Lasair: The Transient Alert Broker for LSST:UK

Matt Nicholl

Royal Astronomical Society Research Fellow

University of Edinburgh

Lasair

Credit to…

The Lasair team:

Amanda Ibsen, Andy Lawrence, Dave Morris,
Matt Nicholl, Stelios Voutsinas, Roy Williams

University of Edinburgh

Stephen Smartt, Ken Smith, David Young

Queens University Belfast

Lasair is currently a broker for the ZTF public alerts stream

We are building the infrastructure to scale up to LSST

- Edinburgh will host LSST UK Data Access Centre

(Lasair means ‘flash’ or ‘flame’ in Irish and Scots gaelic)

Lasair

Lasair is being used (and not just in Edinburgh)

RNAAS RESEARCH NOTES OF THE AAS

Lasair: The Transient Alert Broker for LSST:UK

K. W. Smith[1], R. D. Williams[2], D. R. Young[1], A. Ibsen[2], S. J. Smartt[1], A. Lawrence[2], D. Morris[2], S. Voutsinas[2], and M. Nicholl[2]

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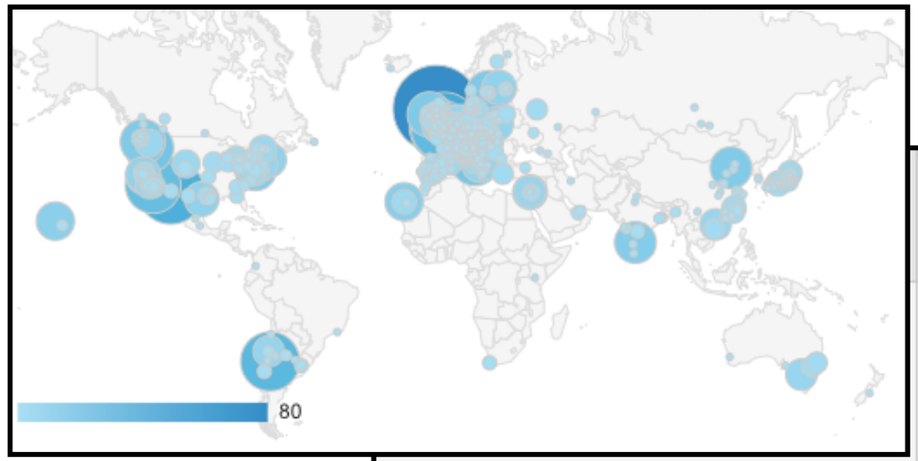
Research Notes of the AAS, Volume 3, Number 1



	Users	New Users
	1,702 % of Total: 100.00% (1,702)	1,601 % of Total: 100.06% (1,600)
1. (not set)	124 (6.07%)	104 (6.50%)
2. Edinburgh	80 (3.92%)	63 (3.94%)
3. London	52 (2.55%)	27 (1.69%)
4. Tucson	45 (2.20%)	41 (2.56%)
5. Santiago	39 (1.91%)	30 (1.87%)
6. Southampton	36 (1.76%)	29 (1.81%)
7. Pasadena	33 (1.62%)	30 (1.87%)
8. Boardman	27 (1.32%)	27 (1.69%)
9. Rome	25 (1.22%)	23 (1.44%)
10. Padua	22 (1.08%)	19 (1.19%)

SOAR telescope spectroscopic classification of optical transients

ATel #12665; *R. Cartier (CTIO), G. Terreran, R. Margutti (Northwestern University)*
on 17 Apr 2019; 00:03 UT
Distributed as an Instant Email Notice Supernovae
Credential Certification: Giacomo Terreran (giacomo.terreran@northwestern.edu)

Subjects: Optical, Supernovae

Tweet

We report the following supernova classifications. The targets were supplied by the Zwicky Transient Facility (https://www.ztf.caltech.edu/; Kulkarni et al. 2018, ATel 11266) data stream processed through the Lasair broker (http://lasair.roe.ac.uk/), and by the All Sky Automated Survey for SuperNovae ASAS-SN (see Shappee et al. 2014, ApJ, 788, 48 and

What it does

Fetching public ZTF alerts via Kafka stream

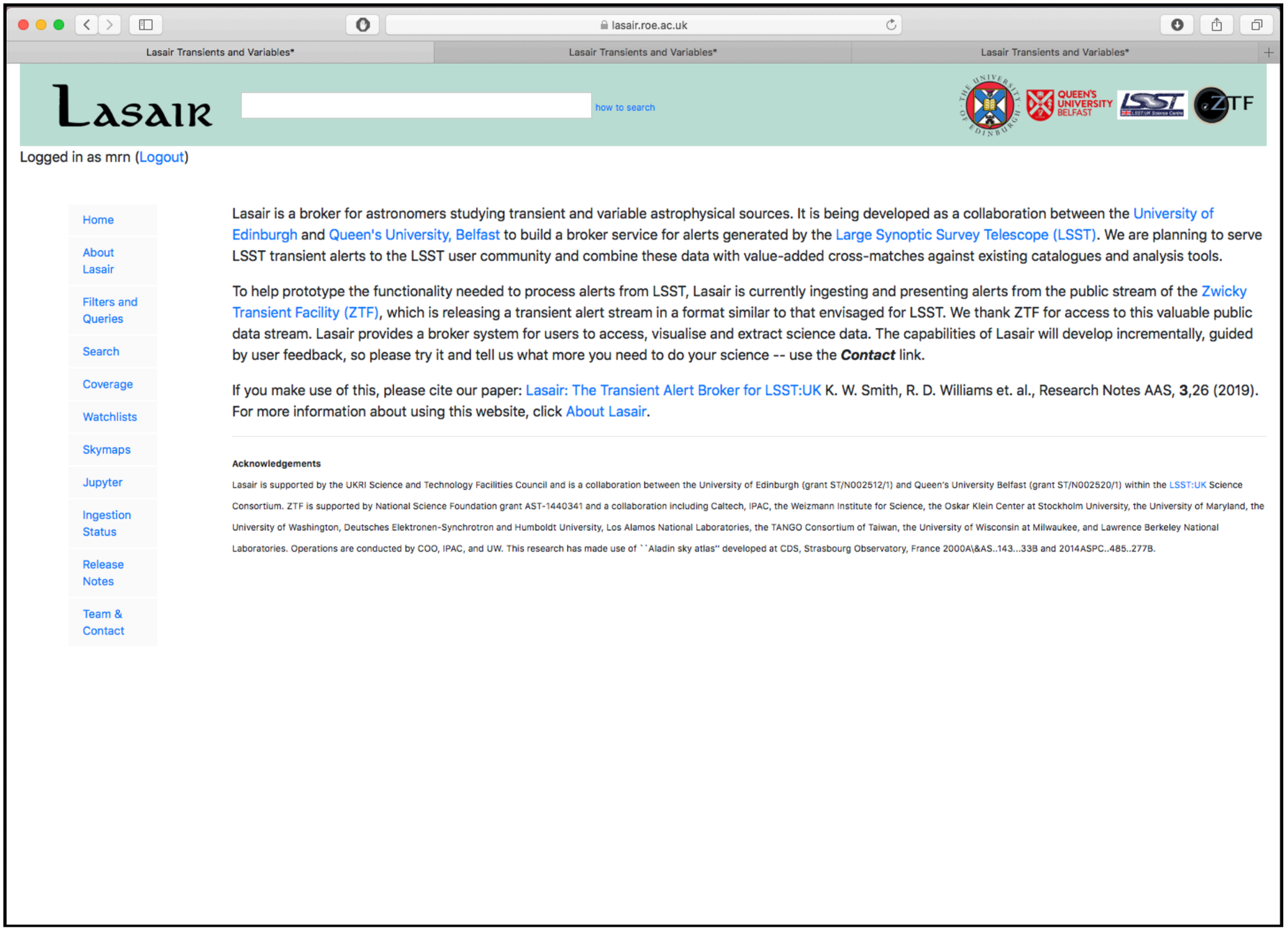
Stores data in relational database(s)

- Candidates table: every alert
- Objects table: candidates grouped into transients (i.e. same ZTF name) with metadata
- ‘Rich’ information: e.g. crossmatches, comments

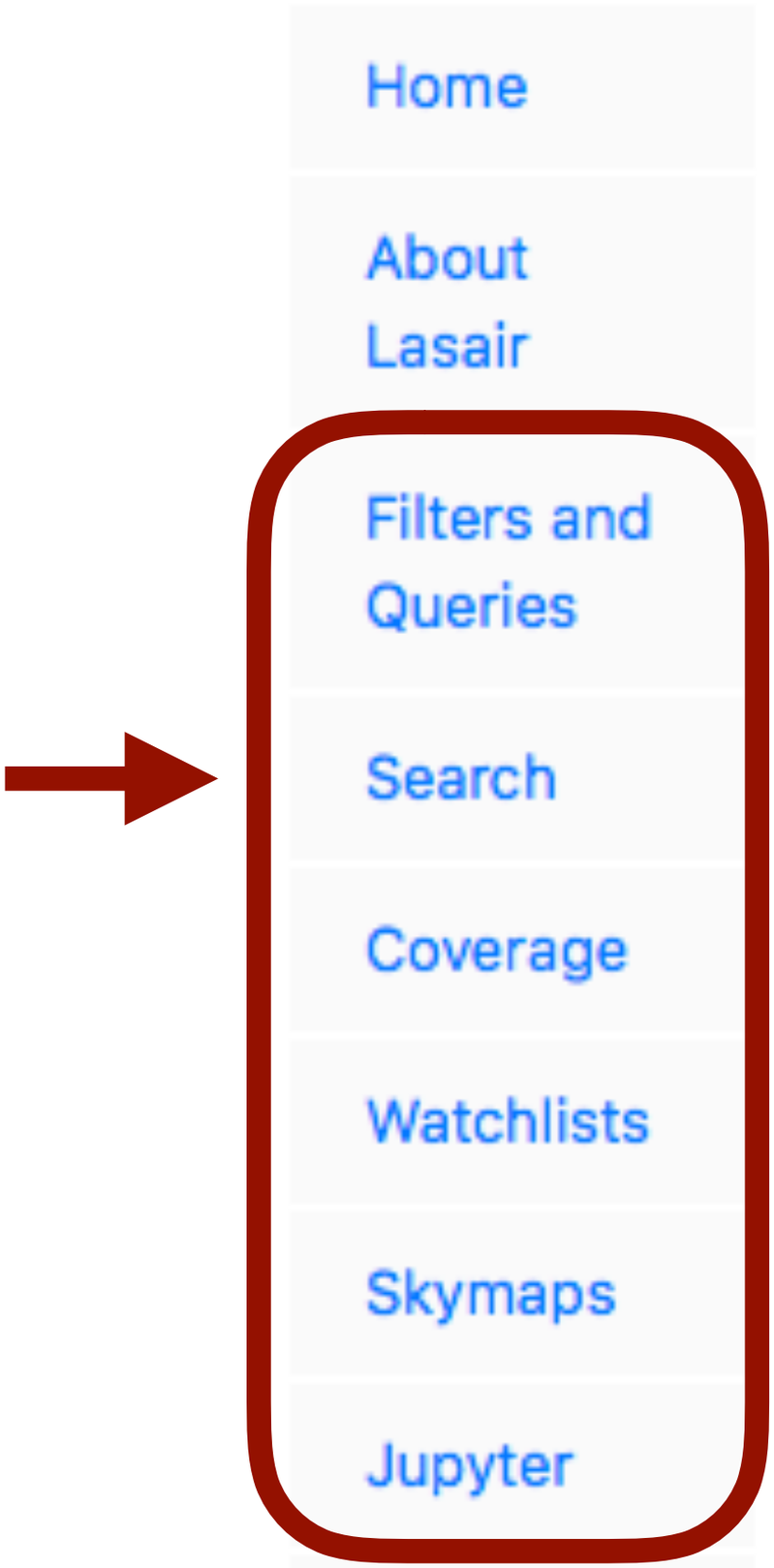
Provides user access in many forms…

Lasair

https://lasair.roe.ac.uk



Matt Nicholl RAS Fellow University of Edinburgh



Lasair is a broker for astronomers study
Edinburgh and Queen's University, Belf
LSST transient alerts to the LSST user

To help prototype the functionality nee
Transient Facility (ZTF), which is releas
data stream. Lasair provides a broker s
by user feedback, so please try it and t

If you make use of this, please cite our
For more information about using this w

Acknowledgements

Lasair is supported by the UKRI Science and Technology F

Consortium. ZTF is supported by National Science Foundat

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Cone Search

Enter RA and Dec and optionally radius in arcseconds, to search for objects in ZTF in that cone. They can be separated by spaces, commas, semicolons, or vertical bars. They can be in decimal degrees (floating point number), or sexagesimal in the form hh:mm:ss and dd:mm:ss or hh mm ss and dd mm ss. If the radius is not specified, it defaults to 5 arcsec. You can also enter an objectId, or a list of object Id, each beginning with 'ZTF'.

