

Rubin Observatory

Transients and Variable Stars Science Collaboration

With thanks to all Collaboration members, and representing contributions from

Federica Bianco, Rachel Street, Andjelka Kovacevic, Dragana Ilic, Sjoert van Velzen, Kelly Hambleton, Sara Bonito, Nina Hernitschek, Massimo Dall’Ora, Raffaella Margutti, Katja Bricman



Rubin Observatory

A New Way to Organize Large Scale Science

Rubin Observatory has no dedicated science team

Instead, the science is to be carried out as a community-led effort

Science Collaborations



Rubin Observatory at Cerro Pachón, Chile
Credit: Rubin Obs/NSF/AURA

Rubin Observatory

Science Collaborations

Eight Science Collaborations dedicated to organizing and supporting different science communities to maximize the science return from Rubin

- Advise Rubin Project on survey
- Focus for training and resources for Rubin Science
- Prepare to derive science from LSST data



Solar System



Strong Lensing



Active Galactic Nuclei



Stars, Milky Way and Local Volume



Informatics and Statistics



Galaxies



Dark Energy



Transients and Variable Stars



Transients and Variable Stars Science Collaboration

15 subgroups dedicated to a range of science topics

Extra-galactic



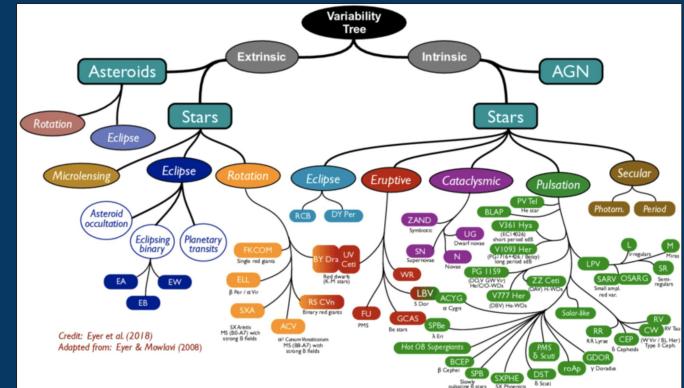
Fast transients
Supernovae
Tidal Disruption Events
Distance Scale

Galactic



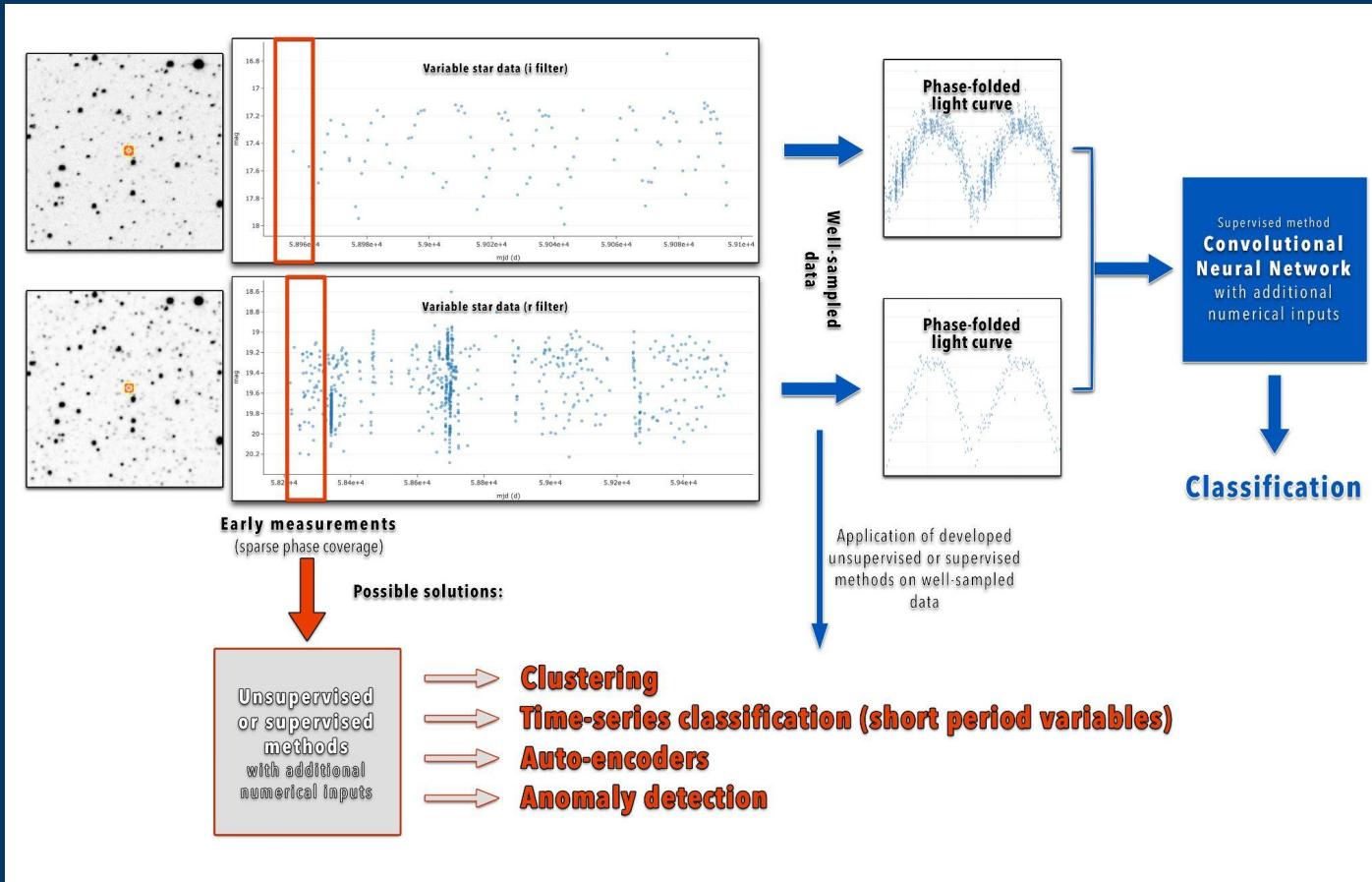
Interacting binaries, Magnetically active stars
Microlensing, Non-degenerate eruptive variables, Transiting exoplanets, Pulsating variables

