Transient Science Enabled by LSST

Transient and Variable Star Science Collaboration
Co-chairs: Federica Bianco (UDelaware), Rachel Street (LCO)
15 subgroups 279 members 11 countries
15 subgroups | 279 members | 11 countries

**Extra-galactic**
- Fast Transients
- Supernovae
- TDEs
- Distance Scale

**Galactic**
- Interacting Binaries
- Mag. Active Stars
- Microlensing
- Non-degenerate Eruptive Variables
- Transiting Exoplanets
- Pulsating Variables
- Galactic

**Methodology**
- Cosmological
- Classification/Characterization
- Multiwavelength Characterization & Counterparts

How will LSST make a difference?

Target sample and rate

- Increase size of known populations
- Build statistical samples of rare events
- Identify precursors of transients

E.g. SNe subclasses
E.g. CVs
E.g. TDE, Kilonovae
CV outbursts
E.g. LBV
How will LSST make a difference?

Target Distribution

Discover targets in regions not previously explored

E.g. Microlensing by single Black holes

E.g. Mapping pulsating variables
How will LSST make a difference?

**Faint limiting magnitude**

Explore higher redshifts and evolution  
E.g. SNe subclasses

Detect rare events across wider area  
E.g. stellar microlensing
How will LSST make a difference?

**Timeseries color information**

Detect and characterize populations  

E.g. Stellar flares  
Magnetically active stars  
White dwarf transits
Organization

The TVS SC organizational structure as of August 2018.

TVS co-Chair

- Membership Review Board (3 members)
- Publication Board (2 members)
- Ethics Board (2+ members)
- Policy Review Board (ad hoc)

Subgroup coordinators

- Microlensing
- Fast Transients
- Interacting Binaries
- Magnetically Active Stars
- Multimwavelength Characterization & Counterparts
- Non-degenerate Eruptive Variables
- Pulsesing Variables
- Supernovae
- Tidal Disruption Events
- Transitting Planets
- Cosmological
- Classification/Characterization
- Distance Scale
- Galactic

LSST-stack Support Team

+ Task Forces
LSST Data Challenge

Simulated LSST light curves of ~3.5 million objects, including full range of astronomical phenomena

https://www.kaggle.com/c/PLAsTiCCs/
arXiv: 1810.00001

Challenge: Accurately classify the objects based on the available photometry

TVS members contributed models of galactic variability to the generation of simulated data
2018 Task Forces

Survey Cadence Planning

• LSST 2018 Call for White Papers
  • Proposals for main survey cadence, Deep Drilling Fields and Minisurveys

• Organized TVS hackathon workshop
• Collaborative, inter-subgroup efforts to identify mutually-beneficial observing strategies
• Develop metrics to assess the science impact of different observing strategies based on simulations of LSST operations

• 14 TVS-led White Papers submitted
2018 Task Forces

Characterization of Variability

- Evaluated the variability parameters from the LSST pipeline in correctly identifying different types of variable sources
- Case-studies of Blazars, RR Lyrae, Cepheids, Luminous Blue Variables

- Highlighted where LSST color-indices will be insufficient
- Identified the additional data required
- Explored alternative metrics
- Tested on SDSS Stripe-82 data
2018 Task Forces

TVS Roadmap

• Detailed description of science goals of all subgroups
• Identified necessary preparatory work
• Identified additional observations required

Living document
2018 Task Forces

Broker Requirements

- Broker developers requested feedback on user requirements
- Conducted two surveys:
  - User requirements
  - Developer constraints
  - Alert content, parameters
  - Catalog cross-matching
  - Classification
  - Distribution/access mechanisms/UIs/APIs
- Summarized in report paper

How fast do you really need alerts?

- 26.7% in 1 min or less
- 20% between 1 and 5 mins
- 20% between 5 and 10 mins
- 6.7% between 10 and 30 mins
- 6.7% between 30 mins and 1 hour
- 20% between 1 and 6 hours
- 20% between 6 and 12 hours
- 20% between 12 and 24 hours

Have your say at: https://ls.st/7vb

2019 Task Forces

Cadence Metrics

Goal: Develop more extensive metrics to enable evaluation of the survey cadence for TVS science

• Become familiar with LSST’s Matrix Analysis Framework (MAF)
• Review the TVS White Paper submissions for cadence proposals
• Design and code MAFs for all TVS submissions
• Create TVS specific (video) tutorials for MAF
Science Platform Evaluation

The LSST Science Platform is envisioned to be the primary way the community will analyze LSST data. Goal is to evaluate its capabilities with respect to TVS science needs
* LSP not yet available for community access

- Gain familiarity with the LSP and share the information with TVS
- Document science analyses use-cases for TVS subgroups
- Evaluate performance of LSP relative to the science use-cases
- Report on LSST Stack Club to TVS
Photometry in Crowded Fields

Goal is to refine parameters in the LSST Stack to optimize crowded field photometry for variable stars and image stacks

- Perform a full test of the Scarlet deblending algorithm using the DECam Bulge dataset
- Publish the results of these tests, plus scientific results
Commissioning

Advise the Project on planning commissioning observations and analysis, and optimize their scientific return wherever possible

- Design on-sky observations to be proposed for the commissioning phase, in order to test the feasibility of our science cases within TVS
- Define minimum requirements for the science cases
- Stretch goal: Design tools/metrics to test feasibility
Find out more

https://lsst-tvssc.github.io

Transients & Variable Stars +
Stars, Milky Way & Local Volume
Joint Workshop

University of Delaware
Oct 14-18 2019

Deblending with Scarlet
Naples, Italy,
Oct 7-9 2019

Supernovae Across SCs
University of Illinois
April 2020