

---



# **lasair Documentation**

***Release v4.1.0***

**Lasair Team**

**2022**



## CORE SERVICES

<b>1</b>	<b>Lasair Search</b>	<b>3</b>
<b>2</b>	<b>Transient Metadata Tags</b>	<b>9</b>
<b>3</b>	<b>Watchlists</b>	<b>15</b>
<b>4</b>	<b>Sky Regions</b>	<b>27</b>
<b>5</b>	<b>Alert Streams</b>	<b>33</b>
<b>6</b>	<b>Lasair API</b>	<b>35</b>
<b>7</b>	<b>Python Notebooks</b>	<b>37</b>
<b>8</b>	<b>FAQs</b>	<b>39</b>
<b>9</b>	<b>Contact Us</b>	<b>45</b>
<b>10</b>	<b>Lasair Talks</b>	<b>47</b>
<b>11</b>	<b>Todo List</b>	<b>49</b>





*Lasair* is being developed by The University of Edinburgh and Queen's University Belfast with the ultimate goal of serving transient alerts from the future [Rubin Legacy Survey of Space and Time \(LSST\)](#) to the astronomical community. *Lasair* (pronounced 'L-AH-s-uh-r') means flame or flash in Scots and Irish gaelic. To prototype functionality needed to process transient event alerts from LSST, Lasair is currently processing and serving data from the public stream of the [Zwicky Transient Facility \(ZTF\)](#), which is releasing a transient alert stream in a format similar to that envisaged for LSST. We thank ZTF for access to this valuable public data stream.

If you make use of Lasair in any of your work, please remember to cite our paper:

*Lasair: The Transient Alert Broker for LSST:UK*, K. W. Smith, R. D. Williams et. al., Research Notes AAS, 3,26 (2019).

Documentation for Lasair is hosted on [Read the Docs](#). The code lives on [github](#).

If you are new to Lasair, start here by learning about our core features:





## LASAIR SEARCH

### Table of Contents

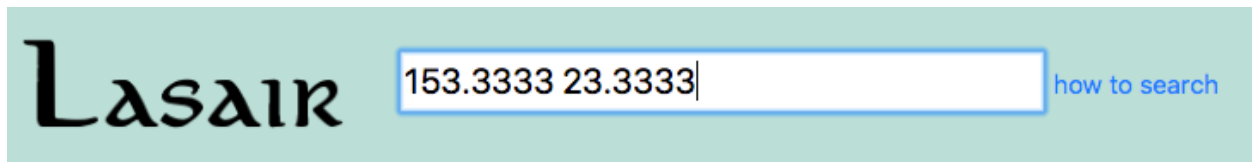
- *The Search Bar*
- *Deep Search*
  - *How to query transients*

## 1.1 The Search Bar

---

### Todo:

- Flesh out how to use the lasair search bar ... text below is from old pages
- 



At the top of every Lasair page is a form that can be filled in to do a cone search. just fill in the coordinates and hit return/enter. Several syntaxes are supported here, including these:

```
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
```

... cone beginning with ...

22.5957 32.8977

Run Cone Search

RA,Dec,radius=22.59570,32.89770,5.0

1 objects found in cone

- [ZTF19acwkwhu](#)

Examples of searches:

- ZTF18acsovsw
- ZTF18acsovsw, ZTF19aagqkrq, ZTF18aawohdr
- 141.15725 25.39508

Results appear in a new window, with the text that was typed, and links to the object that was found, here [ZTF19acwkwhu](#).

## 1.2 Deep Search

---

### Todo:

- Flesh out how to use the lasair deep search/watchlists ... text below is from old pages
- 

### 1.2.1 How to query transients

The Lasair database has information about objects and candidates. Each candidate is a detection made by the telescope, and the collection of detections of a given star is an object. Queries are written with the SQL language, that is built in three pieces through the Lasair web interface:

- WHAT you are selecting (“Select Attributes”)
- WHICH tables to use, and
- CONDITIONS on what you are selecting (“Where”).

Name:

Orion Nebula

Description:

Transients in the Orion Nebula

Active:

☒ Inactive☐ Email to roy@roe.ac.uk (max once a day) and digest☐ Kafka and digestPublic: ☐**SELECT ATTRIBUTES**`objects.objectId, objects.ncandgp`**TABLES TO USE**☐ candidates☐ noncandidates☒ **objects**☐ comments☐ sherlock\_classifications☐ sherlock\_crossmatches**WHERE**`objects.ramean BETWEEN 83.3 AND 84.3 AND  
objects.decmean BETWEEN -5.9 AND -4.9|`[Create query](#)

This example query looks for objects within the Orion Nebula. Once you have logged in to Lasair, you can create a query from the /myquery page, shown at left. Write a name and description, then keep the query inactive and not public (first 2 green boxes). The “select attributes” box has autocomplete for the possible attributes, which are also listed in detail at the /schema page. In this case we chose the object identifier `objectId`, and the number of good candidates, `ncandgp`. Select only the `objects` table – meaning no joins. The “where” box has the square degree of the sky which is the Orion Nebula. Then click “Create query”.

<div>Orion Nebula</div> <div>Edit/delete filter</div> <div>Stream: <i>inactive</i></div>	Transients in the Orion Nebula
--	--------------------------------

Now we can run the query. Go to the page /objlist and find your saved query, then click on its name (green box). The form fields above are now filled in with the details

### SELECT ATTRIBUTES

`objects.objectId, objects.ncandgp`

### TABLES TO USE

- |  |  |   |
|--|--|---|
| <input type="checkbox"/> candidates    | <input checked="" type="checkbox"/> <b>objects</b> | <input type="checkbox"/> comments                 |
| <input type="checkbox"/> noncandidates |  | <input type="checkbox"/> sherlock_classifications |
|  |  | <input type="checkbox"/> sherlock_crossmatches    |

### WHERE

`objects.ramean BETWEEN 83.3 AND 84.3 AND  
objects.decmean BETWEEN -5.9 AND -4.9`

☒ Include only recent events (10 days)

**Run Filter** (check this box for JSON output ☐)

In addition to the saved query, we can add an additional constraint (green box), where we restrict to objects that have had a detection in the last 10 days. Now click “Run filter”.

Showing results for query:

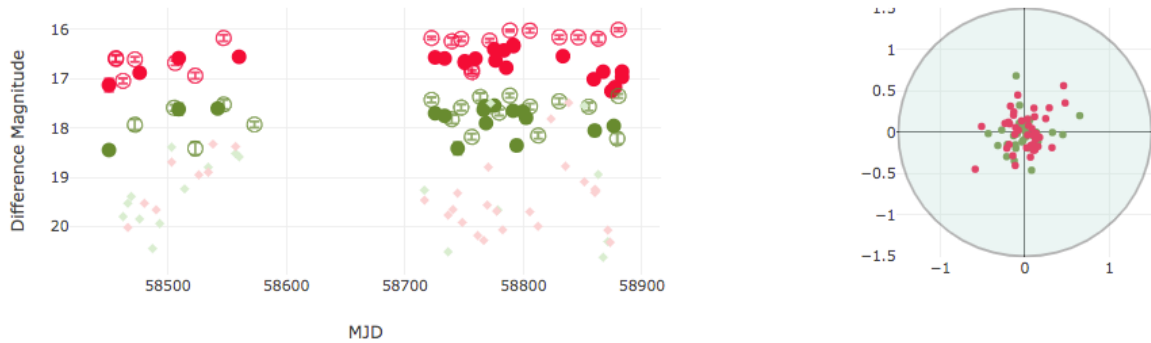
```
SELECT /*+ MAX_EXECUTION_TIME(300000) */ objects.objectId, objects.ncandgp FROM objects WHERE  
objects.jdmax > JDNOW() - 10.00000 AND objects.ramean BETWEEN 83.3 AND 84.3 AND objects.decmean  
BETWEEN -5.9 AND -4.9 LIMIT 1000 OFFSET 0
```

