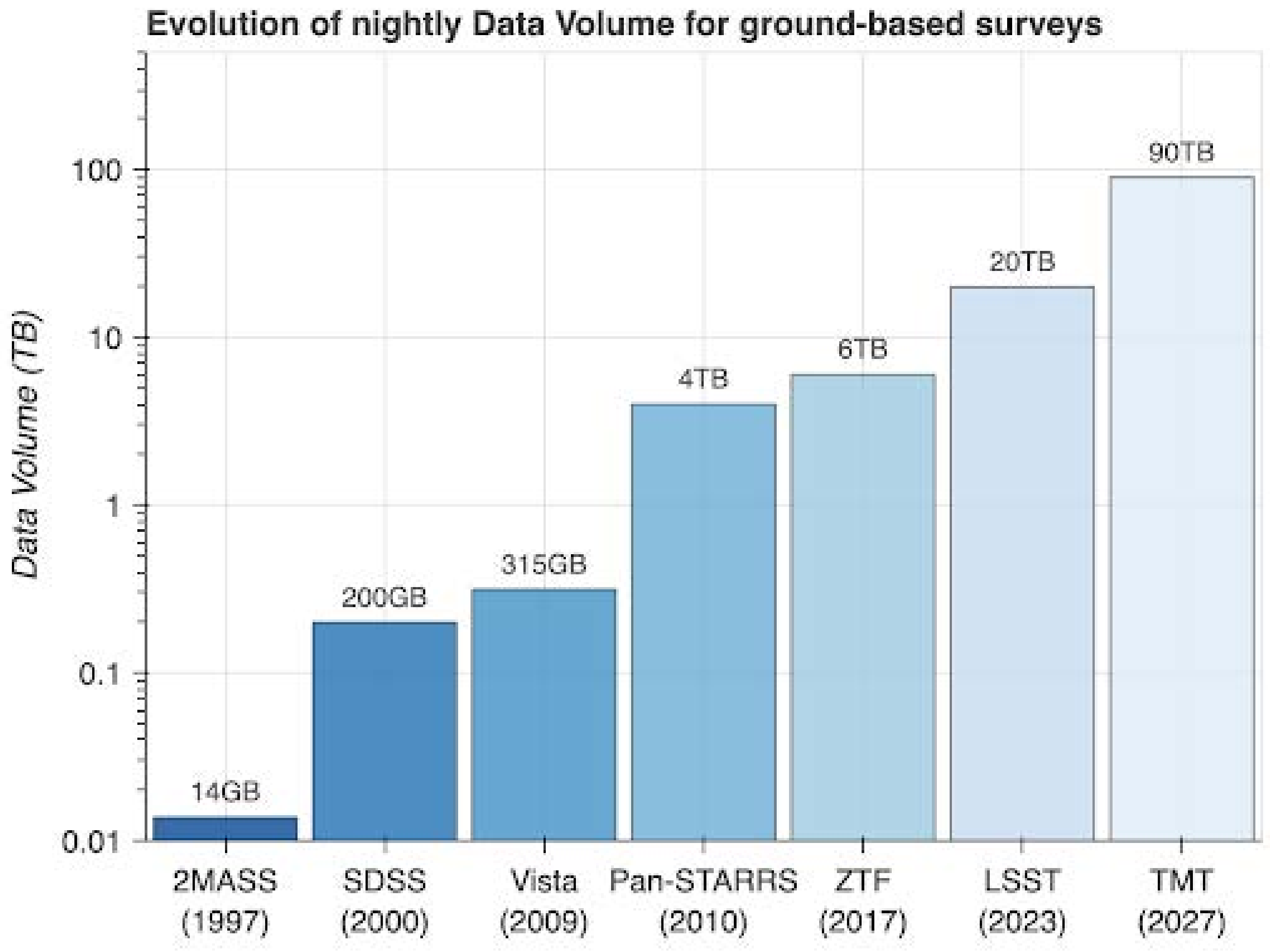
~200 quadruply-lensed quasars Minghao+19



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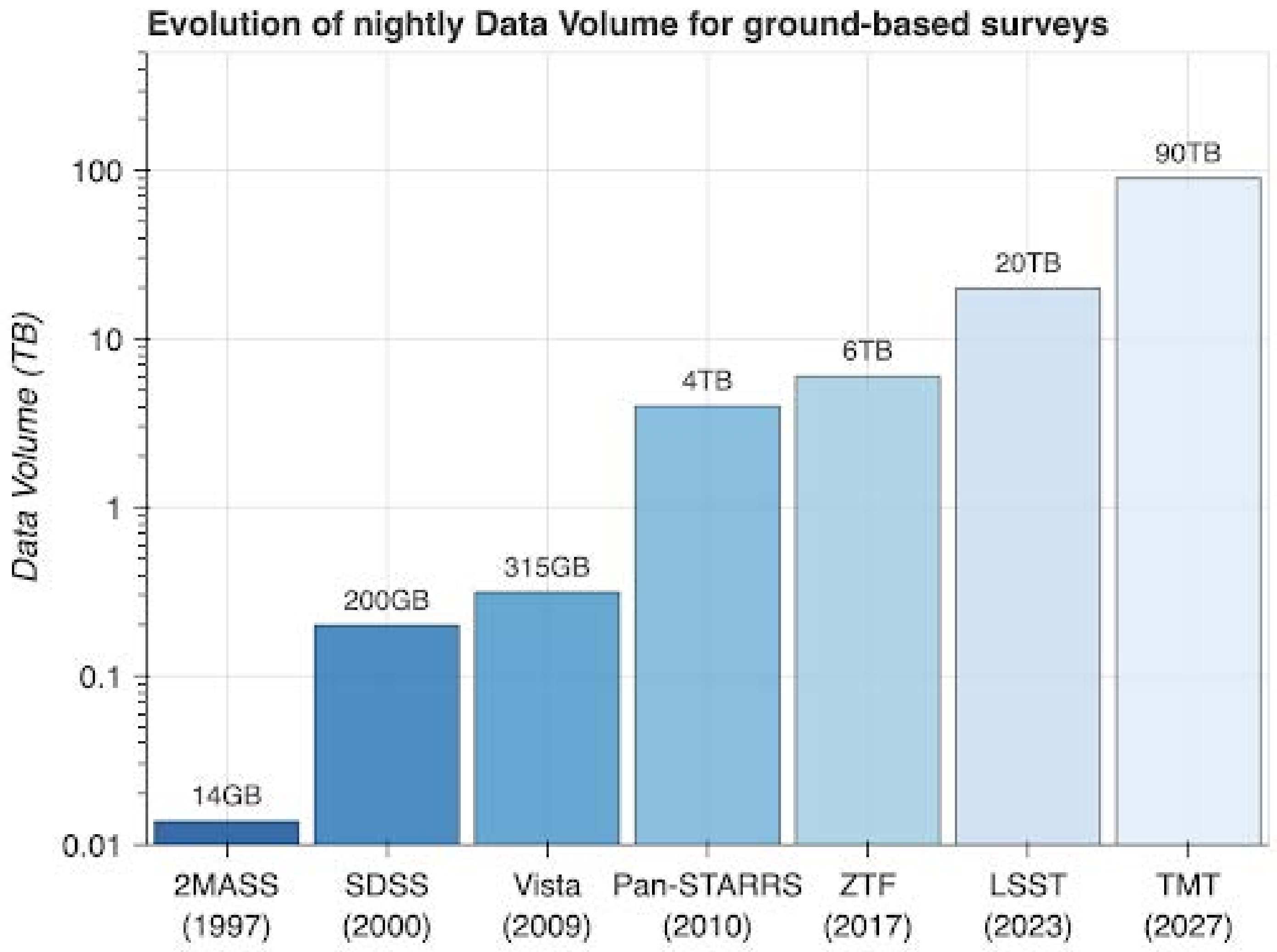
~50 kilonovae Setzer+19, Andreoni+19 (+ ToO)



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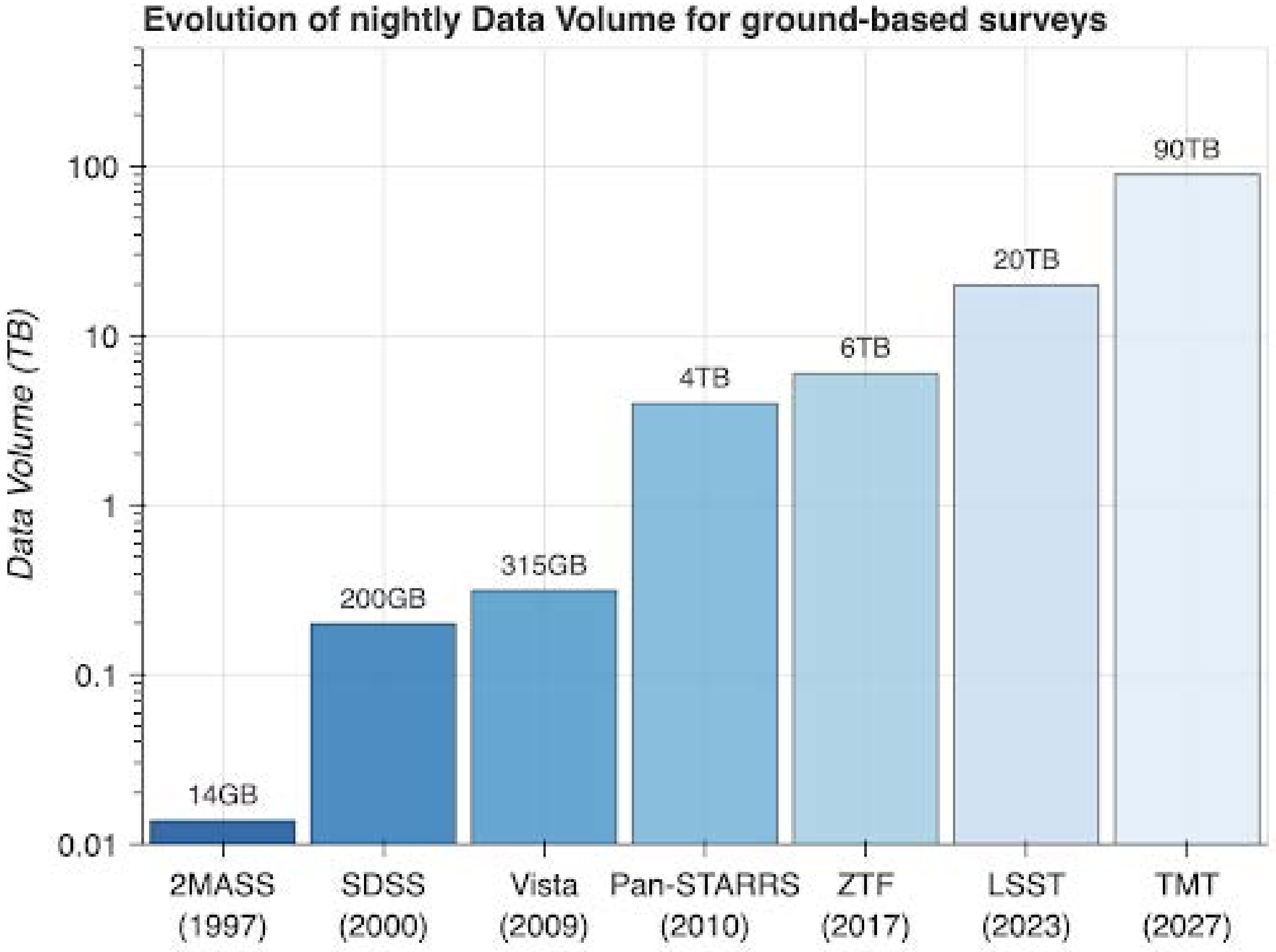
~1000 SNe every night in the LSST sky



At this level of precision,everything is variable, everything is blended, everything is moving.

	u,g,r,i,z,y
Photometric precision Photometric accuracy Astrometric precision Astrometric accuracy # visits Single image 5σ depths 10-year stack 5σ depth	5 mmag 10 mmag 10 mas 50 mas 56, 80, 184, 184, 160, 160 23.9, 25.0, 24.7, 24.0, 23.3, 22.1 26.1, 27.4, 27.5, 26.8, 26.1, 24.9

https://ls.st/srd

Rubin will see ~1000 SN every night!

Credit: Alex Gagliano

@fedhere

LSST has profoundly changed the TDA infrastructure

Photometric Classification

Featured Prediction Competition

PLAsTiCC Astronomical Classification

Can you help make sense of the Universe?

LSST Project · 1,094 teams · 2 years ago

$25,000
Prize Money

Overview | Data | Notebooks | Discussion | Leaderboard | Rules | **Join Competition**

Overview

- Description
- Evaluation
- Prizes
- Timeline
- PLAsTiCC's Team

Help some of the world's leading astronomers grasp the deepest properties of the universe.

The human eye has been the arbiter for the classification of astronomical sources in the night sky for hundreds of years. But a new facility -- the Large Synoptic Survey Telescope (LSST) -- is about to revolutionize the field, discovering 10 to 100 times more astronomical sources that vary in the night sky than we've ever known. Some of these sources will be completely unprecedented!

