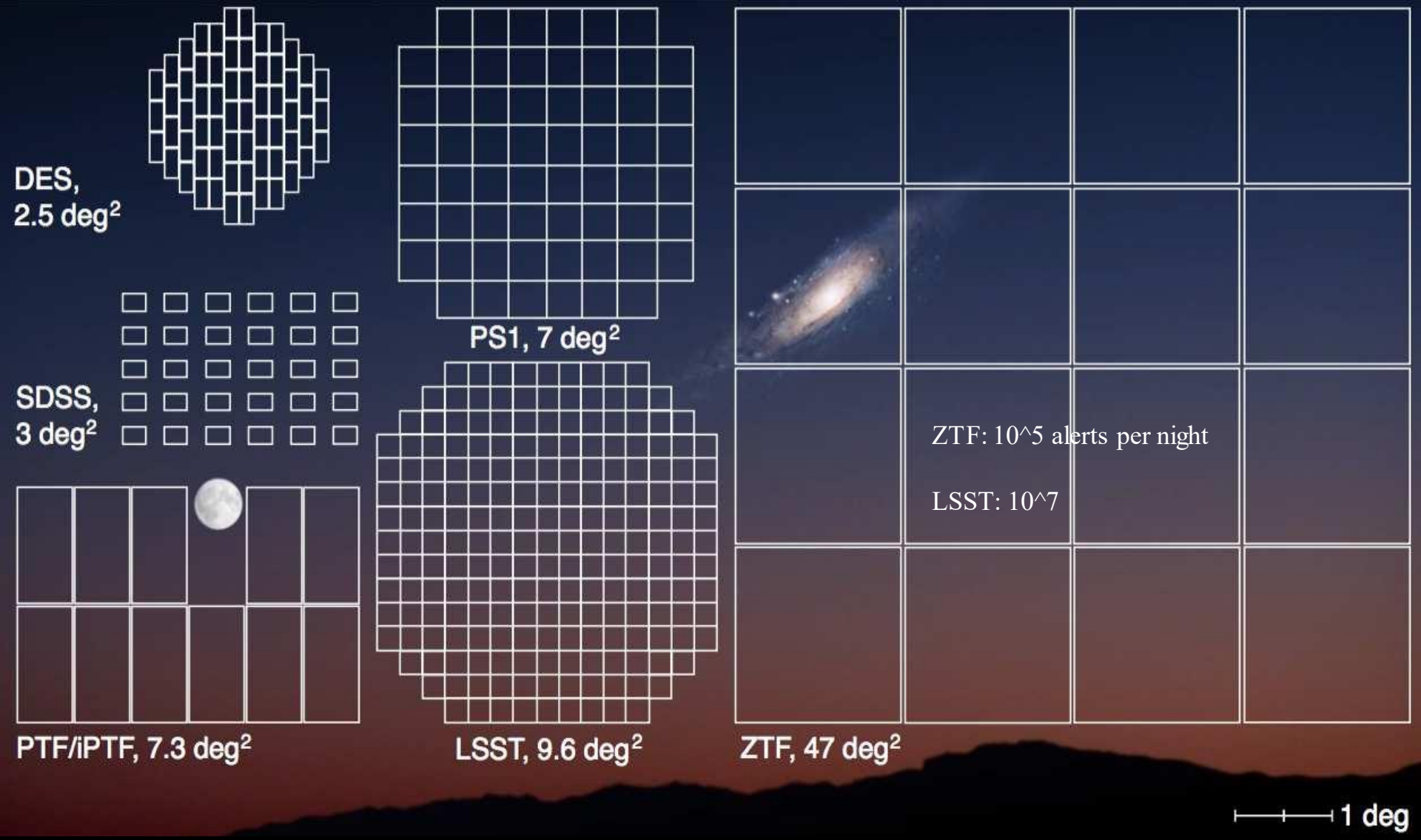
STScI | SPACE TELESCOPE SCIENCE INSTITUTE

ANTARES: A community broker for ZTF and LSST (and more)

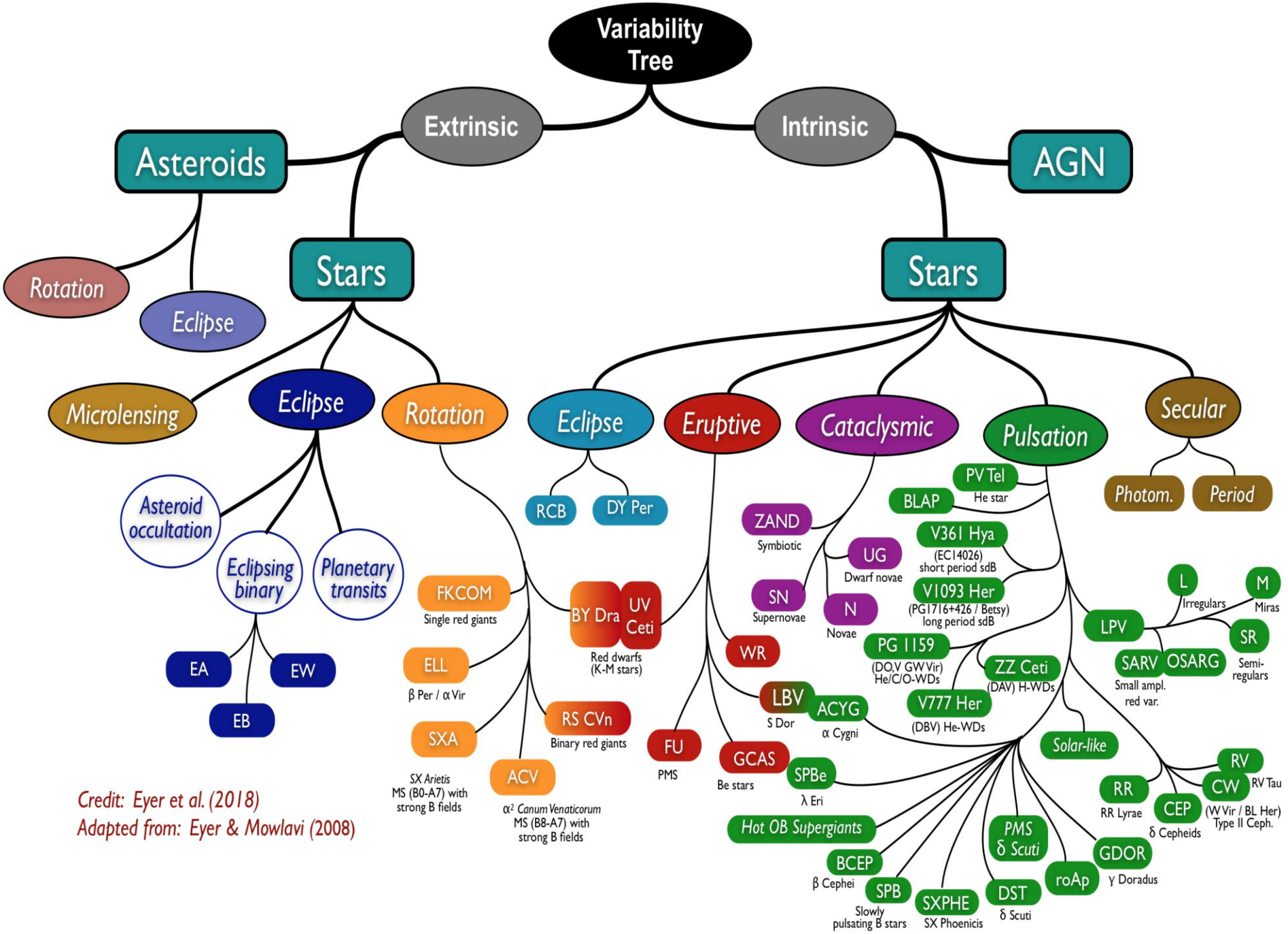
Chien-Hsiu Lee（李見修）, on behalf of the ANTARES team