Showing results 0-317

objectId	ncandgp
<a href="#">ZTF17aaawtse</a>	6
<a href="#">ZTF18acrunqt</a>	7
<a href="#">ZTF17aaarsra</a>	14
<a href="#">ZTF18acrunku</a>	28
<a href="#">ZTF18acrunrp</a>	8
<a href="#">ZTF17aabsape</a>	16

The results appear, as a table with the columns as specified in the “select attributes” part of the query. The actual SQL that runs against the database is shown. You can see (red boxes) an execution time limit of 300 seconds, the “recent” events constraint written as `objects.jdmax > JDNOW() - 10.00000`, and a limit of 1000 results. If more, there will be a link to the next page of results. Notice that the `objectId` is a link

## Object ZTF18acrunqu



● Difference Magnitude | ● Apparent Magnitude (see [note](#))

- Object has 76 candidates, at mean position:
  - (RA, Dec) = (83.775661, -5.758673)
  - (RA, Dec) = (05:35:6.159, -05:45:31.225)
  - (galactic\_lon, galactic\_lat) = (209.339516, -19.588765)
  - (ecliptic\_lon, ecliptic\_lat) = (82.912070, -29.044947)
- NOTE: There are 37 of 76 candidates (below) where the detected brightness is less than the reference brightness (where the magnitude is followed by "f"), also indicated by an open circle in the light curve above
- Classified as VS at distance 0.10 arcsec.
- .
- The transient is synonymous with 3017246067680808832/05350614-0; a B=19.15 mag stellar source four in the GAIA/2MASS/SDSS/GSC/NED catalogues. It's located 0.1 from the stellar source core.
- Information on this webpage also [available as JSON](#).
- [Galactic Extinction](#)
- Conesearch Links (at 5 arcsec): | [Simbad](#) | [NED](#) | [Transient Name Server](#) | [ZTF DR1](#)

This is the information page for a Lasair object. You can see the light curve (top left) and sky locations for the candidates. There is a wealth of information (see this page). In particular, you can click on the “Simbad” link, which fetches information about this source.

## Basic data :

**V\* V482 Ori** -- Variable Star of Orion Type

Distance to the center *arcsec*: 0.06

Other object types: X (CXORRS,SOXS,...), \* ([Ref](#),Haro,...), (V\*,[R2001]), TT? ([Ref](#)), \*iN (Pare)

**ICRS** coord. (*ep=J2000*) : 05 35 06.1550589244 -05 45 31.250

**FK4** coord. (*ep=B1950 eq=1950*) : 05 32 39.1286189404 -05 47 25.346

**Gal** coord. (*ep=J2000*) : 209.3395153834819 -19.58878127285

The Simbad database tells us that the star we selected is a Variable Star of Orion type.

## TRANSIENT METADATA TAGS

---

### Todo:

- Clean up this metadata tag page ... text below is from old pages
- 

### Table of Contents

- *What are Metadata Tags?*
- *Sherlock*
  - *References*
- *Gravitational Wave Regions*
- *alerce\_lc*
- *fastfinder*
- *fink\_early\_sn*

## 2.1 What are Metadata Tags?

## 2.2 Sherlock

Detections in the input data stream that have been aggregated into *objects* (i.e. groups of detections) and identified as static transients (i.e. not moving objects) are spatially context classified against a large number of archival sources (e.g. nearby galaxies, known CVs, AGNs, etc). The information derived from this context check is injected as an object annotation (e.g. see Lasair object page example below). The software used is called *Sherlock* and is discussed below.

*Sherlock* is a software package and integrated massive database system that provides a rapid and reliable spatial cross-match service for any astrophysical variable or transient. The concept originated in the PhD thesis of D. Young at QUB, and has been developed by Young et al. in many iterations and cycles since. It associates the position of a transient with all major astronomical catalogues and assigns a basic classification to the transient. At its most basic, it separates stars, AGN and supernova-like transients. It has been tested within QUB on a daily basis with ATLAS and Pan-STARRS transients, and within PESSTO as part of the PESSTO marshall system that allows prioritising of targets. It is thus a boosted decision tree algorithm. A full paper describing the code, catalogues and algorithms is in preparation (Young et al. in prep). A summary is included in Section 4.2 of “Design and Operation of the ATLAS Transient Science Server” (Smith, Smartt, Young et al. 2020, submitted to PASP: <https://arxiv.org/abs/2003.09052>). We label the current version as the official release of Sherlock 2.0. The major upgrade from previous versions are that

it includes Pan-STARRS DR1 (including the Tachibana & Miller 2018 star-galaxy separation index) and Gaia DR2 catalogues, along with some adjustments to the ranking algorithm.

**That section is copied here and users should currently cite that paper (Smith et al. 2020) for *Sherlock* use:**

A boosted decision tree algorithm (internally known as *Sherlock*) mines a library of historical and on-going astronomical survey data and attempts to predict the nature of the object based on the resulting crossmatched associations found. One of the main purposes of this is to identify variable stars, since they make up about 50% of the objects, and to associate candidate extragalactic sources with potential host galaxies. The full details of this general purpose algorithm and its implementation will be presented in an upcoming paper (Young et al. in prep), and we give an outline of the algorithm here.

The library of catalogues contains datasets from many all-sky surveys such as the major Gaia DR1 and DR2 (Gaia Collaboration et al. 2016, 2018), the Pan-STARRS1 Science Consortium surveys (Chambers et al. 2016; Magnier, Chambers, et al. 2016; Magnier, Sweeney, et al. 2016; Magnier, Schlafly, et al. 2016; Flewelling et al. 2016) and the catalogue of probabilistic classifications of unresolved point sources by (Tachibana and Miller 2018) which is based on the Pan-STARRS1 survey data. The SDSS DR12 PhotoObjAll Table, SDSS DR12 SpecObjAll Table (Alam et al. 2015) usefully contains both reliable star-galaxy separation and photometric redshifts which are useful in transient source classification. Extensive catalogues with lesser spatial resolution or colour information that we use are the GSC v2.3 (Lasker et al. 2008) and 2MASS catalogues (Skrutskie et al. 2006). *Sherlock* employs many smaller source-specific catalogues such as Million Quasars Catalog v5.2 (Flesch 2019), Veron-Cett AGN Catalogue v13 (Véron-Cetty and Véron 2010), Downes Catalog of CVs (Downes et al. 2001), Ritter Cataclysmic Binaries Catalog v7.21 (Ritter and Kolb 2003). For spectroscopic redshifts we use the GLADE Galaxy Catalogue v2.3 (Dálya et al. 2018) and the NED-D Galaxy Catalogue v13.11. *Sherlock* also has the ability to remotely query the NASA/IPAC Extragalactic Database, caching results locally to speed up future searches targeting the same region of sky, and in this way we have built up an almost complete local copy of the NED catalogue. More catalogues are continually being added to the library as they are published and become publicly available.

