Lasair

A future LSST Community Broker
(but now a prototype with ZTF)

Gareth Francis, Andy Lawrence, Terry Sloan, Roy Williams (*Edinburgh*)

Ken Smith, Dave Young (*Belfast*)

Stephen Smartt (*Oxford*)

https://lasair.lsst.ac.uk

Summary

- Object page with Sherlock and TNS
- SQL-based alert filters
- Filter can be static or streaming
- Watchlists and watchmaps
- Lightcurve Features to build filters
- Lasair API with throttling
- Annotations
- Mining Lasair
- Rich documentation and video tutorials

Search by ZTF or TNS name

Log in

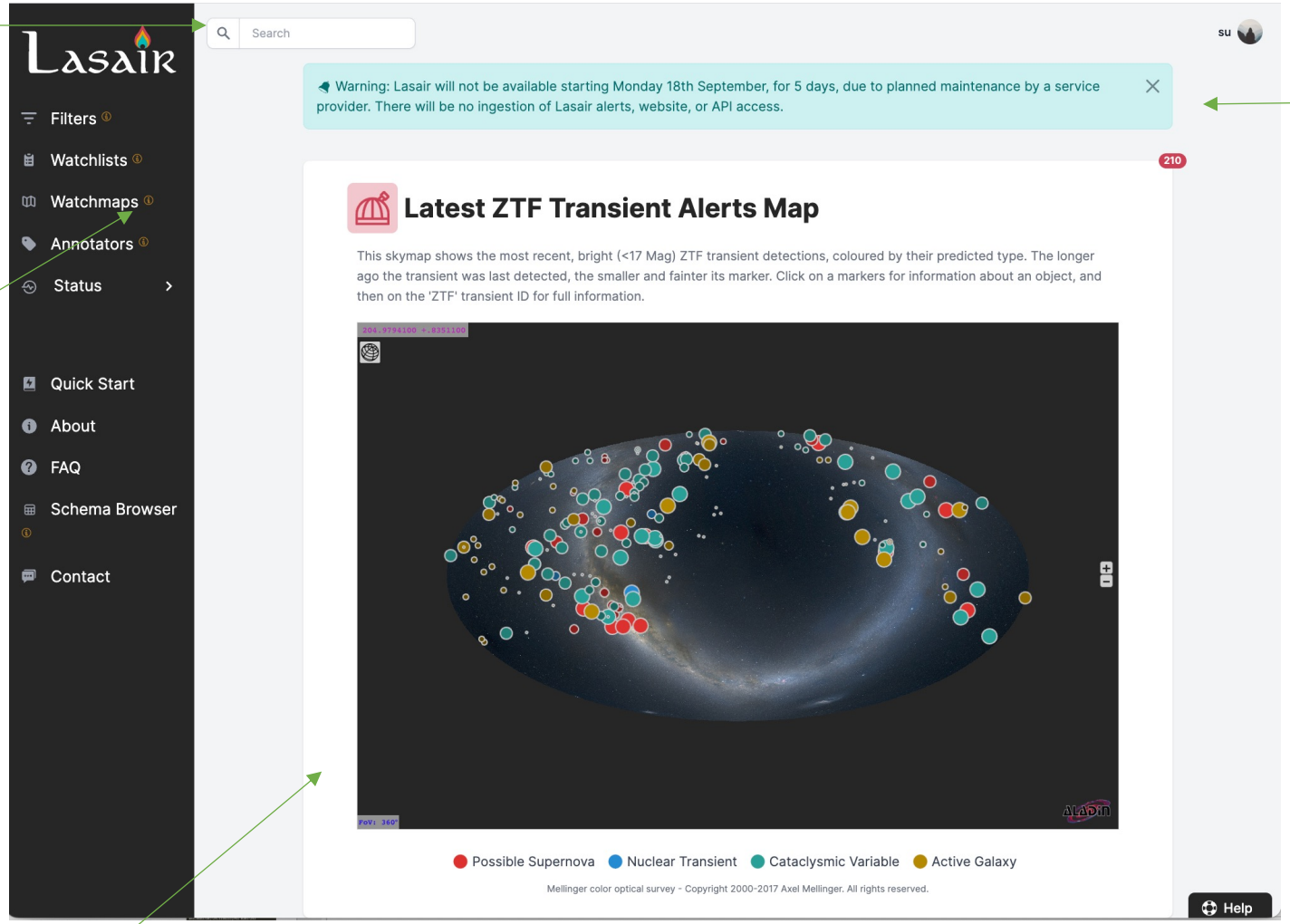
News

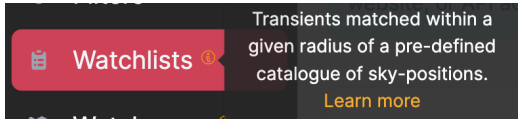
Contextual documentation

Documentation and questions

Some new transients Display or Table

Table Export as JSON or CSV





Latest ZTF Transient Alerts Table

Export

A list of transients found in the map above

Search table...

objectId	ramean	decmean	gmag	rmag	last detected	predicted type
ZTF23abbzycc	350.67016	58.200035	18.523	15.555	3.8	SN
ZTF23abbxvco	358.39279	59.429584	16.683	16.378	3.9	SN
ZTF23abaxkwq	329.37134	41.250268	16.968	16.406	3.9	SN
ZTF23abawvxd	118.80461	12.576606		16.979	0.7	SN
ZTF23abawgqs	107.64151	50.119418	15.985	15.978	5.8	SN

Object page

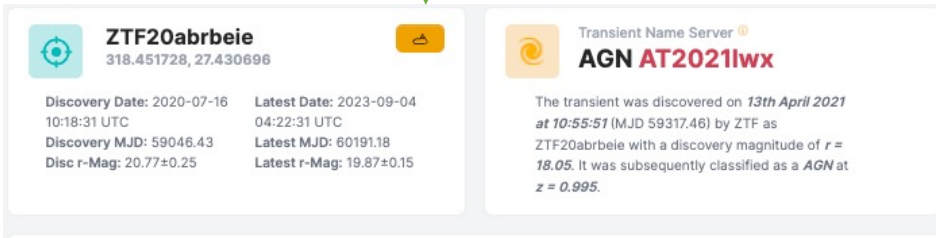
basic info

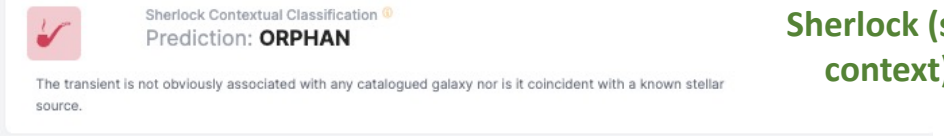
go deeper

TNS

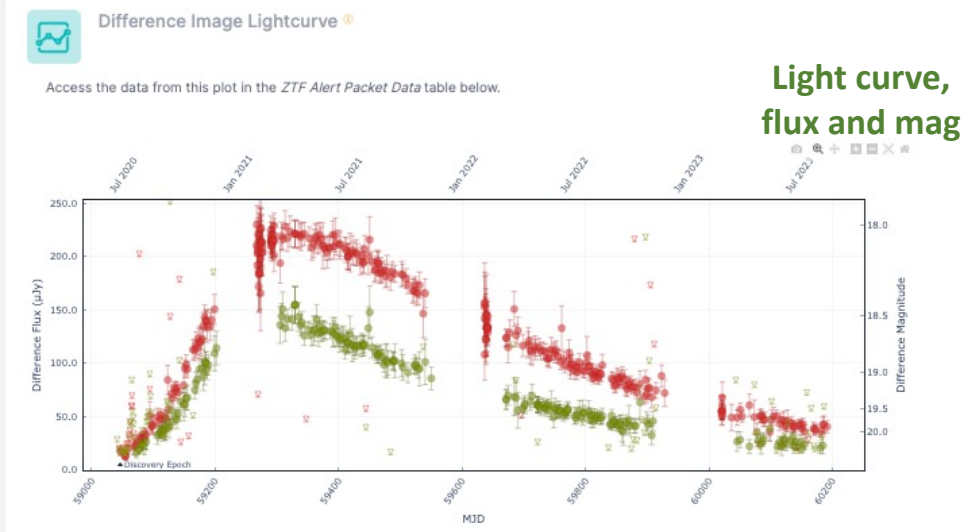
Aladinlite
alert is red square
more layers