Subaru 20th anniversary @ Waikoloa village

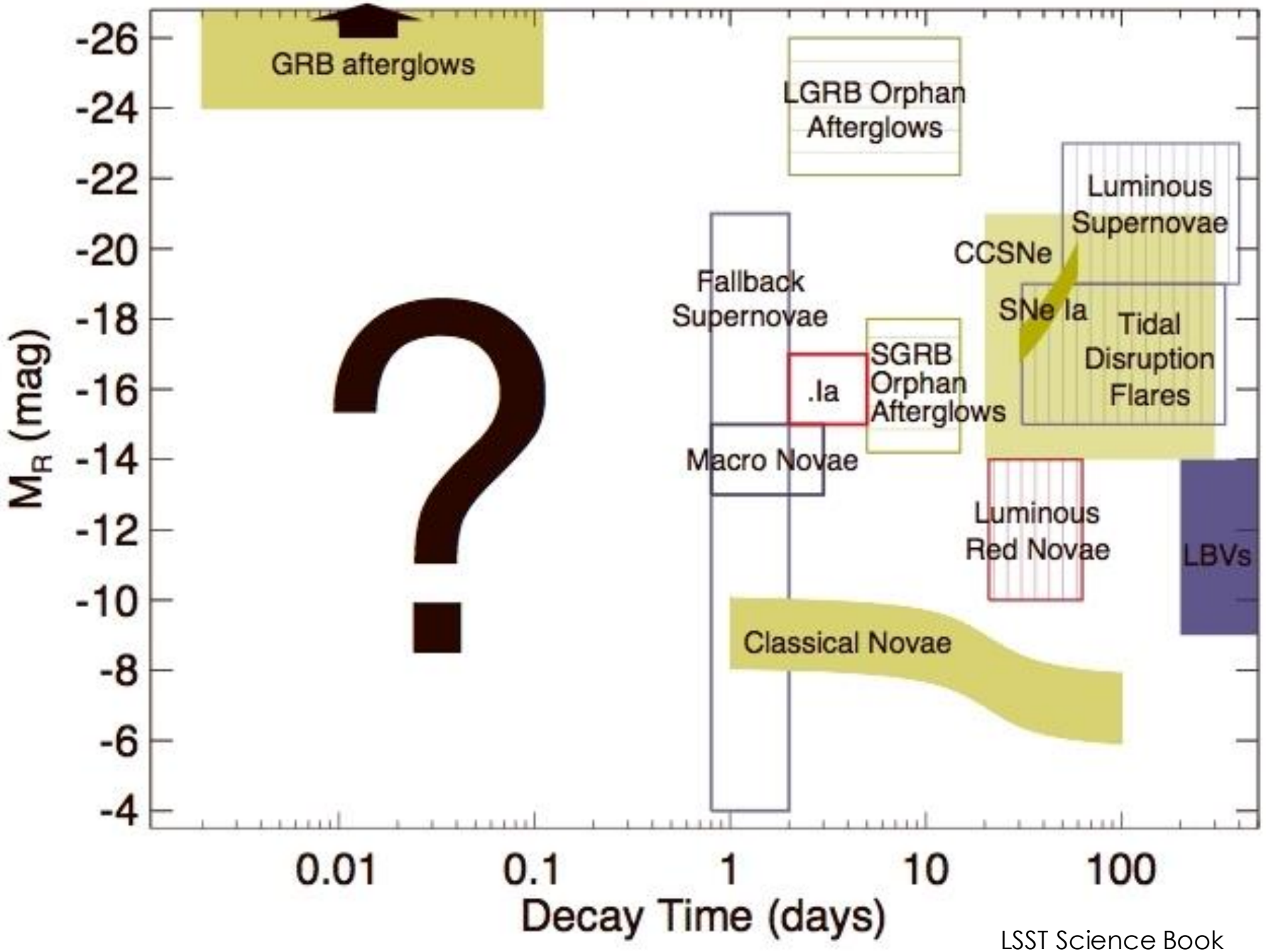
11/19/2019



Laher+2017, arXiv:1708.01584



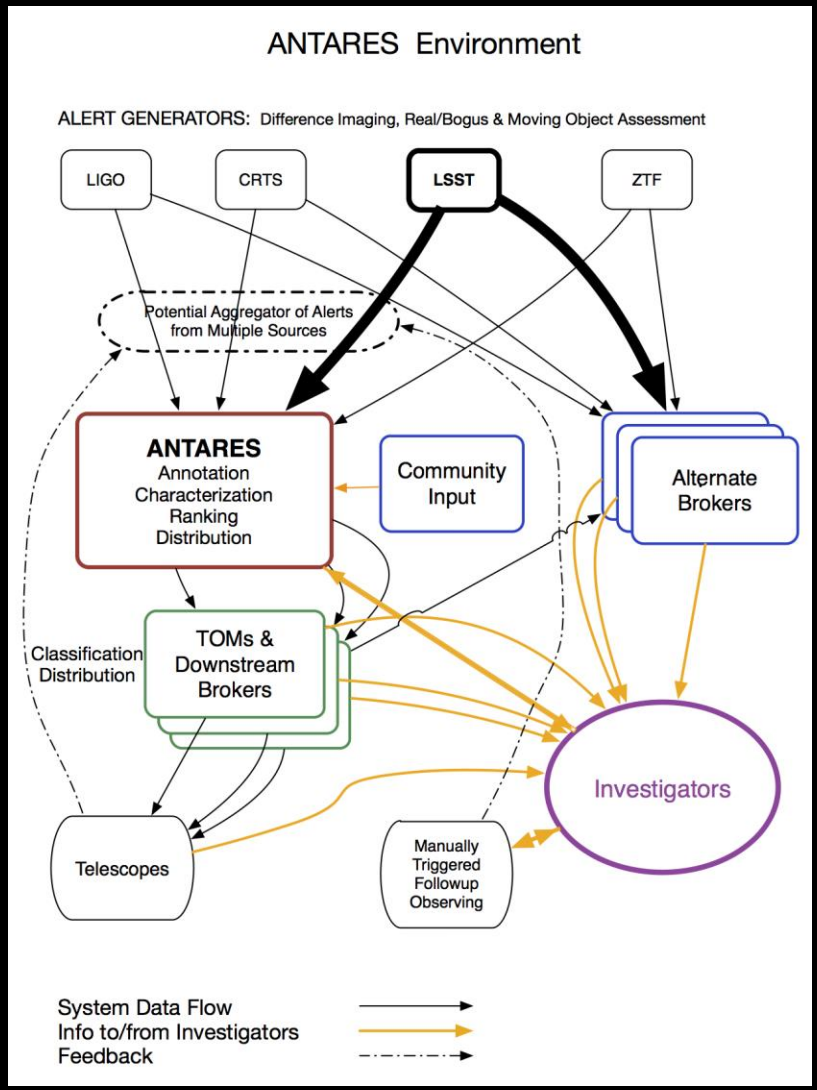
Credit: Eyer et al. (2018)
Adapted from: Eyer & Mowlavi (2008)



LSST Science Book

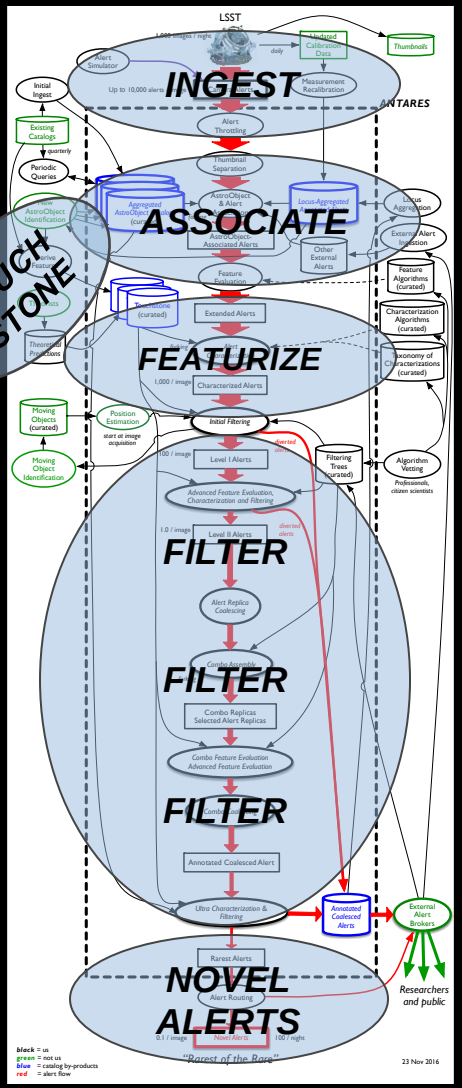
Time Domain Ecosystem

- Alert generators: difference imaging, real/bogus classification, moving object assessment
- Brokers: manage the alert flow, winnowing down to the most interesting lot
  - characterize alerts automatically
  - distribute to interested parties
  - can interface with target and observation managers (TOMs) to trigger rapid follow-up of transient alerts