LSST DESC Dark Energy Science Collaboration

Dark Energy Science Collaboration (DESC)

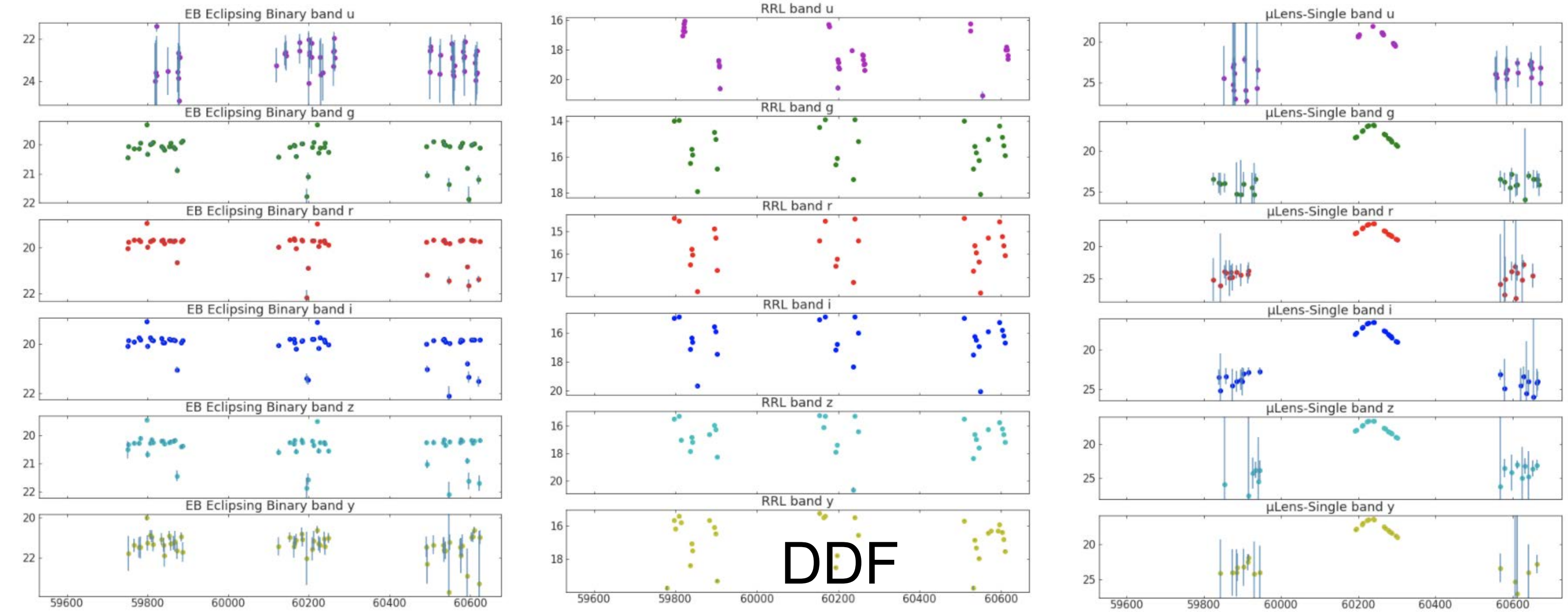
+

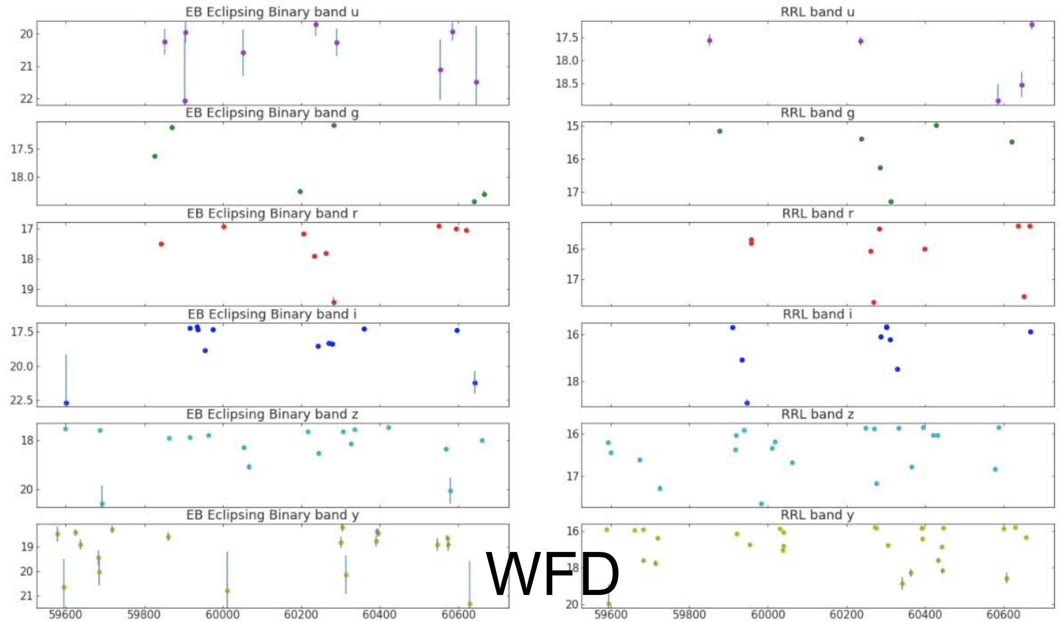
Transients and Variable Science Collaboration (TVS SC)