go deeper

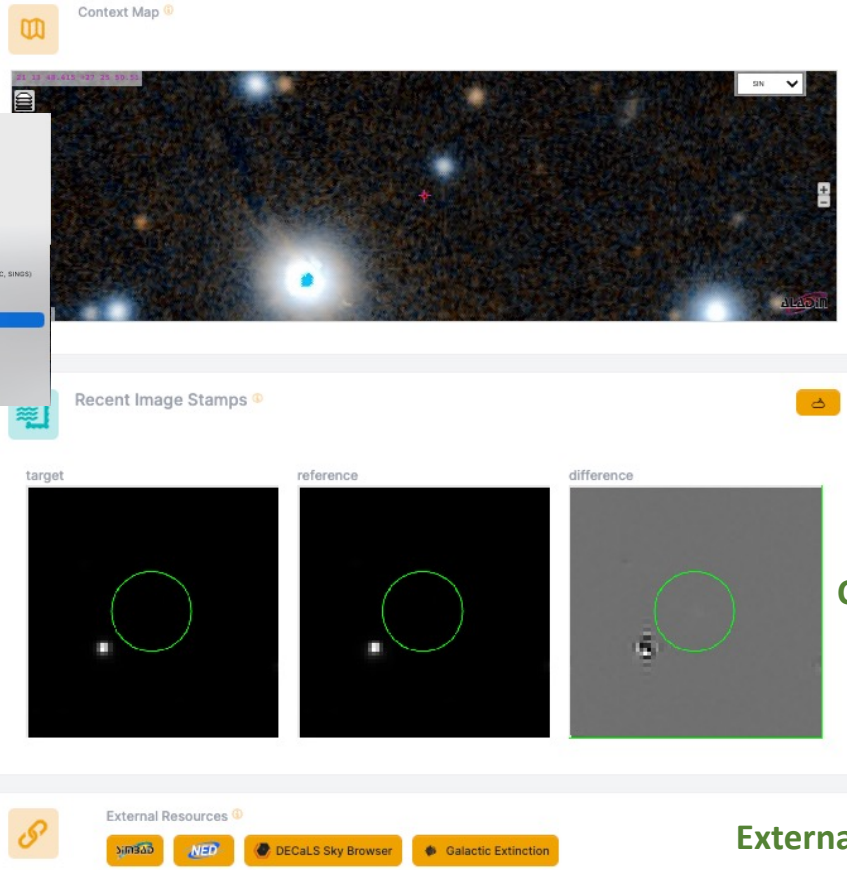




Sherlock (sky context)