At a base-level of matching *Sherlock* distinguishes between transient objects *synonymous* with (the same as, or very closely linked, to) and those it deems as merely *associated* with the catalogued source. The resulting classifications are tagged as *synonyms* and *associations*, with synonyms providing intrinsically more secure transient nature predictions than associations. For example, an object arising from a variable star flux variation would be labeled as *synonymous* with its host star since it would be astrometrically coincident (assuming no proper motion) with the catalogued source. Whereas an extragalactic supernova would typically be *associated* with its host galaxy - offset from the core, but close enough to be physically associated. Depending on the underpinning characteristics of the source, there are 7 types of predicted-nature classifications that *Sherlock* will assign to a transient:

1. **Variable Star** (VS) if the transient lies within the synonym radius of a catalogued point-source,
2. **Cataclysmic Variable** (CV) if the transient lies within the synonym radius of a catalogued CV,
3. **Bright Star** (BS) if the transient is not matched against the synonym radius of a star but is associated within the magnitude-dependent association radius,
4. **Active Galactic Nucleus** (AGN) if the transient falls within the synonym radius of catalogued AGN or QSO.
5. **Nuclear Transient** (NT) if the transient falls within the synonym radius of the core of a resolved galaxy,
6. **Supernova** (SN) if the transient is not classified as an NT but is found within the magnitude-, morphology- or distance-dependant association radius of a galaxy, or
7. **Orphan** if the transient fails to be matched against any catalogued source.

For Lasair the synonym radius is set at 1.5. This is the crossmatch-radius used to assign predictions of VS, CV, AGN and NT. The process of attempting to associate a transient with a catalogued galaxy is relatively nuanced compared with other crossmatches as there are often a variety of data assigned to the galaxy that help to greater inform the decision to associate the transient with the galaxy or not. The location of the core of each galaxy is recorded so we will always be able to calculate the angular separation between the transient and the galaxy. However we may also have measurements of the galaxy morphology including the angular size of its semi-major axis. For Lasair we reject associations if a transient is separated more than 2.4 times the semi-major axis from the galaxy, if the semi-major axis

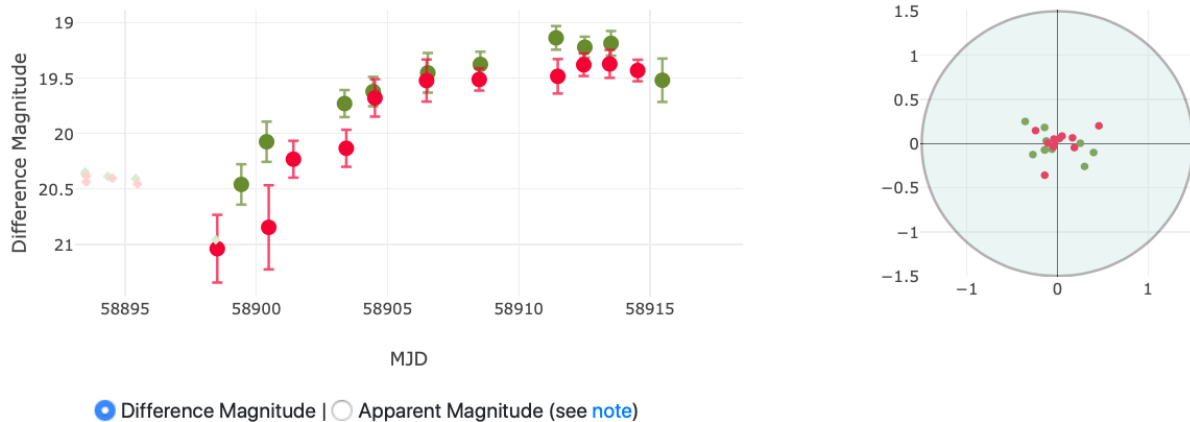


measurement is available for a galaxy. We may also have a distance measurement or redshift for the galaxy enabling us to convert angular separations between transients and galaxies to (projected) physical-distance separations. If a transient is found more than 50 Kpc from a galaxy core the association is rejected.

Once each transient has a set of independently crossmatched synonyms and associations, we need to self-crossmatch these and select the most likely classification. The details of this will be presented in a future paper (Young et al. in prep). Finally the last step is to calculate some value added parameters for the transients, such as absolute peak magnitude if a distance can be assigned from a matched catalogued source, and the predicted nature of each transient is presented to the user along with the lightcurve and other information (see Figure 1).

We have constructed a multi-billion row database which contains all these catalogues. It currently consumes about 4.5TB and sits on a separate, similarly specified machine to that of the Lasair database. It will grow significantly as new catalogues are added (e.g. Pan-STARRS 3\_\_ DR2, VST and VISTA surveys, future Gaia releases etc).

## Object ZTF20aapocis



- Object has 21 candidates, at mean position:
  - (RA, Dec) = (214.593847, 62.298135)
  - (RA, Dec) = (14:18:22.523, 62:17:53.286)
  - (galactic\_lon, galactic\_lat) = (106.694266, 52.002348)
  - (ecliptic\_lon, ecliptic\_lat) = (163.958814, 66.535272)
- Classified as SN at distance 3.96 arcsec.

• The transient is possibly associated with 1237654400235667637/SDSSJ14182; a B=18.13 mag galaxy found in the SDSS/GLADE catalogues. It's located 1.35 S, 4.20 W (9.7 Kpc) from the galaxy centre. A host  $z=0.138$  implies a transient  $M = -18.03$ .

- Information on this webpage also [available as JSON](#).
- [Galactic Extinction](#)
- Conesearch Links (at 5 arcsec): | [Simbad](#) | [NED](#) | [Transient Name Server](#) | [ZTF DR1](#)

Lasair

object page. Non-detections are shown as faint diamonds, which display the  $5\sigma$  limiting magnitude. The object was context classified as a SN by Sherlock, and (probable) host annotations are highlighted in the red box.

**Lasair object page.** Non-detections are shown as faint diamonds, which display the  $5\sigma$  limiting magnitude. The object was context classified as a SN by Sherlock, and (probable) host annotations are highlighted in the red box.

The Sherlock code is open source and can be found at: <https://github.com/thespacedoctor/sherlock>. Documentation is also available online here: <https://qub-sherlock.readthedocs.io/en/stable/>.

Although the code for Sherlock is public, it requires access to a number of large databases which are custom built from their original, public, releases. The latter is proprietary and therefore would require some effort from users to reproduce. As part of the Lasair project we are exploring public access to the integrated Sherlock code and database information through an API.

Sherlock 2.0 was reviewed as a LSST:UK Deliverable in March 2020. The review noted that an algorithm enhancement

would be desirable to take into account stellar proper motions, since some proper motion stars will be variable and if cross-matched with a static catalogue will fall outside the nominal match radius. This is an enhancement we will taken forward for future versions.