TVSSC

LSST: Science Collaborations

LSST CORPORATION

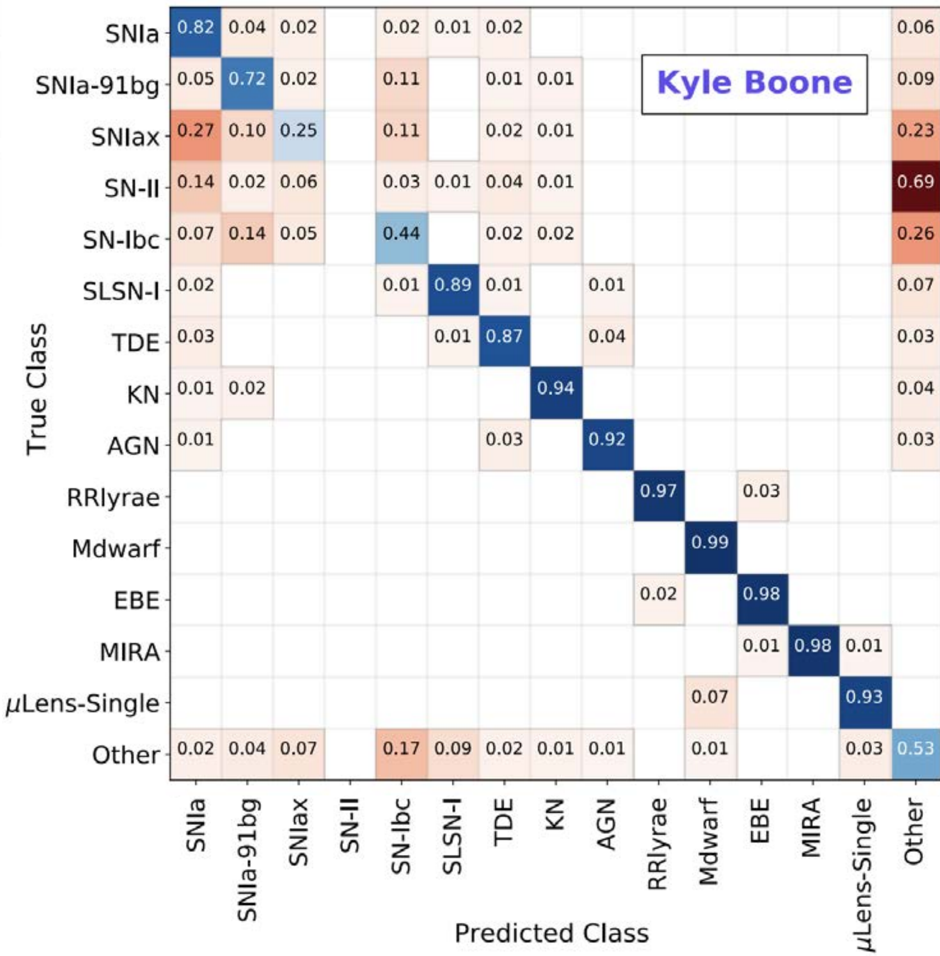




Kaggle PLAsTiCC challenge

AVOCADO classifier

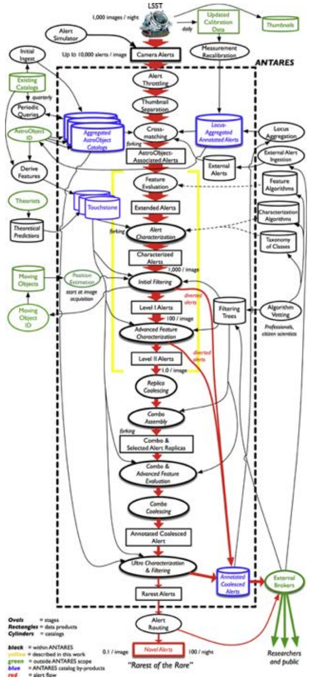
https://arxiv.org/abs/1907.04690



the astronomy discovery chain

Discovery Engine

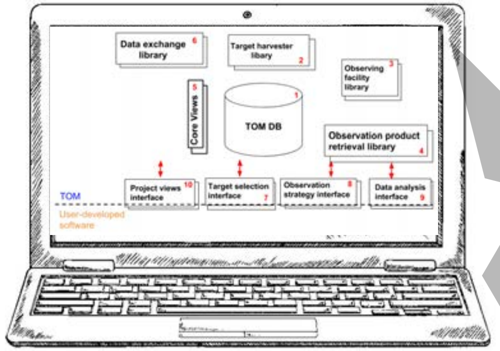
10M alerts/night



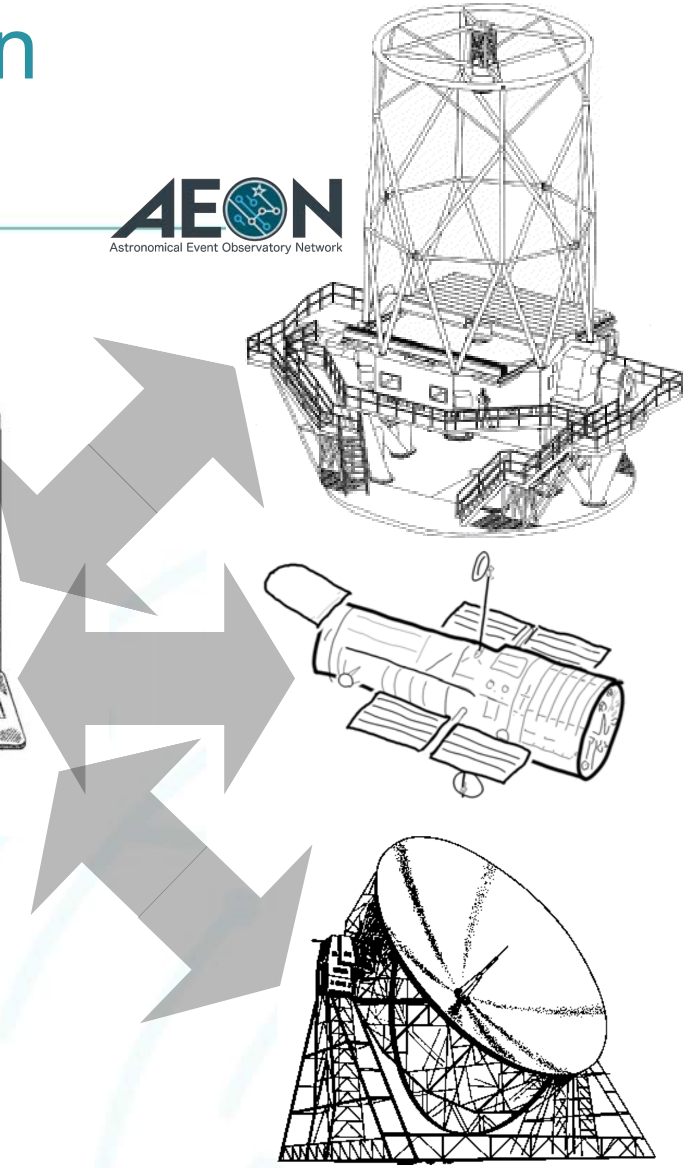
Community Brokers

ALeRCE ANTARES beta LASAIR

FINK Pitt-Google Broker BABAMUL



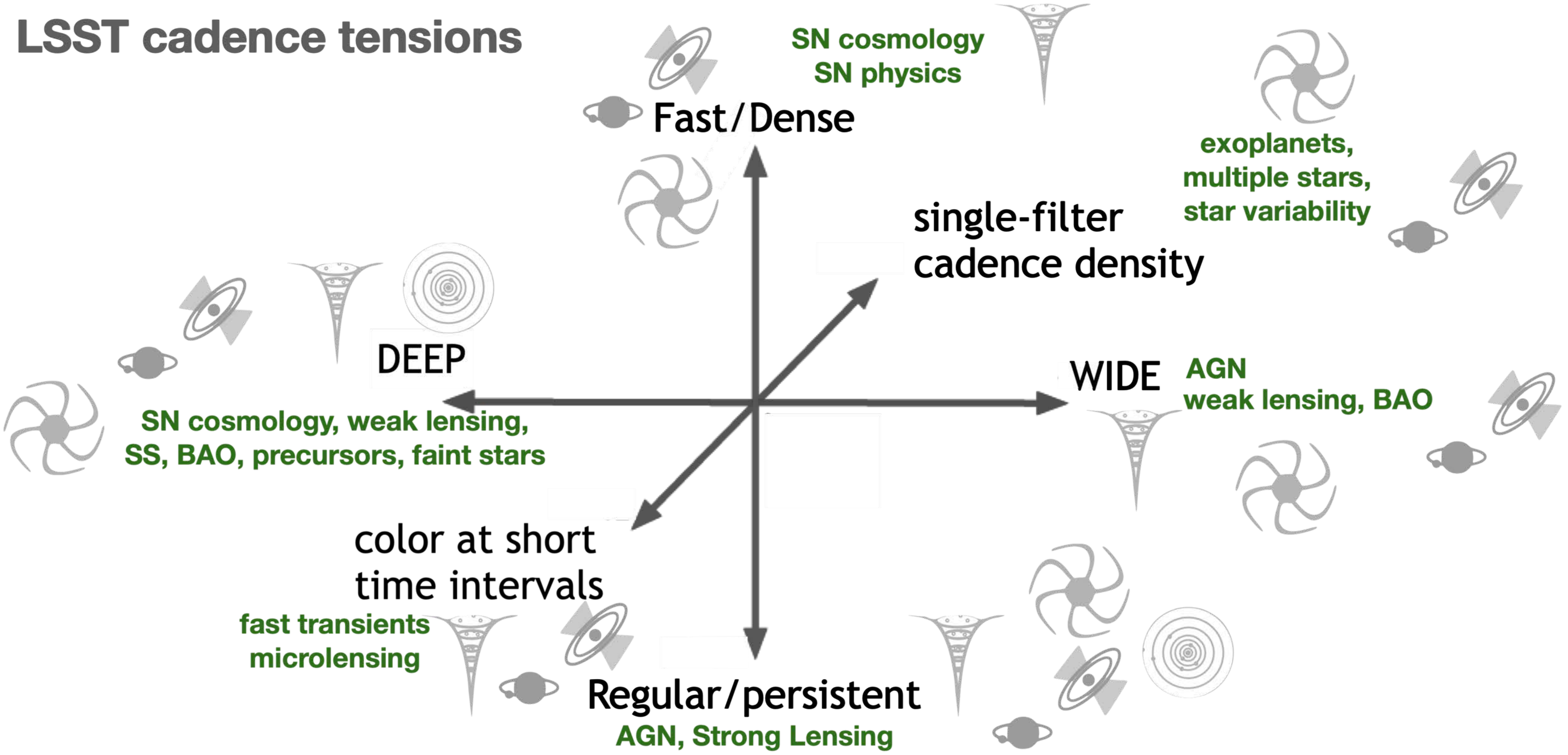
target observation managers



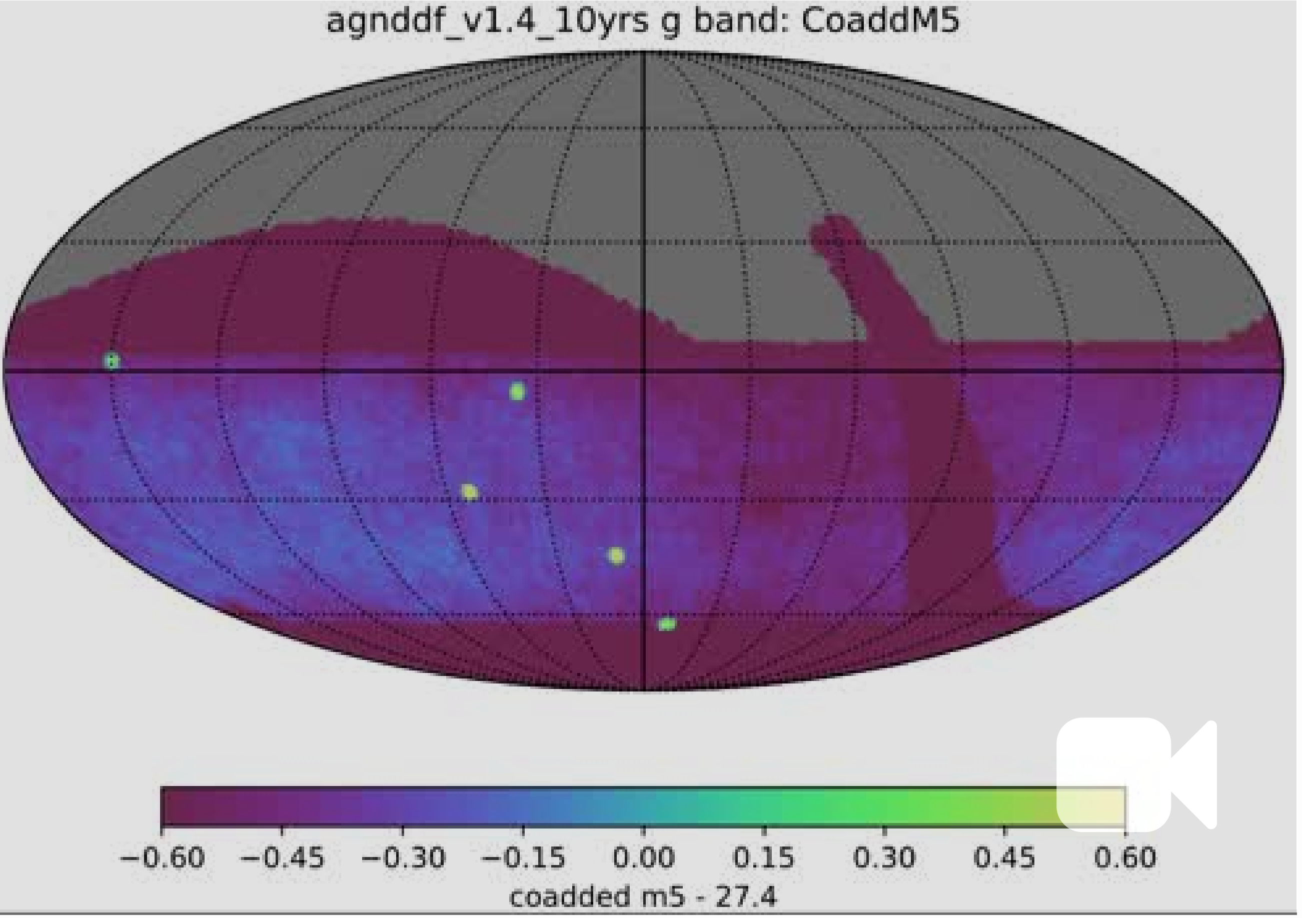
federica bianco - fbianco@udel.edu

LSST survey strategy optimization

Rubin LSST survey design

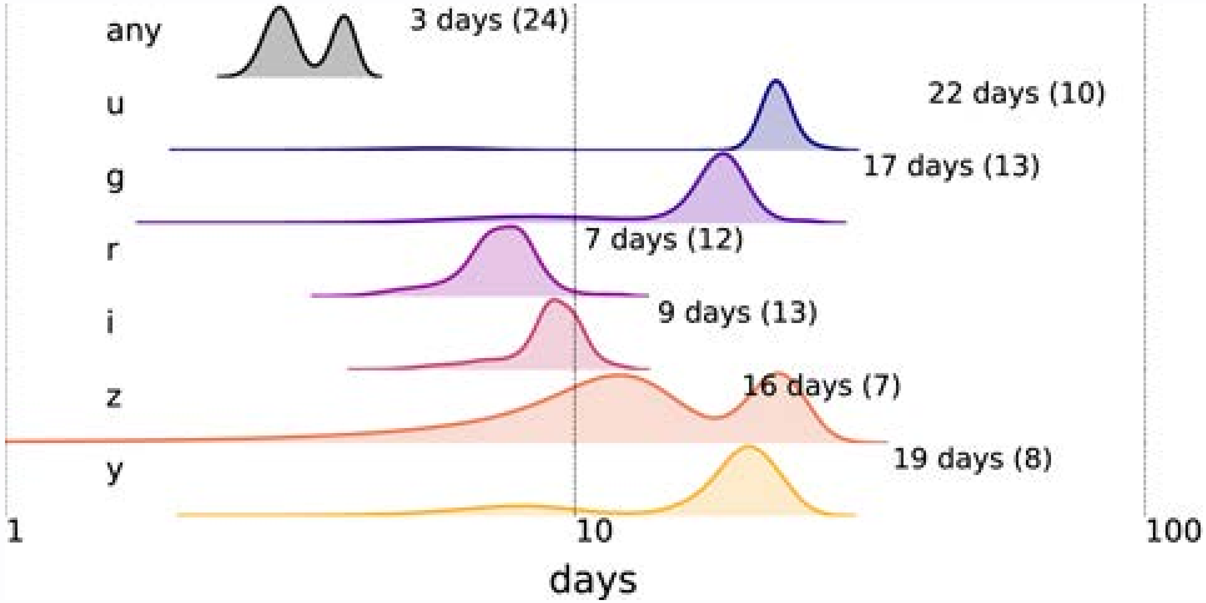


Rubin LSST survey design



distributions of time gaps

in 76 LSST simulations (2018)



Li et al. 2021

https://iopscience.iop.org/article/10.3847/1538-4365/ac3bca

Rubin LSST survey design

Because the Rubin LSST data is open to all US scientists and to a broader yet community worldwide, to truly make it a survey of and for and of the people, Rubin Observatory called the community to design its survey -

this is a uniquely "democratic" process!

	COSEP	White Papers	Cadence Notes
date	2015-17	2018	2021
response	single document 9 chapters 25 science cases	46 papers 467 unique authors	39 notes 218 unique authors
available simulations (OpSim)	14	16	173

Bianco et al. 2021

https://iopscience.iop.org/article/10.3847/1538-4365/ac3e72

The Purpose of the SCOC

The SCOC is advisory to the Rubin Observatory Operations Director (currently Bob Blum). It will begin its work in 2020, and will be a standing committee throughout the life of Rubin Observatory operations.

https://www.lsst.org/content/charge-survey-cadence-optimization-committee-scoc

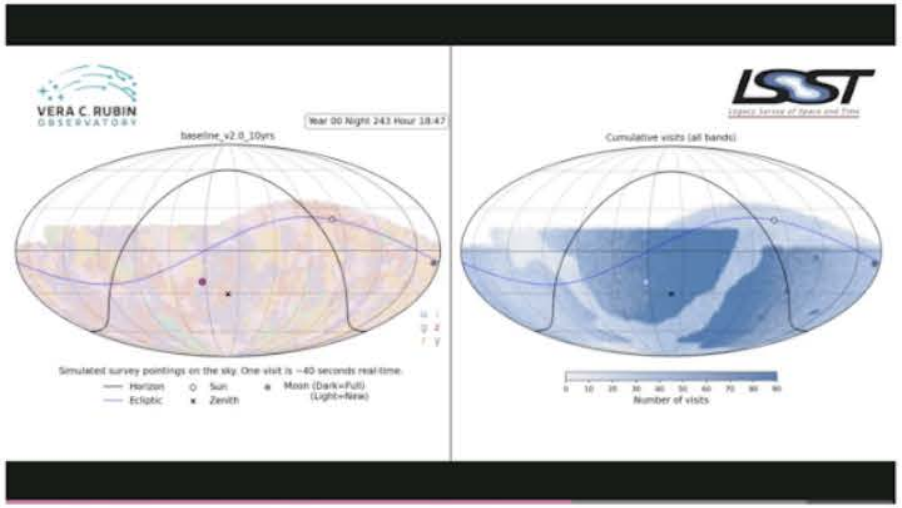
Rubin LSST survey design

VERA C. RUBIN OBSERVATORY

An ApJ Supplements focus issue dedicated to community contribution to the Survey Strategy Optimization

THE ASTROPHYSICAL JOURNAL
SUPPLEMENT SERIES

Rubin LSST Survey Strategy Optimization



The Vera C. Rubin Observatory's Legacy Survey of Space and Time (LSST) will provide unprecedented data that will be made available to all US and Chilean scientists and to international member scientists for a diverse range of astrophysical investigations, from cosmology to solar system studies and from stellar astrophysics to transients to galaxy evolution. In any synoptic survey such as this one, the choice of cadence—the pattern in which the telescope moves across the sky and periodically revisits each field—is of vital importance in maximizing the scientific utility of the data. Yet, identifying the optimal cadence for a broad range of scientific goals is a challenge. As part of the survey design and characterization process, Rubin Observatory involved the LSST science community by soliciting Cadence White Papers and Cadence Notes. Peer-reviewed journal articles describing scientific investigations that motivate and support these notes are published in this focus issue as a record of the factors which influenced survey design, and for guidance for future surveys that may confront many of the same issues faced by Rubin Observatory.

The focus issue is open for submissions that are published on a rolling basis

https://iopscience.iop.org/journal/0067-0049/page/rubin_cadence

OPEN ACCESS

Optimization of the Observing Cadence for the Rubin Observatory Legacy Survey of Space and Time: A Pioneering Process of Community-focused Experimental Design

Federica B. Bianco[1,2,3,4], Željko Ivezić[5], R. Lynne Jones[6], Melissa L. Graham[5], Phil Marshall[7], Abhijit Saha[8], Michael A. Strauss[9], Peter Yoachim[10], Tiago Ribeiro[11], Timo Anguita[12,13] + Show full author list

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Rubin LSST Survey Strategy Optimization
Citation Federica B. Bianco *et al* 2022 *ApJS* **258** 1

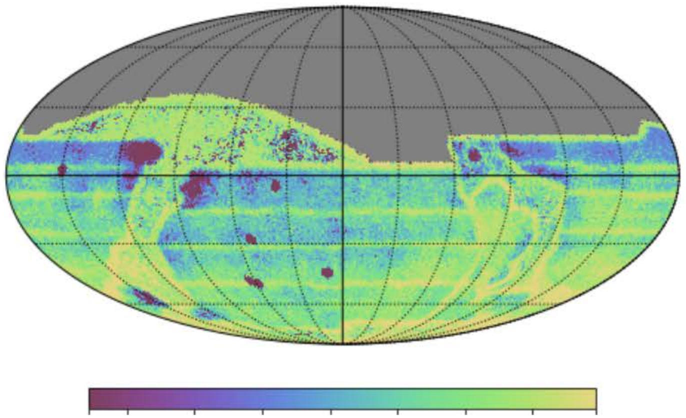
The call for cadence white papers generated an unprecedentedly collaborative process that lead to 46 white papers in 2018

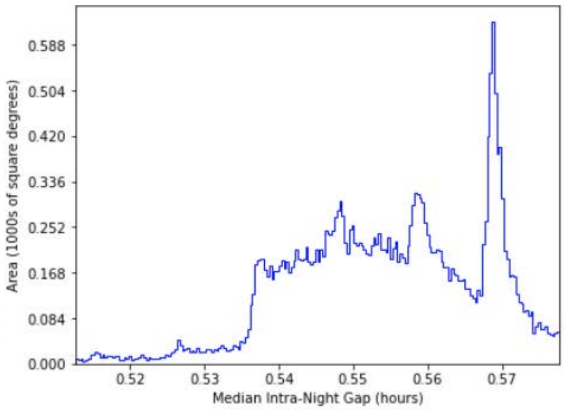
https://observablehq.com/embed/@f7f7156e50925896/rubin-lsst-science-collaborations-cadence-

Currently 12 have been turned into peer review work

https://observablehq.com/embed/@f7f7156e50925896/rubin-lsst-science-collaborations-cadence-white-paper-by-s?cells=chart