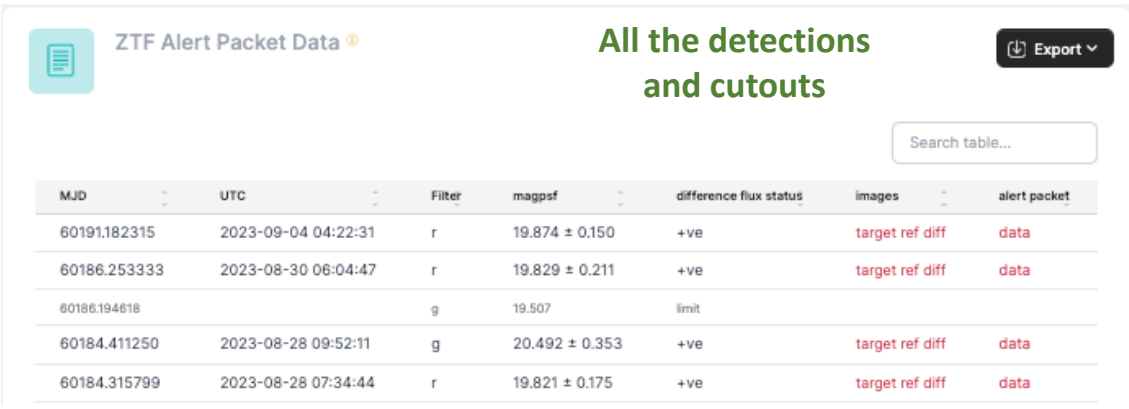


Light curve, flux and mag



Cutout images

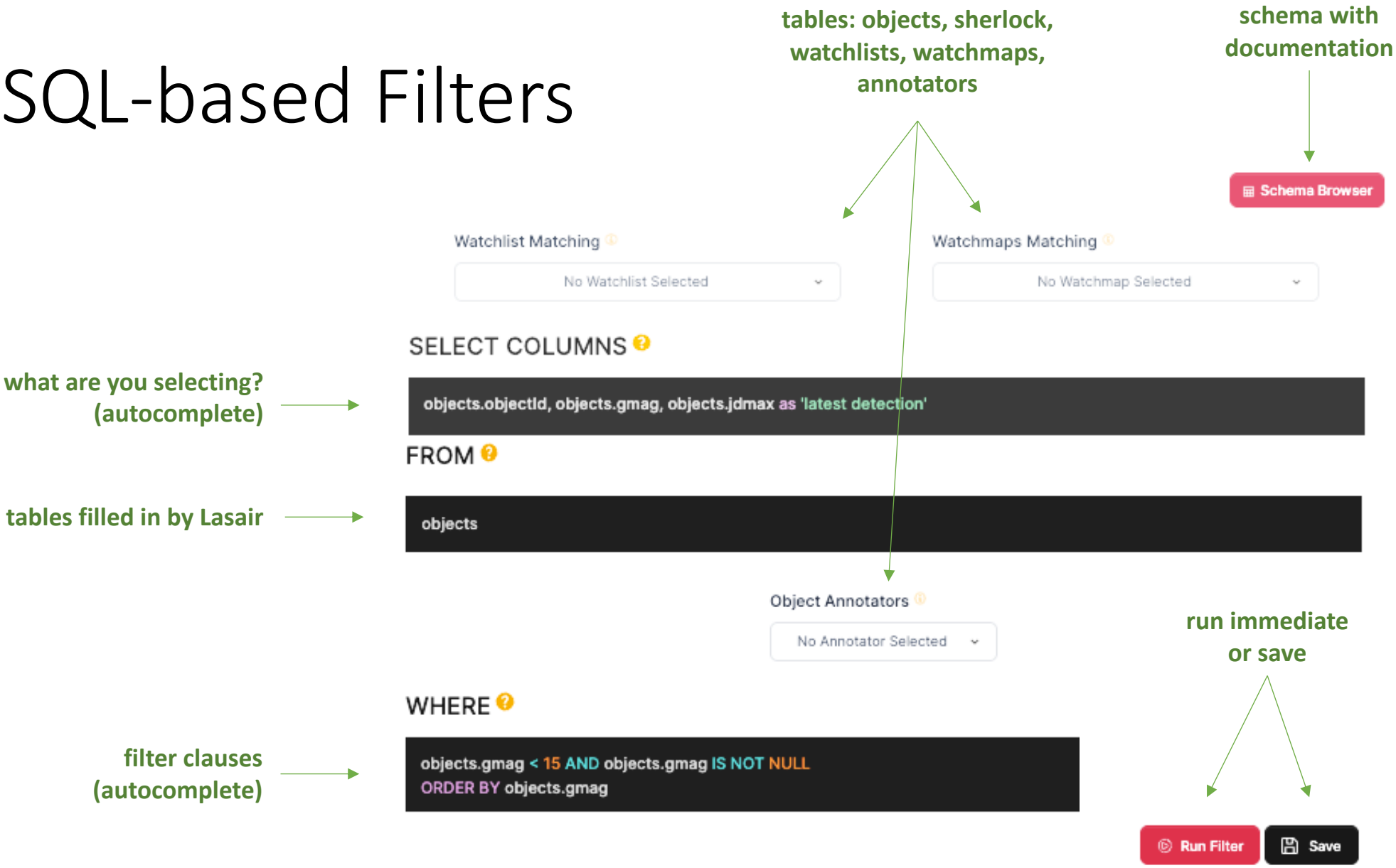
External resources



All the detections and cutouts

https://lasair.lsst.ac.uk

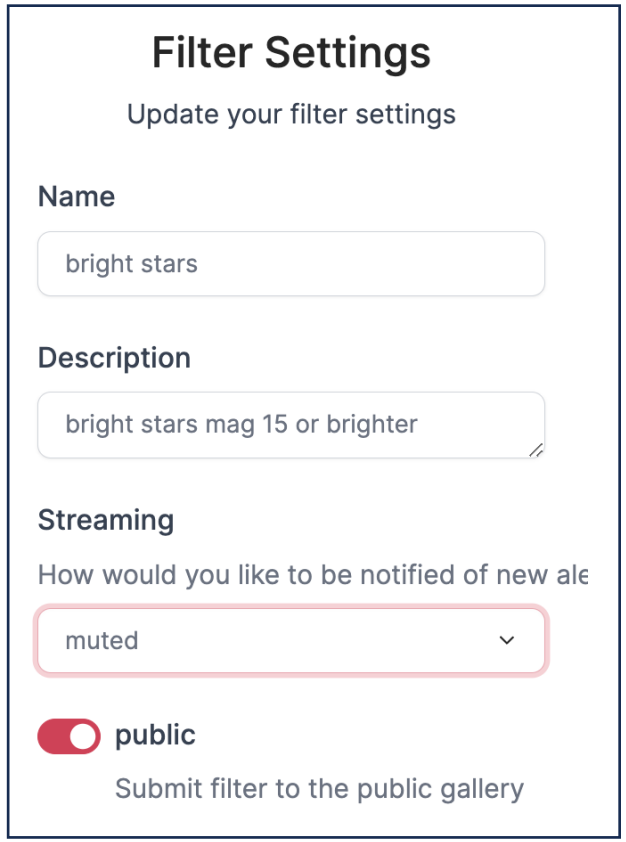
SQL-based Filters

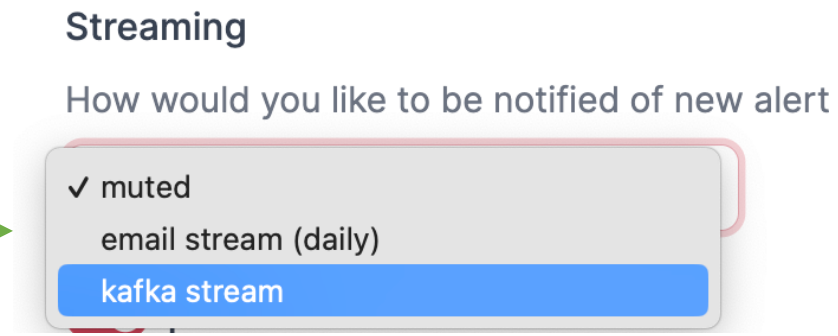


https://lasair.lsst.ac.uk

Save Filter: Muted or Active?

Active means it runs in real time as alerts come in!
Muted just means its stored in your account



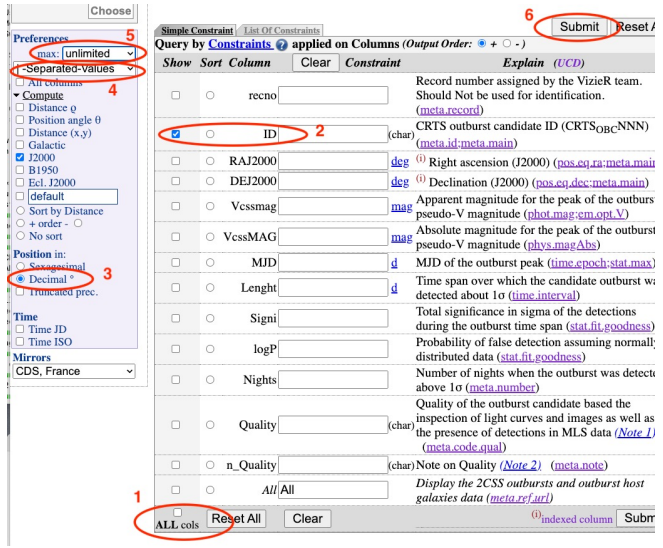


Can share filters, watchlists, watchmaps, if you like

Watchlist

A personal list of interesting sources

Active watchlist means catch associated alerts



See dox for how to build from Vizier

'BL Lac for TeV' Watchlist Associations

BL Lac candidates for TeV observations (Massaro+, 2013) The watchlist contains 42 sources with a default association radius of **5.0 arcsec**. The watchlist is **active** .

Duplicate | Export

Watchlist Results

Export

Transient objects located within an association radius of a source in the 'BL Lac for TeV' watchlist.

Search table...

Catalogue ID	separation (arcsec)	cone_id	objectId	ramean	decmean	rmag	gmag
1ES 1101-232	0.776	76160	ZTF23aabpgop	165.90697	-23.492015	18.783	19.108
Markarian 180	1.956	76162	ZTF23aabglsz	174.10889	70.157167	17.100	
B3 2247+381	0.184	76179	ZTF22aaexcvb	342.52397	38.410310	17.724	18.296
Markarian 180	0.416	76162	ZTF21abjxnjl	174.11019	70.157637	17.193	17.228
H 1426+428	0.164	76168	ZTF21aaqpvak	217.13595	42.672540	18.871	19.036