ANTARES DOES

- ingest alerts generated outside ANTARES
- annotate alerts with their history and external contextual data from associated astro-object
- derive features for the alert & compare against the ‘Touchstone’
- filter/rank the alerts
- distribute novel alerts, while the rest are stored with their added values in the LADB



10 million / night

100 / night

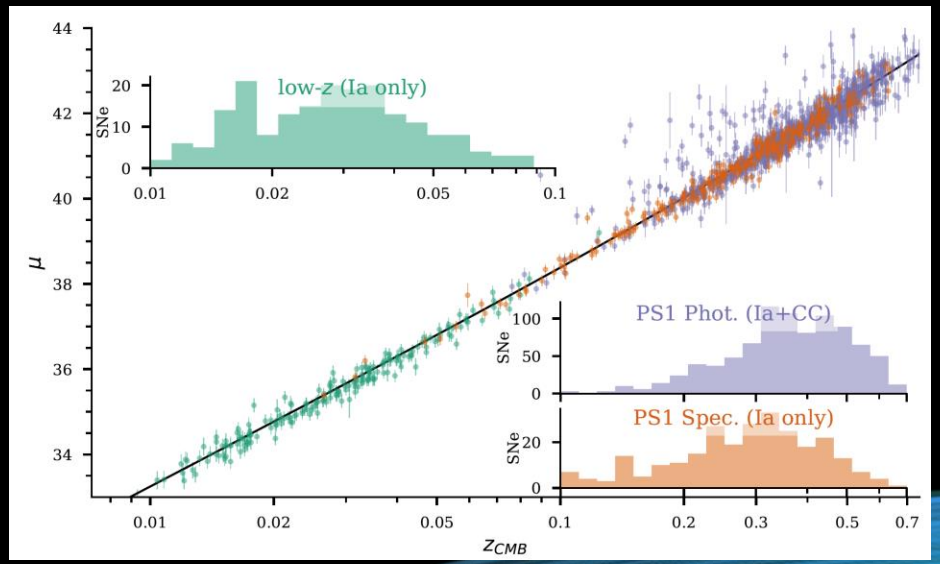
ANTARES DOES NOT

- perform difference imaging and identification of sources on images
- real-bogus assessment of the source
- moving object identification
- follow-up coordination