current survey specifications

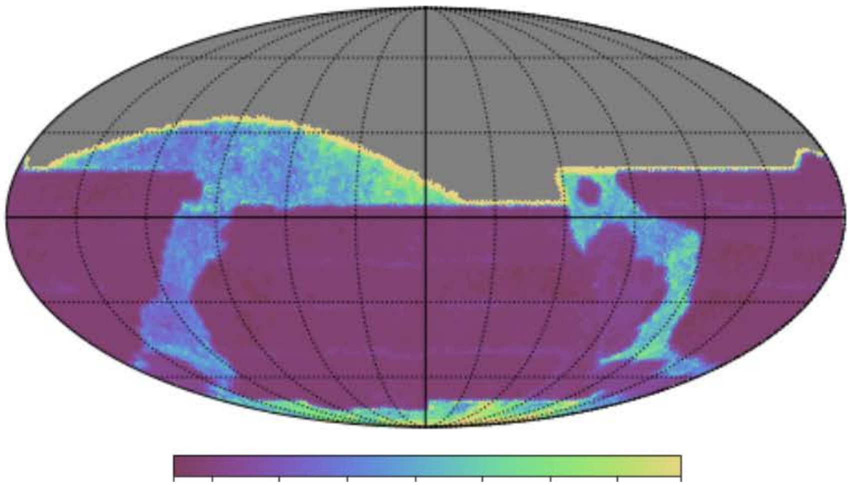




0.52 intranight gap 0.576

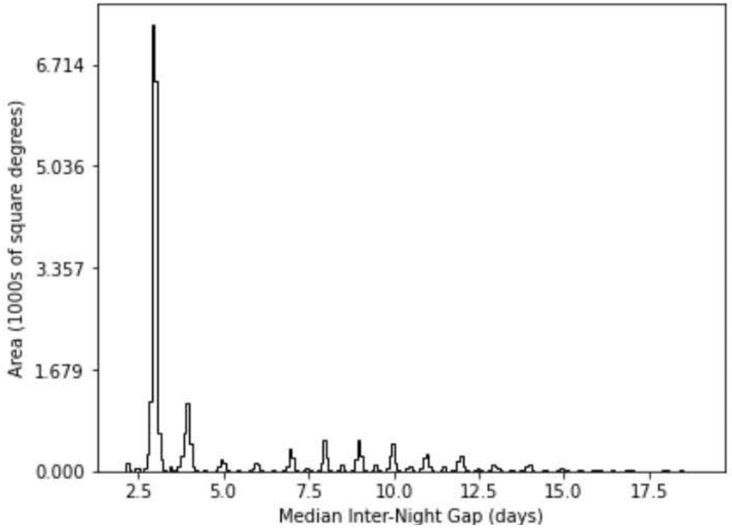
hours

any filter



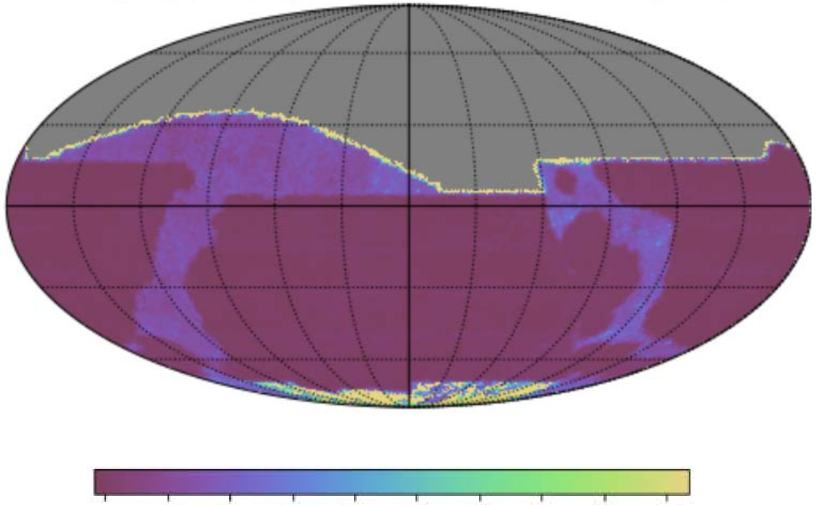
3 median internight gap 15

days



ls.st/opsims

r band



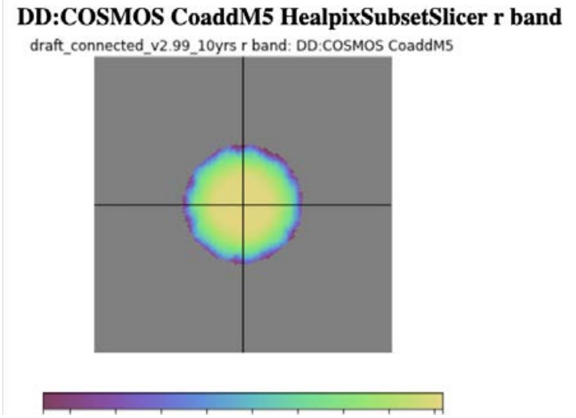
5 median internight gap 50

days

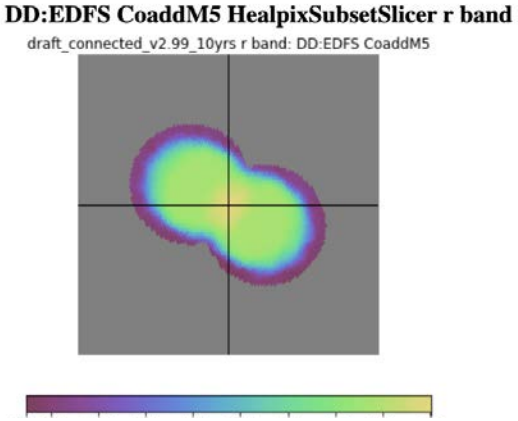
survey specifications

(current baseline)

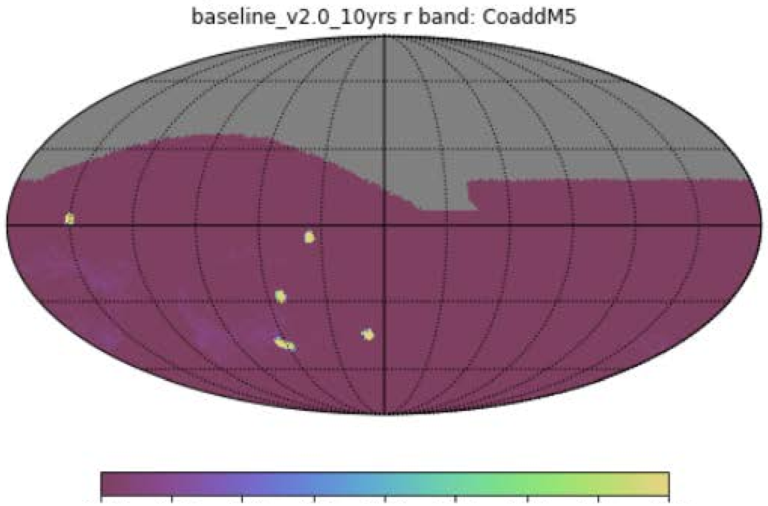
Group: *Basics*; Subgroup: *Coadd M5*; Slicer: *HealpixSubsetSlicer*						
	DD:COSMOS CoaddM5	**DD:ECDFS CoaddM5**	**DD:EDFS CoaddM5**	**DD:ELAISS1 CoaddM5**	**DD:WFD CoaddM5**	**DD:XMM_LSS CoaddM5**
g band	28.64	28.30	28.07	28.25	26.74	28.16
i band	28.20	27.83	27.59	27.79	26.36	27.70
r band	28.63	28.25	28.06	28.25	26.91	28.16
u band	27.41	27.01	26.83	26.98	25.78	26.93
y band	26.72	26.37	26.13	26.34	24.81	26.28
z band	27.30	27.03	26.78	26.99	25.61	26.94



26.8 29.05



26.8 28.6



26.9 coadd 5σ depth 28.1

source http://astro-lsst-01.astro.washington.edu:8080/?runId=2

survey specifications

(current baseline)

The SCOC has recommended Euclid DF South as the 5th DDF - 2-pointings observed collectively to the depth of other DDFs

SCOC endorsement of Euclid Deep Field South observations

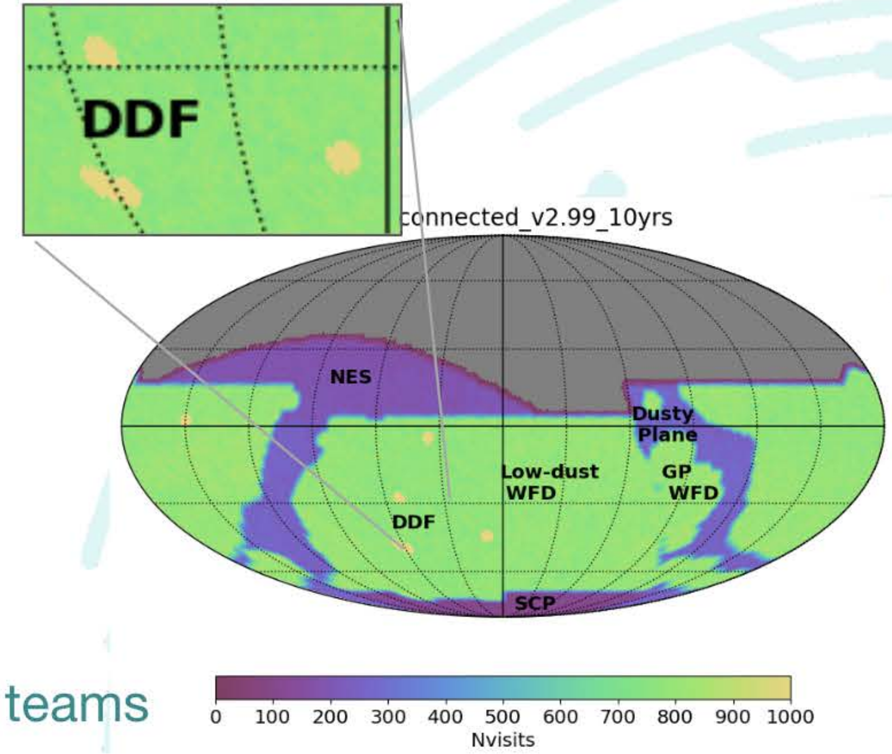
Science Survey Strategy

fed federica bianco Transients & Variable Stars member Mar 23

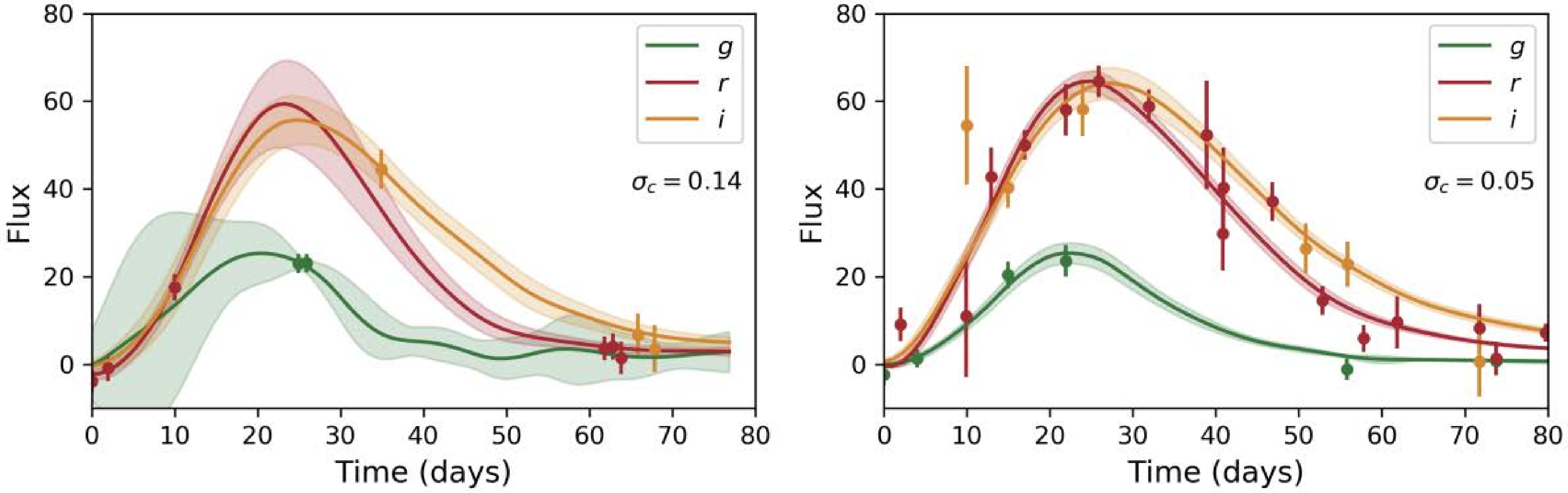
Dear colleagues,

Following the release of the Recommendations of the Euclid-Rubin Derived Data Products (DDP) Working Group 10, the Rubin Survey Cadence Optimization Committee (SCOC) 2 has conducted an analysis of the impact of the selection of the specific Euclid Deep Field South (EDF-S) pointing as the fifth Rubin Deep Drilling Field (DDF) and delivered the following recommendation to the Rubin Operation Director:

The Rubin SCOC supports the selection of the Euclid Deep Field South (EDF-S) centered at (RA, Dec) = (61.24, -48.42) as the 5th Rubin LSST Deep Drilling Field (DDF). This decision is informed by an analysis of the impact of choosing a 5th Rubin LSST DDF at the location of the EDF-S with a footprint that spans two LSST pointings to a collective depth equal to half the nominal depth of a single Rubin DDF, which demonstrated that this choice does not adversely impact any existing metrics of Rubin science throughput to a significant level. Thus we recommend and encourage the Rubin and Euclid leadership to advance discussions on specific observing and co-observing cadence strategies that can maximize the joint scientific output without impacting the current Rubin LSST science goals. Iterating with the committee, once more information about the expected observing cadence and depth are available, will enable us to make more informed and detailed recommendations.



Input needed to schedule the observations by the Euclid+Rubin teams



Lochner et al 2018

https://arxiv.org/pdf/1812.00515.pdf

Pies in the LSST sky

THE ASTROPHYSICAL JOURNAL, 868:38 (10pp), 2018 November 20

Searching for Subsecond Stellar Variability with Wide-field Star Trails and Deep Learning

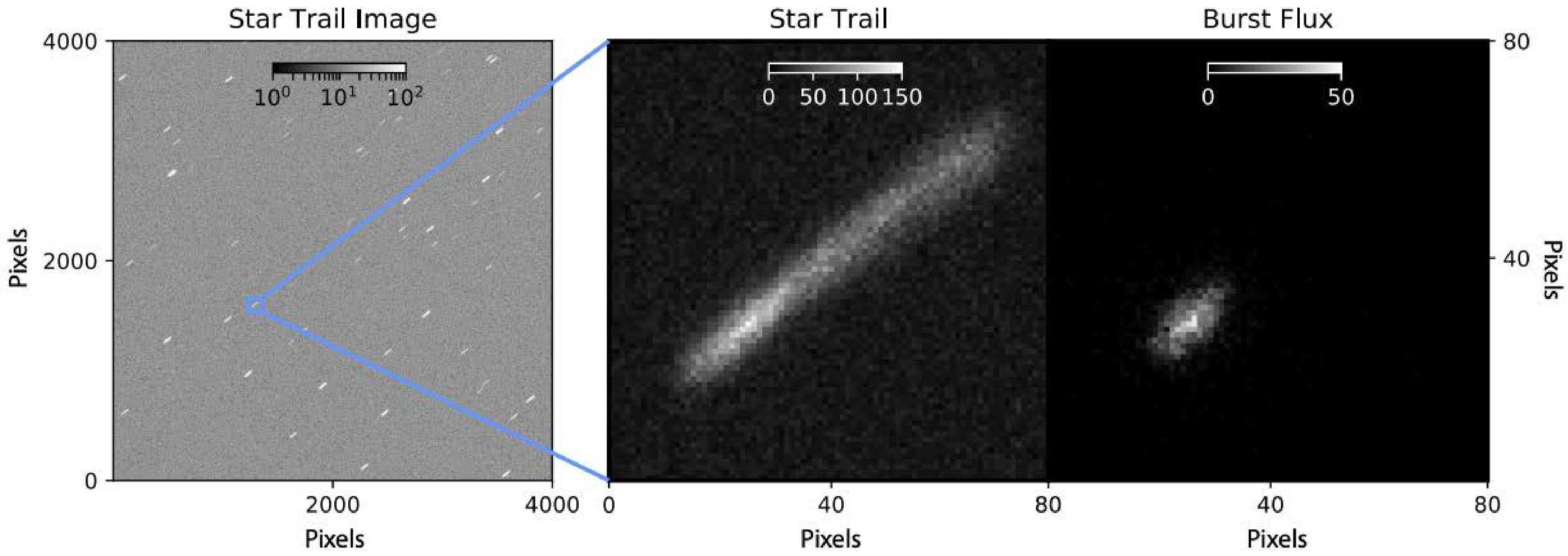
David Thomas[1,2,6] and Steven M. Kahn[2,3,4,5]

We present a method that enables wide-field ground-based telescopes to scan the sky for subsecond stellar variability. The method has operational and image processing components. The operational component takes star trail images. Each trail serves as a light curve for its corresponding source and facilitates subexposure photometry. We train a deep neural network to identify stellar variability in wide-field star trail images. We use the Large Synoptic Survey Telescope Photon Simulator to generate simulated star trail images and include transient bursts as a proxy for variability. The network identifies transient bursts on timescales down to 10 ms. We argue that there are multiple fields of astrophysics that can be advanced by the unique combination of time resolution and observing throughput that our method offers.