(check this box for JSON output)

Run Cone Search

Examples of searches:

- ZTF18acsovsw, ZTF19aagqkrq, ZTF18aawohdr
- 141.15725 25.39508
- 141.15725;25.39508
- 141.15725| 25.39508
- 141.15725, 25.39508, 5.0
- 09:24:37.74 | +25:23:42.3
- 09:24:37.74 | +25:23:42.3 10.0
- 09 24 37.74 +25 23 42.3
- 09 24 37.74 | +25 23 42.3 5
- 09 24 37.74 ; +25 23 42.3 5

By object name
List of names
Coordinates:
  Degrees
  Sexagesimal
  Cone radius
Very forgiving with formatting!

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18:10:26.4, 43:45:17.3, 180

(check this box for JSON output ☐)

Run Cone Search

Examples of searches:

- ZTF18acsovsw
- ZTF18acsovsw, ZTF19aagqkrq, ZTF18aawohdr
- 141.15725 25.39508
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18:10:26.4, 43:45:17.3, 180

(check this box for JSON output ☐)

Run Cone Search

RA,Dec,radius=272.61000,43.75481,180.0
3 objects found in cone

- ZTF19abgcbey
- ZTF19aavijev
- ZTF18abrznyg

← Links to object pages

Examples of searches:

- ZTF18acsovsw
- ZTF18acsovsw, ZTF19aagqkrq, ZTF18aawohdr
- 141.15725 25.39508
- 141.15725;25.39508
- 141.15725| 25.39508
- 141.15725, 25.39508, 5.0
- 09:24:37.74 | +25:23:42.3
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- 09 24 37.74 +25 23 42.3
- 09 24 37.74 | +25 23 42.3 5
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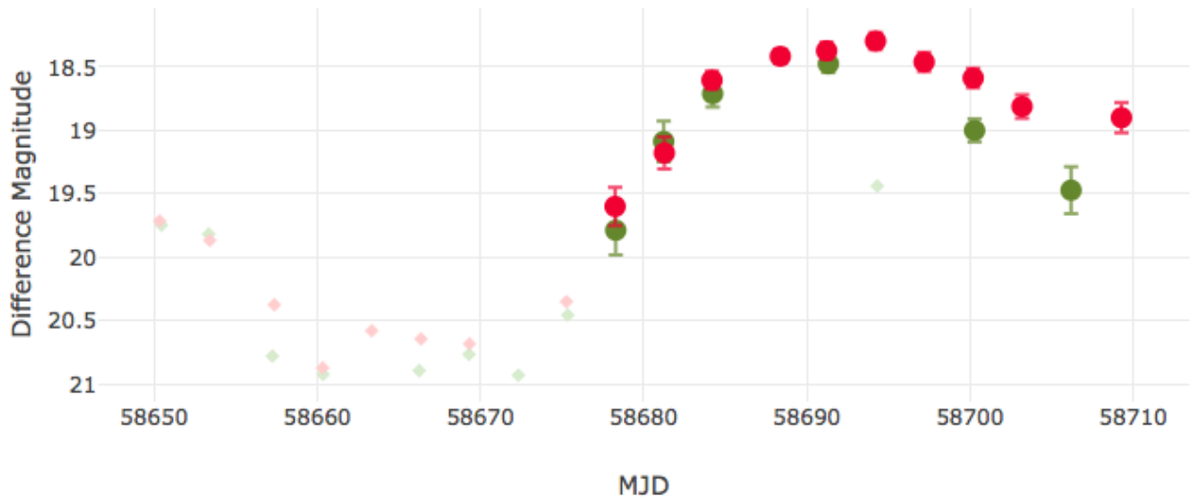
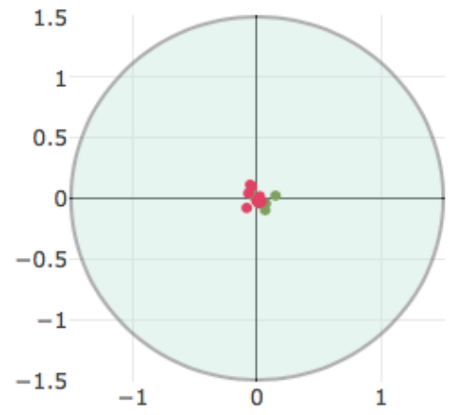
Object ZTF19abgcbey





Difference Magnitude | Apparent Magnitude (see note)

- Object has 17 candidates, at mean position:
  - (RA, Dec) = (272.610118, 43.754824)
  - (RA, Dec) = (18:10:26.428, 43:45:17.367)
  - (l, b) = (71.010261, 25.450380)
- Classified as NT at distance 0.07 arcsec.
-
- The transient is synonymous with *SDSS J181026.41+434517.3*; an r=17.66 mag galaxy found in the SDSS DR12 PhotoObjAll Table catalogue. It's located 0.1 (0.1 Kpc) from the galaxy core. A host photoZ=0.080 (±0.026) implies a transient *M* = -18.2.
- Information on this webpage also available as JSON.
- Conesearch Links (at 5 arcsec): | Simbad | NED | Transient Name Server | ZTF DR1

Comments

Lasair Bot	Aug. 14, 2019, 9:20 a.m.	In TNS as SN2019lks at 0.1 arcsec, discovered 2019-07-14 06:44:28 (MJD 58678.00) by ZTF

New comment

Sherlock classifications table (qub-sherlock.readthedocs.io)

Machine-readable output

Automated TNS checks

Comments table by user or code

Matches with star, galaxy, AGN and variable catalogs for contextual classification and z

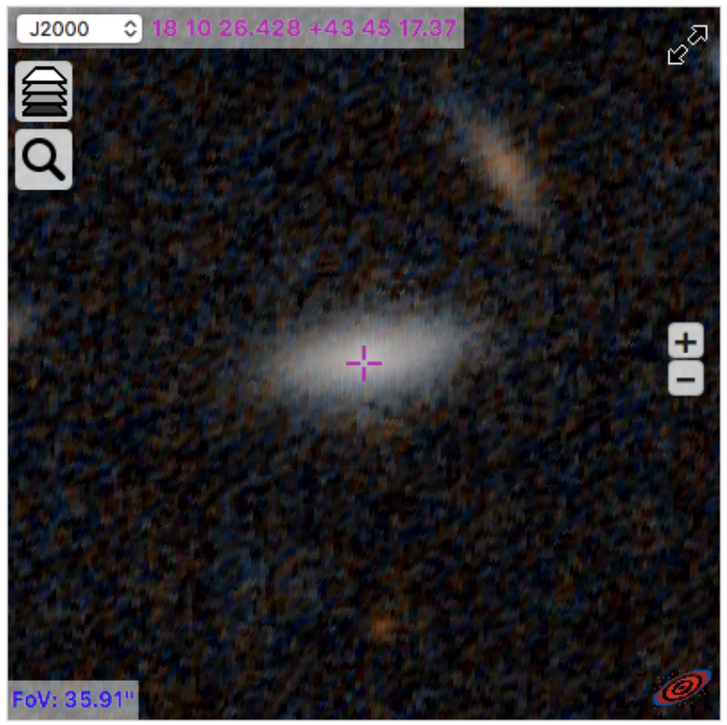
Crossmatches

rank	ID	Catalog	Type	Separation	r-mag	g-mag	photoZ
1	1237668681532441089	SDSS DR12 PhotoObjAll Table	galaxy	0.07	17.6617	18.3819	0.079843

Sherlock crossmatches table: detailed info on nearest object(s)

AladinLite

Image layer is PanSTARRS DR1; use the layers icon to change it ( ). You can also overlay PanSTARRS and/or Gaia DR2 catalog.

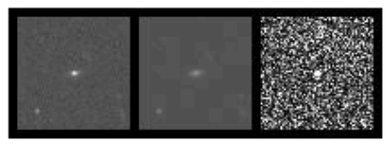
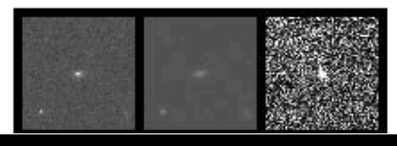


Display field in AladinLite
Optional catalog overlay

Gaia
2MASS
SDSS DR12
GSC
Glade galaxies
Downes CV
Million quasars
NED galaxies
NED agn

Candidates (To sort, click the column headings)

All candidates associated with object

MJD	UTC	Filter	magpsf		candidate	Image(target, ref, diff)
58709.269	2019-08-14 06:26:54	r	18.901 ± 0.119	t	955268694915015006	
58709.157	2019-08-14 03:45:55	g	19.773 ± 0.231	1	955156894915015033	
58706.182	2019-08-11 04:22:30	g	19.473 ± 0.185	t	952182304915015027	

Links for more info

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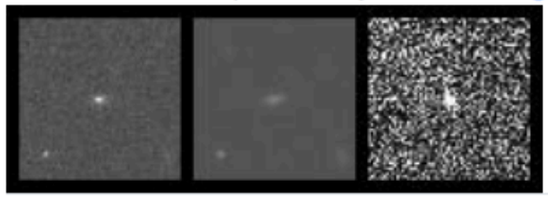
Candidate object

This candidate is part of object ZTF19abgcbey.



jd	2458706.6823032
ra	272.6101299
dec	43.7548165
magpsf	19.4731
sigmapsf	0.185262
magnr	19.232
sigmagnr	0.073
magzpsci	26.1701
isdiffpos	t
nid	952
field	725
xpos	2792.67
ypos	1713.28

Contains all info from ZTF alerts

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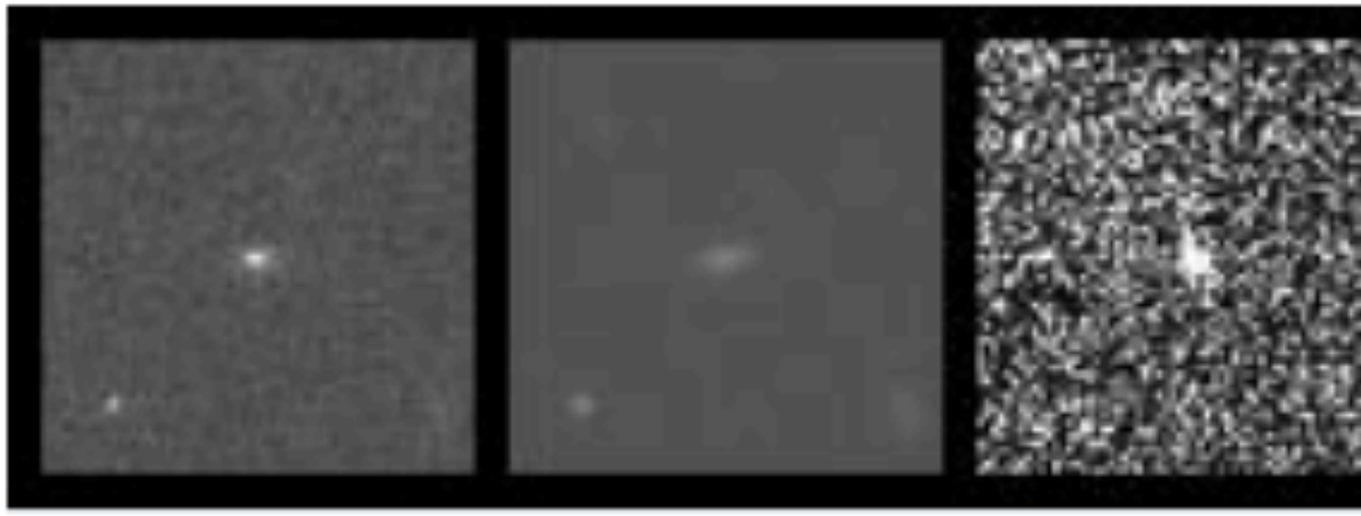
Candidate object

This candidate is part of object ZTF19a



jd

ra

dec

magpsf

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Lasair Filters

The following is a small selection of event filters that Lasair can produce.
The following may take up to a minute to execute. Please be patient.