Methodology



Cosmological Classification/Characterization
Multiwavelength characterization and counterparts
Anomalies and True Novelties

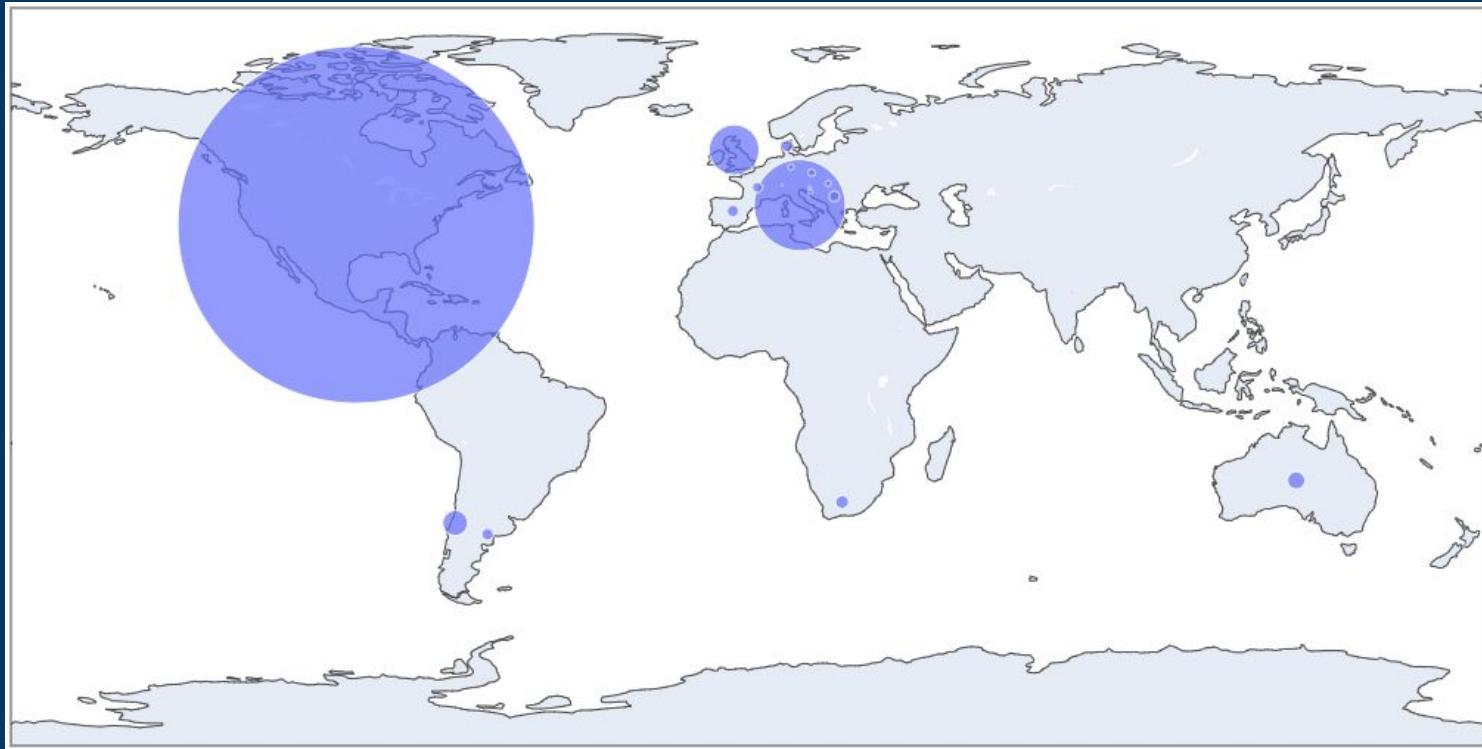
Classification & Characterization Subgroup