Cadence White Paper

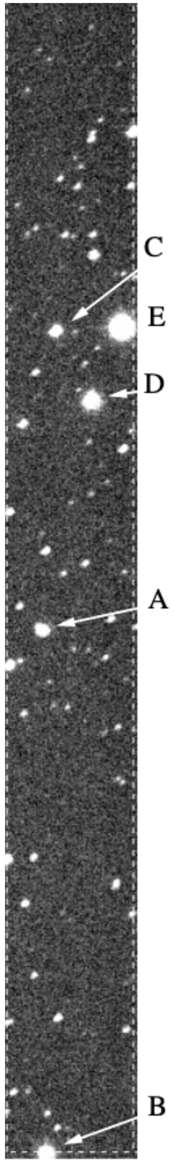
Unveiling the Rich and Diverse Universe of Subsecond Astrophysics through LSST Star Trails

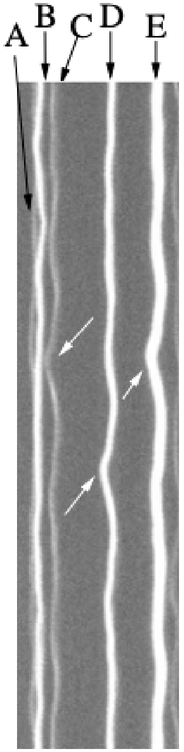
David Thomas[1,2], Steven M. Kahn[2,3], Federica B. Bianco[4,5], Željko Ivezić[6], Claudia M. Raiteri[7], Andrea Possenti[8], John R. Peterson[9], Colin J. Burke[10], Robert D. Blum[11], George H. Jacoby[12], Steve B. Howell[13], Grzegorz Madejski[2], *with the support of the LSST Transients and Variable Stars Collaboration*

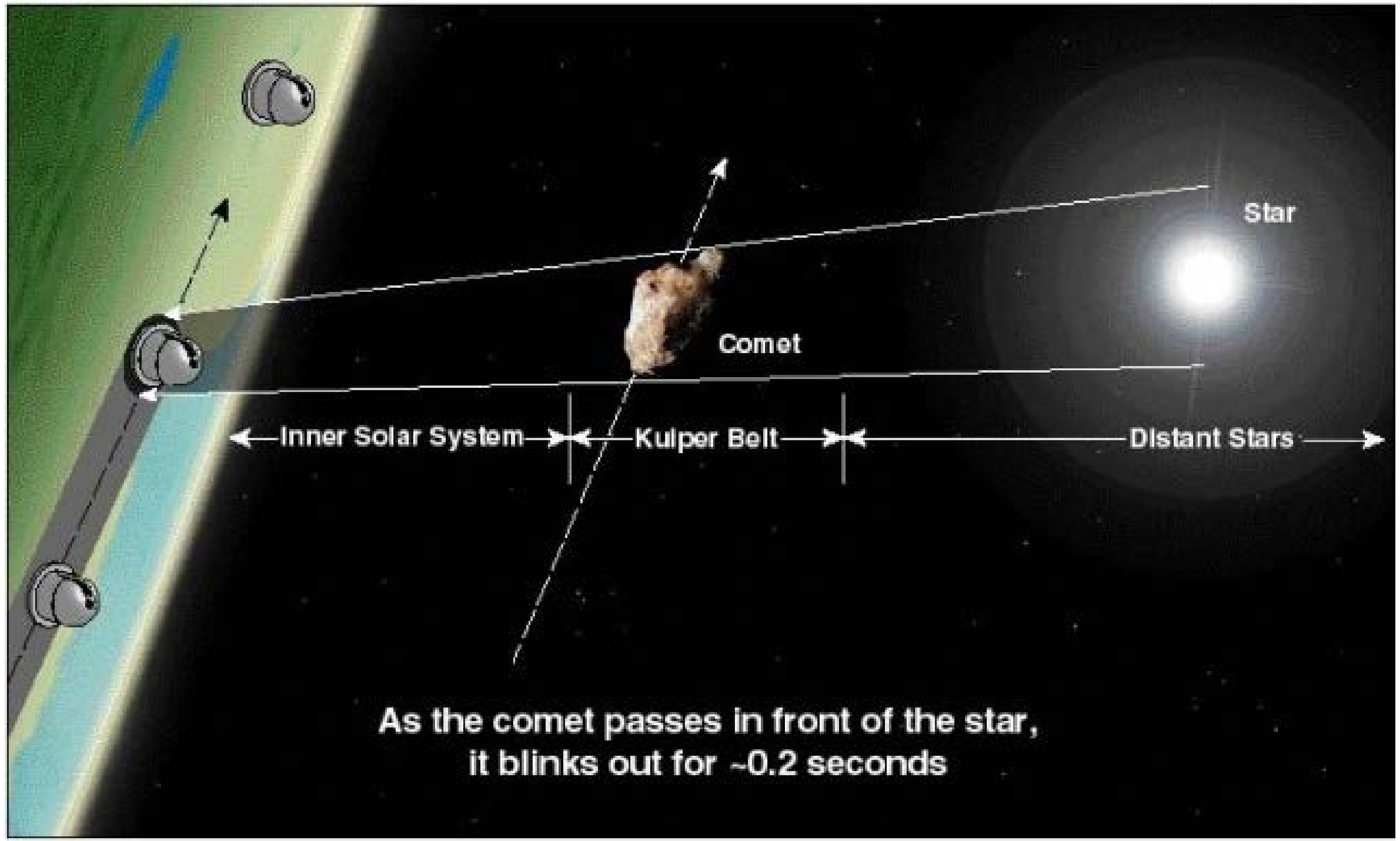


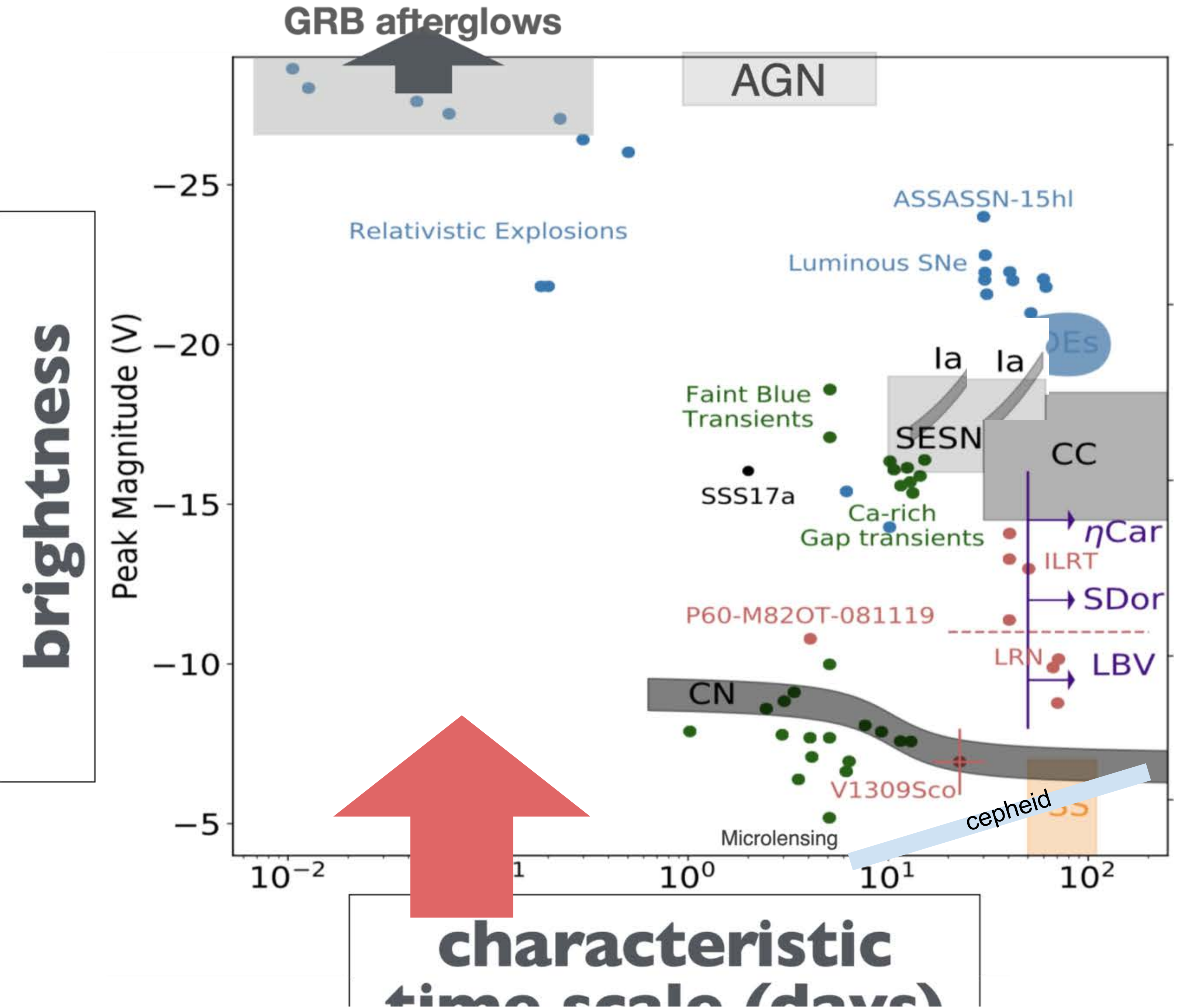
A SEARCH FOR OCCULTATIONS OF BRIGHT STARS BY SMALL KUIPER BELT OBJECTS USING MEGACAM ON THE MMT

F. B. Bianco[1,2,3], P. Protopapas[2,3], B. A. McLeod[2], C. R. Alcock[2], M. J. Holman[2], and M. J. Lehner[1,2,4]





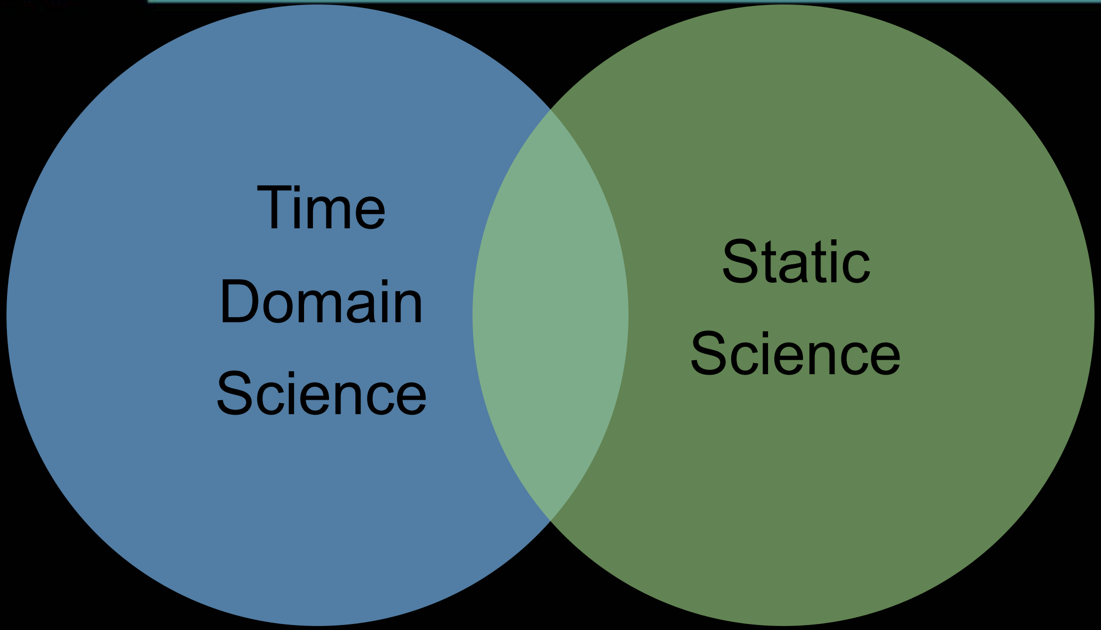


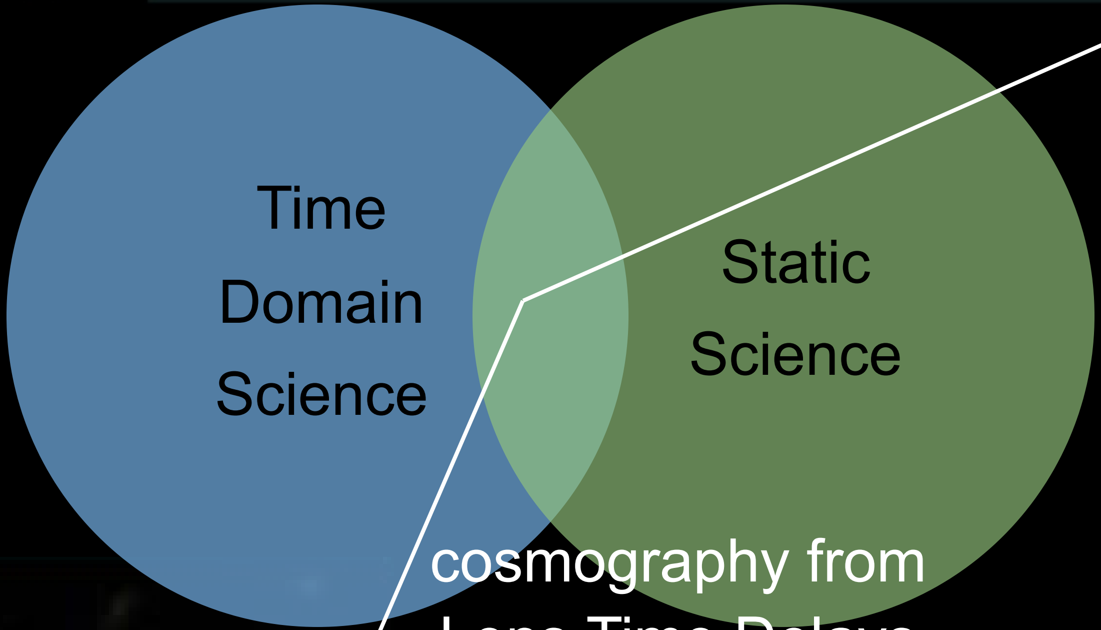


The violent and rapidly varying radiation from black holes, neutron stars, and white dwarfs makes them promising targets for high time resolution imaging. The rotation, pulsation, and local accretion dynamics of these compact stellar remnants tends to occur on timescales ranging from seconds to milliseconds. Their extreme densities also makes them an excellent testing ground for nuclear, quantum, and gravitational physics.