Name	Description
SN-like candidates in last 14 days	SN-like candidates (Sherlock classifications SN, NT and orphans). Rejects Pan-STARRS star matches
All nuclear transients and TDE candidates	Near core of inactive catalogued galaxies (within 1"), flags Pan-STARRS stellar matches to let user judge star/galaxy separation. Objects discovered in last 30 days.
TNS crossmatch	This query finds all Lasair objects that are in the Transient Name Server, meaning they have a comment that includes the string 'TNS'. The most recent are first.

Lasair Filters and Queries

Lasair also provides a more powerful freeform SQL interface where you can see the SQL for these streams, customise for yourself, make and save your own filters.

Click Here to Build Your Own Filter

Filters: produce sub-stream satisfying some criteria
=> run automatically on newly ingested data (i.e. real-time)
Queries: search database for events satisfying criteria
=> run at any time by user on all current and historical events

} Both use SQL

"Every filter is a query, but not every query is a filter" - Roy Williams

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Click Here to Build Your Own Filter

The lazy option: default filters

Advanced option: build your own

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Filter the ZTF object database

The form below is a builder for SQL SELECT queries on the ZTF database of objects. There are three tables that can be joined in SELECT queries (only SELECT queries are allowed). See examples below. The tables are:

- **objects**: The astrophysical objects which consist of a series of candidates (aka detections). The object has a light curve, the candidate has a single magnitude and date.
- **sherlock_crossmatches**: Information about each object derived from multiple catalogs by the Sherlock software. The crossmatches have a *rank* 1,2,3... where 1 is considered most likely.
- **candidates**: The individual detections provided by ZTF each night. Each is associated with an *object*, which is a cluster of detections within 1.5 arcsec, and presumed to be an astrophysical object.

For detailed information about the attributes of these three tables, that you can use in the filters : click here.

- The public survey uses two filters: fid=1 (g) and fid=2 (r)
- For each observing field of the survey and each of the g and r filters, ZTF will only issue candidate alerts when it has built up a *reference image* of that field with that filter, by stacking 15 good images.
- Once that is in place, each fresh image is subtracted from the reference, and any 5-sigma difference generates a candidate alert.
- When a candidate is within 1.5 arcseconds of a previous candidate, it gets the same *objectId*. Thus a light curve can be obtained from all the candidates that have a given objectId.
- More details of the processing pipeline are available here.
- Further cuts can be made to remove spurious candidates, The highest quality candidates satisfy the criterion `candidates.rb >= 0.65 and candidates.nbad = 0 and candidates.fwhm <= 5 and candidates.elong <= 1.2 and abs(candidates.magdiff) <= 0.1`. See example below.
- If you would like to learn the SQL language, this is a good resource.

List of attributes that you can query on

SELECT

FROM JOIN OF

- [ ] candidates
- [ ] noncandidates
- [ ] objects
- [ ] comments
- [ ] sherlock_classifications
- [ ] sherlock_crossmatches

SELECT

Free text (SQL)

FROM JOIN OF

- ☐ candidates
- ☐ noncandidates
- ☐ objects
- ☐ comments
- ☐ sherlock_classifications
- ☐ sherlock_crossmatches

Available tables
Checklist loads tables
in advance for real-time filters

WHERE ORDER

Free text (SQL)

Run Filter (check this box for JSON output ☐)

(If you would like to create your own stored filters, you should be signed in. See links at top left.)

Contributed Stored Filters

Stored filters created and made public are listed below. Click on the name of the filter to push it into the area above.

Name	Owner	Description	Query
SN-like candidates in last 14 days	Stephen Smartt	SN-like candidates (Sherlock classifications SN, NT and orphans). Rejects Pan-STARRS star matches	objects.objectId, objects.ramean, objects.decmean, objects.jdmin - 2400000.5 AS mjdmin, objects.jdmax - 2400000.5 AS mjdmax, objects.magrmin, latestrmag, sherlock_classifications.classification, IF(distpsnr1 < 2 AND candidates.sgscore1 > 0.49, "Within 2arcsec of PS1 star", "Not Near PS1 star") score --- objects,candidates,sherlock_classifications --- sherlock_classifications.classification NOT IN ("VS" , "AGN", "CV", "BS") AND objects.jdmin > JDNOW() - 14 AND objects.ncand > 3 AND candidates.objectId = objects.objectId AND (candidates.jd > JDNOW() - 14) AND candidates.magpsf < 20 AND candidates.rb >= 0.75 AND candidates.nbad = 0 AND candidates.isdiffpos = "t"

Clicking on a stored query populates the form

Only return events with candidates in last X days

SELECT

```
objects.objectId,
    objects.ramean,
    objects.decmean,
    objects.jdmin - 2400000.5 AS mjdmin,
```

FROM JOIN OF

- [x] candidates
- [ ] noncandidates
- [x] objects
- [ ] comments
- [x] sherlock_classifications
- [ ] sherlock_crossmatches

WHERE ORDER

```
sherlock_classifications.classification NOT IN ("VS" , "AGN", "CV", "BS")
        AND objects.jdmin > JDNOW() - 14
        AND objects.ncand > 3
        AND candidates.objectId = objects.objectId
```

- [x] Include only recent events (10 days)

Go!

Run Filter (check this box for JSON output ☐)

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Showing results for query:

```
SELECT /*+ MAX_EXECUTION_TIME(300000) */ objects.objectId, objects.ramean, objects.decmean, objects.jdmin - 2400000.5 AS mjdmin, objects.jdmax -
2400000.5 AS mjdmax, objects.magrmin, latestrmag, sherlock_classifications.classification, IF(distpsnr1 < 2 AND candidates.sgscore1 > 0.49,
"Within 2arcsec of PS1 star", "Not Near PS1 star") score FROM objects,candidates,sherlock_classifications WHERE objects.objectId =
candidates.objectId AND objects.primaryId = sherlock_classifications.transient_object_id AND objects.jdmax > JDNOW() - 10.00000 AND
candidates.jd > JDNOW() - 10.00000 AND sherlock_classifications.classification NOT IN ("VS" , "AGN", "CV", "BS") AND objects.jdmin > JDNOW() -
14 AND objects.ncand > 3 AND candidates.objectId = objects.objectId AND (candidates.jd > JDNOW() - 14) AND candidates.magpsf < 20 AND
candidates.rb >= 0.75 AND candidates.nbad = 0 AND candidates.isdiffpos = "t" AND candidates.fwhm <= 5 AND ABS(candidates.magdiff) <= 0.1 AND
candidates.elong <= 1.2 ORDER BY score , mjdmin DESC LIMIT 1000 OFFSET 0
```

Showing results 0-276

objectId	ramean	decmean	mjdmin	mjdmax	magrmin	latestrmag	classifi
ZTF19abplzzk	305.8292512666667	66.31878223333334	58708.21114580007	58710.21499999985	18.5624	18.7438	ORPHAN
ZTF19abpjeyk	354.72404789999996	5.610869725	58707.435277800076	58707.47921299981	19.2637	19.2637	ORPHAN
ZTF19abpjeyk	354.72404789999996	5.610869725	58707.435277800076	58707.47921299981	19.2637	19.2637	ORPHAN
ZTF19abpecvt	15.7024001	2.0186318	58706.40167819988	58706.419421299826	18.4728	18.4989	ORPHAN

FROM JOIN OF

- [ ] candidates
- [ ] noncandidates
- [ ] objects
- [ ] comments
- [ ] sherlock_classifications
- [ ] sherlock_crossmatches

WHERE ORDER

Run Filter (check this box for JSON output ☐)

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Filter the ZTF object database

The form below is a builder for SQL SELECT queries on the ZTF database of objects. There are three tables that can be joined in SELECT queries (only SELECT queries are allowed). See examples below. The tables are:

- **objects**: The astrophysical objects which consist of a series of candidates (aka detections). The object has a light curve, the candidate has a single magnitude and date.
- **sherlock_crossmatches**: Information about each object derived from multiple catalogs by the Sherlock software. The crossmatches have a *rank* 1,2,3... where 1 is considered most likely.
- **candidates**: The individual detections provided by ZTF each night. Each is associated with an *object*, which is a cluster of detections within 1.5 arcsec, and presumed to be an astrophysical object.

For detailed information about the attributes of these three tables, that you can use in the filters : click here.

- The public survey uses two filters: fid=1 (g) and fid=2 (r)
- For each observing field of the survey and each of the g and r filters, ZTF will only issue candidate alerts when it has built up a *reference image* of that field with that filter, by stacking 15 good images.
- Once that is in place, each fresh image is subtracted from the reference, and any 5-sigma difference generates a candidate alert.
- When a candidate is within 1.5 arcseconds of a previous candidate, it gets the same *objectId*. Thus a light curve can be obtained from all the candidates that have a given objectId.
- More details of the processing pipeline are available here.
- Further cuts can be made to remove spurious candidates, The highest quality candidates satisfy the criterion `candidates.rb >= 0.65 and candidates.nbad = 0 and candidates.fwhm <= 5 and candidates.elong <= 1.2 and abs(candidates.magdiff) <= 0.1`. See example below.
- If you would like to learn the SQL language, this is a good resource.

SELECT

FROM JOIN OF

- [ ] candidates
- [ ] noncandidates
- [ ] objects
- [ ] comments
- [ ] sherlock_classifications
- [ ] sherlock_crossmatches

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First name and Last name

Preferred username

Your email

After you sign up, you will enter your email again, and respond to that email.

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SELECT

FROM JOIN OF

- [ ] candidates
- [ ] noncandidates
- [ ] objects
- [ ] comments
- [ ] sherlock_classifications
- [ ] sherlock_crossmatches

Run Filter (check this box for JSON output ☐)

My Stored Queries

Stored filters that you control are listed below. Click on the name of the filter to push it into the filter area above, or the link below the name to edit it.

Create new stored filter

Name	Description	Query
SLSNe Edit/delete filter	Supernovae more than 1.5 mags brighter than host galaxy	DISTINCT objects.objectId, objects.latestrmag, candidates.srmag1 ---- candidates, objects, sherlock_classifications ---- sherlock_classifications.classification NOT IN ("VS" , "AGN", "CV", "BS") AND objects.ncand > 1 AND objects.magrmin+1.5 < candidates.srmag1 AND candidates.sgscore1 < 0.5 AND candidates.isdiffpos IN ("t",1) AND objects.jdmin > JDNOW() - 14 ORDER BY objects.ncand DESC
C-SNAILS Edit/delete filter	Classification Survey for Nuclear trAnslents with Liverpool and Lasair	DISTINCT objects.objectId, objects.latestgmag as g, objects.maggmin as g_max, candidates.sgmag1 as g_host, objects.latestrmag as r, objects.magrmin as r_max, candidates.srmag1 as ---- candidates, objects ---- objects.jdmin > 2458659.5 AND objects.ncand >= 2 AND objects.sherlock_classification NOT IN ("VS" , "AGN", "CV", "BS") AND candidates.distpsnr1 < 0.5 AND candidates.sgscore1 < 0.