International Collaboration

390+ members

5 continents



JEDI: Justice, Equity Diversity and Inclusion

Chair: Rosaria Bonito

Subgroup to review all aspects of TVS with the goal of promoting inclusion and diversity in all our activities

Current work in progress includes:

- Kickstarter programs to mentor students, inclusivity training
- Novel data visualizations, inc. sonification, 3D printing
- Collating information for refugee scientists
- Broadening awareness of Rubin
- Fostering inclusive recruitment practices



TVS Task Forces

Survey cadence proposals
and metrics

Software

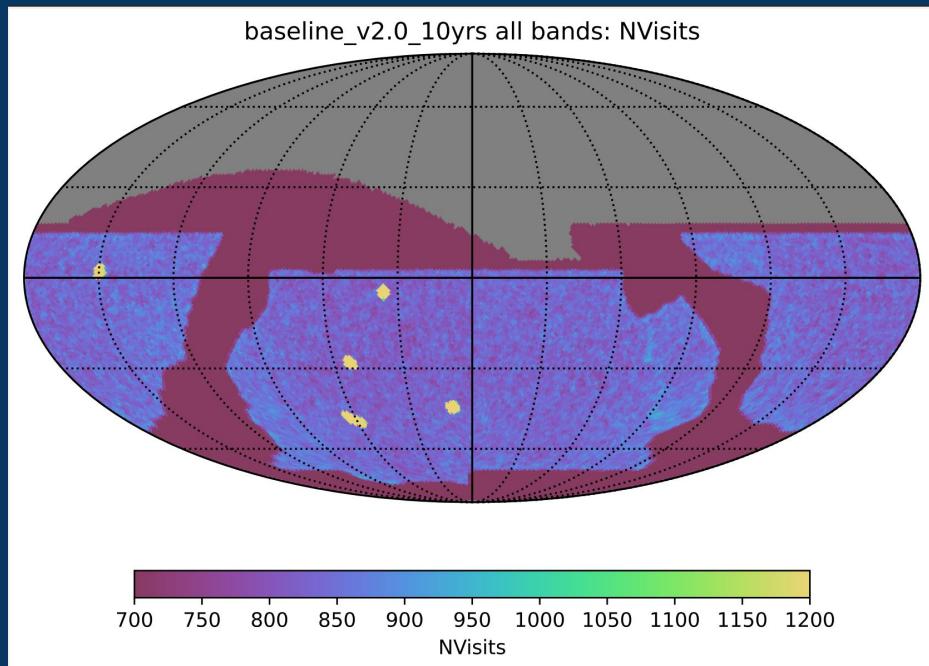
Crowded field photometry

Data Preview 0

Survey Strategy Task Force

Chair: Rachel Street

Rubin has invited community input on its survey strategy in several phases:



- 2017: Community Observing Strategy Evaluation Paper [Marshall et al, 2017 <https://arxiv.org/pdf/1708.04058.pdf>]
- 2018: Survey Cadence White Papers <https://www.lsst.org/submitted-whitepaper-2018>
- 2020: Survey Cadence Notes <https://www.lsst.org/content/survey-cadence-notes-2021>
- 2021-current: Software to evaluate simulations of different survey strategies

Tidal Disruption Events Subgroup

Coordinator:
Sjoert van Velzen

Comparison of survey strategy simulations to recommend best strategy for TDE detection



Plots from Bricman et al (in prep)



Non-Degenerate Eruptive Variables

Coordinator: Rosaria Bonito

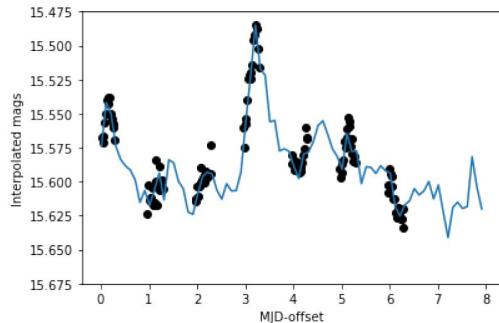


Figure 4: OpSim db = carina_v1.7_10yrs; the Carina Nebula pointing with the proper number of points covering the LC.

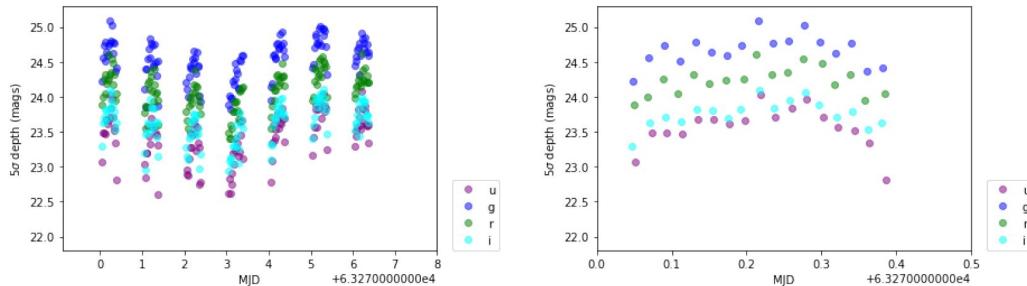


Figure 5: OpSim db = carina_v1.7_10yrs; more than 100 points per filter in one week (left panel), ≈ 20 points per filter in each night, corresponding to the required cadence of 30 minutes for 10 hours each night in each filter, ugri (right panel).

Microsurvey proposals to discover Young Stellar Objects in selected Star Forming Regions

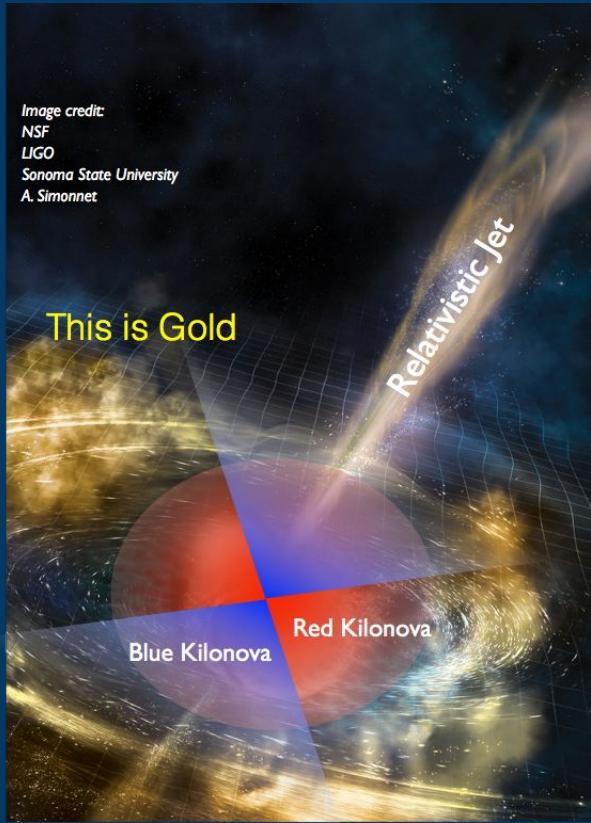
Assessment of survey strategy simulations, including metric development