File format

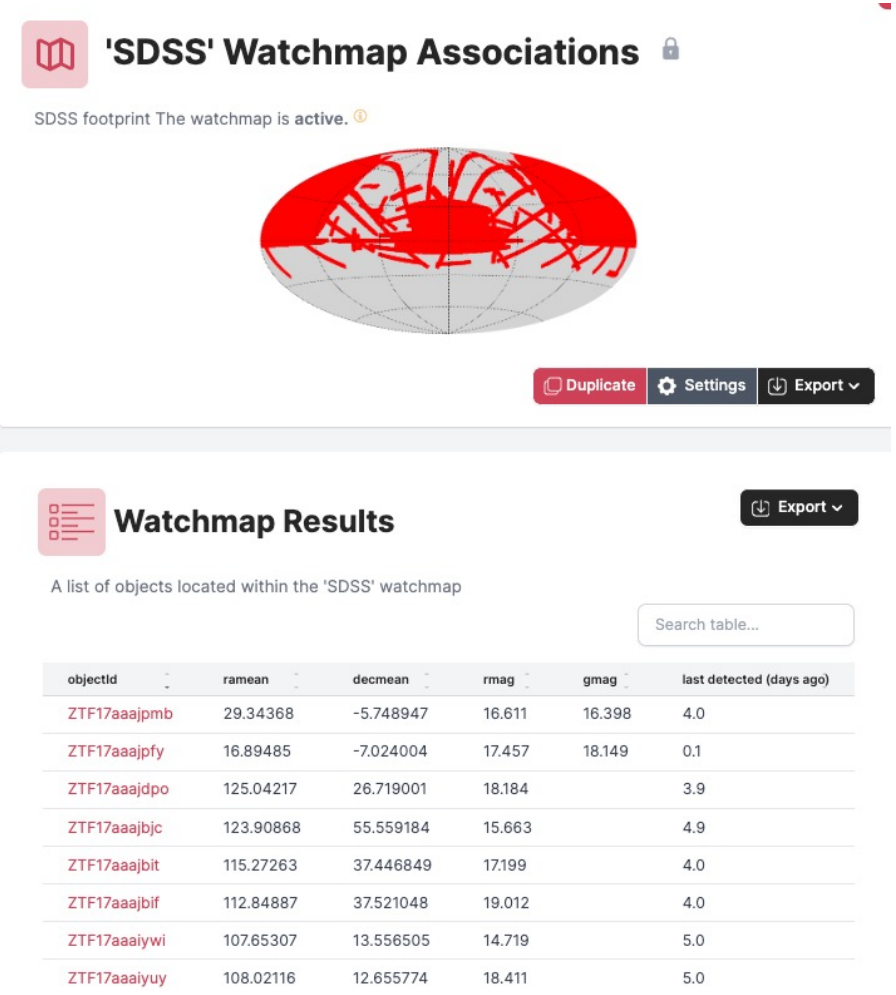
RA, Dec, Name <radius>

```
003.4835000|-18.9018056|SHBL J001355.9-185406
008.3931667|-19.3591389|KUV 00311-1938
008.9692500|+59.8345278|1ES 0033+595
028.1650000|+01.7881667|RGB J0152+017
035.6650000|+43.0355000|3C 66A
038.2025000|+20.2881389|1ES 0229+200
045.8603750|-24.1198333|PKS 0301-243
049.9658333|+18.7596111|RBS 0413
057.3465833|-11.9908889|1ES 0347-121
064.2186667|+01.0899722|1ES 0414+009
072.3528750|-43.8358056|PKS 0447-439
076.9840000|+67.6234167|1ES 0502+675
```

Watchmap

A subset of the sky

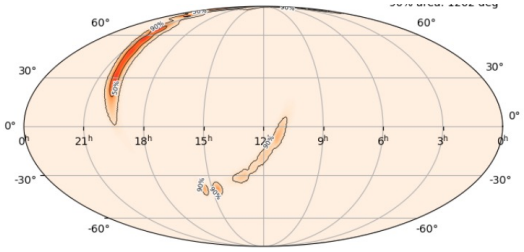
Active watchmap means catch associated alerts



objectId	ramean	decmean	rmag	gmag	last detected (days ago)
ZTF17aaajpmb	29.34368	-5.748947	16.611	16.398	4.0
ZTF17aaajpfy	16.89485	-7.024004	17.457	18.149	0.1
ZTF17aaajdpo	125.04217	26.719001	18.184		3.9
ZTF17aaajbjc	123.90868	55.559184	15.663		4.9
ZTF17aaajbit	115.27263	37.446849	17.199		4.0
ZTF17aaajbif	112.84887	37.521048	19.012		4.0
ZTF17aaaiywi	107.65307	13.556505	14.719		5.0
ZTF17aaaiyuy	108.02116	12.655774	18.411		5.0

Watchmaps are based on MOC

- Software is at [MOCpy]
- Code to [create a MOC from a polygon]
- Easy to make MOC from LIGO skymap



https://lasair.lsst.ac.uk

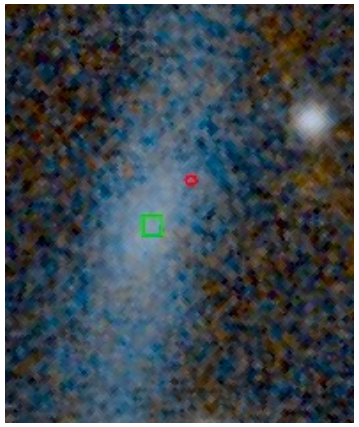
Sherlock

Classifies by sky position

Sherlock Contextual Classification

Prediction: **Supernova**

The transient is possibly associated with *134652602229491416*; an r=19.08 mag galaxy found in the PS1 catalogue. Its located 2.68" N, 2.44" W from the galaxy centre.



Catalogues searched by Sherlock

- Gaia catalogues
- Pan-STARRS catalogues
- SDSS DR12
- GSC
- 2MASS
- Million Quasars Catalog
- Veron-Cett AGN Catalogue
- Downes Catalog of CVs
- Ritter Cataclysmic Binaries Catalog
- GLADE Galaxy Catalogue v2.3
- NED-D Galaxy Catalogue v13.1
- etc etc

Classifications

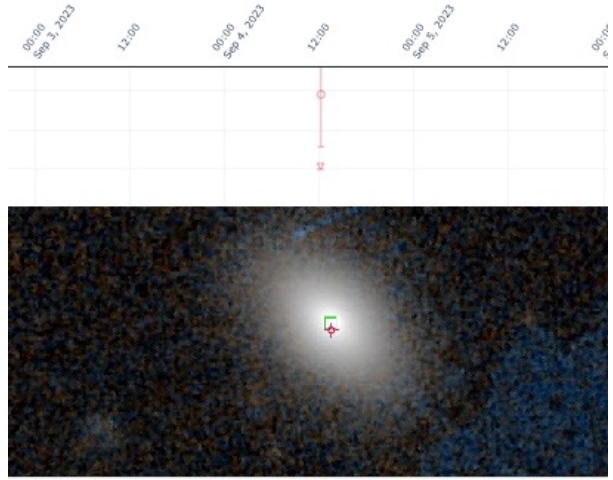
- **Variable Star** (VS)
- **Cataclysmic Variable** (CV)
- **Bright Star** (BS)
- **Active Galactic Nucleus** (AGN)
- **Nuclear Transient** (NT) core of a galaxy
- **Supernova** (SN) near galaxy but not NT
- **Orphan** not matched

Talk by Dave Young

Rich Filter

Join with sherlock, TNS, watchlist, watchmap, annotations

Example: TDE galaxies in SDSS active in last month



Watchlist Matching

E+A galaxies (mr scholl)

Watchmaps Matching

SDSS

SELECT COLUMNS

User Input

```
objects.objectId, watchlist_hits.name
```

FROM

Generated automatically

```
objects, 'E+A galaxies' as watchlist_hits, SDSS (watchmap)
```

WHERE

User Input

```
objects.jdmax > jdnow()-30
```

Run Filter | Save

Filter Results

objectId	name
ZTF23abawwaa	1237667211578769408
ZTF23abatklm	1237665442601435392
ZTF19abuoqzz	127953398696730064
ZTF19aabybwz	1237654385731698688
ZTF18adalgnn	143322227888669344
ZTF18abtmtit	1237663782602801408
ZTF18abtgunq	1237657584949460992
ZTF18aarmxfg	1237661851483242752
ZTF18abtgunq	1237657584949460992
ZTF18aarmxfg	1237661851483242752