Click to edit

Contributed Stored Filters

Stored filters created and made public are listed below. Click on the name of the filter to push it into the area above.

Name	Owner	Description

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Run automatically on incoming data stream

=> query becomes a filter

SLSNe

Supernovae more than 1.5 mags brighter than host galaxy

Active: ☑ (Topic name is SLSNe)

Public: ☐

Click here to see substream

Allow other users to see/run as query

SELECT

```
DISTINCT
    objects.objectId,
    objects.latestrmag,
    candidates.srmag1
```

FROM JOIN OF

☑ candidates
☐ noncandidates
☑ objects
☐ comments
☑ sherlock_classifications
☐ sherlock_crossmatches

WHERE ORDER

```
    sherlock_classifications.classification NOT IN ("VS" , "AGN", "CV", "BS")
        AND objects.ncand > 1
        AND objects.magrmin+1.5 < candidates.srmag1
        AND candidates.sgscore1 < 0.5
```

Update query

Delete this query

https://lasair.roe.ac.uk/lasair/static/ztf/streams/SLSNe

https://lasair.roe.ac.uk/lasair/static/ztf/streams/SLSNe | Lasair Transients and Variables* | Lasair Transients and Variables*


```
{"objectId": "ZTF19abmpoxa", "latestrmag": 18.2733, "srmag1": 20.6397},
{"objectId": "ZTF19abocled", "latestrmag": 18.8769, "srmag1": 21.7168},
```


Returns substream as JSON
Populated each day
(only been running for one day!)

URL = lasair.roe.ac.uk/static/ztf/streams/<STREAM_NAME>

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SLSNe

Supernovae more than 1.5 mags brighter than host galaxy

Active: ☑ (Topic name is SLSNe)

Public: ☐

SELECT

```
DISTINCT
    objects.objectId,
    objects.latestrmag,
    candidates.srmag1
```

FROM JOIN OF

☑ candidates
☐ noncandidates
☑ objects
☐ comments
☑ sherlock_classifications
☐ sherlock_crossmatches

WHERE ORDER

```
    sherlock_classifications.classification NOT IN ("VS" , "AGN", "CV", "BS")
        AND objects.ncand > 1
        AND objects.magrmin+1.5 < candidates.srmag1
        AND candidates.sgscore1 < 0.5
```

Update query

Delete this query

SLSNe

Supernovae more than 1.5 mags bright

Active: ☑ (Topic name is SLSNe)

Public: ☐

SELECT

```
DISTINCT
    objects.objectId,
    objects.latestrmag,
    candidates.srmag1
```

FROM JOIN OF

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A watchlist is a set of points in the sky, together with a radius in arcseconds. It is assumed to be a list of "interesting" sources, so that any transient that falls within the radius of one of the sources might indicate activity of that source. Each user of the Lasair system has their own set of watchlists, and can be alerted when a ZTF transient is coincident with a watchlist source.

You can create a watchlist of sources by preparing a text file, where each comma-separated line has an identifier for the source, then the RA and Dec in decimal degrees. One way to do this is with Vizier and a spreadsheet program such as Excel or Numbers. Here is an example of the CSV data. The 42 entries are *BL Lac candidates for TeV observations (Massaro+, 2013)*

An "Active" watchlist is one that is compared immediately when new ZTF candidates are ingested, with an alert sent immediately to the owner of the watchlist. (This feature is not yet implemented).

To create your own watchlists, you must log in.

Watchlists will be soon be combined with filters:
e.g. alert when source brightens by >X mag

Public Watchlists

Watchlists created and made public are listed below. Click on the name of the watchlist for more information and crossmatching.

Name	Owner	Description	Radius	Active
Cataclysmic Variables	Roy Williams	Catalog of Cataclysmic Variables (Downes+ 2001-2006) Vizier V/123A	0.2 arcsec	
BL Lac for TeV	Roy Williams	BL Lac candidates for TeV observations (Massaro+, 2013)	1.0 arcsec	
AM CVn	Roy Williams	These are 56 very close binaries of compact objects, from "The physical properties of AM CVn stars: new insights from Gaia DR2", Ramsay et al 2018 A&A 620A 141	1.0 arcsec	
AM Her	Gavin Ramsay	Magnetic CVs (B>10MG). some go into prolonged low states. see Cropper 1990 SSRv 54 195. Objects marked with an asterix indicate its eclipsing and 'A' indicates asynchronous	5.0 arcsec	✓

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Name	Cataclysmic Variables
Description	Catalog of Cataclysmic Variables (Downes+ 2001-2006) Vizier V/123A
Radius (arcsec)	0.2
Active	no
Public	yes

Watchlist has 1830 sources under watch.

‘Active’ and ‘public’
similar to filters
Login to make your own

Watchlist			Crossmatch ZTF			
Object	**RA**	**Dec**	**objectId**	**candidates**	**mag range**	**Sherlock class**
V1390Cyg_GR177	307.0971667	39.0653611	ZTF18aawbjiz	277	3.1	CV
V516Cyg_S4530	311.79075	41.9240278	ZTF18aazvhdb	245	3.6	CV
Her_SDSSJ163605+465205	249.020875	46.8679167	ZTF18aagtesn	241	3.0	CV
Cyg1_NSV25181	308.5604583	50.8016389	ZTF17aaadzll	218	2.5	CV
Dra_SDSSJ132723+652854	201.8474179	65.4817783	ZTF18aaieivs	200	2.3	CV
V513Cas_MacCv4	4.5620833	66.30375	ZTF18abbuvtf	185	2.7	CV
V1504Cyg_SVS710	292.2352083	43.0936944	ZTF18abjtwlb	134	5.5	CV
FTCam_AntipinV64	50.3095833	61.09075	ZTF18abodmfy	127	3.5	CV
Her_	267.0242917	34.0670833	ZTF18aajrzvj	119	2.1	AGN
And_SDSSJ001856+345444	4.7372083	34.9123056	ZTF17aaaehqt	115	2.0	CV
Her_SDSSJ165359+201010	253.4960802	20.169572	ZTF18aabvkix	106	3.2	CV
RULMi_CBS-119/Ton1143	150.531073	33.8500853	ZTF17aacwmyu	97	3.9	CV
EGLac_S4617	342.6620833	55.2477778	ZTF18abasxdk	96	2.1	CV
FYPer_640.1936	70.4859583	50.71	ZTF18aabtynl	87	3.5	CV
BIOri_1.1916	80.9657083	1.0085556	ZTF17aaagyuc	87	2.2	CV
Peg_AntipinV79	328.64025	35.8381667	ZTF17aaawerk	84	2.6	CV
Peg_SDSSJ214354+124458	325.9774999	12.7493891	ZTF18abecurw	81	3.5	CV
HQMon_93.1933	107.8905833	0.8685278	ZTF17aaanqyh	80	2.3	CV
ABDra_90.1934	297.277125	77.739694	ZTF18absnnsr	79	4.4	CV

Input

Output

Description	Catalog of Cataclysmic Var
Radius (arcsec)	0.2
Active	no
Public	yes

Watchlist has 1830 sources under watc

Watchlist

Object	RA
V1390Cyg_GR177	307.
V516Cyg_S4530	311.
Her_SDSSJ163605+465205	249
Cyg1_NSV25181	308
Dra_SDSSJ132723+652854	201.

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Gravitational Wave Skymaps

The following LIGO-Virgo skymaps have been released, and are available here as fits files. Each is encoded by the event date as GWyymmdd. For latest information, see also GraceDB.

- GW151226
- GW170818
- GW151012
- GW170817
- GW170104
- GW170823
- GW170608
- GW170814
- GW170809
- GW170729
- S190408an
- GW150914
- S190412m
- S190405ar
- S190421ar
- S190425z
- S190426c
- S190503bf
- S190510g
- S190510g_1
- S190510g_2
- S190512at
- S190513bm
- S190513bm_1
- S190517h
- S190512at_1
- S190518bb
- S190519bj
- S190521g
- S190521g_1

All new LIGO-Virgo skymaps here

Alert to LSST:UK Slack channel when new skymap is available

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Gravitational Wave Skymap: S190814bv_4

The probability contours of the location of the gravitational-wave counterpart are shown below; the sky background can be changed with the selector, and the interface allows arbitary zooming. The 9 contour lines show percentiles of the probability density: the outermost line contains 90% and the innermost contains 10%. The three checkboxes below are as follows:

- Coverage: shows if the ZTF survey has covered the skymap in the date range specified. Note that ZTF did not start until 20180527.
- Candidates: Shows the ZTF candidates surrounding the skymap and in a time window around the event time. The form fields are in days, as differences from the event time.
- Galaxies: Shows galaxies that may have the counterpart, with the size of the symbol as the 3D probability density at that galaxy position and distance.

Remember to click "submit" to refresh the page.

Distance	267.4 ± 51.6 Mpc
ISO Date:	2019-08-14T21:10:38.995869
Julian date:	2458710.382
Percent probability:	BNS=0.0, NSBH=0.0, BBH=0.0 MassGap=0.0
max prob RA,Dec	12.8, -25.2

Handy summary:

- Marginalised distance
- Alert time
- Source type probabilities
- Position of highest probability density