Science Use Cases

Transients on Demand

- Common transients don't all need follow up
- Targeted/scheduled programs can get transients as needed
- Filters can be flexibly scheduled to accommodate a variety of needs

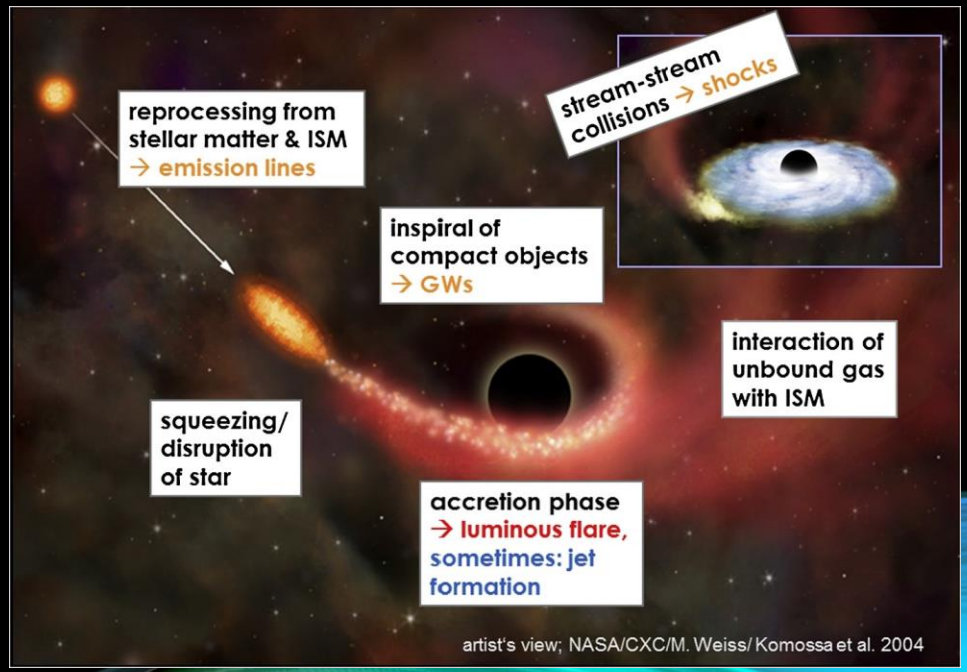


Pan-STARRS Type Ia Supernovae, Jones et al. 2018

Science Use Cases

Nuclear Activity: AGN and TDEs

- Identify by location (currently using Van Velzen criteria)
- Multiwavelength catalogs can help distinguish AGN from TDE
- Multiwavelength variability would be useful



Science Use Cases

Known Solar System Objects

- New Solar System objects are on-project task
- Known Solar System objects flagged in the alert stream can be redirected to a moving-object broker
- Already doing this with ZTF stream and NAU (SNAPS) team
- Filter on streaked sources

Comet 29P, image credit: Damian Peach

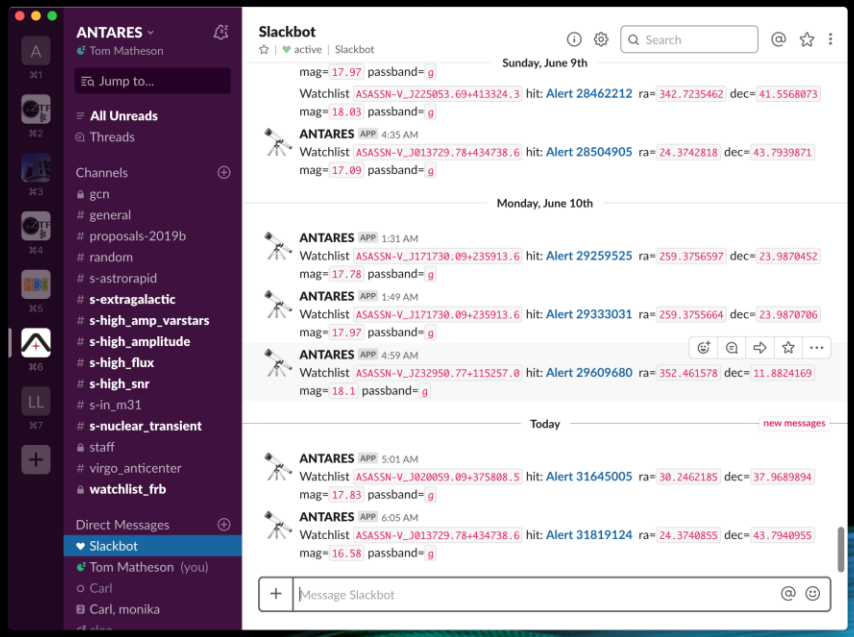
ANTARES Streams

Stream Name	Description
extragalactic	This stream finds alerts that fall within 1 arcsec of a galaxy or extended source listed in the 2MASS extended source catalog, the NASA/IPAC Extragalactic Database, the NYU Value-Added Galaxy Catalog, the Sloan Digitized Sky Survey Galaxy catalog, and the Veron Catalog of Quasars & AGNs.
high_amplitude	This stream uses a filter to find alerts having amplitude (defined as RMS ampitude) above a threshold obtained based on the Variability Probability Distribution Function (VPDF). For the time being we set the threshold to a fixed value of 1 magnitude.
high_amplitude_variable_stars	Same as "high_amplitude" but for known variable stars.
high_flux_ratio_wrt_nn	This stream uses a filter to find alerts having counterparts in their respective reference images within 1 arcsec and exhibiting large flux changes. For the time being we set the threshold to a factor 3 in g-band and a factor 5 in r-band; these are defined empirically from the ingested ZTF alerts so far.
high_snr	This stream uses a filter to find alerts having high signal-to-noise ratio (SNR). The thresholds defining "high SNR" are SNR>50 in g-band and SNR>55 in R-band. These are thresholds determined empirically from the ingested ZTF alerts so far to flag the top ~3 percentile alerts.
in_m31	This stream reports all alerts within a 2x2 squared-degree box centered on M31.
nuclear_transient	This stream reports transients close to the center of a galaxy. We use the criteria by van Velzen et al. (2018) that locate alerts within 0.6" of a galaxy (star/galaxy score < 0.3 from Pan-STARRS imaging).
s190425z_near_glade_host	
siena_mag_coord_cut	Filters alerts by magnitude and coordinate for Siena College's .7m telescope (by Albany, NY).
siena_mag_coord_cut2	Filters alerts by magnitude and coordinate for Siena College's .7m telescope (by Albany, NY). Updated for mag correction to use for variable stars.
ztf_known_solar_system	Deprecated. Use "ztf_sso_candidates" and "ztf_sso_confirmed".
ztf_sso_candidates	Includes all ZTF detections of previously known Solar System small bodies as identified by the ZTF system and after detection reliability has been checked.
ztf_sso_confirmed	A subset of 'ztf_sso_candidates' with positional uncertainties and positional residuals between predicted and measured positions are less than one arcsec as compared to JPL Horizons ephemerides.