Bonito & Venuti et al. 2021
Cadence Note

Bonito & Venuti et al. ApJS, in preparation

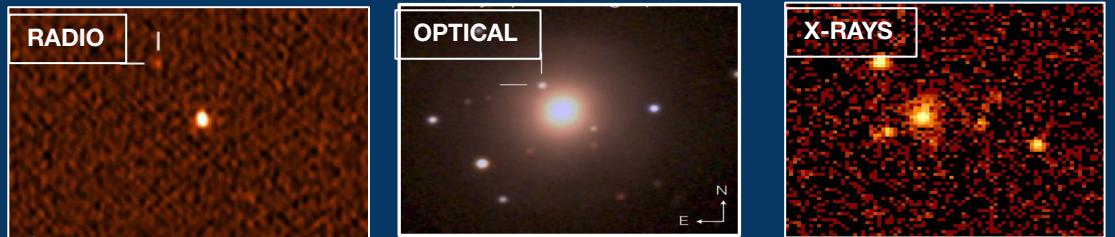
Gravitational Waves

Credit: Raffaella Margutti



Target of Opportunity observations of GW detections from the Rubin Observatory can help us understand the progenitors and physics of binary neutron star mergers

GW170817: GWs + light from the same celestial object



See Andreoni et al. 2022

<https://ui.adsabs.harvard.edu/abs/2021arXiv211101945A/abstract>

Software Task Force

Chair: Federica Bianco

Rubin science will depend critically on building suitable software tools

- Suggest software to be developed in support of TVS science, and outlining a mechanism for members to propose software for development
- Review currently available software
- Review the TVS Science Roadmap to identify needed software packages
- Define and document software for development and the package requirements
- Selecting software to be developed as directable software development by international contributors
- Designed a mechanism to validate software performance
- Lower the barrier to entry for use of the software by TVS members



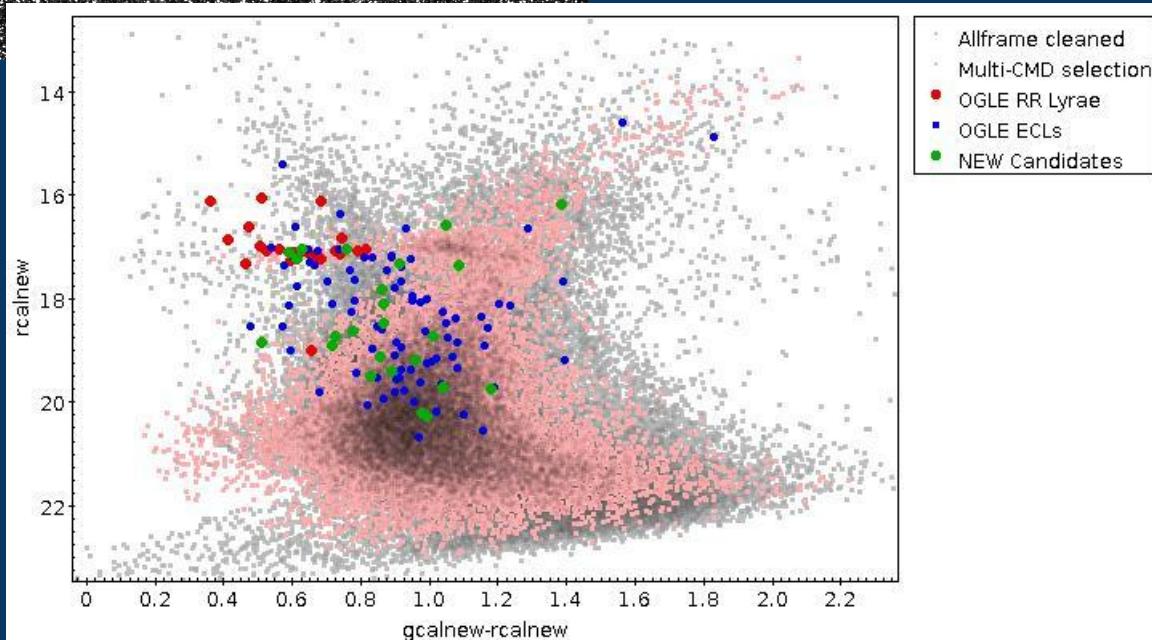
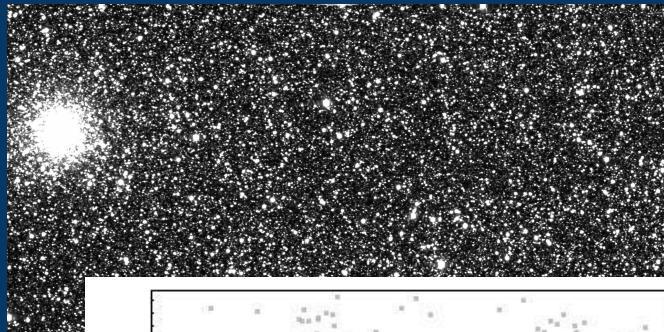
Crowded Field Photometry Task Force