Coverage of ZTF From 20190814 To 20190814

Show ZTF candidates From -1.000 To 1.000

Show galaxies from GLADE *doubleclick a galaxy*

Submit

Mellinger coloured

Projection: SINUS

J2000 333.620 -15.115

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max prob RA,Dec 12.8, -25.2

Coverage of ZTF From 20190814 To 20190814

Show ZTF candidates From -1.000 To 1.000

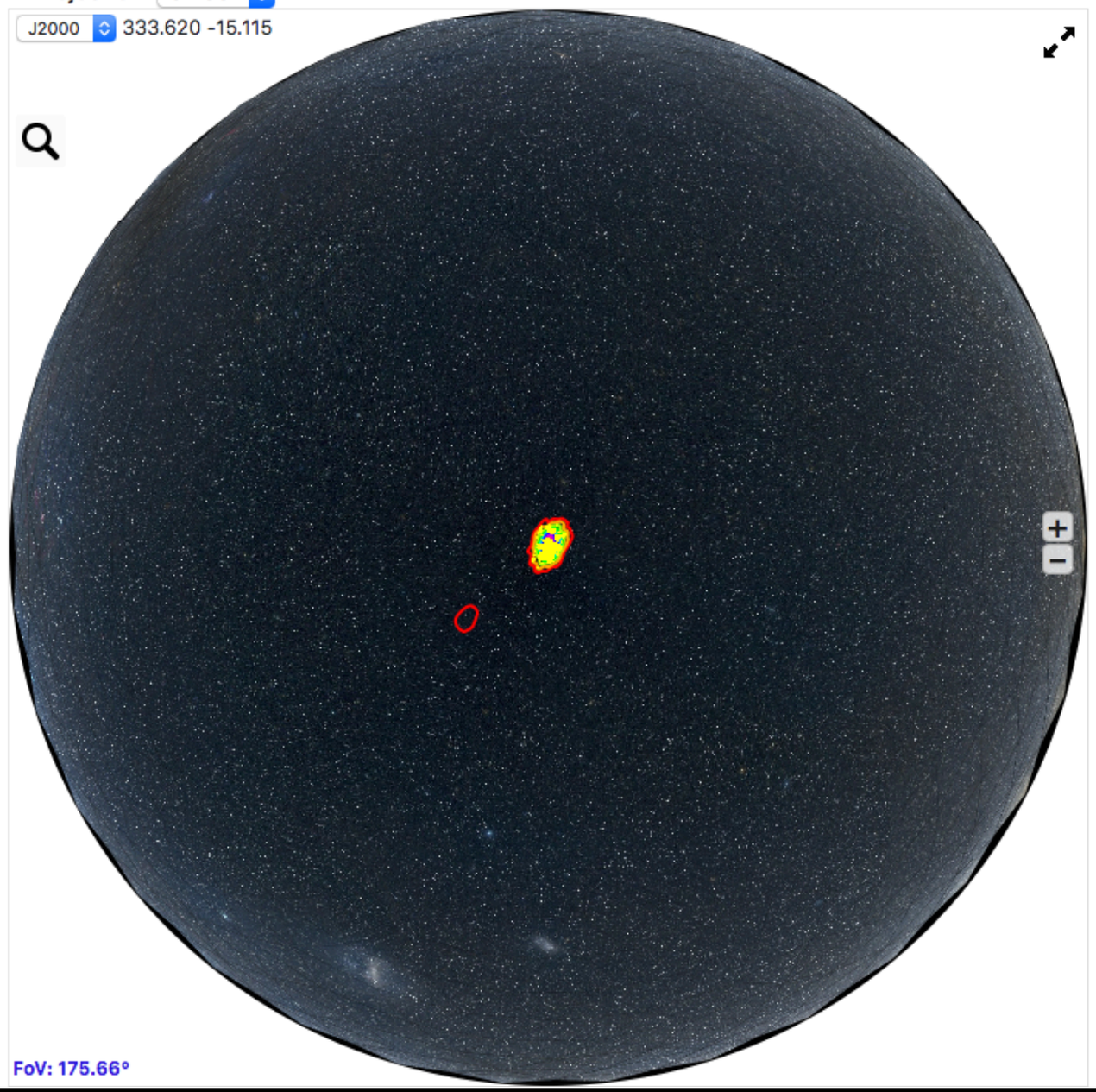
Show galaxies from GLADE *doubleclick a galaxy*

Submit

Mellinger coloured

Projection: SINUS

J2000 333.620 -15.115



Toggle on/off:

- ZTF coverage of field (currently nothing public following a GW alert)
- ZTF candidates (same)
- GLADE galaxies

max prob RA,Dec 12.8, -25.2

Coverage of ZTF From 20190814 To 20190814

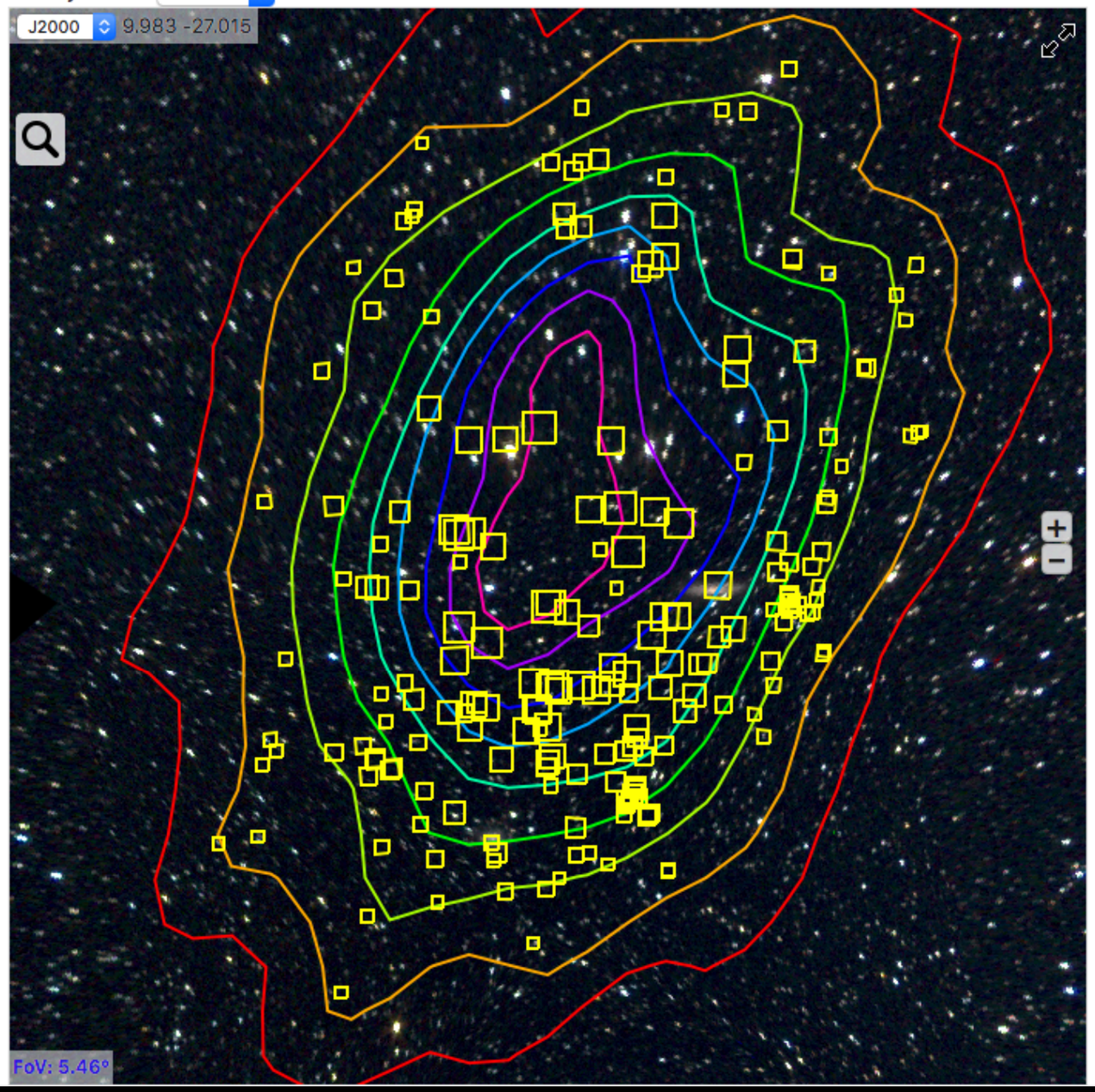
Show ZTF candidates From -1.000 To 1.000

Show galaxies from GLADE *doubleclick a galaxy*

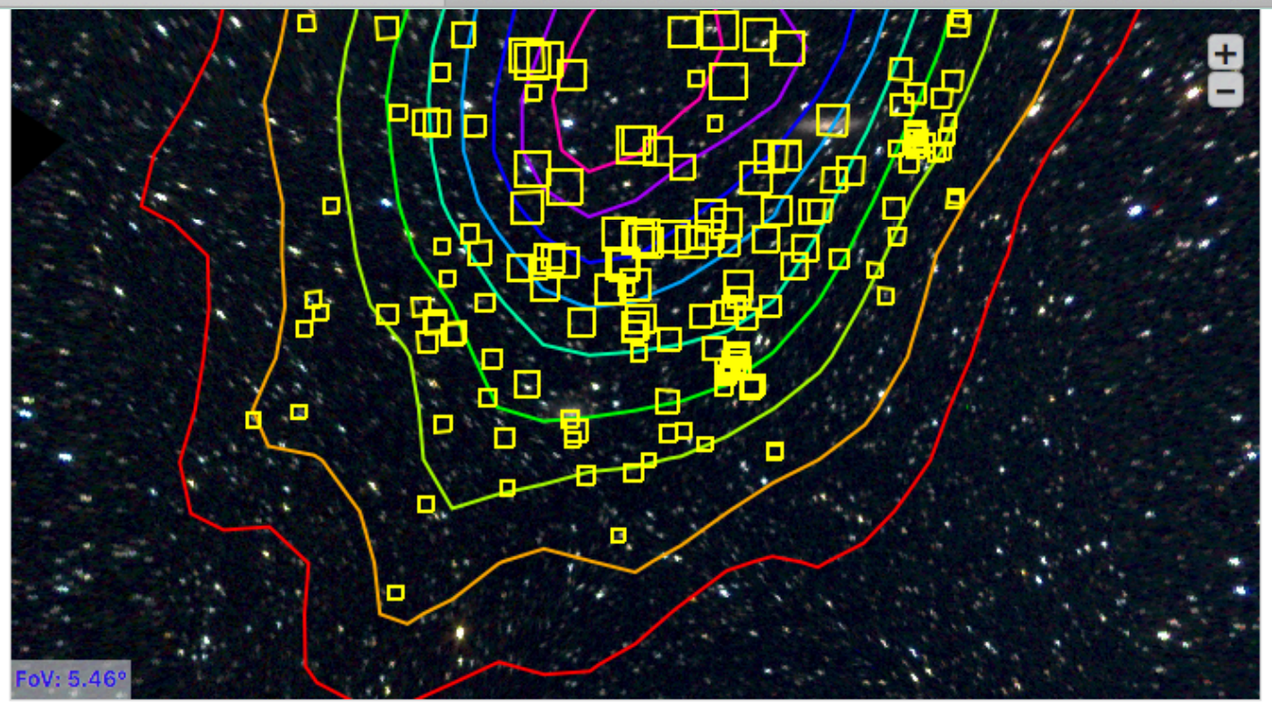
Submit

Mellinger coloured

Projection: SINUS



Zoom in to see galaxies
Area of square proportional to probability



200 most probable galaxies

Name (NED link)	Percent probability	Distance (Mpc)
LEDA 787700	0.77	274.4
LEDA 777629	0.75	271.7
00494172-2503029	0.71	261.4
LEDA ESO474-035	0.69	271.3
LEDA 3235511	0.68	263.3
LEDA 3235474	0.65	260.3
LEDA 3235467	0.65	269.4
LEDA 3235463	0.64	258.9
LEDA 3235460	0.63	277.1
LEDA 198197	0.62	297.7
LEDA 773232	0.60	278.5
LEDA 3235913	0.58	261.5
LEDA 3235862	0.58	260.2
00485495-2504100	0.54	242.4
LEDA 3235917	0.54	293.7

Zoom in to see galaxies
Area of square proportional to probability

200 most probable galaxies are listed

Click on name or yellow square for galaxy info from NED

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9 contour lines show percentiles of the probabilit

- Coverage: shows if the ZTF survey has cov
- Candidates: Shows the ZTF candidates sur
- Galaxies: Shows galaxies that may have the

Remember to click "submit" to refresh the page.

Distance	267.4 ± 51.6 Mpc
ISO Date:	2019-08-14T21:10
Julian date:	2458710.382
Percent probability:	BNS=0.0, NSBH=0
max prob RA,Dec	12.8, -25.2

☐ Coverage of ZTF From

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Lasair and Jupyter

Below are some Jupyter notebooks that use the ZTF candidate catalog. If you have a login, use the server that can connect to the ZTF database at https://jupyter.lsst.uk. Logging in is via a user's institutional credentials, rather than having to remember yet another username/password combination. Access is on a limited basis, since Lasair is a technology prototype, not a production system; to make a request, write to lasair-help@lists.roe.ac.uk saying what you would like to do with the Jupyter access to Lasair.