Science Use Cases

Watchlists

- Users upload csv file
- Direct notification when your object of interest alerts
- Slack configuration controls intrusiveness of notifications
- Watch known galaxy lenses and recurrent novae.

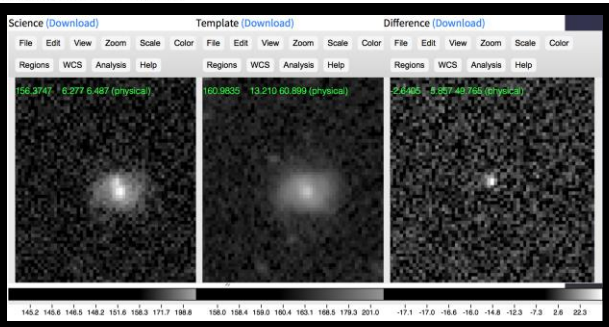


PRELIMINARY RESULTS FROM OUR TEAM

Spectroscopic classification of ZTF19aazcxwk as a Type Ia Supernova

ATel #12935; *Arizona-NOAO Temporal Analysis and Response to Events System (ANTARES) team*
on 12 Jul 2019; 22:01 UT
Distributed as an Instant Email Notice Supernovae
Credential Certification: Chien-Hsiu Lee (lee@noao.edu)

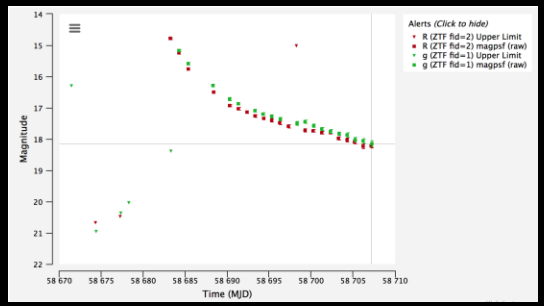
Subjects: Optical, Transient



Spectroscopic observation of a dwarf nova superoutburst ZTF19abgsssu

ATel #12980; *Monika Soraisam (NOAO), Chien-Hsiu Lee (NOAO), Gautham Narayan (STScI), Thomas Matheson (NOAO), Abhijit Saha (NOAO), Arizona-NOAO Temporal Analysis and response to Events System (ANTARES) team, Thomas G. Brink, Kishore C. Patra, Thomas de Jaeger, WeiKang Zheng, Benjamin E. Stahl, Alexei V. Filippenko (UC Berkeley), Howard E. Bond (Penn State, STScI)*
on 2 Aug 2019; 06:27 UT
Credential Certification: Monika Soraisam (soraisam@noao.edu)

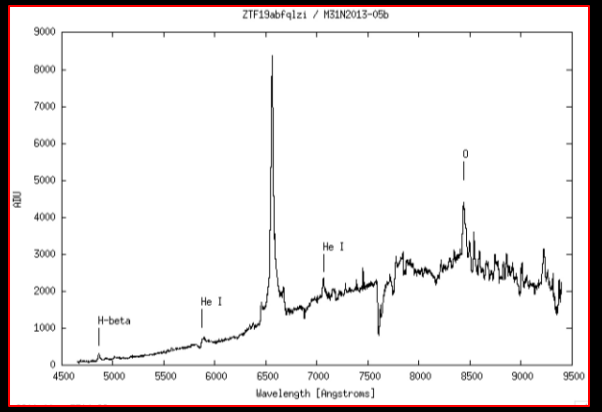
Subjects: Optical, Cataclysmic Variable, Nova, Transient



Confirmation of the 2019 nova outburst from RN M31N 1960-12a/2013-05b

ATel #12943; *Monika Soraisam (NOAO), Chien-Hsiu Lee (NOAO), Gautham Narayan (STScI), Thomas Matheson (NOAO), Abhijit Saha (NOAO), Arizona-NOAO Temporal Analysis and Response to Events System (ANTARES) team*
on 15 Jul 2019; 20:14 UT
Credential Certification: Monika Soraisam (soraisam@noao.edu)