## 2.2.1 References

- Alam, Shadab, Franco D Albareti, Carlos Allende Prieto, F Anders, Scott F Anderson, Timothy Anderton, Brett H Andrews, et al. 2015. “The Eleventh and Twelfth Data Releases of the Sloan Digital Sky Survey: Final Data from SDSS-III.” *The Astrophysical Journal Supplement Series* 219 (1). IOP Publishing: 12. <https://doi.org/10.1088/0067-0049/219/1/12>.
- Chambers, K. C., E. A. Magnier, N. Metcalfe, H. A. Flewelling, M. E. Huber, C. Z. Waters, L. Denneau, et al. 2016. “The Pan-STARRS1 Surveys.” *ArXiv E-Prints*, December.
- Dálya, G, G Galgóczi, L Dobos, Z Frei, I S Heng, R Macas, C Messenger, P Raffai, and R S de Souza. 2018. “GLADE: A galaxy catalogue for multimessenger searches in the advanced gravitational-wave detector era.” *Monthly Notices of the Royal Astronomical Society* 479 (2): 2374–81. <https://doi.org/10.1093/mnras/sty1703>.
- Downes, Ronald A, Ronald F Webbink, Michael M Shara, Hans Ritter, Ulrich Kolb, and Hilmar W Duerbeck. 2001. “A Catalog and Atlas of Cataclysmic Variables: The Living Edition.” *The Publications of the Astronomical Society of the Pacific* 113 (7): 764–68. <https://doi.org/10.1086/320802>.
- Flesch, Eric W. 2019. “The Million Quasars (Milliquas) Catalogue, v6.4.” *arXiv.org*, December, arXiv:1912.05614. <http://arxiv.org/abs/1912.05614v1>.
- Flewelling, H. A., E. A. Magnier, K. C. Chambers, J. N. Heasley, C. Holmberg, M. E. Huber, W. Sweeney, et al. 2016. “The Pan-STARRS1 Database and Data Products.” *ArXiv E-Prints*, December.
- Gaia Collaboration, A. G. A. Brown, A. Vallenari, T. Prusti, J. H. J. de Bruijne, C. Babusiaux, C. A. L. Bailer-Jones, et al. 2018. “Gaia Data Release 2. Summary of the contents and survey properties” 616 (August): A1. <https://doi.org/10.1051/0004-6361/201833051>.
- Gaia Collaboration, A. G. A. Brown, A. Vallenari, T. Prusti, J. H. J. de Bruijne, F. Mignard, R. Drimmel, et al. 2016. “Gaia Data Release 1. Summary of the astrometric, photometric, and survey properties” 595 (November): A2. <https://doi.org/10.1051/0004-6361/201629512>.
- Lasker, Barry M, Mario G Lattanzi, Brian J McLean, Beatrice Bucciarelli, Ronald Drimmel, Jorge Garcia, Gretchen Greene, et al. 2008. “The Second-Generation Guide Star Catalog: Description and Properties.” *The Astronomical Journal* 136 (2). IOP Publishing: 735–66. <https://doi.org/10.1088/0004-6256/136/2/735>.
- Magnier, E. A., K. C. Chambers, H. A. Flewelling, J. C. Hoblitt, M. E. Huber, P. A. Price, W. E. Sweeney, et al. 2016. “Pan-STARRS Data Processing System.” *ArXiv E-Prints*, December.
- Magnier, E. A., E. F. Schlafly, D. P. Finkbeiner, J. L. Tonry, B. Goldman, S. Röser, E. Schilbach, et al. 2016. “Pan-STARRS Photometric and Astrometric Calibration.” *ArXiv E-Prints*, December.
- Magnier, E. A., W. E. Sweeney, K. C. Chambers, H. A. Flewelling, M. E. Huber, P. A. Price, C. Z. Waters, et al. 2016. “Pan-STARRS Pixel Analysis : Source Detection & Characterization.” *ArXiv E-Prints*, December.
- Ritter, H, and U Kolb. 2003. “Catalogue of cataclysmic binaries, low-mass X-ray binaries and related objects (Seventh edition).” *Astronomy and Astrophysics* 404 (1). EDP Sciences: 301–3. <https://doi.org/10.1051/0004-6361:20030330>.
- Skrutskie, M. F., R. M. Cutri, R. Stiening, M. D. Weinberg, S. Schneider, J. M. Carpenter, C. Beichman, et al. 2006. “The Two Micron All Sky Survey (2MASS)” 131 (February): 1163–83. <https://doi.org/10.1086/498708>.
- Tachibana, Yutaro, and A. A. Miller. 2018. “A Morphological Classification Model to Identify Unresolved PanSTARRS1 Sources: Application in the ZTF Real-time Pipeline” 130 (994): 128001. <https://doi.org/10.1088/1538-3873/aae3d9>.
- Véron-Cetty, M P, and P Véron. 2010. “A catalogue of quasars and active nuclei: 13th edition.” *Astronomy and Astrophysics* 518 (July). EDP Sciences: A10. <https://doi.org/10.1051/0004-6361/201014188>.

1. <https://ned.ipac.caltech.edu/Library/Distances/>

## 2.3 Gravitational Wave Regions

## 2.4 alerce\_lc

The [ALeRCE light curve classifier](#) uses variability features computed from the ZTF alert stream, and colors obtained from AllWISE and ZTF photometry. We apply a Balanced Random Forest algorithm with a two-level scheme, where the top level classifies each source as periodic, stochastic, or transient, and the bottom level further resolves each of these hierarchical classes, amongst 15 total classes. This classifier corresponds to the first attempt to classify multiple classes of stochastic variables (including core- and host-dominated active galactic nuclei, blazars, young stellar objects, and cataclysmic variables) in addition to different classes of periodic and transient sources, using real data.

Reproduced with permission from the [Alerce Community Broker](#). *responsible user: Roy Williams*

The [Alerce Stamp Classifier](#) is based on a convolutional neural network, trained on alerts ingested from the Zwicky Transient Facility (ZTF). Using only the science, reference and difference images of the first detection as inputs, along with the metadata of the alert as features, the classifier is able to correctly classify alerts from active galactic nuclei, supernovae (SNe), variable stars, asteroids and bogus classes, with high accuracy (94 percent) in a balanced test set.

Reproduced with permission from the [Alerce Community Broker](#). *responsible user: Roy Williams*

## 2.5 fastfinder

Fastfinder is an early-time, fast transient alerting system in development at Queen's University Belfast. The purpose of Fastfinder is to identify any fast-evolving extragalactic transients, such as Kilonovae, from the LSST alert-stream using only the transient's early-time photometry. By comparing the transient's photometric characteristics to that of the parameter space of known fast-evolving transient classes, Fastfinder generates probabilistic scores on the likelihood of the transient's spectral type. *responsible user: Michael Fulton*

## 2.6 fink\_early\_sn

[Fink](#) is a LSST Community Alert Broker being developed by an international community of researchers with a large variety of scientific interests, including among others multi-messenger astronomy, supernovae, solar system, anomalies identification, microlensing and gamma-ray bursts optical counterparts. This sub-stream focuses on early supernova type Ia. In order to tag an alert as an early supernova Ia candidate, Fink mainly uses 2 criteria: (a) Ia probability larger than 50% from the [early supernova Ia module](#), (b) Ia probability larger than 50% from either one of the deep learning classifier based on [SuperNNova](#). These candidates are also sent nightly to TNS for spectroscopic follow-up. Users should expect about 90% purity based on current performance. See also the [filter code](#).

Reproduced with permission from the [Fink Community Broker](#). *responsible user: Roy Williams*



## WATCHLISTS

### Table of Contents

- *Static Watchlists*
- *Create new watchlist*
  - *Build a Watchlist of your sources*
  - *Find outbursts from my watchlist*
  - *Get real-time alerts from ZTF*
- *Smart Watchlists*

### 3.1 Static Watchlists

---

#### Todo:

- Flesh out how to use static watchlists ... text below is from old pages
- 

### 3.2 Create new watchlist

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 or l-separated line has RA and Dec in decimal degrees, an identifier, with optional radius in arcseconds. One way to do this is with [Vizier](#) and a spreadsheet program such as Excel or Numbers. Here is [an example of the data](#). The 42 entries are *BL Lac candidates for TeV observations (Massaro+, 2013)*

An “Active” watchlist is one that is run every day, so that it is up to date with the latest objects.