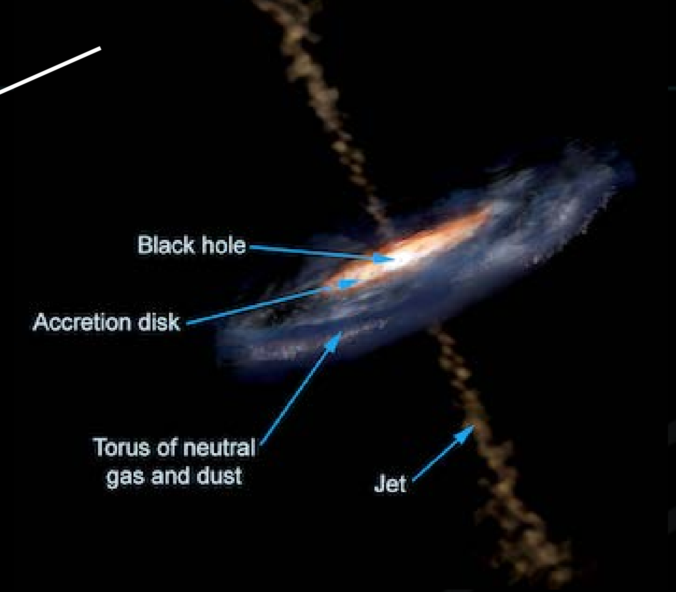
Supplemented the study of
- cataclysmic variable stars,
- X-ray binary stars,
- flare stars,
- blazars
- Fast Radio Bursts


Time
Domain
Science
Static
Science


Time
Domain
Science
Static
Science



AGN



STRONG LENSING

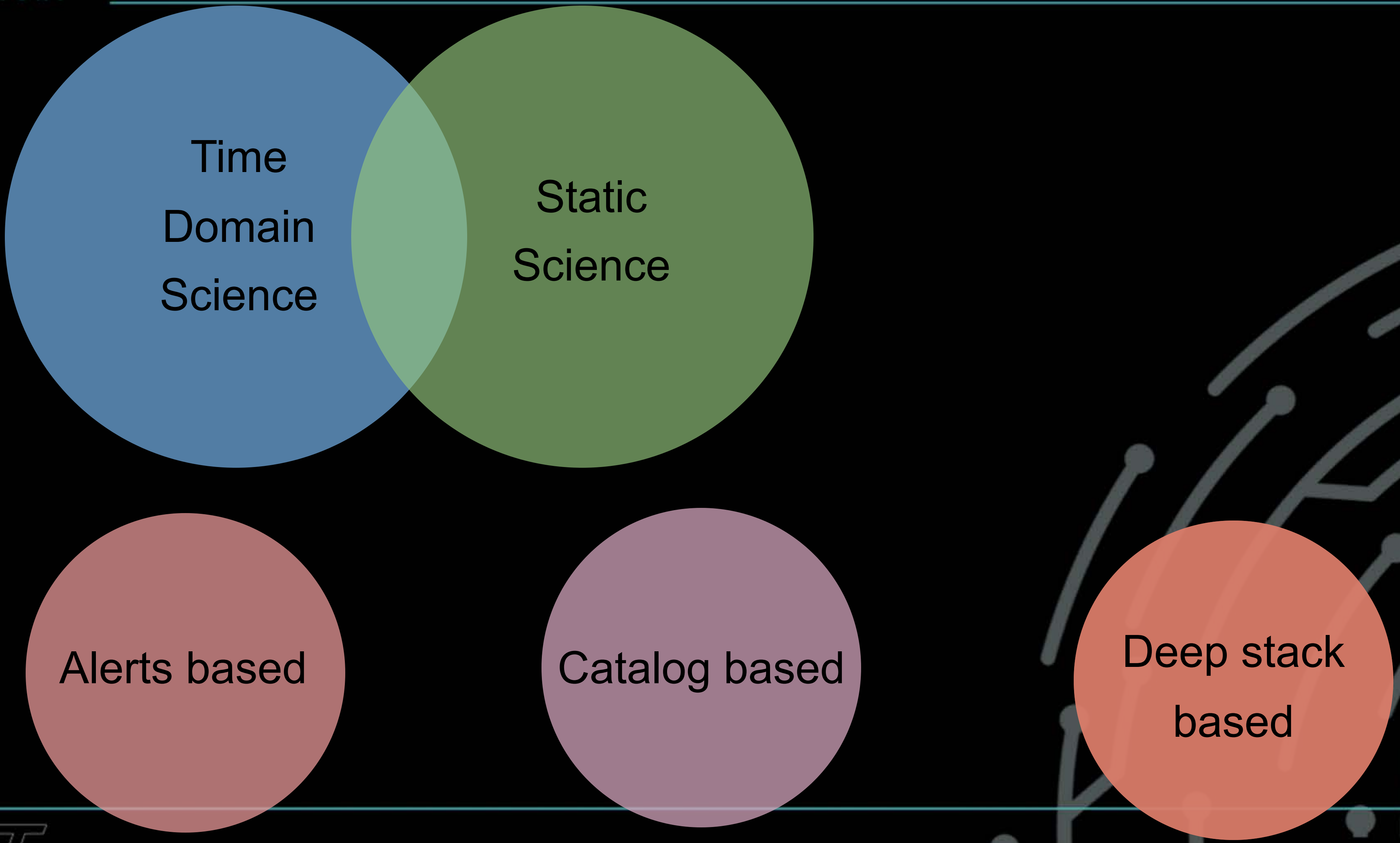
cosmography from Lens Time Delays (SL+DESC)

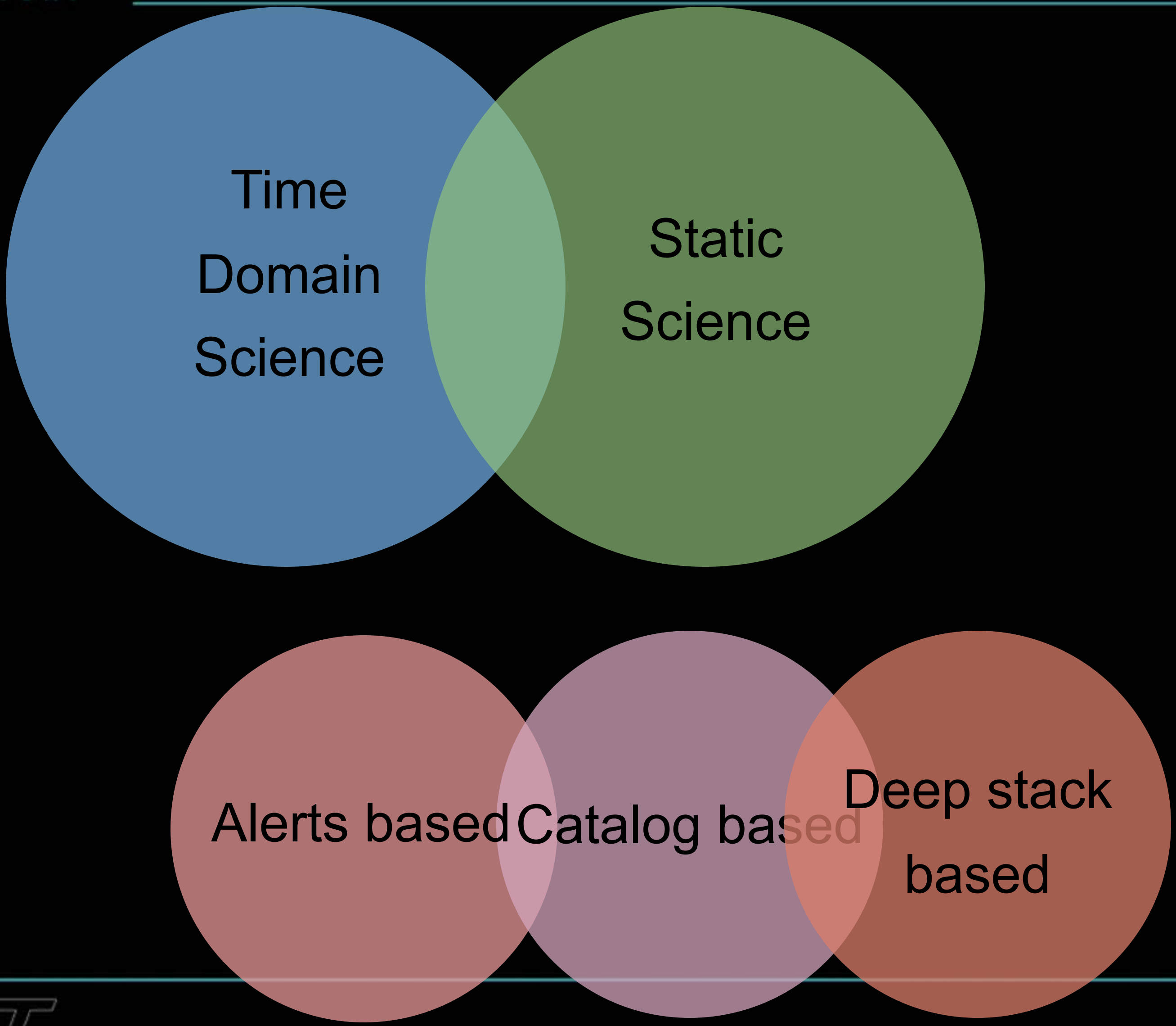
resolved high z galaxy properties (SL+Gal)

calibration of cluster mass function with with S+W Lensing

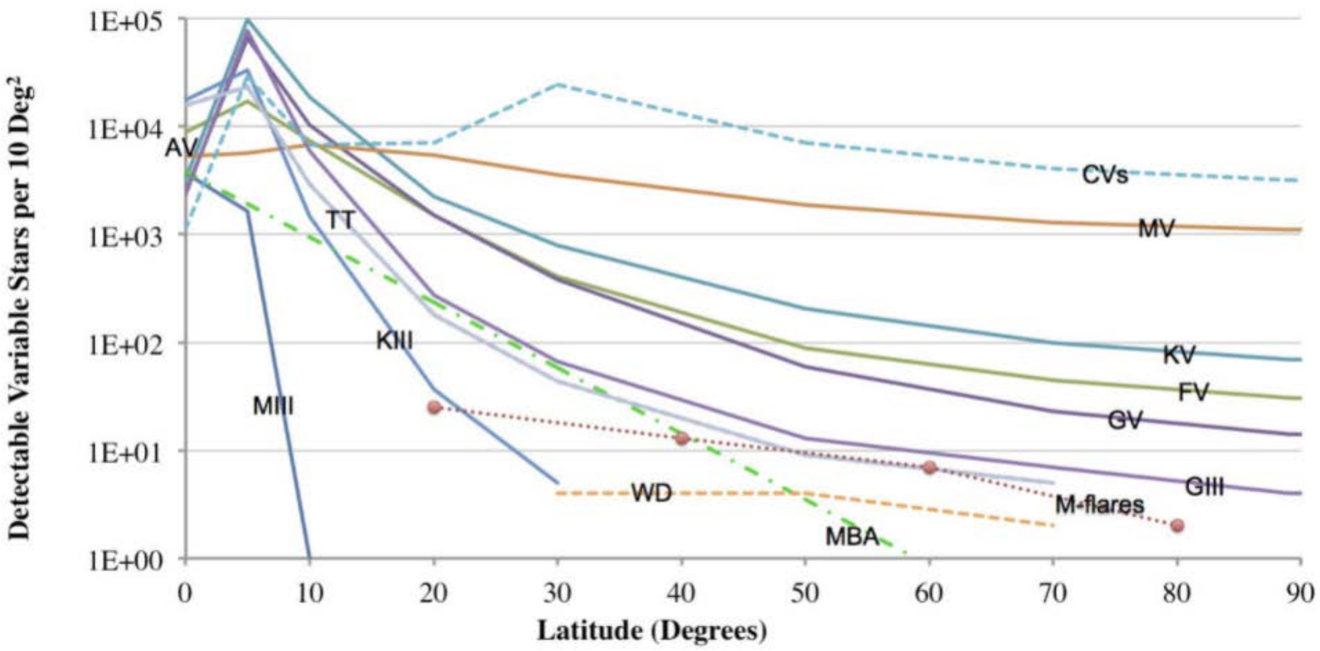
50M+ AGNs to z~7.5 (AGN+Gal)

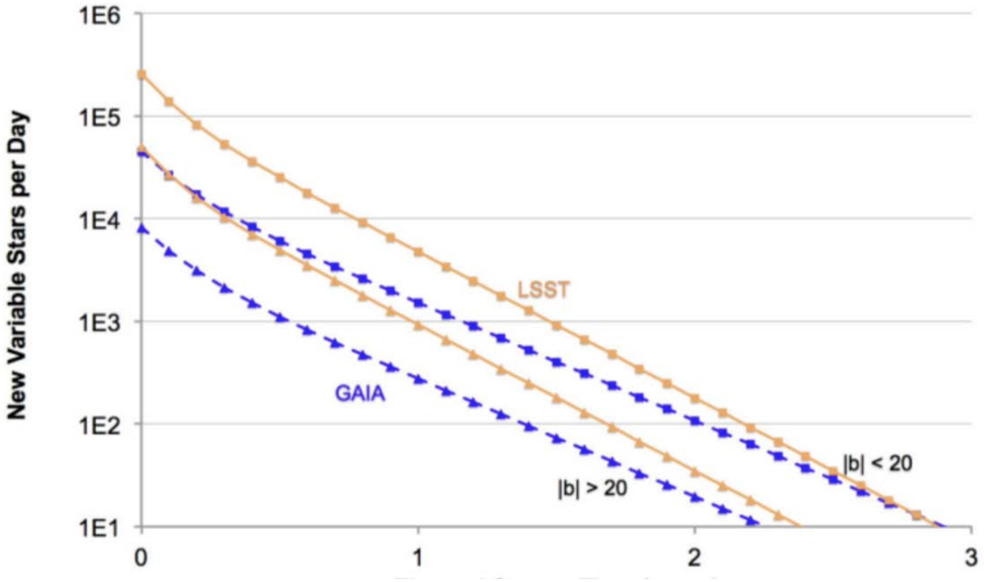
variability, microlensing, binaries (AGN+TVS)