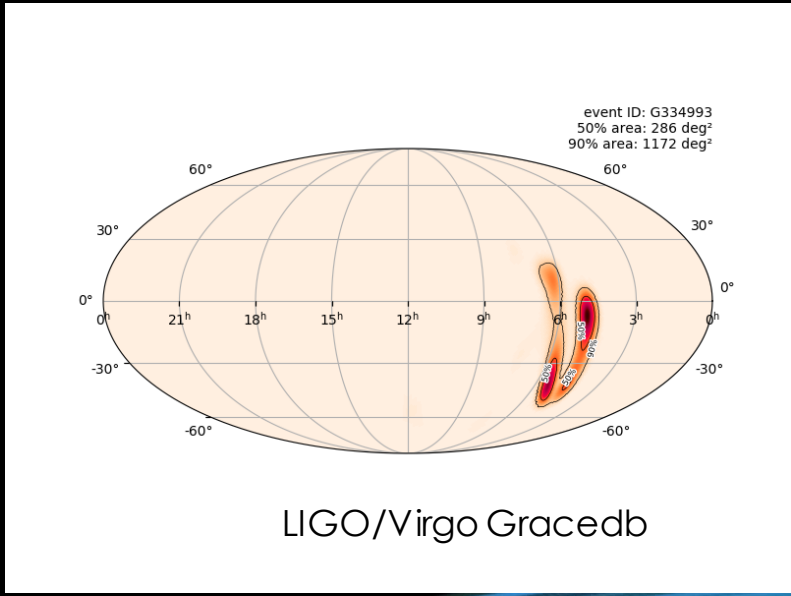
Subjects: Optical, Nova, Transient



WE WANT TO DO MORE

Enabling Multi-Messenger Astronomy

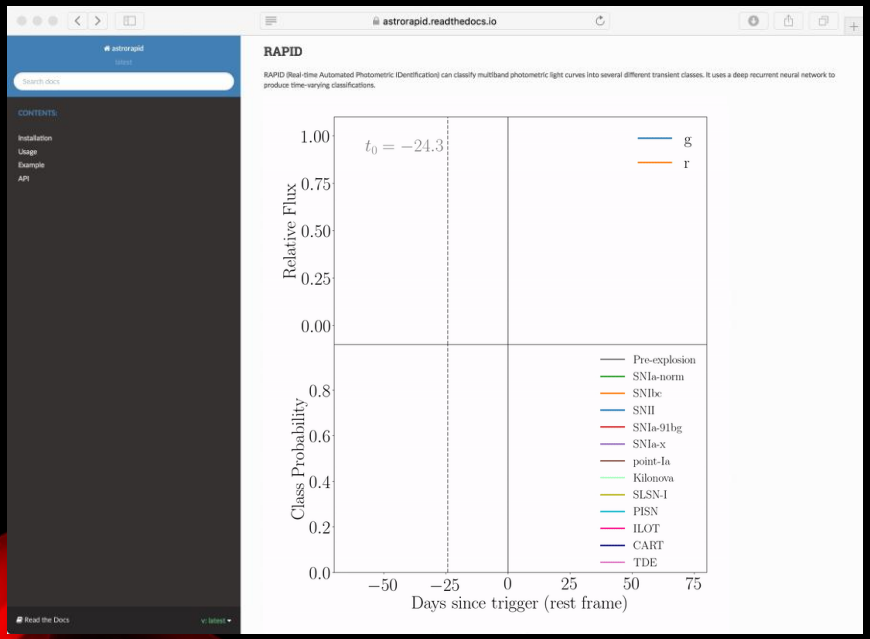
- Automatic retrieval of LIGO/Virgo skymaps
- Associate all subsequent alerts within recent skymaps
- Filter using distance and other features

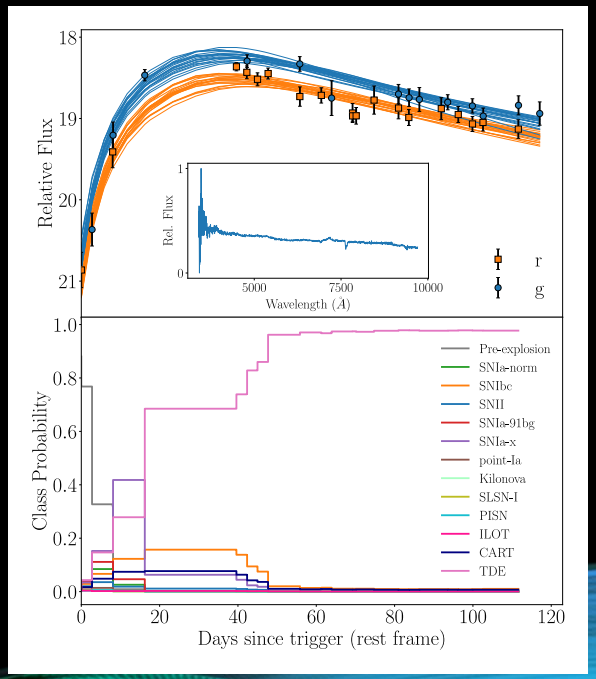


LIGO/Virgo Gracedb

Machine learning

RAPID: A deep learning classifier



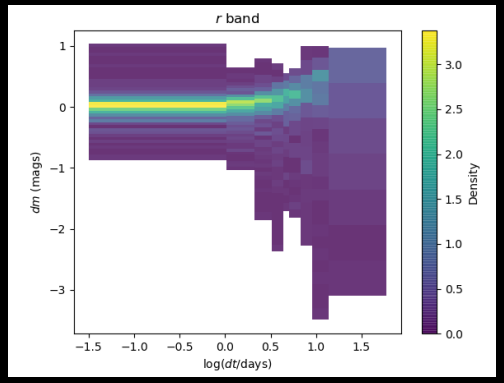


RAPID classifier identifying ZTF18abxftqm as TDE, Muthakrishna et al. 2019

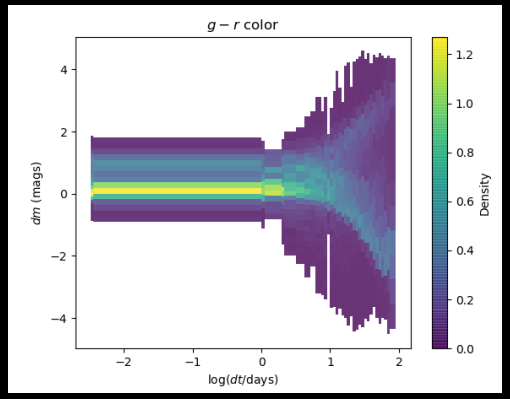
Statistic learning

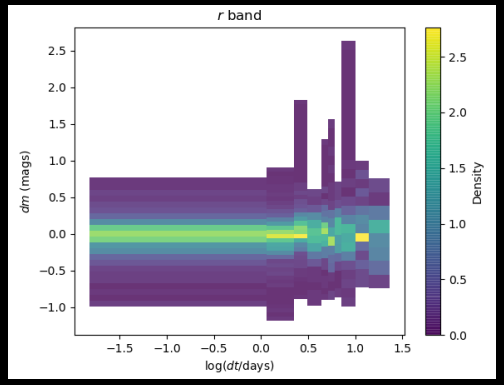
Anomaly detection filters based on Probability density function models

Based on SDSS data (Sako+2018)