Chairs: Michael Rich and Massimo Dall’Ora, Spokesperson: Kelly Hambleton

Many TVS science goals will depend on high-quality photometry from very crowded Galactic Plane fields, where Rubin’s deep limiting magnitude will result in heavy blending

- Gain experience with LSST photometry in crowded fields and its impact on accuracy, completeness, detection and characterization of variability
- Identify/design the tools necessary to analyze the data
- Provide feedback to the Rubin pipeline development team

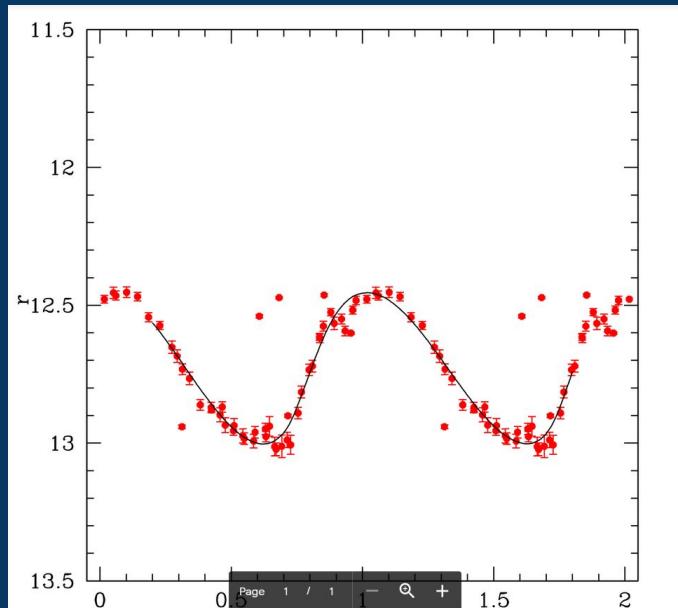
Photometry of Bulge Globular Cluster NGC 6569



- Deep DECam data of very crowded field used as proxy for LSST
- Catalog of known variables discovered by OGLE
- Several new variable discoveries made

Photometry of Bulge Globular Cluster NGC 6569

Several new variable stars discovered, demonstrating the potential of LSST data



Now analysing individual variables for physical insights

- Changes in periodicity over time
- RR Lyrae period-luminosity relations in multiple passbands

See Marconi et al (in prep)