There are a few notebooks listed below. These and many others can be downloaded with the command
git clone https://github.com/lsst-uk/jupyter_notebooks

- Fetching data from many sources: Transient Name Server, PanSTARRS images, Open Astronomy catalogs. (HTML, ipynb)
- Find transients in a host galaxy much more luminous than the host (HTML, ipynb)
- Plotting the path of a Kuiper belt object Makemake (HTML, ipynb)
- Light curves of frequently-observed minor planets (HTML, ipynb)
- Display an object in Jupyter that replicates the web page for the object (HTML, ipynb)
- Plotting sky coverage on Mollweide projection (HTML, ipynb)
- Star/galaxy separation analysis (HTML, ipynb)

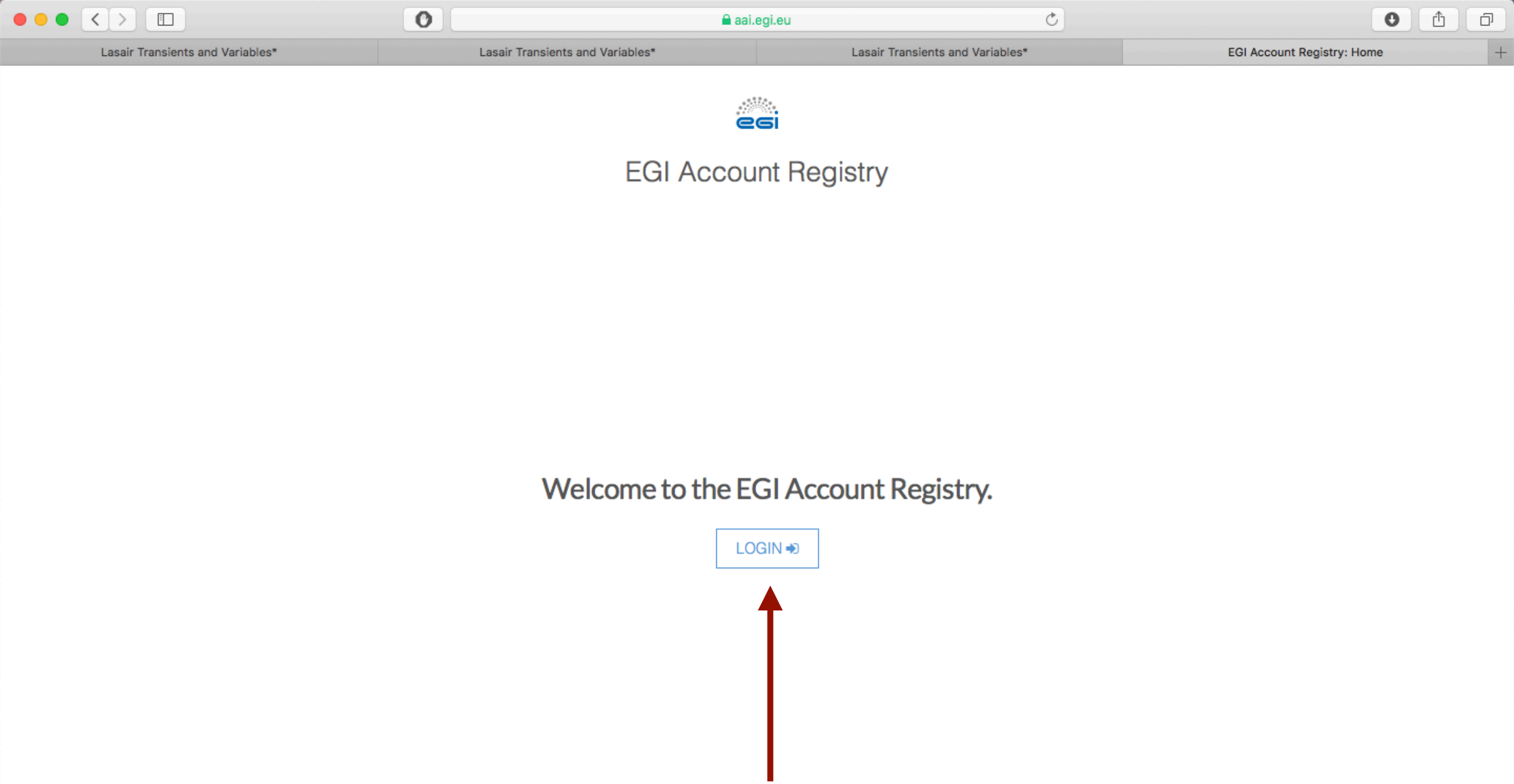
Example notebooks available

Please Contact us with any notebooks that you would like to share.

Pro-level users:
Login* to our Jupyter service and access the database with Python

Do your analysis within Lasair and output only the results!

*this is a separate, more restricted account
(but if you're a real astronomer, you will be approved)


aai.egi.eu
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EGI Account Registry: Home
EGI Account Registry
Welcome to the EGI Account Registry.
LOGIN
Once approved for Jupyter access,
sign up via: aai.egi.eu

Check-in

Choose your academic/social account

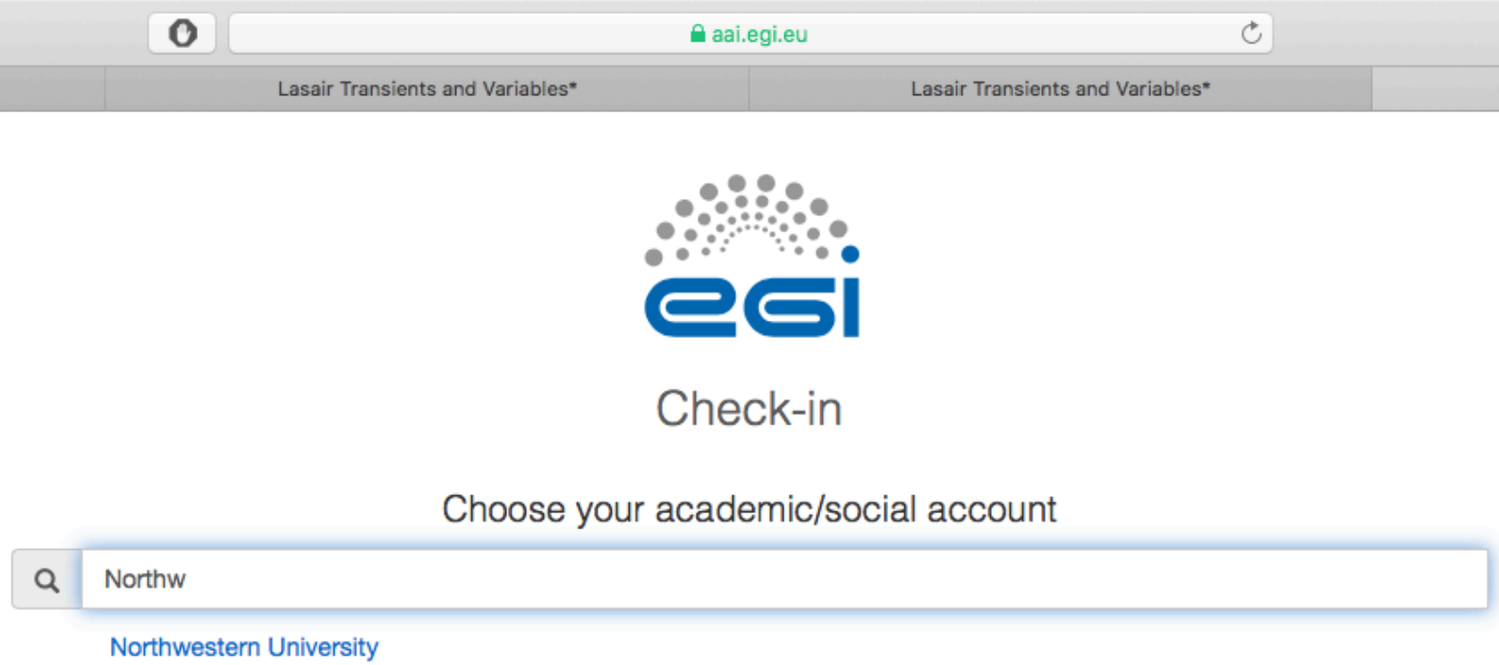
Search...

University of Edinburgh
A. T. Still University
AAF Virtual Home
AAI@EduHr Single Sign-On Service
Aalborg University
Aalto University
Aarhus School of Marine and Technical Engineering
Aarhus University
Abertay University
Aberystwyth University
Aberystwyth University IdP 3.1 Test
ABES - French Bibliographic Agency for Higher Education
Abingdon and Witney College
Absalon University College
Academic Analytics
Academic Scientific Research Computer Network of Armenia (ASNET-AM)

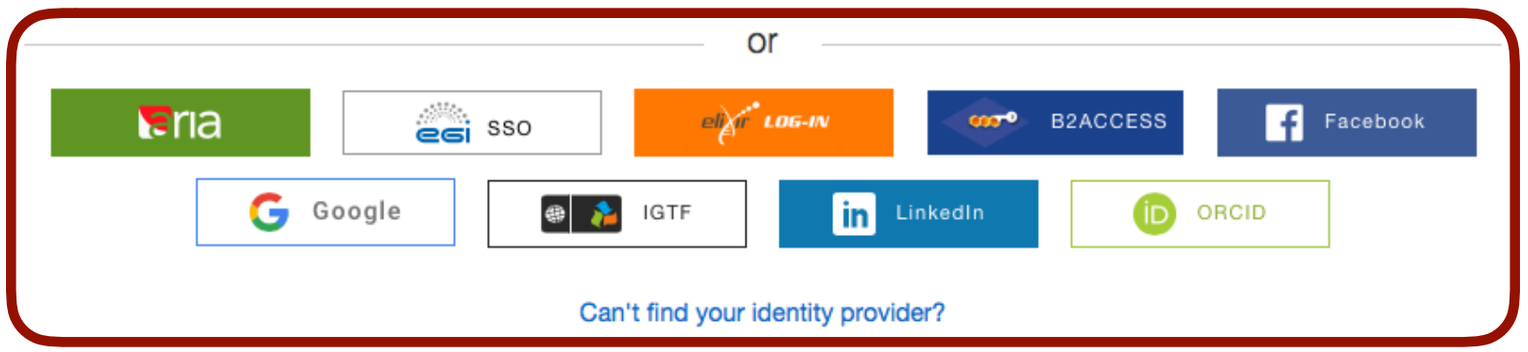
or

ria | egi SSO | elixir LOG-IN | B2ACCESS | Facebook | Google | IGTF | LinkedIn | ORCID

Can't find your identity provider?



Or if you can’t find your institution, can use social account



jupyter.lsst.ac.uk

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Spawner Options

Image ZTF Notebook Size Small (1G / 1 CPU) Group UKLSST

Spawn

Specify memory needed

Start session

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Files | Running | Clusters

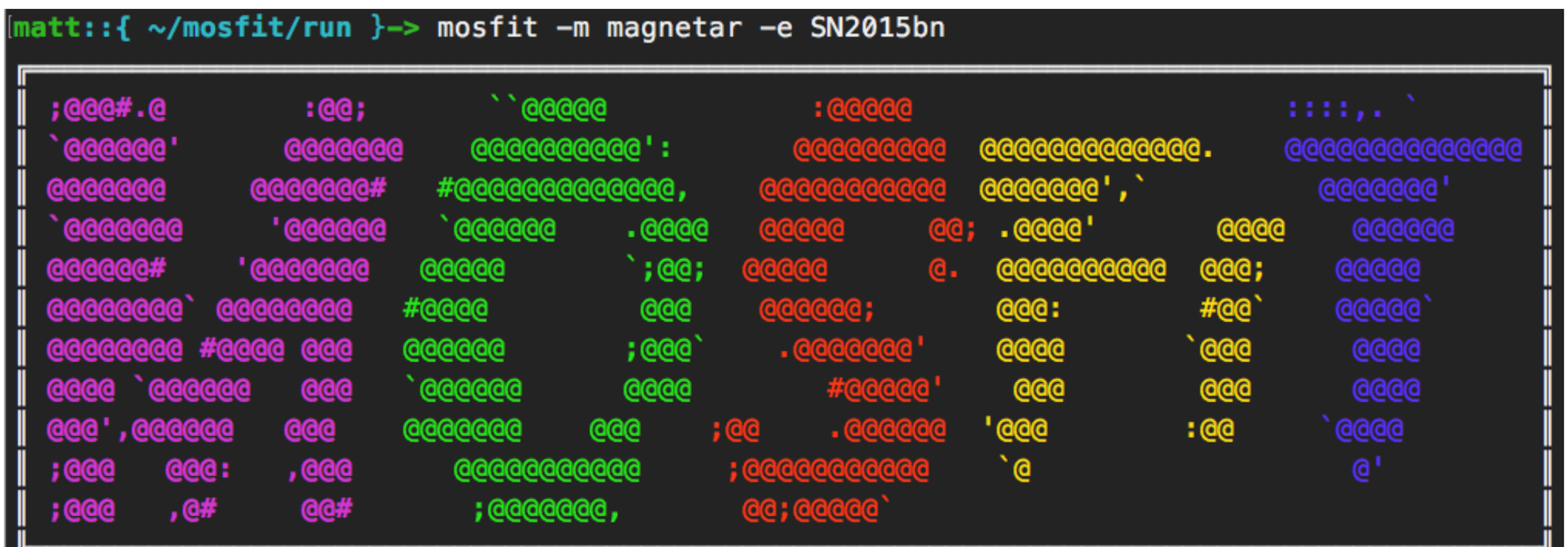
Select items to perform actions on them.