Lightcurve Features

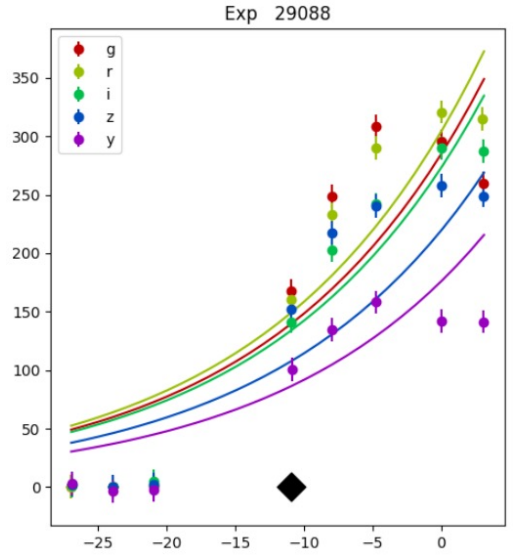
Proposed for LSST
NOT on ZTF system

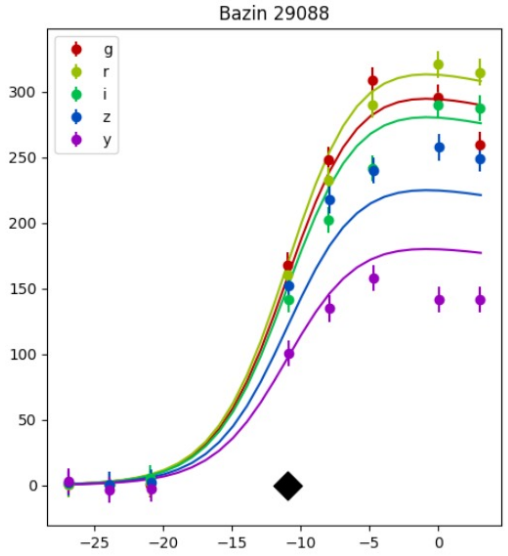
From Rubin

- Big set of features for periodic sources
- Set of features for stochastic sources

Lasair added value for explosive transients

- Simple statistics min/mean/max/ndata 6 bands
  - Times of first and last diaSource
  - Latest flux in 6 bands
- Sherlock: distance in Mpc if available
- fluxJump
  - How many sigma above previous level
- Linear magnitude fit 6 bands
- BazinExpBlackBody
  - 2D time-wavelength surface
  - Bazin or Exp least residual
- Fastfinder
  - Incline/decline in 6 bands





Lasair API

Enabling mining and annotation

`pip install lasair`

Talk by Ken Smith

cone
cone search on all the objects in the Lasair database

query
SQL SELECT query on the Lasair database

objects
machine-readable version of the object web page

lightcurves
simple lightcurves for a number of objects

annotate
add annotation to Lasair object

sherlock/objects
returns Sherlock information about a list of named objects

sherlock/position
returns Sherlock information about a sky position

Annotations

Add your classification to Lasair objects

Ask a Lasair team member to build your space

You need your API token

```
{
  "lsst-g": {
    "absolute_peak_mag_val":  -20.687,
    "absolute_peak_mag_err":    1.933,
    "overall_incline_rate_val": 0.011,
    "overall_incline_rate_err": 0.021
}
```

No schema but can be queried!

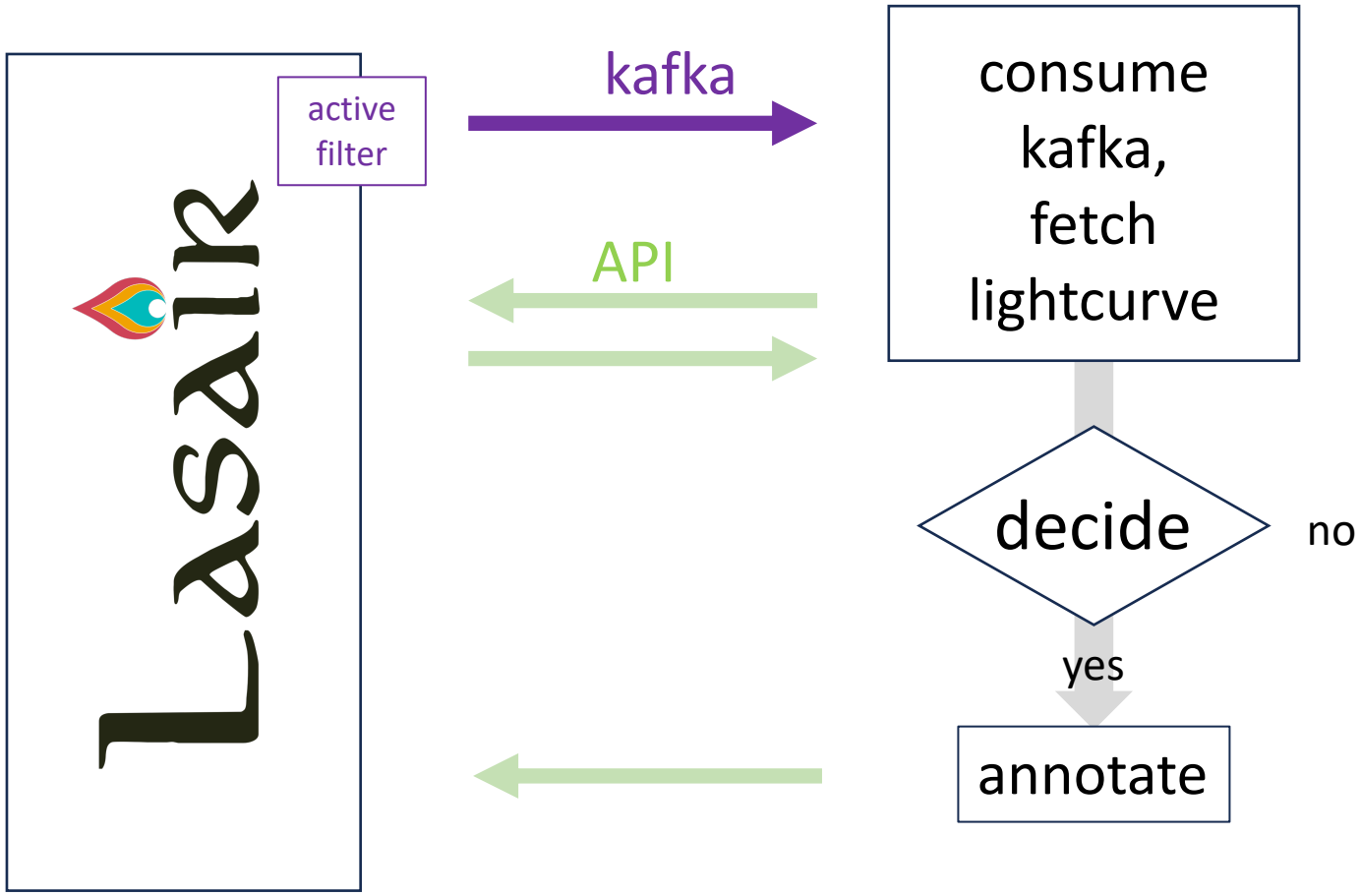
objectId: the Lasair object being annotated

classification: a short string drawn from a fixed vocabulary, eg “kilonova”.