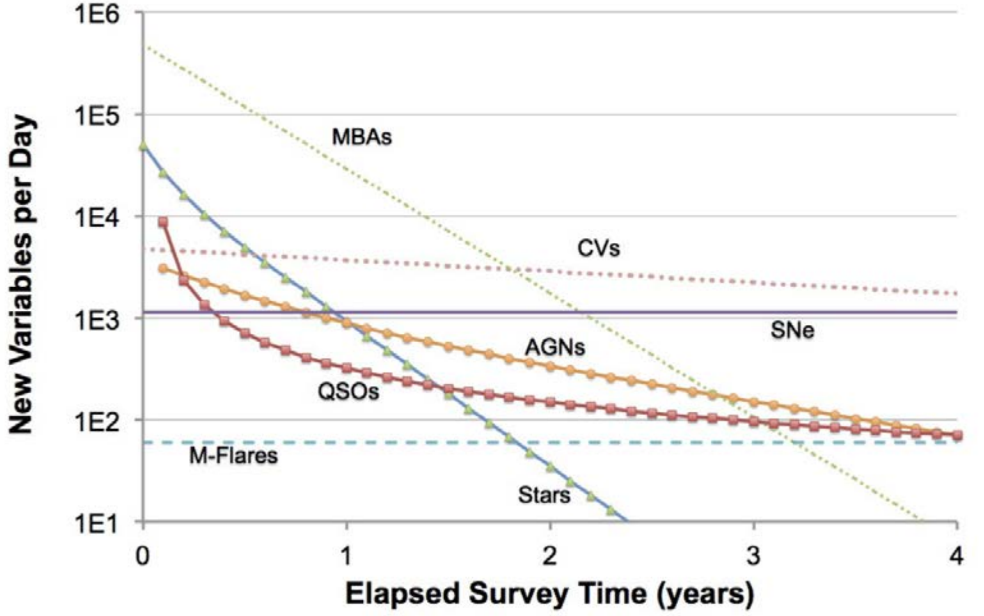

Time
Domain
Science
Static
Science
Alerts based
Catalog based
Deep stack
based


Time
Domain
Science
Static
Science
Alerts based
Catalog based
Deep stack
based

from rare to statistical samples





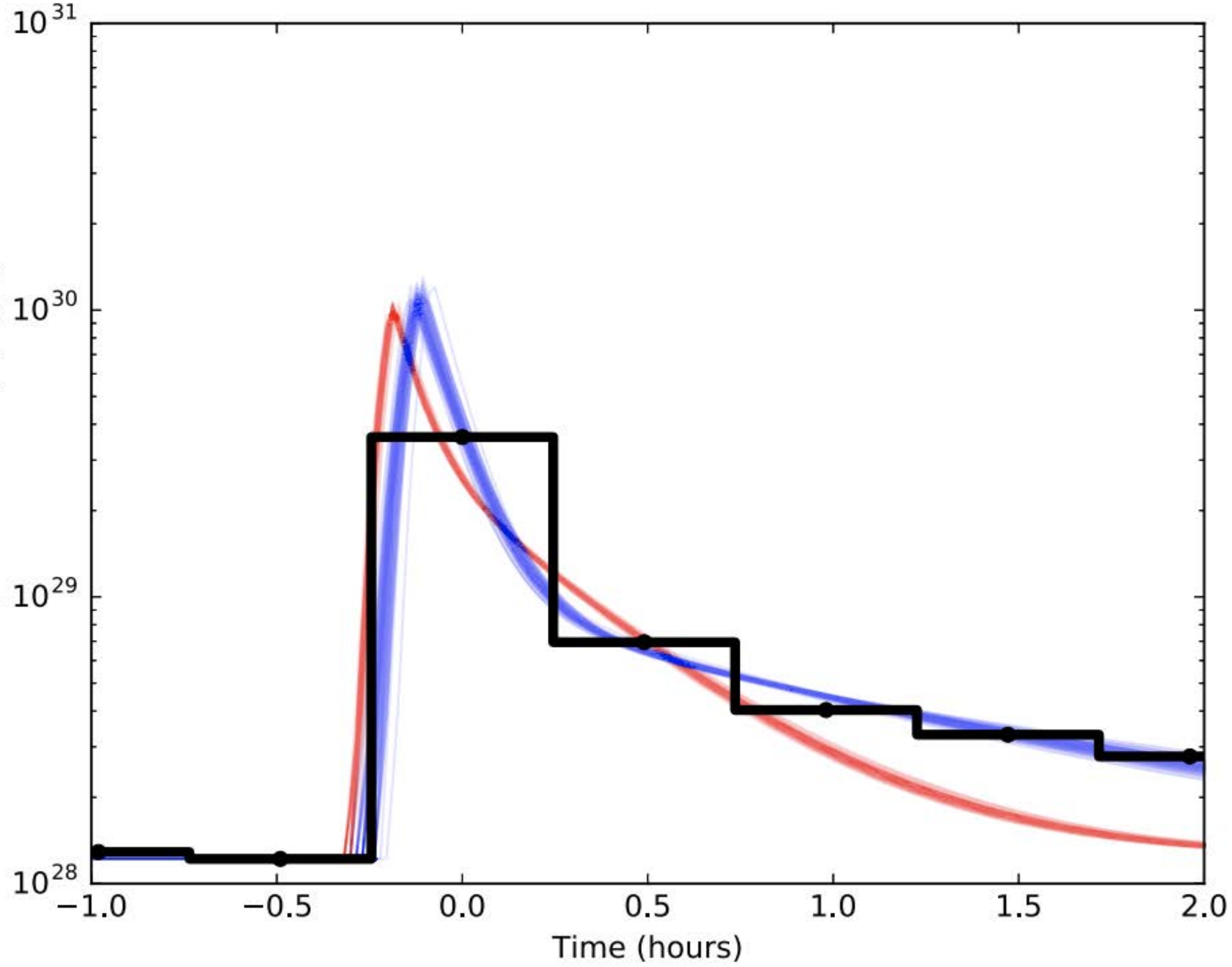


Stephen T. Ridgway+ 2014

THE VARIABLE SKY OF DEEP SYNOPTIC SURVEY

arXiv:1409.3265

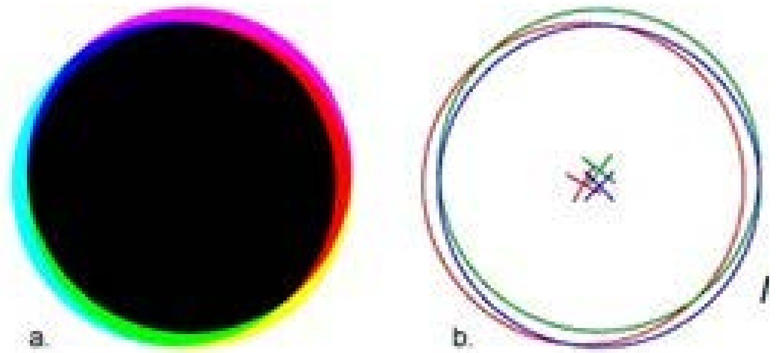
from dense time-limited or color-limited to sparse multiband



Gizis, Paduel, et al. 2017

What can we learn from 1 data point?

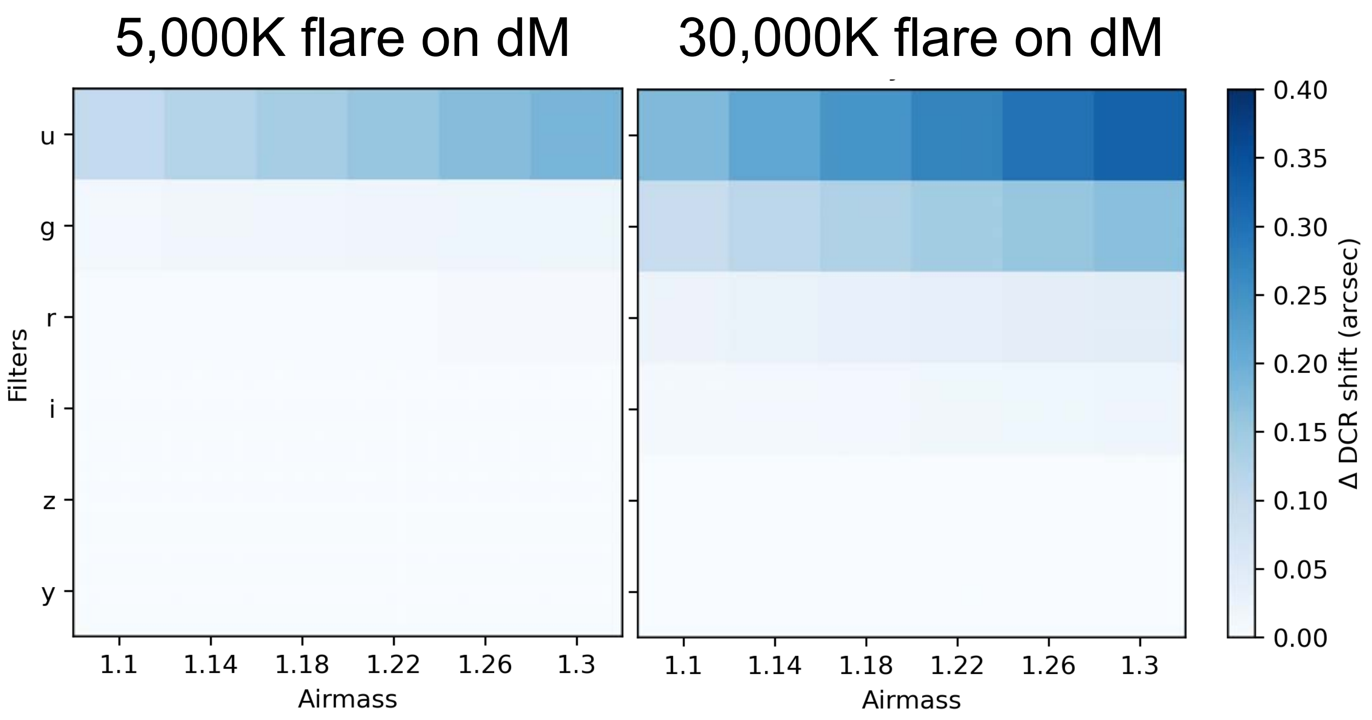
Because LSST will have exquisite image quality we may be able to measure color from atmospheric diffraction



Magnitude -> Flare energy

Star displacement -> color -> flare temperature

from dense time-limited or color-limited to sparse multiband high accuracy



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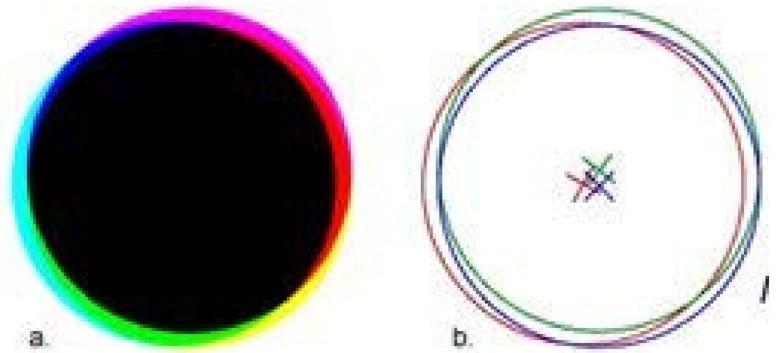


Riley Clarke, Davenport, Gizis, Bianco, in prep

Magnitude -> Flare energy

Star displacement -> color -> flare temperature

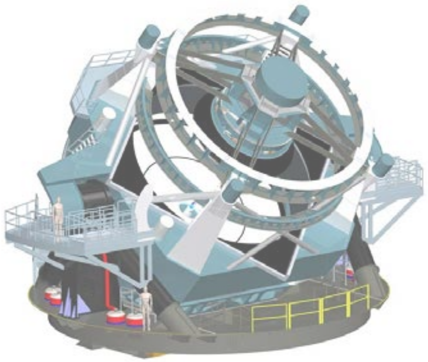
Survey coordination

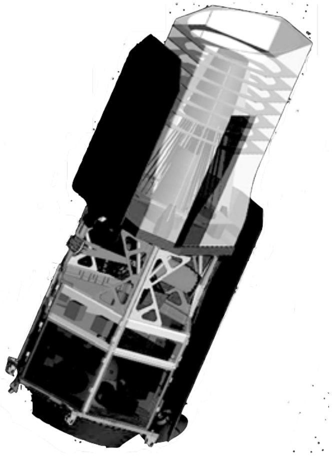
Micro- and meso-lensing for stellar physics

- detect microlensing events where both the lens and source lie in the Magellanic Clouds, and explore stellar and stellar remnant populations in another galaxy.
- LSST will investigate the mass distribution offaint objects in the local neighborhood, such as low mass dwarfs, stellar remnants, andfree-floating planets.

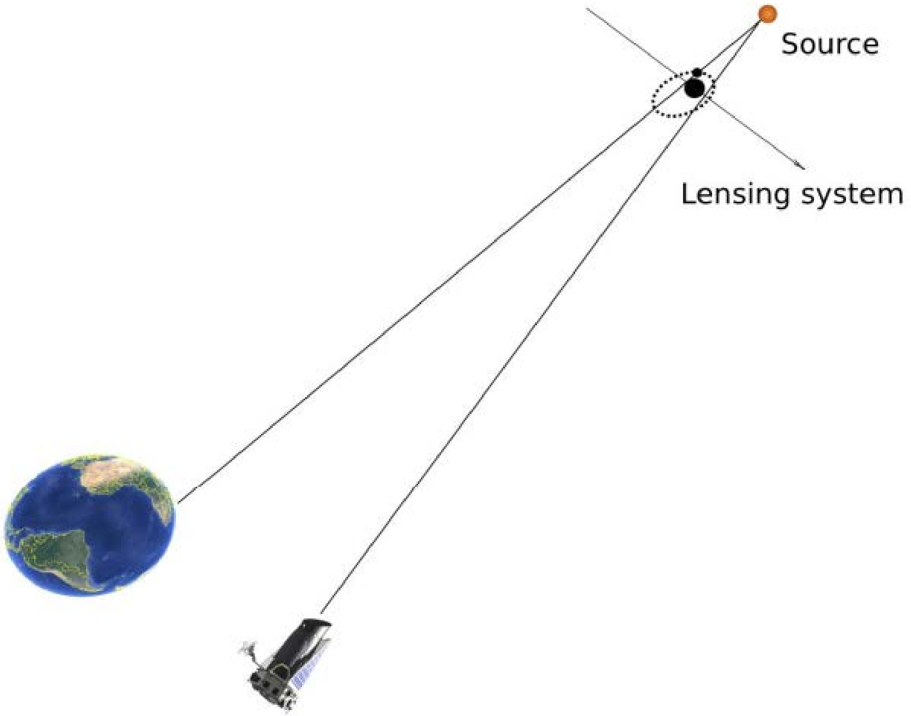
Humbleton et al 2022

TVS Roadmap





Rubin + *Roman*



Street + 2018, arxiv/1812.04445

Will we discover new physics?