Upload | New | Refresh

0 /	Name	Last Modified	File size
cache		a month ago	
cutouts		2 days ago	
jupyter		a month ago	
models		a month ago	
modules		a month ago	
old-snails		3 days ago	
products		2 days ago	
skymaps		2 minutes ago	
targets		2 days ago	
C-SNAILS.ipynb		a minute ago	389 kB
mosfit.ipynb		seconds ago	350 kB
skymaps_Fergus_Davidson.ipynb		19 hours ago	107 kB
password.txt		2 days ago	10 B
settings.py		2 months ago	77 B
tns-api-key.txt		seconds ago	40 B

Built-in modelling!

```
matt::{ ~/mosfit/run }-> mosfit -m magnetar -e SN2015bn
```



```
### MOSFiT -- Version 1.1.6 (7028be609f40ab86) ###
    Authored by James Guillochon & Matt Nicholl
Additional contributions from Brenna Mockler & Ashley Villar
            Released under the MIT license

Code: https://github.com/guillochon/MOSFiT
Documentation: https://mosfit.readthedocs.io
```

Guillochon, Nicholl+ 2018

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mosfit Last Checkpoint: an hour ago (unsaved changes)

Logout | Control Panel

File Edit View Insert Cell Kernel Widgets Help | Trusted | Python 3

Run | Code

A ZTF transient you like
(or the result of some query)

Specify model, and redshift if possible

Fixed params to
speed up fit

Available models

Simple API to get object page in JSON:
https://lasair.roe.ac.uk/object/ZTF19…/json/

In [3]:
```
transient = 'ZTF19aamrais'

redshift = '0.11'

model = 'slsn'

fixed_parameters = 'kappa 0.1 kappagamma 0.01 Mns 2.0 thetapb 1.57 temperature 6000.0 nhhost 1.8e16'

# models: csm, csmni, default (nickelcobalt), ia, ic, kilonova, magnetar, magni, rprocess, slsn, tde
# csm, slsn, default, tde, kilonova are most reliable
```

In [4]:
```
import matplotlib.pyplot as plt
import numpy as np
from collections import OrderedDict
import os

%matplotlib inline

# Sometimes needed to prevent a weird import error
%env GIT_PYTHON_REFRESH=quiet

import mosfit

import time

start = time.time()
```

```
env: GIT_PYTHON_REFRESH=quiet
```

In [5]:
```
# Get Lasair data for specified transient in JSON format

import requests
import json

query_url = 'https://lasair.roe.ac.uk/object/'+transient+'/json/'

data = requests.get(query_url)

data = data.json()
```

In [6]:
```
# Restructure for compatibility with MOSFiT, i.e. Astrocats format, starting with metadata

newdict = {}

newdict[transient] = {
```

In [6]:
```
# Restructure for compatibility with MOSFiT, i.e. Astrocats format, starting with metadata

newdict = {}

newdict[transient] = {
    "name":transient,
    "sources":
        [
            {
                "name":"ZTF Alerts",
                "bibcode":"2019PASP..131a8001P",
                "alias":"1"
            },
            {
                "name":"Lasair",
                "bibcode":"2019RNAAS...3a..26S",
                "alias":"2"
            },
            {
                "name":"Transient Name Server",
                "reference":"https://wis-tns.weizmann.ac.il",
                "alias":"3"
            }
        ],
    "alias":
        [
            {
                "value":transient,
                "source":"1"
            }
        ],
    "photometry":
        [
        ]
}
```

These cells convert to Open Supernova Catalog format for MOSFiT

In [7]:
```
# Populate photometry in Astrocats format from ZTF candidates

for i in data['candidates']:
    if i['fid'] == 1:
        band = "g"
    elif i['fid'] == 2:
        band = "r"
    elif i['fid'] == 3:
        band = "i"
    else:
        band = ""

    if not 'diffmaglim' in i:
        if i['isdiffpos'] == 't':
            newdict[transient]["photometry"].append(
                {
                    "time":str(i['mjd']),
                    "u_time":"MJD",
                    "band":band,
                    "magnitude":str(i['magpsf']),
                    "e_magnitude":str(i['sigmapsf']),
                    "telescope":"ZTF",
                    "instrument":"ZTF",
                    "source":"1,2"
```

In [8]:
```
# Check for classification and redshift in TNS

tns_url = "https://wis-tns.weizmann.ac.il/api/get/"
with open('tns-api-key.txt','r') as f:
    api_key = f.read()


search_obj = OrderedDict([("ra",data['objectData']['ramean']), ("dec",data['objectData']['decmean']),
                ("radius","2.5"), ("units","arcsec"), ("objname",""), ("internal_name","")])

search_url = tns_url+'search'
search_data = [('api_key',(None, api_key)), ('data',(None,json.dumps(search_obj)))]

r = requests.post(search_url, files=search_data)
# If transient is known, will have an IAU name (AT/SN 20XXyy), add such names to our objects
if r.json()['data']['reply']:
    iau_name = r.json()['data']['reply'][0]['objname']

    newdict[transient]["alias"].append( { "value":iau_name, "source":"3" } )

    # Now check if object has a classification attached
    # Always will for 'SN' names, but could also happen for 'AT', e.g. if TDE rather than SN
    get_obj = OrderedDict([("objname",iau_name), ("photometry","0"), ("spectra","0")])
    get_url = tns_url+'object'
    get_data = [('api_key',(None, api_key)), ('data',(None,json.dumps(get_obj)))]

    r2 = requests.post(get_url, files=get_data)

    # If classified, add type to dictionary
    if r2.json()['data']['reply']['object_type']['name']:

        print(r2.json()['data']['reply']['object_type']['name'])

        newdict[transient]["claimedtype"] = [
            {
                "value":r2.json()['data']['reply']['object_type']['name'],
                "source":"3"
            }
                ]

        print(r2.json()['data']['reply']['redshift'])

        newdict[transient]["redshift"] = [
            {
                "value":str(r2.json()['data']['reply']['redshift']),
                "source":"3"
            }
                ]
    else:
        newdict[transient]["redshift"] = [
            {
                "value":str(redshift),
                "source":"2"
            }
                ]
```

```
SLSN-II
0.1173
```

Check in TNS, get type and more accurate redshift

In [9]:
```
# Write MOSFiT-compatible json to file

with open(transient+'.json', 'w') as outfile:
    json.dump(newdict, outfile, indent='\t')
```

Save formatted data

In [38]:
```
os.system('mosfit -e ./'+transient+'.json -m '+model+' -F '+fixed_parameters+
          ' -i 500 -N 80 --local-data-only --cache-path ./cache --quiet -S 50 -E 30 30')

# The --cache-path flag is essential to avoid permissions issues!!!
```

Out[38]: 0

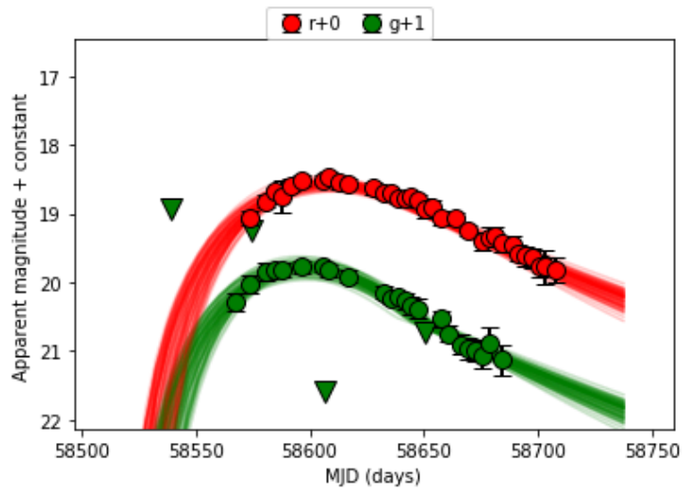
In [39]:
```
# Plot light curve

filts = {'u': 'u', 'g': 'g', 'r': 'r', 'i': 'i', 'z': 'z', 'y': 'y', 'Y': 'y', "u'": 'u', "g'": 'g', "r'": 'r', "i'": '
        'U': 'U', 'B': 'B', 'V': 'V', 'R': 'R', 'R_s': 'R', 'F625W': 'r', 'F625W_ACS': 'r', 'I': 'I', 'J': 'J', 'H': 'H
        'UVW2': 'W2', 'UVM2': 'M2', 'UVW1': 'W1', 'F606W': 'R', 'F475W': 'g', 'F775W': 'i', 'F850W': 'z', 'F814W': 'I',
        'FUV': 'FUV', 'NUV': 'NUV', 'F110W_IR': 'J', 'F160W_IR': 'H', 'F475W_ACS': 'g', 'F775W_ACS': 'i', 'F850W_ACS':

cols = {'u': 'midnightblue', 'g': 'g', 'r': 'r', 'i': 'gold', 'z': '0.2', 'y': 'hotpink', 'U': 'indigo', 'B': 'b', 'V':
        'I': 'darkgoldenrod', 'J': 'peru', 'H': 'brown', 'K': 'orange', 'G': 'k', 'W2': 'blueviolet', 'M2': 'mediumslat
        'FUV': 'hotpink', 'NUV': 'cyan', 'F218W':'C0', 'F225W':'C1', 'F275W':'C2', 'F336W':'C3'}

offset = {'u': +2, 'g': +1, 'r': +0, 'i': -1.5, 'z': -5, 'y': -2.5, 'U': +4.5, 'B': +3, 'V': +1.5, 'R': -0.3, 'o': -1.3
          'G': -2, 'W2': +8, 'M2': +7, 'W1': +6, 'FUV': +5, 'NUV': +4.5, 'F218W':+8, 'F225W':+7, 'F275W':+6, 'F336W':+5

order = ['UVW2','W2','UVM2','M2','UVW1','W1','U','u',"u'",'B','g',"g'",'V','r', "r'",'R','R_s','i',"i'",'I','z',"z'",'y


fig = plt.figure(1)
plt.clf()
```

Initiate quick run of MOSFiT using only local data and no interactive prompts

```
with open('products/walkers.json', 'r') as f:
    data = json.loads(f.read())

data = data[list(data.keys())[0]]
lc1 = data['photometry']

lc = []
lims = []

mod_lc = {}
n_walkers = len(data['models'][0]['realizations'])
for i in range(1,n_walkers+1):
    mod_lc[str(i)] = []

listbands = []
listcombos = []

# Identify real data and models and sort by bands
for i in lc1:
    if 'model' in i:
        if not 'telescope' in i:
            i['telescope'] = 'generic'
        if not 'instrument' in i:
            i['instrument'] = 'generic'
        if not 'system' in i:
            i['system'] = 'generic'
        combo = filts[i['band']]+i['system']+i['telescope']+i['instrument']
        mod_lc[i['realization']].append([i['time'],i['magnitude'],filts[i['band']],combo])
```

(Plotting stuff)

```
plt.show()
```



Success!