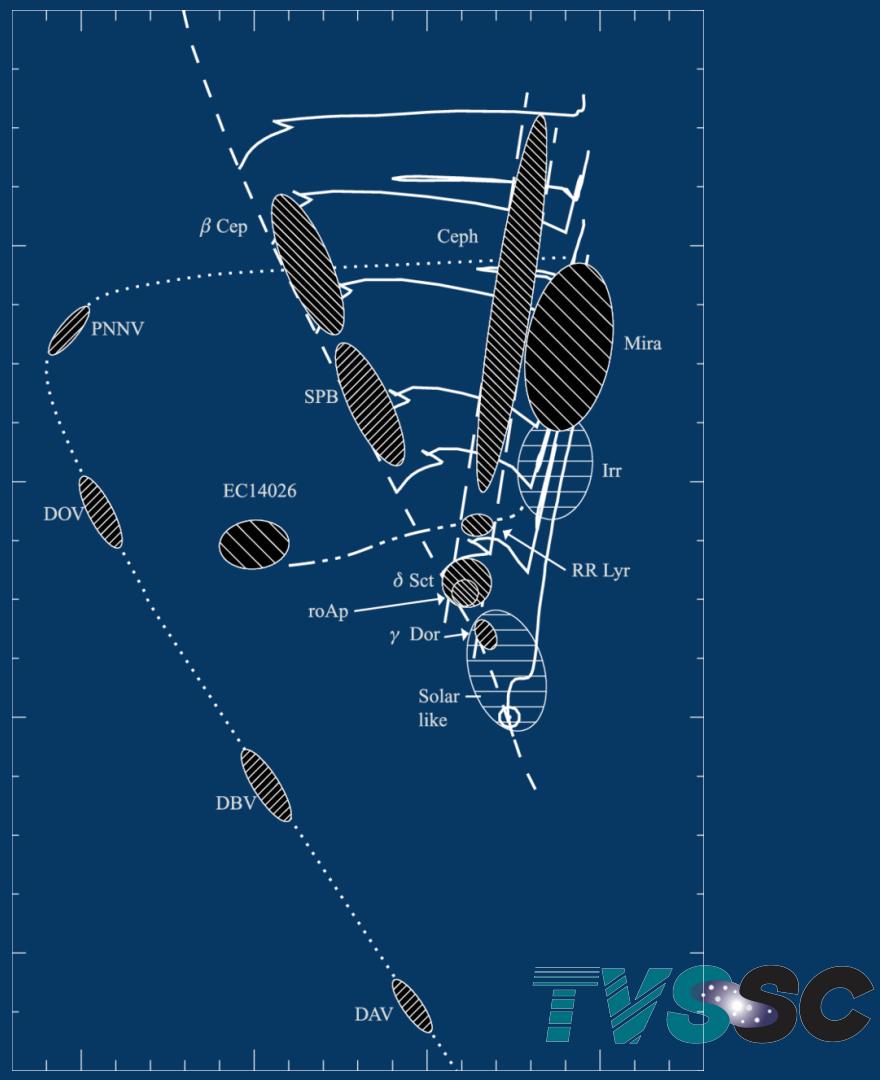
Pulsating Star Subgroup

Coordinator: Kelly Hambleton

Goal is to evaluate the pulsational H-R diagram that will be explored using Rubin data

Subgroup working to produce a Science Roadmap

Credit: Jørgen
Christensen-Dalsgaard



Data Preview 0

Chairs: Rosaria Bonito, Vincenzo Petrecca

Simulated LSST datasets made available through Rubin analysis platform for community exploration

- Integration test of LSST Science Pipeline and Rubin Science Platform
- Build community experience with LSST data products and analysis tools

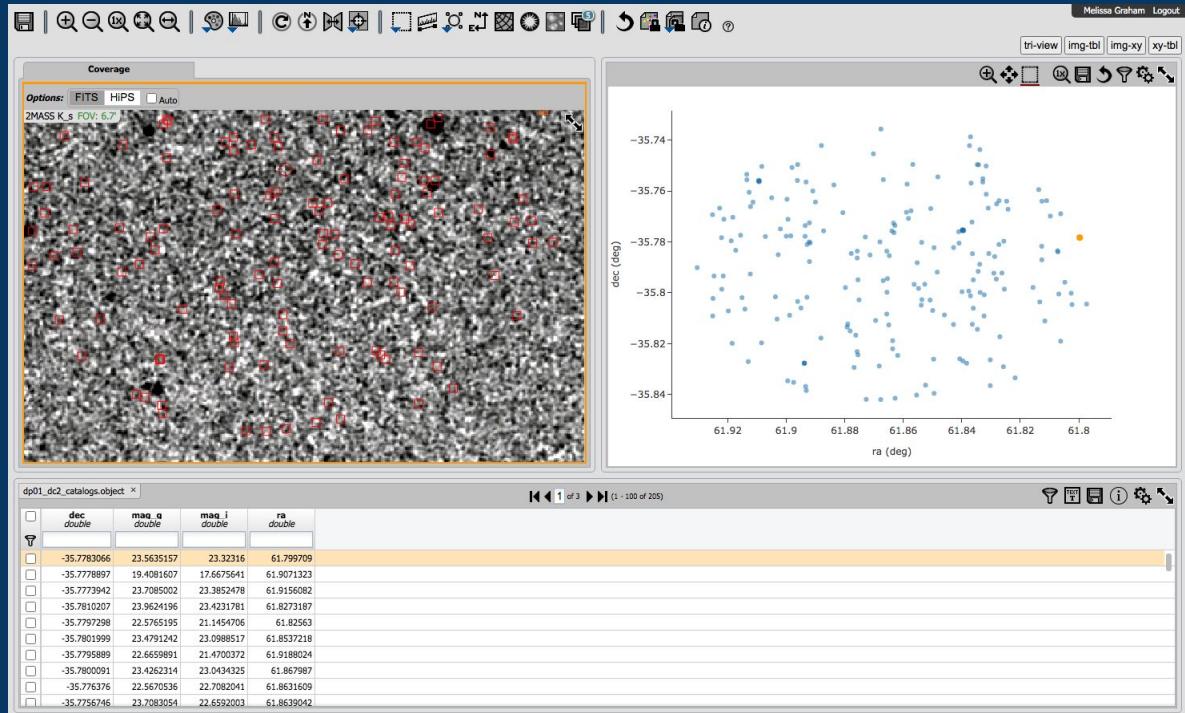
For more information on Rubin Data Previews: <https://dp0-1.lsst.io/>