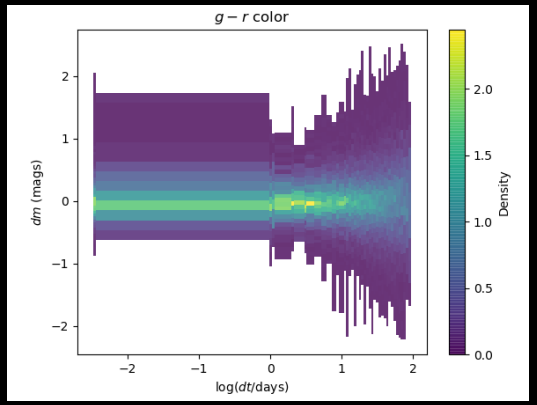


SNIa



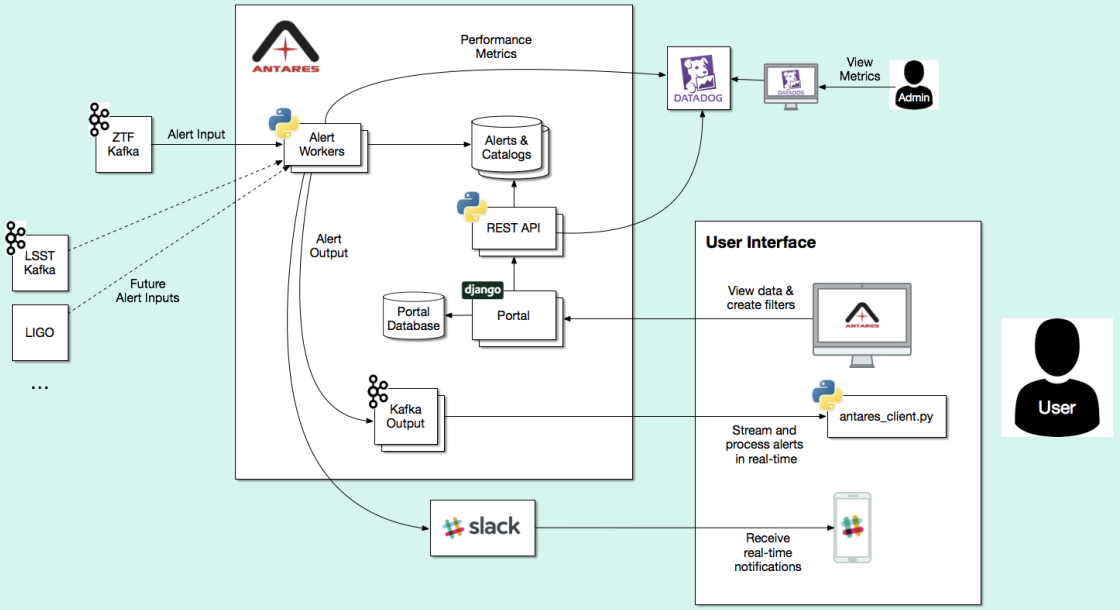


AGNs



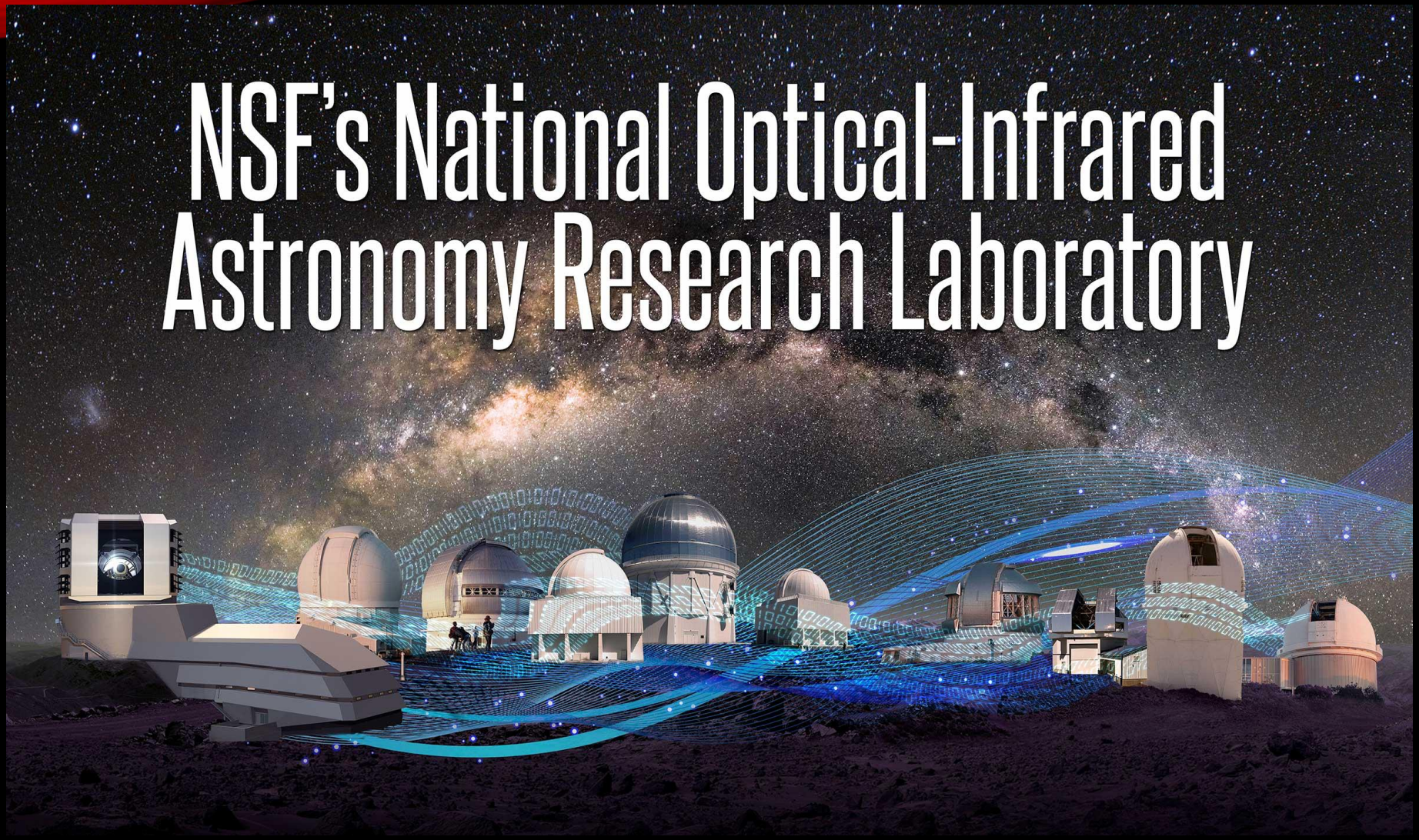
Data Products

- Output three ways
  - Web portal
  - Slack Channel (antares-noao.slack.com)
  - Kafka streams (Python API; could be full stream, if resources allow)
- Archive
  - Longer timescale analysis
- Communication with downstream systems
  - Brokers/TOMs
  - Incorporate features as requested by community to enable follow up