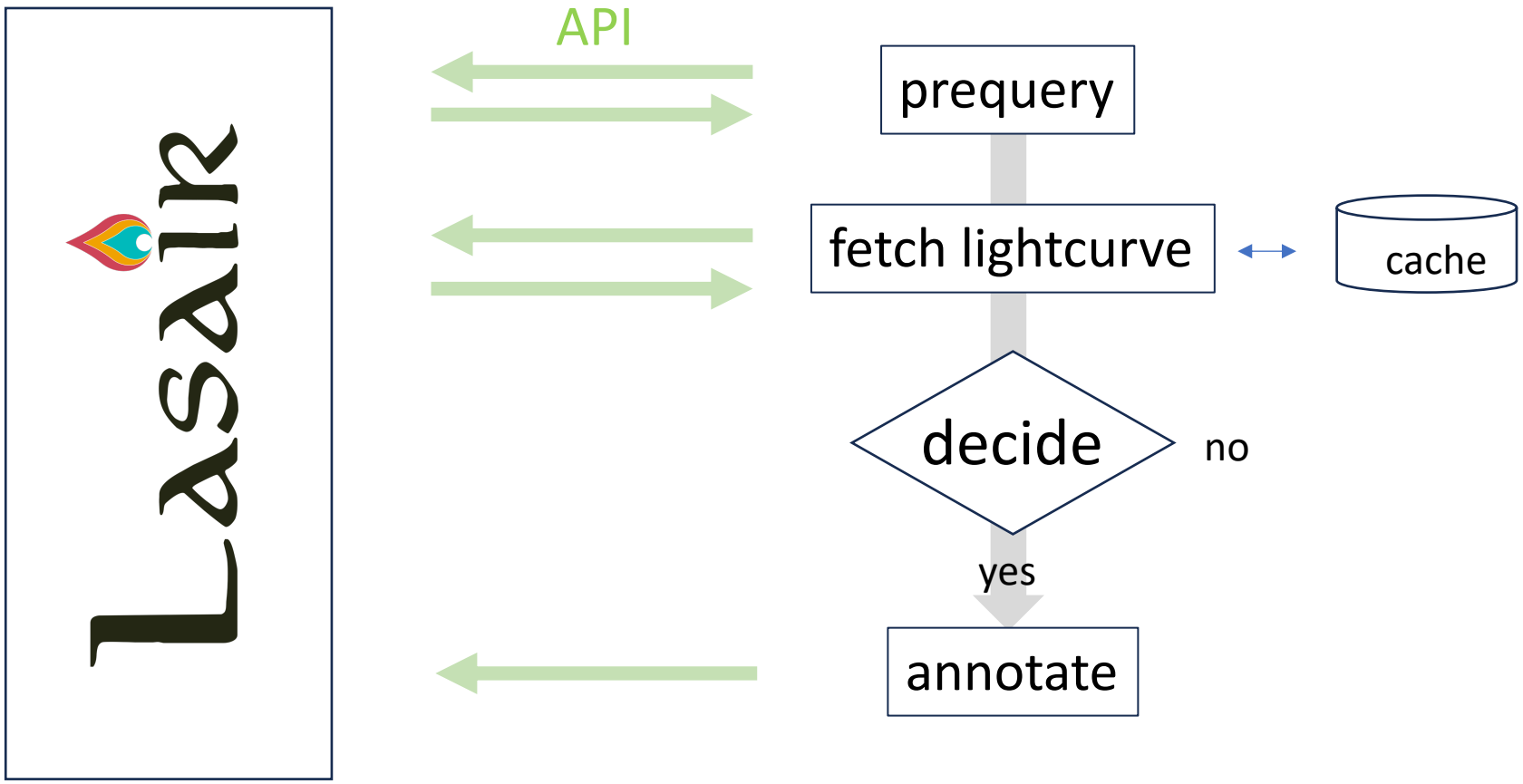
explanation: a natural language explanation of the classification, eg “probable kilonova but could also be supernova”

classjson: the annotation information expressed as a JSON dictionary

Real-time Annotation

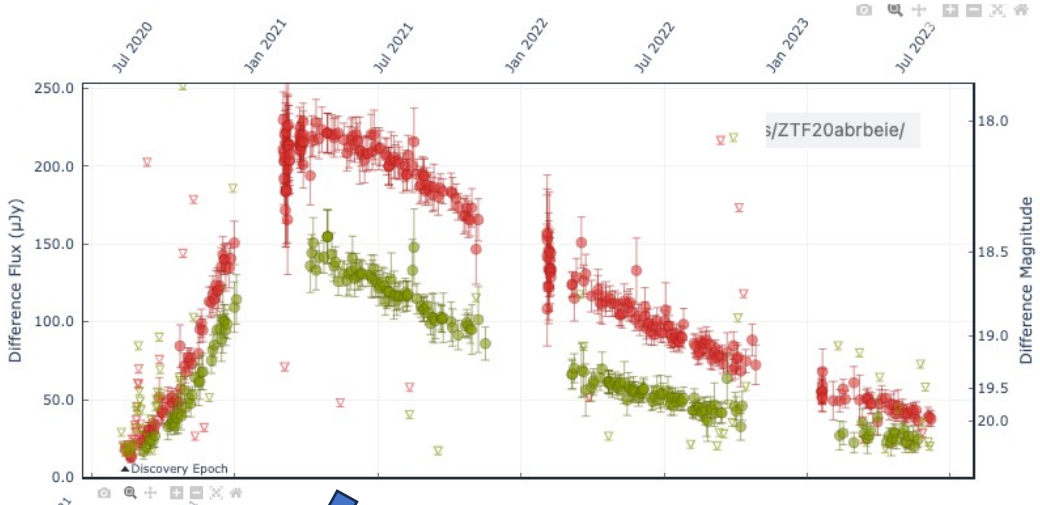


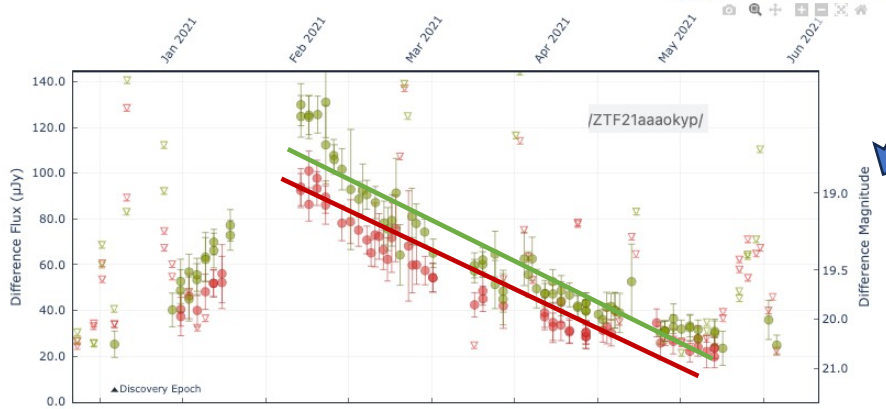
Mining Lasair

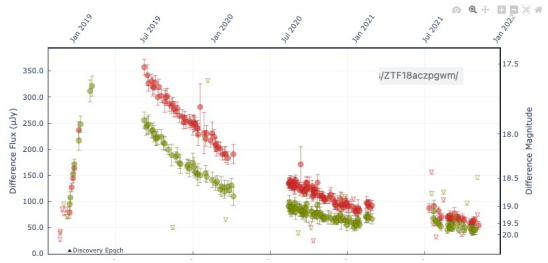


SlowFinder

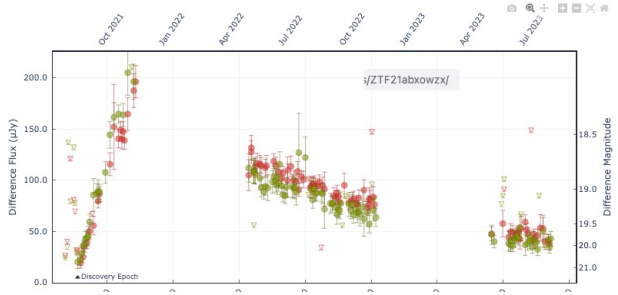
Mining Lasair to find more slow faders with Wiseman et. al.