Preparing to discover the unknown with Rubin LSST - I: Time domain

Xiaolong Li[1], Fabio Ragosta[2], William I. Clarkson[3] and Federica B. Bianco[1,4,5,6]

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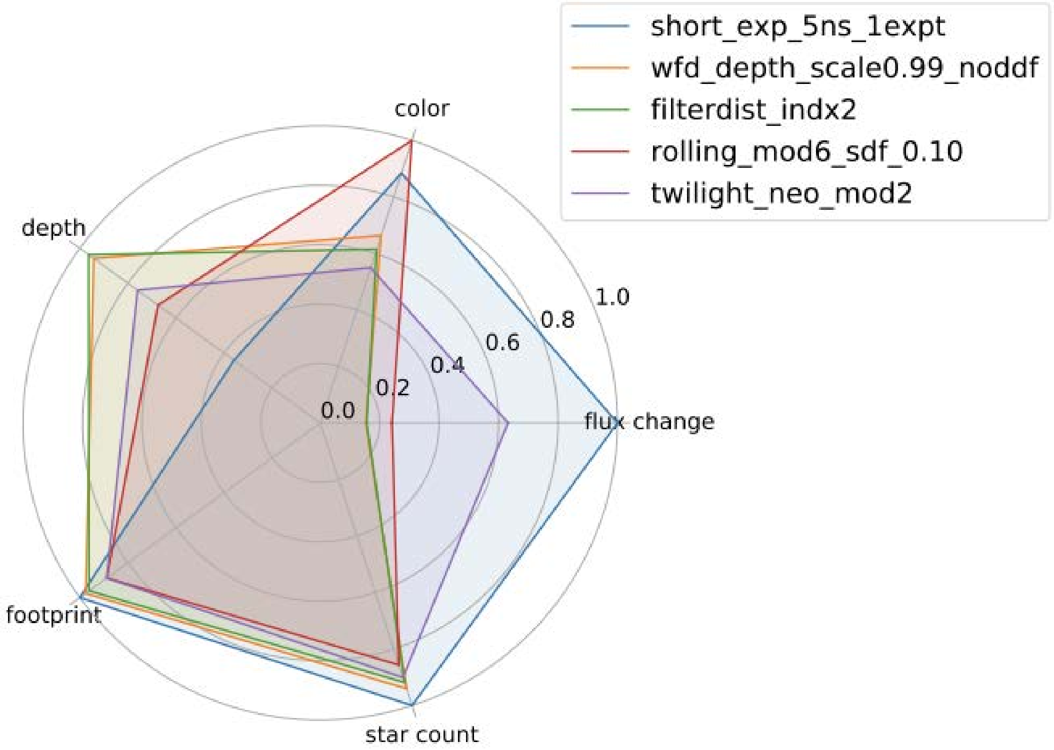
[2] *INAF and University of Naples "Federico II", via Cinthia 9, 80126 Napoli, Italy*
Department of Natural Sciences, University of Michigan - Dearborn, 4901 Evergreen Road, Dearborn, MI 48128, USA
[4] *Joseph R. Biden, Jr., School of Public Policy and Administration, University of Delaware, Newark, DE 19717 USA*
[5] *Data Science Institute, University of Delaware, Newark, DE 19717 USA*
[6] *CUSP: Center for Urban Science and Progress, New York University, Brooklyn, NY 11201 USA*

(Dated: July 23, 2021)



A comparative assessment of LSST potential surveys in the discovery of unknown unknowns

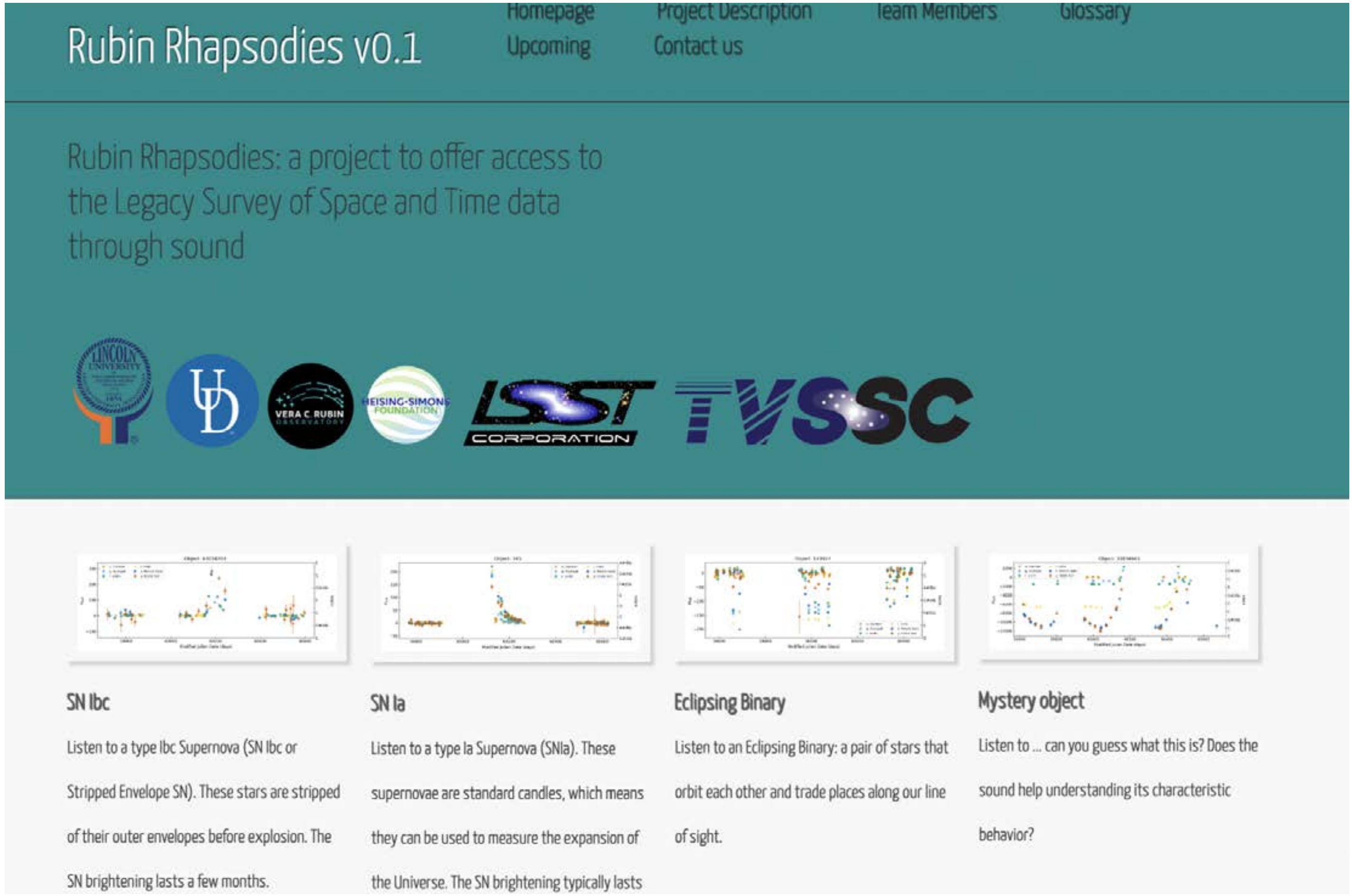
Li et al 2021

Research Inclusion: sonification of LSST lightcurves

Rubin Rhapsodies

https://lsst-tvssc.github.io/RubinRhapsodies/

Scan the code with your phone camera to hear the sonifications of the data above on our website!
Be careful! *Some notes can be very high pitched. Make sure the volume is appropriate.*



thank you!

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Biden School of Public Policy and Administration
Data Science Institute

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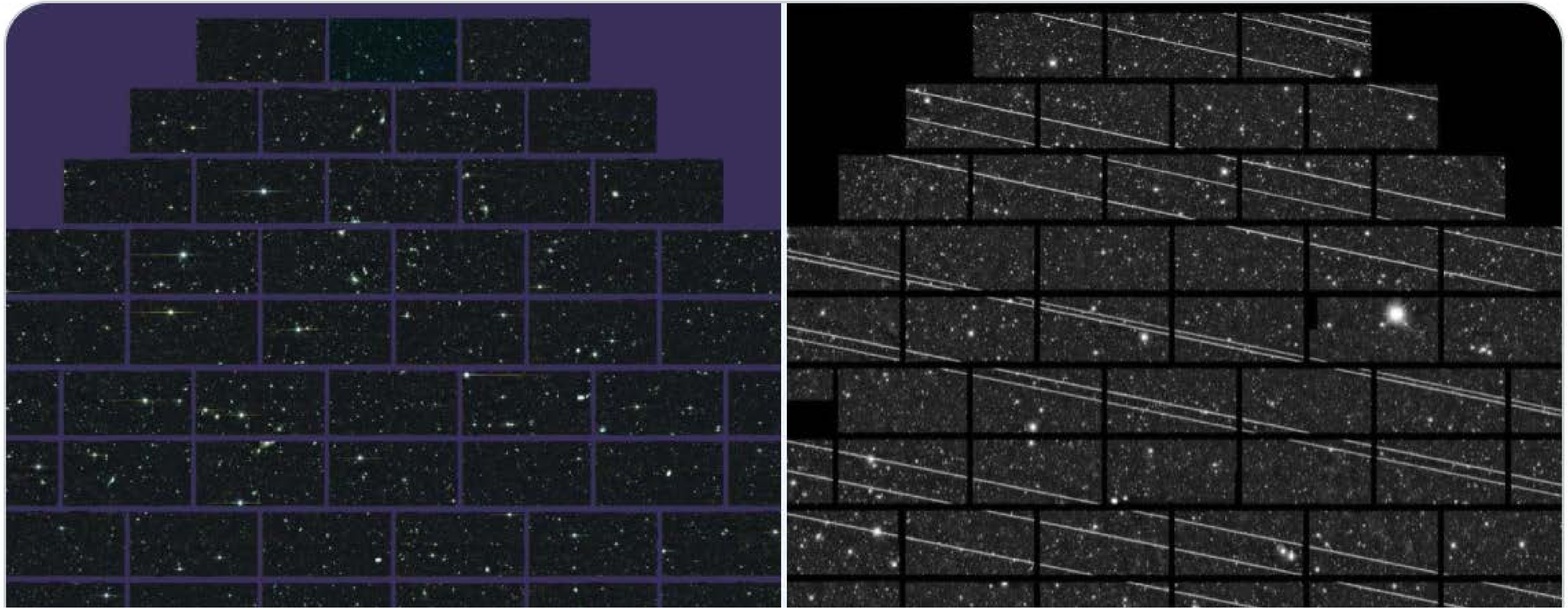
Rubin Observatory LSST

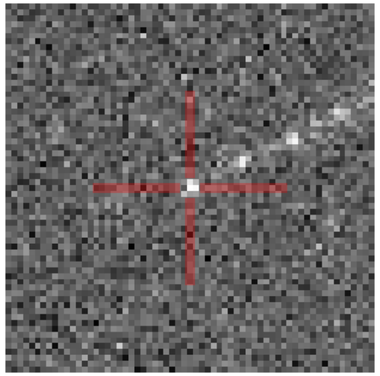
Meredith Rawls
@merrdiff

How it started: How it's going:



Time domain Rubin LSST science

Iridium satellite number 35 lit up the predawn sky west of Boston at 5 a.m. EST on February 1, 1998, *Sky & Telescope*



Satellite flares
can be mitigated:

- orientation of satellite,
- directing flares away from observer
- knowing coordinates to associate them to alerts

if not mitigate there would be bogus alerts and images ruined by saturating flares

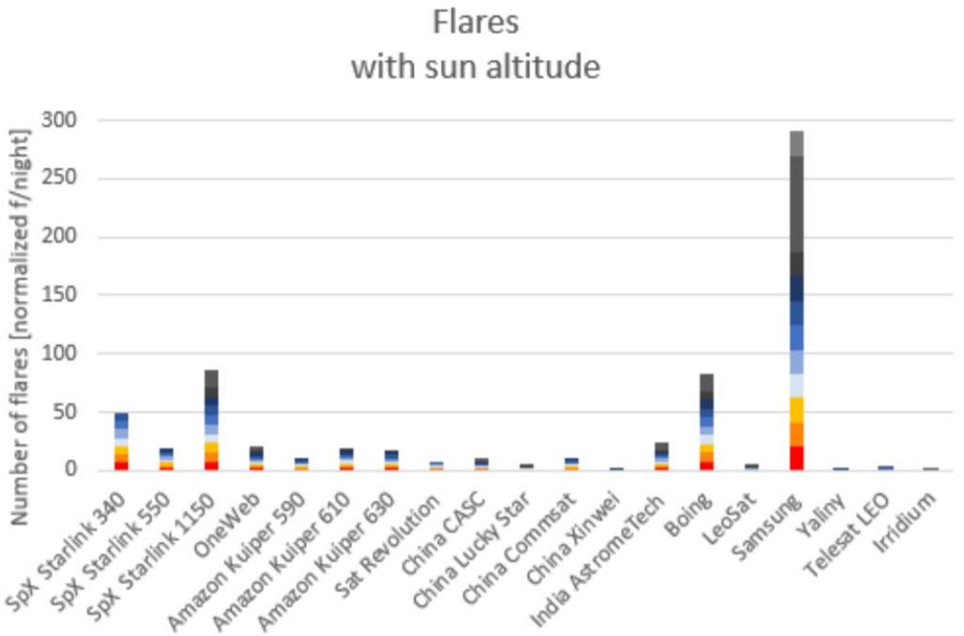


Fig. 9. Number of flares for each constellation, simply scaling them to one-third of the flares caused by the original Iridium satellites (which had three large antennas) and to the number of satellites. This is the number of observable flares per night, or the number of flares per week brighter than –5 mag for a mid-latitude site. The colour encodes the sun elevation below the horizon, from 0° (red), –18° (pale blue), and into the night (darker blue to greys).

Hainaut & Williams 2020

https://arxiv.org/abs/2003.01992

Rubin Observatory

Science Collaborations

Legacy Survey of Space and Time