Building the Infrastructure for
Time-Domain Alert Science in the LSST Era
May 22-25, 2017 • Tucson, AZ
LCOGT
NOAO
AEON
Astronomical Event Observatory Network
TOM
TOM TOOLKIT
Broker
Science platform
ANTARES
NOAO DATALAB
LSST
Real-time alert filtering
Long-term alert exploration

NSF's National Optical-Infrared Astronomy Research Laboratory



ANTARES AND YOU…

jupyter AntaresFilterDevKit Last Checkpoint: Last Wednesday at 3:57 PM (autosaved)

Logout Control Panel

File Edit View Insert Cell Kernel Widgets Help Trusted Python 3

Run Code

In [ ]:
```
__author__ = 'Carl Stubens <cstubens@noao.edu>'
__version__ = '20190731' # yyyymmdd
__datasets__ = ['']
__keywords__ = ['ANTARES', 'transient']
```

ANTARES Filter Development Kit

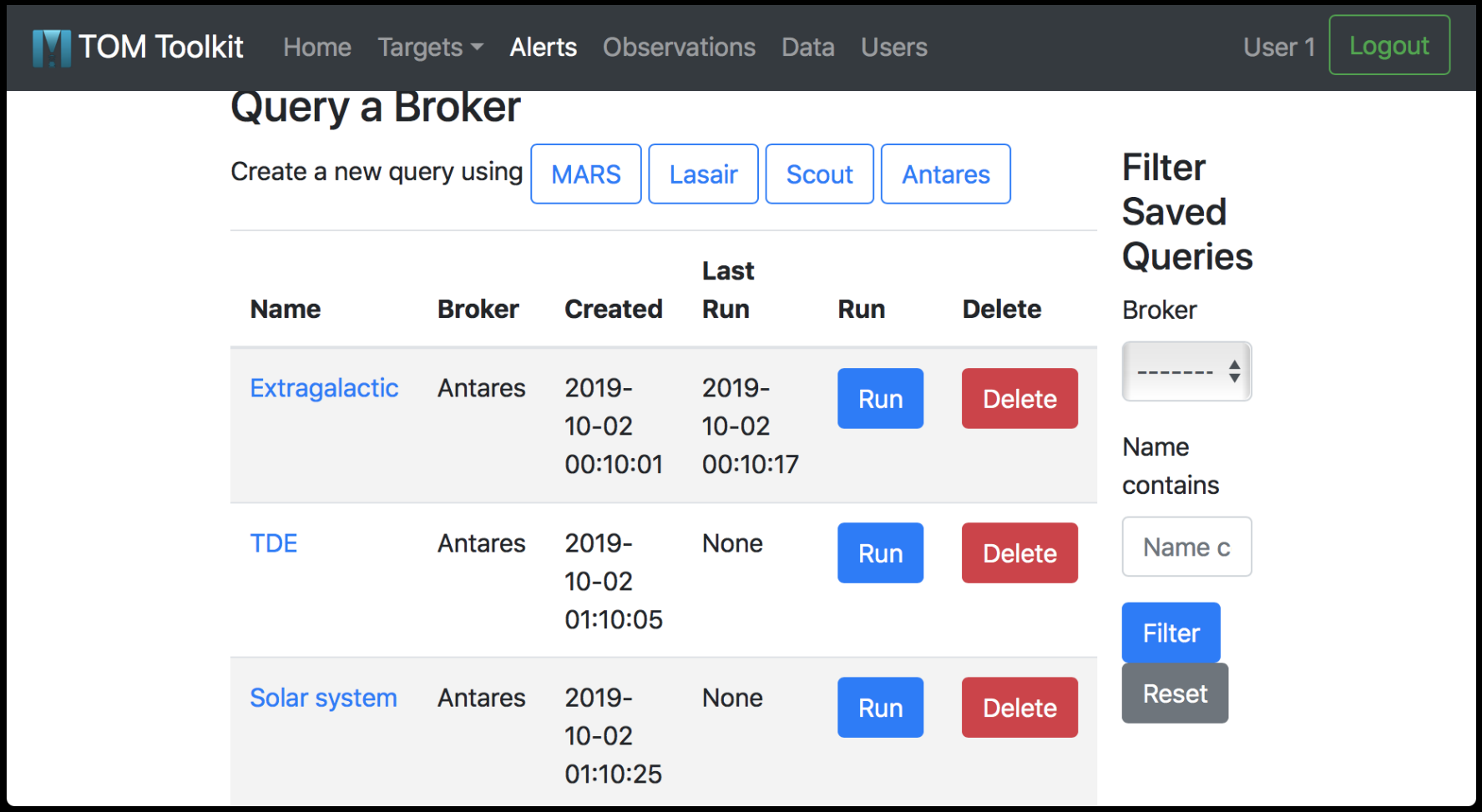
Carl Stubens, ANTARES Team.

Many thanks to Mike Fitzpatrick, Adam Scott, Knut Olsen, Jennifer Andrews, Robert Nikutta.

Summary

This Notebook demonstrates how to write filters for ANTARES and test them against a sample of real data from ZTF.

This Notebook is intended to be used in NOAO DataLab's Jupyter environment. There, you will have access to ANTARES test data. If you're not running in DataLab, sign up for DataLab, then log in to the notebook server.


TOM Toolkit
Home
Targets
Alerts
Observations
Data
Users
User 1
Logout
Query a Broker
Create a new query using
MARS
Lasair
Scout
Antares
Name
Broker
Created
Last Run
Run
Delete
Extragalactic
Antares
2019-10-02 00:10:01
2019-10-02 00:10:17
Run
Delete
TDE
Antares
2019-10-02 01:10:05
None
Run
Delete
Solar system
Antares
2019-10-02 01:10:25
None
Run
Delete
Filter Saved Queries
Broker

Name contains
Name c
Filter
Reset

DEMOS @ AAS 235

Please join us for a demo at our booth if you want to know:

- how to connect to ANTARES streams (via API or TOM)
- how to write your own filter

Pre-requisite:

- Register at ANTARES: https://antares.noao.edu/accounts/register/
- Register at DataLab: https://datalab.noao.edu/help/register.php?qa=register