post peak linear fit

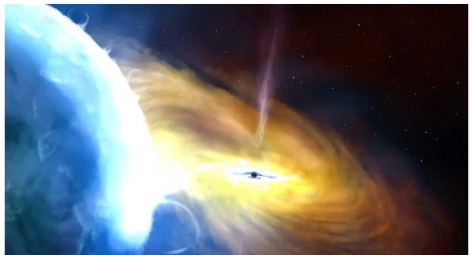


The New York Times

The Biggest Explosion in the Cosmos Just Keeps Going

For three years, telescopes have monitored "one of the most luminous" events ever: a supermassive black hole consuming a gigantic cloud of interstellar gas.

Give this article

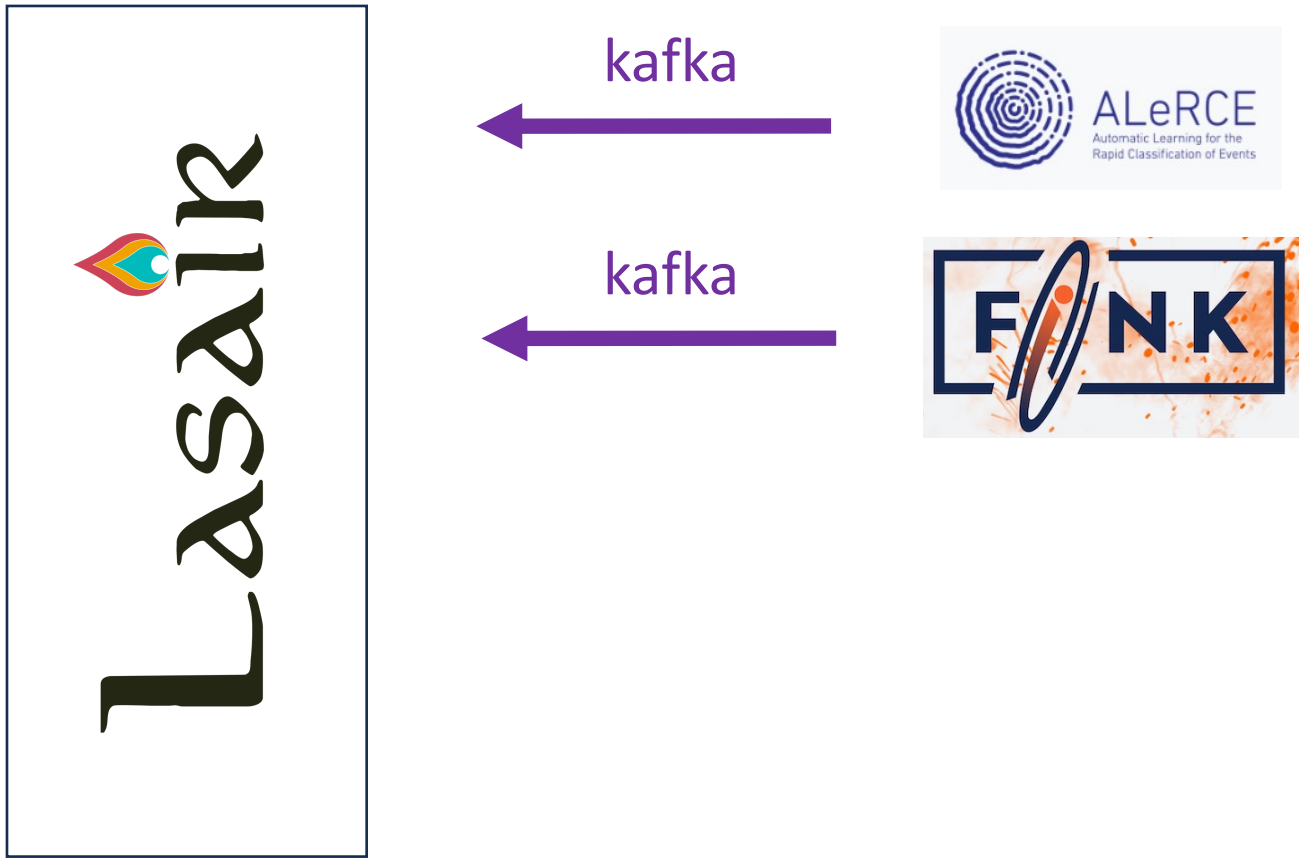


Talk by Phil Wiseman

https://lasair.lsst.ac.uk

Annotations from other brokers

with permission



Selecting on annotation detail

Alerce lightcurve classifier finds SLSN

SELECT COLUMNS

```
objects.objectId,
JSON_EXTRACT(alerce_lc.classdict, '$.SLSN') as SLSN
```

FROM

```
objects, alerce_lc (annotator)
```

Object Annotators

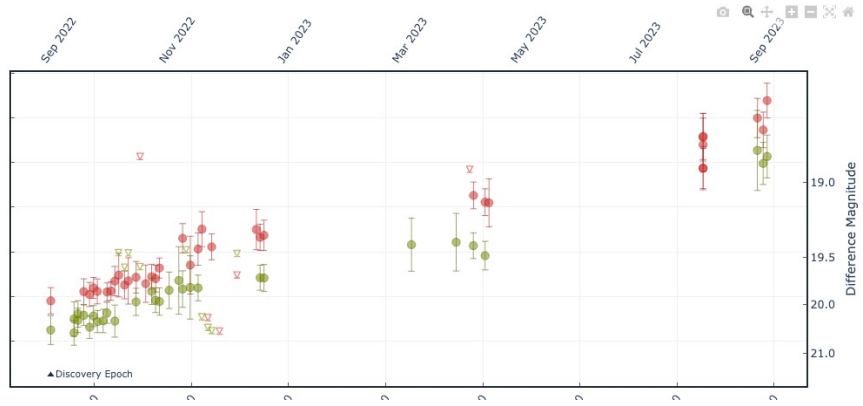
alerce_lc

WHERE

```
objects.jdmax > jdnow()-7
AND JSON_EXTRACT(alerce_lc.classdict, '$.SLSN') > 0.05
```

From Gaia transients 27/1/2023
Alerce SLSN = 0.349
Sherlock says AGN from WISEA ugh