Data Preview 0

LSST simulated data products served through the Rubin Science Platform

Preparation of Jupyter notebook tutorials for different example analyses



For more information on Rubin Data Previews: <https://dp0-1.lsst.io/>



Preparing for Astrophysics with LSST Program

Initiative to provide resources and training to enable researchers to get involved in Rubin research and overcome barriers to entry

Fund science publications

Support meetings and workshops

Provide access to software training and tools

Kickstarter Grants

Supported by



Preparing for Astrophysics with LSST Program

Kickstarter Grants

Funding opportunities for Rubin research designed to promote inclusive and collaborative research, open to members world wide

35 Kickstarter grants awarded to PIs from 9 countries

For more information, see: <https://lsst-sci-prep.github.io/>



Preparing for Astrophysics with LSST Program

Info on computing resources

LINCC Frameworks program

Software training opportunities

Software design training

Software development techniques
training

Workshops planned for ~April 2022



For more information, see: <https://lsst-sci-prep.github.io/>



TVS Science Collaboration

<https://lsst-tvssc.github.io/>

LSST TVS SC | □ INTRO | □ MEMBERS AND ROLES | □ SUBGROUPS | □ TASK FORCES | □ DOCUMENTS | □ EVENTS | □ BECOME A MEMBER |

TVSSC

**RUBIN LSST
TRANSIENTS
AND VARIABLE
STARS**

SCIENCE COLLABORATION

LATEST

RNAAS RESEARCH NOTES OF THE AAS

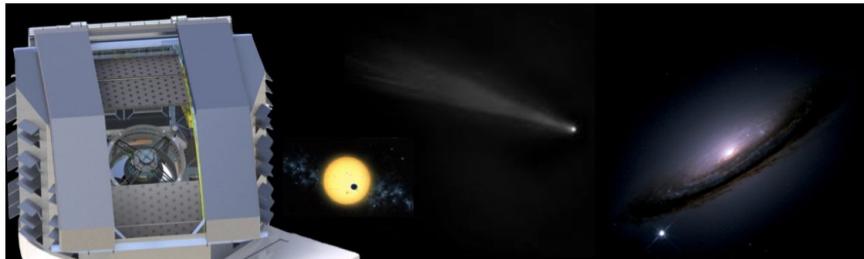
Impact of Rubin Observatory LSST Template Acquisition Strategies on Early Science from the Transients and Variable Stars Science Collaboration: Time-critical Science Cases

R. A. Street¹ , F. B. Bianco² , R. Bento³ , T. Giannini⁴ , M. L. Graham⁵ , R. Mergulhão⁶ , E. Mason⁷ , A. Pastorelli⁸ , M. C. Strolz⁹ , P. Schrödter¹⁰  + Show full author list

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Research Notes of the AAS, Volume 5, Number 3

THE TVS SCIENCE COLLABORATION



The [Vera C. Rubin Observatory](#) Legacy Survey of Space and Time (LSST) Transients and Variable (TVS) Stars Collaboration focuses on the study of the transient and variable sky through the LSST data, including a large and diverse range of phenomena: variable events, periodic or not, explosive and eruptive transients, and geometric transients (e.g. eclipsing binaries and planets). Variability is a tell tale of the nature of the objects observed, but it also enables galactic studies (the mapping of the galactic structure), extragalactic studies (the characterization of the intracluster medium), and cosmological