You must be logged in to create a watchlist

### 3.2.1 Build a Watchlist of your sources

Many astronomers are interested in transients that are associated with specific astronomical objects, perhaps active galaxies or star formation regions. Once you have an account on Lasair, you can create any number of watchlists, to be used in the query engine. To be specific, suppose we are interested in the 42 objects in the catalogue BL Lac candidates for TeV observations (Massaro+, 2013), that can be found in the Vizier library of catalogues. You can make your watchlist “public”, so other Lasair users can see it and use it in queries, and you can make your watchlist “active”, meaning that the crossmatch (see below) is done automatically every day.

The screenshot shows the Lasair Vizier interface for building a watchlist. The main table lists various astronomical constraints and their descriptions. The interface includes several key elements highlighted with red circles and numbers:

- 1**: The "ALL cols" button at the bottom of the constraints table.
- 2**: The "TeVCat" constraint selected in the table.
- 3**: The "Decimal" option selected under "Position in:" in the Preferences sidebar.
- 4**: The "l-separated-values" option selected under "Output" in the Preferences sidebar.
- 5**: The "Submit" button at the top right of the constraints table.

The main table lists constraints such as "recno", "BZCat", "TeVCat", "WISE", "z", "u\_z", "FX", "FTev", "2FGL", "[3.4/4.6]", "e\_[3.4/4.6]", "[4.6/12]", "e\_[4.6/12]", "FIR", "e\_FIR", "X/IR", "Simbad/Simbad", "\_RA", and "\_DE". Each constraint has a checkbox, a column name, a unit, and a description.

How to use the Vizier interface to get suitable data to upload. Once you have your catalogue,

- deselect all the columns
- select a column that can act as the ID for each source. These need to be unique and not empty: if not, you must edit the resulting file to make it so.
- Choose “Decimal” for the coordinates
- Choose “l-separated” for the format

- Click submit to download the file.

Name:

Description:

default radius  
(arcsec), max

360:

Paste here the  
list of sources  
to be watched,  
as comma-  
separated  
values RA,  
**Dec, ID**  
<,radius> with  
RA and Dec in  
decimal  
degrees, and  
radius in  
arcseconds:

```
[lcc=meta.id.assoc]
_RAJ2000|_DEJ2000|TeVcat
deg|deg|
-----|-----|-----
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
```

Fill in the name and description of the watchlist. Choose a default value of the radius to use in matching, in arcseconds. Open the file and paste the contents. Each line should be RA, Dec, ID, and may have a fourth entry, the radius to use in matching, in arcseconds, if different from the default. Then click “Submit Form”.



An "Active" watchlist is one that is run every day, so that it is up to date with the latest objects.

[Create new watchlist](#)

```
Bad line 0: _RAJ2000,_DEJ2000,TeVcat could not convert string to float: '_RAJ2000'Bad line 0:
deg,deg, could not convert string to float: 'deg'Bad line 0: -----,-----,-----
-- could not convert string to float: '-----' Watchlist created successfully with 42 sources
```

## My Watchlists

Your private watchlists are listed below. Click "Create new watchlist" above to make a new one. Click on the name of the watchlist for more information and crossmatching.

Name	Description	Radius	Active	Public	
<a href="#">SDSS Quasar</a>	Main DR9 Quasar catalog with z<1.5 VII/269/dr9	10.0 arcsec	✓		<a href="#">(delete)</a>
<a href="#">Cataclysmic Variables</a>	Catalog of Cataclysmic Variables (Downes+ 2001-2006) Vizier V/123A	0.2 arcsec		✓	<a href="#">(delete)</a>
<a href="#">WFCAM</a>	J/A+A/573/A100/WVSC Post annotation WFCAM Variable Star	1.0 arcsec	✓		<a href="#">(delete)</a>

Here is a successful creation of a watchlist. Some messages – “Bad line” – because there were some lines without data, but you can ignore these, and look for where it says “Watchlist created successfully”. You can now find it in the list of “My Watchlists”.



watchlist crossmatched [Found 3424 candidates, 35 objects , ]

[Run Crossmatch](#)

The "Run Crossmatch" button compares all ZTF transients with your watchlist sources and reports the matches. It may take a few seconds so please be patient.

Watchlist				Crossmatch ZTF			
RA	Dec	Object	Radius	objectId	candidates	mag range	Sherlock class
300.303625	43.8813333	MAGIC J2001+435	1.0	<a href="#">ZTF18aaxdpoz</a>	285	3.0	AGN
184.467	30.1168611	1ES 1215+303	1.0	<a href="#">ZTF18aabxehk</a>	227	2.9	AGN
342.5239583	38.4103611	B3 2247+381	1.0	<a href="#">ZTF18abmodtn</a>	212	1.4	AGN
102.6936667	25.0498889	1ES 0647+250	1.0	<a href="#">ZTF17aadptpa</a>	208	2.4	AGN
35.665	43.0355	3C 66A	1.0	<a href="#">ZTF18aabezmq</a>	204	3.4	AGN
102.1985	15.2735556	RX J0648.7+1516	1.0	<a href="#">ZTF18abvmpjc</a>	199	1.9	AGN
356.770125	51.7049722	1ES 2344+514	1.0	<a href="#">ZTF18abbuwwg</a>	177	2.2	AGN
185.3820417	28.2329167	W Comae	1.0	<a href="#">ZTF17aaapqiz</a>	146	2.3	AGN
122.4549583	52.3161944	1ES 0806+524	1.0	<a href="#">ZTF18acbznzg</a>	144	2.5	AGN
153.7672083	49.4335556	1ES 1011+496	1.0	<a href="#">ZTF18abalsiv</a>	141	2.2	AGN
174.1100833	70.1575278	Markarian 180	1.0	<a href="#">ZTF18aakdfgo</a>	138	3.1	AGN
330.680375	42.2777778	BL Lacertae	1.0	<a href="#">ZTF18abmjhvi</a>	131	4.3	AGN
185.3414583	30.177	1ES 1218+304	1.0	<a href="#">ZTF18aacapwh</a>	129	2.6	AGN
64.2186667	1.0899722	1ES 0414+009	1.0	<a href="#">ZTF18aaxdpoz</a>	125	1.3	AGN

Click on any of your watchlists, and look for the button "Run Crossmatch". This finds all the transients that are within the radius of any of the sources of the watchlist. The left four columns come from your input, and the right four from the Lasair crossmatch. There is a clickable objectId, the number of candidates of that object, and other information.

### 3.2.2 Find outbursts from my watchlist

Once you have made a watchlist, you may be interested in being notified whenever something unusual – outburst for example – happens to one of your sources. Thus we combine a watchlist with a query on magnitude that detects fast rise. For the watch list see Build a Watchlist of your sources, and for the query we utilise the moving averages of apparent magnitudes that Lasair provides. See this paper for more information.

Name **AM CVn**

Description 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

Radius (arcsec) **1.0**

Active ☒

Public ☒

[Update watchlist](#)

Watchlist has 55 sources under watch. To see the original input data, click [here](#).

[Run Crossmatch](#)

The "Run Crossmatch" button compares all ZTF transients with your watchlist sources and reports results. Please be patient.