In [42]:
```
# From MOSFiT default notebook, by James Guillochon

# import corner

# import logging
# logging.disable(logging.WARNING)

# model = data['models'][0]


# # Construct walker arrays for corner
# corner_input = []
# pars = [x for x in model['setup'] if model['setup'][x].get('kind') == 'parameter' and
#         'min_value' in model['setup'][x] and 'max_value' in model['setup'][x]]
# weights = []
# for realization in model['realizations']:
#     par_vals = realization['parameters']
#     if 'weight' in realization:
#         weights.append(float(realization['weight']))
#     var_names = ['$' + ('\\log\\, ' if par_vals[x].get('log') else '') +
#                  par_vals[x]['latex'] + '$' for x in par_vals if x in pars and 'fraction' in par_vals[x]]
#     corner_input.append([np.log10(par_vals[x]['value']) if
#                          par_vals[x].get('log') else par_vals[x]['value'] for x in par_vals
#                          if x in pars and 'fraction' in par_vals[x]])
# weights = weights if len(weights) else None
# ranges = [0.999 for x in range(len(corner_input[0]))]
# cfig = corner.corner(corner_input, labels=var_names, quantiles=[0.16, 0.5, 0.84],
#                      show_titles=True, weights=weights, range=ranges)
```

In [40]:
```
print('Time taken = %d' %(time.time()-start))
```

```
Time taken = 328
```

And only took 5 minutes for OK solution

Lasair

C-SNAILS: Classification Survey for Nuclear trAnslents with Liverpool and LaSair

Matt Nicholl RAS Fellow University of Edinburgh

jupyter.lsst.ac.uk

Lasair Transients and Variables* | Lasair Transients and Variables* | Home | C-SNAILS

C-SNAILS Last Checkpoint: a minute ago (autosaved)

Logout | Control Panel

File Edit View Insert Cell Kernel Widgets Help

Trusted | Python 3

Run | Code

In [1]:
```
# List objects in queue here

in_queue = ['ZTF19abnmnrz','ZTF19abocled','ZTF19abpangr']

# Classifications so far:

classified = {}

classified['ZTF19abclykm'] = {'class':'SLSN IIn z=0.092 (LT)'}
classified['ZTF19abcudso'] = {'class':'AGN z=0.22 (LT)'}
classified['ZTF19abgcbey'] = {'class':'SN Ia z=0.056 (LT)'}
classified['ZTF19abgcnqu'] = {'class':'CV (LT)'}
classified['ZTF19abfpvle'] = {'class':'SN Ia? z=0.1 (LT)'}
classified['ZTF19abidbya'] = {'class':'Blue continuum (LT)'}
classified['ZTF19abgjlef'] = {'class':'SN Ia z=0.058 (LT)'}
classified['ZTF19abhisnk'] = {'class':'Blue continuum z=0.0788 (LT)'}
classified['ZTF19abhhjcc'] = {'class':'Blue continuum z=0.1525 (LT)'}
classified['ZTF19abdkcye'] = {'class':'Unclear, broad features, needs better reduction (LT)'}
classified['ZTF19abidfsb'] = {'class':'Blue continuum z=0.076 (LT)'}
classified['ZTF19abjioie'] = {'class':'Blue continuum, broad(?) Ha, z=0.087 (LT)}'}
classified['ZTF19abjjyps'] = {'class':'Observed, data not yet processed'}
classified['ZTF19ablesob'] = {'class':'SN Ic z=0.056 (LT)'}
classified['ZTF19abkfxfb'] = {'class':'SN II z=0.032 (LT)'}
```

In [2]:
```
import mysql.connector
%matplotlib inline
import matplotlib.pyplot as plt
import numpy as np
import requests
import json
from collections import OrderedDict
import wget
import matplotlib.image as mpimg
import os
from astropy.table import Table
import time
from astropy.io import ascii
from datetime import date
import glob
import smtplib, ssl


# connect to database (from Roy's code)
import settings
msl = mysql.connector.connect(\
          user    =settings.DB_USER, \
```

Early results

2019-08-01 14:06:41 Type: Object/s-Discovery/Classification

C-SNAILS spectra of optical transients

Authors: Matt Nicholl, Phil Short, Andy Lawrence, Nic Ross (Edinburgh), Stephen Smartt (QUB)

Source Group: C-SNAILS

Keywords: Time-domain,

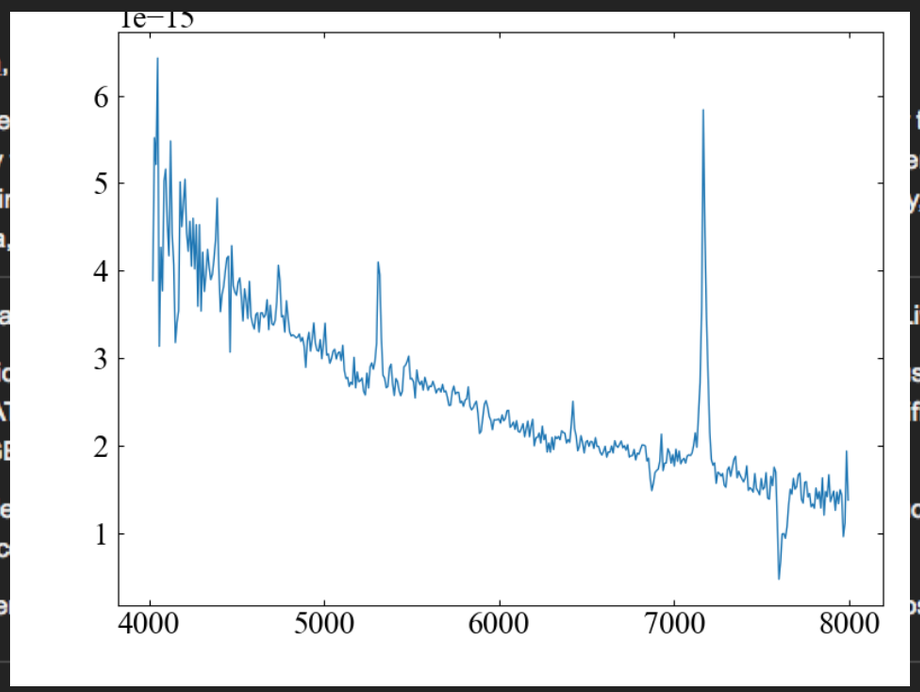
Abstract: We announce transients with Liverpool and LaSair. C-SNAILS targets are selected automatically r. Classification spectra are obtained using the Liverpool Telescope and SPRAT. Our i , we have identified 4 nuclear transients showing relatively featureless blue continua,

We announce the first observa iverpool and LaSair.

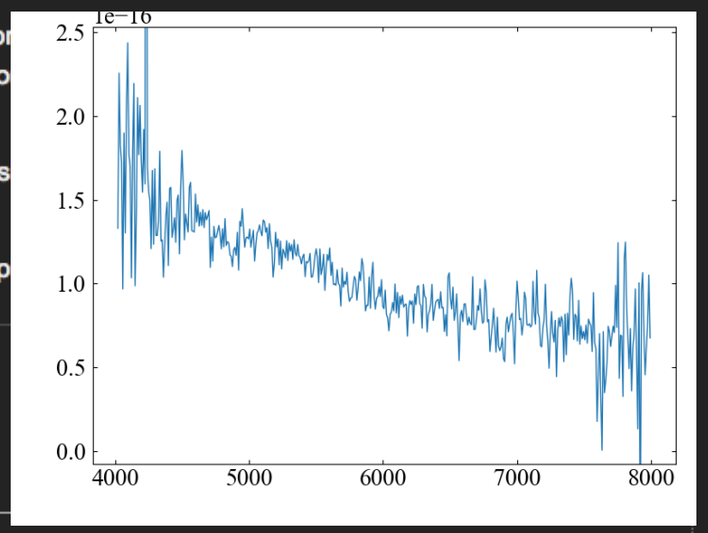
Targets are selected automatic sing the Lasair br spectroscopically using SPRAT fications were do (Blondin & Tonry 2007) and GE

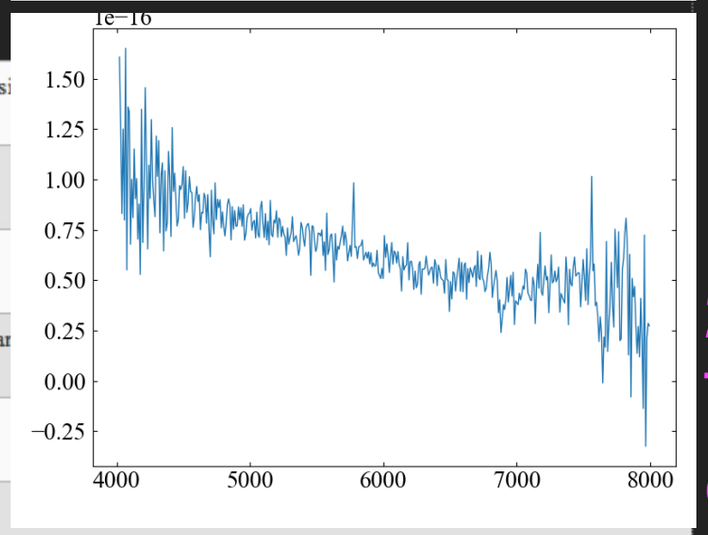
Our initial observations include clear transients s 0.15. Follow-up of these sourc

AT2019meg is particularly inte ossible bump or p



1 superluminous supernova IIn





2 good TDE candidates

Related Objects:

Show current TNS values

Catalog	Name	Reported RA	Reported DEC	Reported Obj-Type	Reported Redshift	Host Name	Host Redshift	Remarks
TNS	2019meh [ZTF19abclykm]	21:27:17.452	+64:24:59.17	SLSN-II	0.093			Narrow/intermediate width Balmer and He I emissi and a peak luminosity ~ -22.5 mag
TNS	2019mei [ZTF19abcudso]	19:57:19.998	+09:31:32.35	AGN	0.212			
TNS	2019lky [ZTF19abgjlef]	00:29:47.679	+17:33:26.90	SN Ia	0.058			
TNS	2019lby [ZTF19abfpvle]	21:14:04.522	-11:35:26.83	SN I	0.1			Redshift from template matching. DASH prefers ar Spectrum includes substantial host contribution.
TNS	2019lse [ZTF19abhisnk]	01:54:50.725	+41:05:48.32	Other	0.079			Blue continuum, host emission lines
TNS	2019mal [ZTF19abidfsb]	23:09:06.584	-17:40:27.34	Other	0.076			Blue continuum, host emission lines
TNS	2019meg [ZTF19abhhjcc]	18:45:16.178	+44:26:19.14	Other	0.152			Blue continuum, host emission lines. At this redshift the transient has an absolute mag ~ -20.1. Early light curve may exhibit a bump/plateau.
TNS	2019lwu [ZTF19abidbya]	23:11:12.315	-01:00:10.80	Other				Blue continuum, agrees with ePESSTO+ observations (AstroNote #2019-58)

Matt Nicholl RAS Fellow University of Edinburgh

Next steps…

Experimenting with new technologies for faster DB access

Scalability for LSST

More cross-matching, e.g. importing PS1 catalog to Sherlock

Automated alerts (already exist for GW) based on filters and watchlists

Machine learning light curve classification (RAPID - see Daniel Muthukrishna's talk)

Tell me what *you* want from Lasair and we'll help you do it!