ZTF22abfnjrg



ZTF22abfnjrg

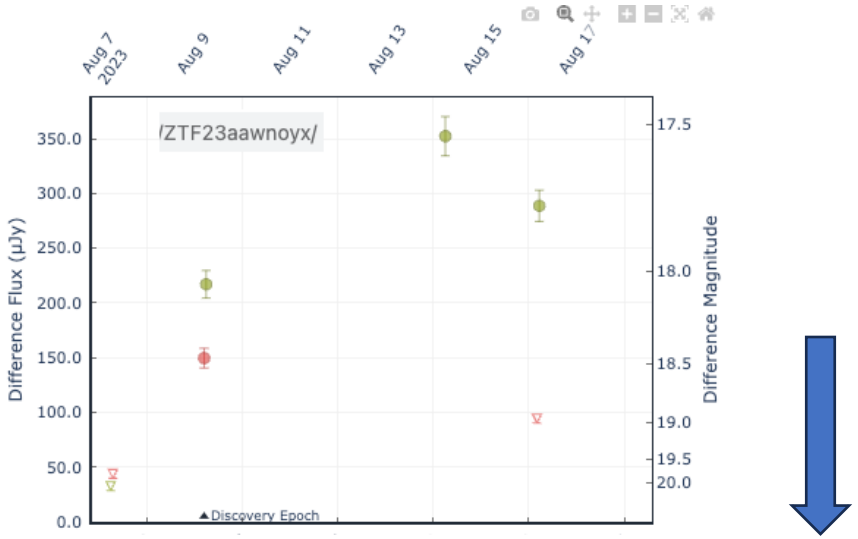
https://lasair-ztf.lsst.ac.uk

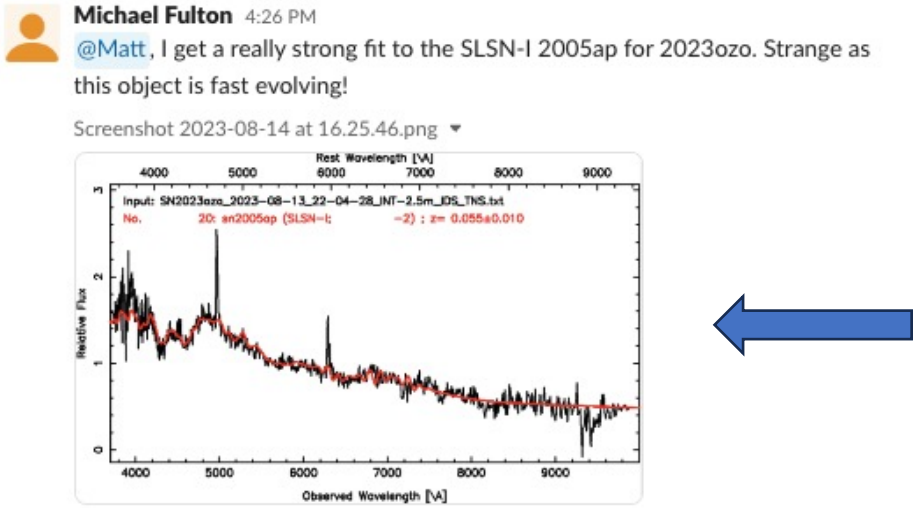
FastFinder

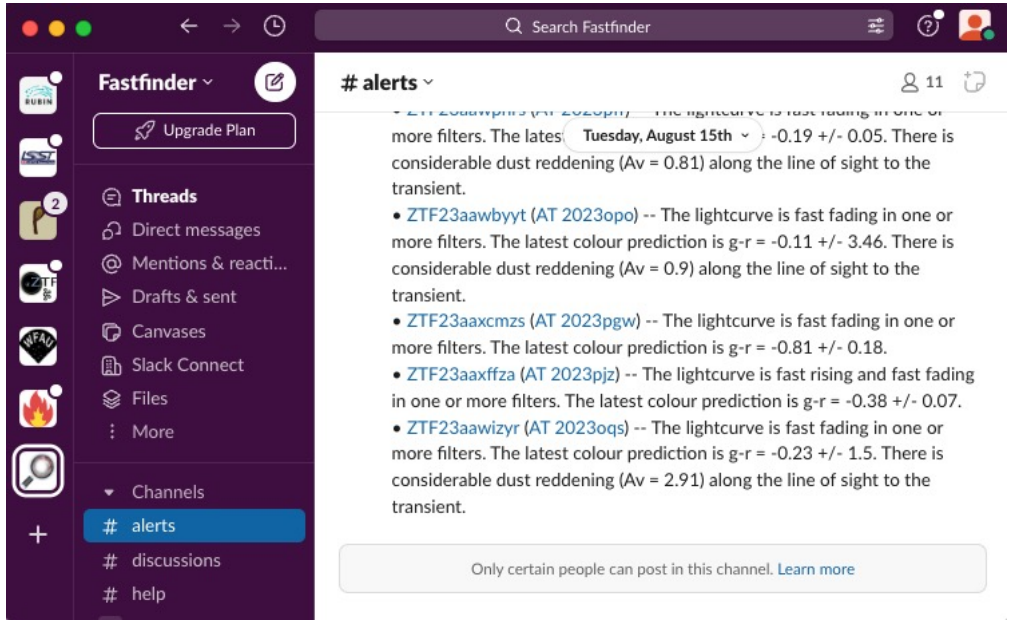
A Lasair annotator from M. Fulton

Now with a slackbot and discussion channel

Talk by Michael Fulton





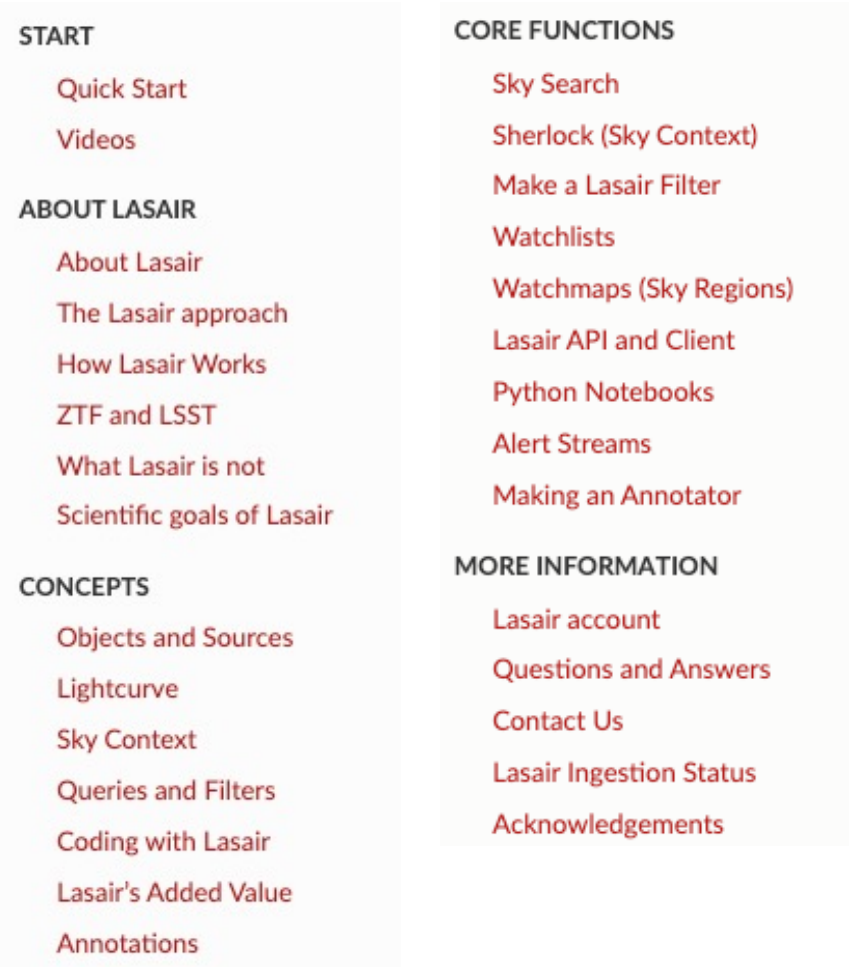


https://lasair.lsst.ac.uk

Rich Documentation

Deep-linked from Lasair web

How-to Video



https://lasair.readthedocs.io