Watchlist				Crossmatch ZTF			
RA	Dec	Object	Radius	objectId	candidates	mag range	Sherlock class
291.159375	59.6963056	KL Dra	None	<a href="#">ZTF18aarkcxh</a>	248	3.3	CV
289.7715833	48.2516667	PTF1 J1919+4815	None	<a href="#">ZTF18aaptcay</a>	142	2.0	VS
207.2300833	7.9599444	CR Boo	None	<a href="#">ZTF18abaelhm</a>	116	3.4	CV
109.8005	48.9763056	PTF1 J0719+4858	None	<a href="#">ZTF18aaawjmk</a>	116	5.1	CV
190.2417917	-1.9886667	SDSS J1240-0159	None	<a href="#">ZTF18acyerom</a>	86	4.9	CV
212.8263333	48.2159722	SDSS J1411+4812	None	<a href="#">ZTF18aaoutxxk</a>	78	7.6	CV
121.2062083	16.2735833	SDSS J0804+1616	None	<a href="#">ZTF18aatlpr</a>	72	1.7	AGN
334.7920417	31.58975	PTF1 J2219+3135	None	<a href="#">ZTF18abcqadc</a>	51	3.5	VS
160.8545	56.5494444	SDSS J1043+5632	None	<a href="#">ZTF18aahkmei</a>	51	2.9	VS

For this example, we use a watchlist of 56 AM CVn stars, which are binaries of compact object (eg white dwarf) with a very short orbit – less than an hour. This screenshot shows a recent crossmatch of the watchlist with ZTF.

## Outburst AMCanVen

Outburst from moving averages, and watchlist of AMCanVen

Public: ☒

Active:

- ☐ Inactive
- ☐ Email to roy@roe.ac.uk (max once a day) and digest
- ☒ Kafka and digest

### SELECT ATTRIBUTES

```
objects.objectId, objects.ncandgp, watchlist_hits.name, jdnnow()- objects.jdmax
```

### TABLES TO USE

- |   |  |  |  |
|---|--|--|--|
| <ul style="list-style-type: none"> <li><input type="checkbox"/> candidates</li> <li><input type="checkbox"/> noncandidates</li> </ul> | <input checked="" type="checkbox"/> <b>objects</b> | <ul style="list-style-type: none"> <li><input type="checkbox"/> comments</li> <li><input type="checkbox"/> sherlock_classifications</li> <li><input type="checkbox"/> sherlock_crossmatches</li> </ul> | <ul style="list-style-type: none"> <li><input checked="" type="checkbox"/> Watchlist             <ul style="list-style-type: none"> <li><input type="radio"/> SDSS Quasar</li> <li><input type="radio"/> Cataclysmic Variables <i>inactive</i></li> <li><input type="radio"/> WFCAM</li> <li><input type="radio"/> BL Lac for TeV <i>inactive</i></li> <li><input checked="" type="radio"/> AM CVn</li> <li><input type="radio"/> AM Her</li> <li><input type="radio"/> Outbursts of CVs <i>inactive</i></li> <li><input type="radio"/> BLLac for TeV <i>inactive</i></li> <li><input type="radio"/> Stripe82 AGN</li> </ul> </li> </ul> |
|---|--|--|--|

### WHERE

```
(-objects.latest_dc_mag_g02 > -objects.latest_dc_mag_g28 + 0.5)
and
(-objects.latest_dc_mag_r02 > -objects.latest_dc_mag_r28 + 0.5)
```

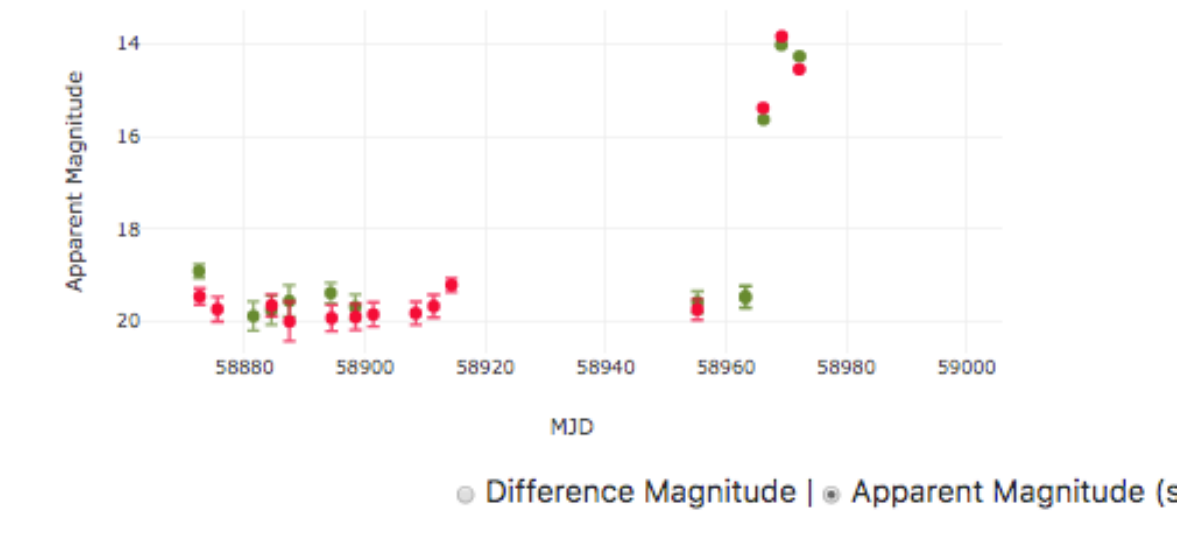
This is the active query, that builds a Kafka stream, and joins the object table with the watchlist shown above. The selection criterion at the bottom looks for a magnitude difference between the 2-day moving average (latest\_dc\_mag\_g02), and the 28-day moving average (latest\_dc\_mag\_g28), and requires a difference of at least 0.5 magnitude in both g and r.

Showing latest 41 for topic: 2OutburstAMCanVen

<i>UTC sent</i>	<i>objectId</i>	<i>ncandgp</i>	<i>name</i>
2020-05-03 07:22:19	<a href="#">ZTF18acyerom</a>	6	SDSS J1240-0159
2020-05-03 04:53:50	<a href="#">ZTF18acyerom</a>	5	SDSS J1240-0159
2020-05-02 07:30:14	<a href="#">ZTF18abaelhm</a>	26	CR Boo
2020-04-30 07:18:51	<a href="#">ZTF18acyerom</a>	4	SDSS J1240-0159
2020-04-30 06:00:31	<a href="#">ZTF18acyerom</a>	3	SDSS J1240-0159
2020-04-27 10:33:16	<a href="#">ZTF18acyerom</a>	2	SDSS J1240-0159

Here is some output from the query in a period of 6 days. The same object appears several times (SDSS J1240-0159).

## Object ZTF18acyerom



We see in the light curve the brightening by 5 magnitudes. Make sure you select the “Apparent Magnitude”, which are more more suitable for variable star work.

### 3.2.3 Get real-time alerts from ZTF

The Lasair broker can send immediate “push” notifications when your active query/filter sees an interesting alert. Here is how to make that happen with email notification. First make sure you are logged in to your Lasair account (top left of screen), then go to create new stored query. This page is about how to get email alerts from your active query; the process is very similar for Kafka alerts, except that you will fetch the results by machine instead of by email. See article Reading a Kafka Stream.

Name:

Bright Stars

Description:

toy query to find bright stars

Active:

- ☐ Inactive
- ☒ Email to roy@roe.ac.uk (max once a day) and digest
- ☐ Kafka and digest

Public: ☐

**SELECT ATTRIBUTES**

objects.objectId, objects.latestrmag, jdnnow()-objects.jdmax as since

**TABLES TO USE**

- |  |  |  |   |                                    |
|--|--|--|---|------------------------------------|
| <input type="checkbox"/> candidates    | <input checked="" type="checkbox"/> <b>objects</b> | <input type="checkbox"/> comments              | <input type="checkbox"/> sherlock_classifications | <input type="checkbox"/> Watchlist |
| <input type="checkbox"/> noncandidates |  | <input type="checkbox"/> sherlock_crossmatches |   |                                    |

**WHERE**

objects.latestrmag < 12

Fill in the form as shown here. Name and description, then check the “email” box, and fill in the SELECT as objects.objectId, objects.latestrmag, jdnnow()-objects.jdmax as since check the “objects” table, and fill in the WHERE as objects.latestrmag < 12 Then click “Create Query”

## Lasair query 2brightstars

donotreply@lasair.roe.ac.uk

To: Roy Williams

Your active query with Lasair on topic 2brightstars

```
{
  "objectId": "ZTF18abmedeg",
  "latestmag": 11.8633,
  "since": 1.0424884702078998,
  "UTC": "2020-04-06 13:35:41"
},
{
  "objectId": "ZTF18abmedeg",
  "latestmag": 11.8633,
  "since": 1.0370370810851455,
  "UTC": "2020-04-06 13:27:51"
},
{
  "objectId": "ZTF18abmedeg",
  "latestmag": 11.8633,
  "since": 1.0315972659736872,
  "UTC": "2020-04-06 13:20:01"
},
{
  "objectId": "ZTF18abmedeg",
  "latestmag": 11.8633,
  "since": 1.026169024873525,
  "UTC": "2020-04-06 13:12:11"
},
{
  "objectId": "ZTF18abmedeg",
  "latestmag": 11.8633,
  "since": 1.0206481921486557,
  "UTC": "2020-04-06 13:04:14"
},
{
  "objectId": "ZTF18abmedeg",
  "latestmag": 11.8633,
  "since": 1.0151389329694211,
  "UTC": "2020-04-06 12:56:17"
},
{
  "objectId": "ZTF18abmedeg",
  "latestmag": 11.8633,
  "since": 1.0096875438466668,
  "UTC": "2020-04-06 12:48:27"
},
{
  "objectId": "ZTF18abmedeg",
  "latestmag": 11.8633,
  "since": 1.0042477292008698,
  "UTC": "2020-04-06 12:40:36"
},
{
  "objectId": "ZTF18abmedeg",
  "latestmag": 11.8633,
  "since": 0.9987731920555234,
  "UTC": "2020-04-06 12:32:43"
},
{
  "objectId": "ZTF18abmedeg",
  "latestmag": 11.8633,
  "since": 0.993310228921473,
  "UTC": "2020-04-06 12:24:53"
},
{
  "objectId": "ZTF18abmedeg",
  "latestmag": 11.8633,
  "since": 0.9877778221853077,
  "UTC": "2020-04-06 12:16:54"
},
{
  "objectId": "ZTF18abmedeg",
  "latestmag": 11.8633,
  "since": 0.9824190251529217,
  "UTC": "2020-04-06 12:09:10"
},
{
  "objectId": "ZTF18abmedeg",
  "latestmag": 11.8633,
  "since": 0.9768171738833189,
  "UTC": "2020-04-06 12:01:07"
}
```

Nothing will happen immediately. You can run the query in the usual way from the web browser, but you will have to wait for some alerts to arrive before your active query will be triggered. Once that happens, you will get an email at the address you used to create your account. Something like the message shown here. Note that the attributes you chose above are reported (objectId, latestmag, since), together with the UTC time at which the alert was triggered.

		objects.decmean BE
bright stars	bright stars	objects.objectId,
Edit/delete filter		----
Stream: 2brightstars		objects
		----
		objects.latestmag

In addition to the email, the webserver holds the last 1000 alerts that went to this channel. The link is in your list of queries.

IR

[how to search](#)[.logout\)](#)

Showing latest 671 for topic: 2brightstars

<i>UTC sent</i>	<i>objectId</i>	<i>latestmag</i>	<i>since</i>
2020-04-07 10:08:39	<a href="#">ZTF18abmedeg</a>	11.8633	1.8986574509181082
2020-04-07 09:59:16	<a href="#">ZTF18abmedeg</a>	11.8633	1.892199118155986
2020-04-07 09:44:21	<a href="#">ZTF18abmedeg</a>	11.8633	1.8818403221666813
2020-04-07 09:36:55	<a href="#">ZTF18abmedeg</a>	11.8633	1.876689859200269
2020-04-07 09:29:15	<a href="#">ZTF18abmedeg</a>	11.8633	1.8713542111217976
2020-04-07 09:21:14	<a href="#">ZTF18abmedeg</a>	11.8633	1.8657870809547603

Click on that link and it will show you a page like this one.

### 3.3 Smart Watchlists





## SKY REGIONS

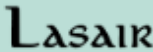
### Table of Contents

---




#### Todo:


- Flesh out how to use the sky region maps ... text below is from old pages
- 

The current list of available skymaps is shown at <https://lasair.roe.ac.uk/skymap/>. It is a much longer list than when the page was designed. Below is a typical example.



[how to search](#)



logged in as roy ([Logout](#))

[Home](#)  
[About Lasair](#)  
[Filters and Queries](#)  
[Search](#)  
[Coverage](#)  
[Watchlists](#)  
[Skymaps](#)  
[Jupyter](#)  
[Ingestion Status](#)  
[Release Notes and Documents](#)  
[Team & Contact](#)

## Gravitational Wave Skymap: S190720a\_1

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 arbitrary 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	$1070.9 \pm 323.3$ Mpc
ISO Date:	2019-07-20T00:08:36.705340
Julian date:	2458684.506
Percent probability	BNS=0, NSBH=0, BBH=98 MassGap=0
max prob RA,Dec	0.6, -49.5

☐ Coverage of ZTF  
☐ Show ZTF candidates  
☒ Show galaxies from [GLADE](#) *doubleclick a galaxy*

From

To

From

To

Mellinger coloured


▼

Projection:

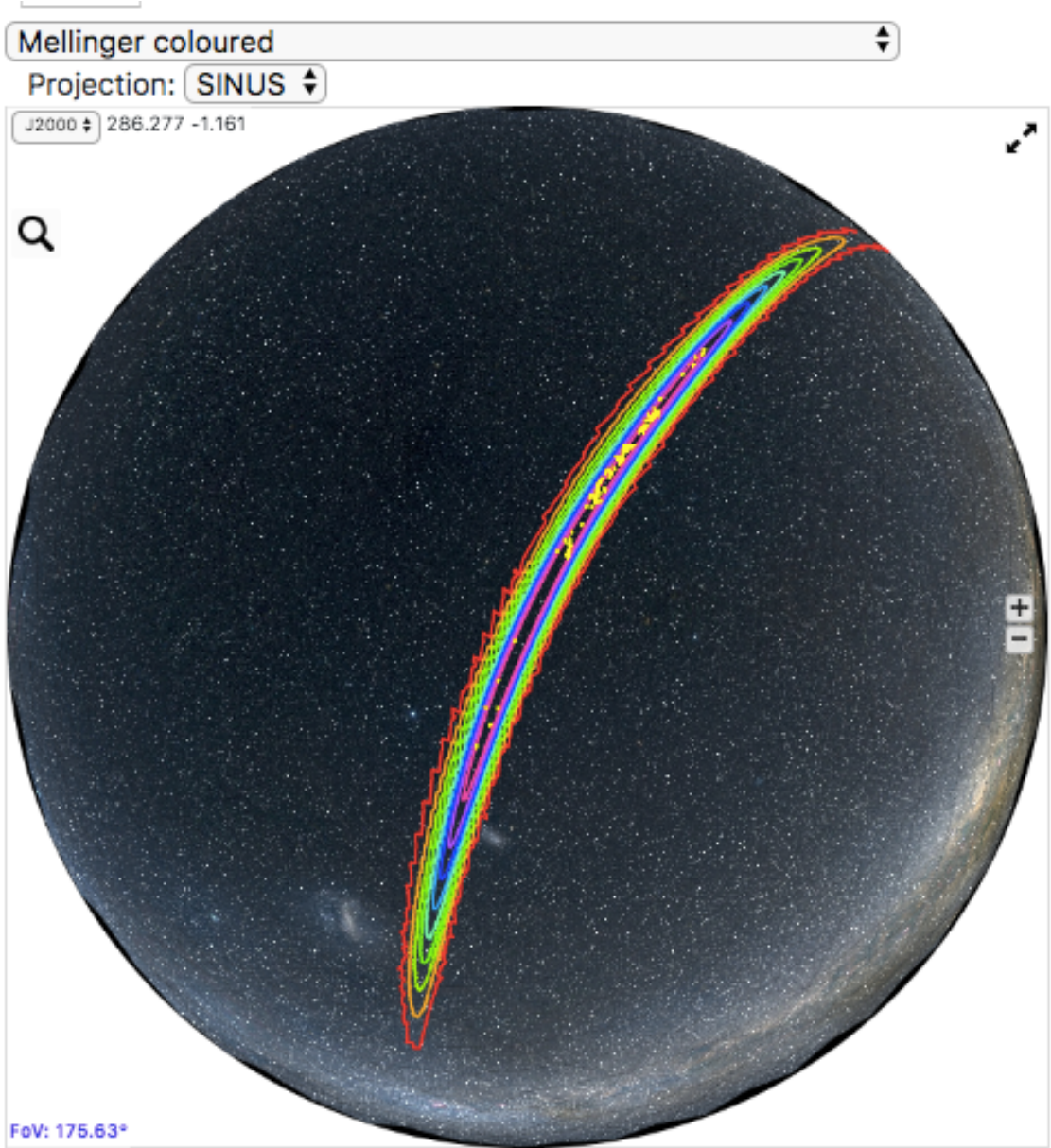
SINUS

J2000

↓



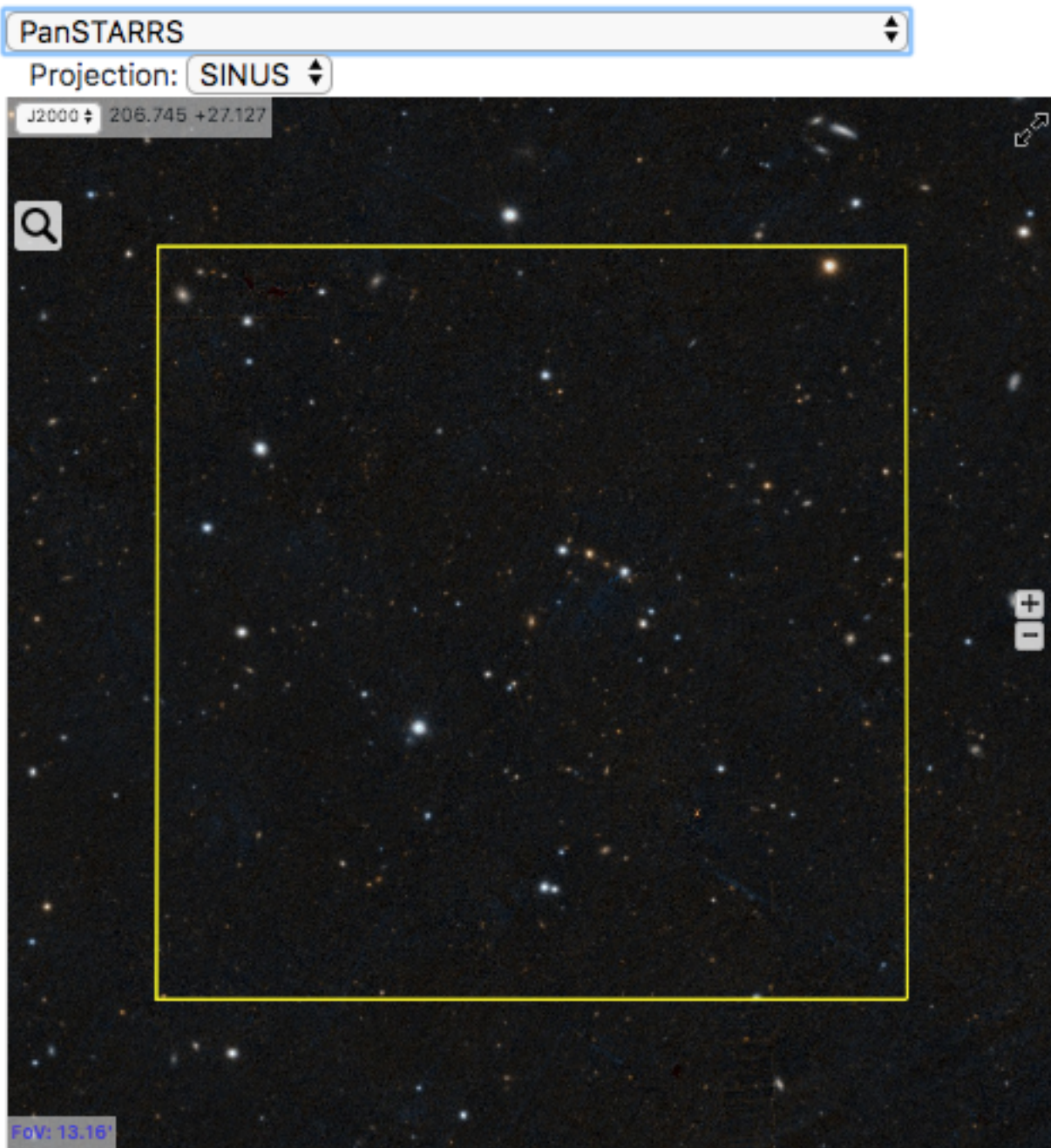
The name of the GW skymap comes from the official LVC sources, as linked from the header test (top red oval). Now look at the distance, and the event-type. A BNS (binary neutron star) event at a “near” location (less than 100 mega-parsecs) would be most exciting, as there would be a good chance for optical and other telescopes to identify it. Below we describe how the three checkboxes in the green box can provide further information.



Name (NED link)	Percent probability	Distance (Mpc)
<a href="#">LEDA 2794635</a>	0.00	1218.
<a href="#">LEDA 3324680</a>	0.00	1180.
<a href="#">LEDA 2794618</a>	0.00	1132.
<a href="#">LEDA 2794602</a>	0.00	1127.

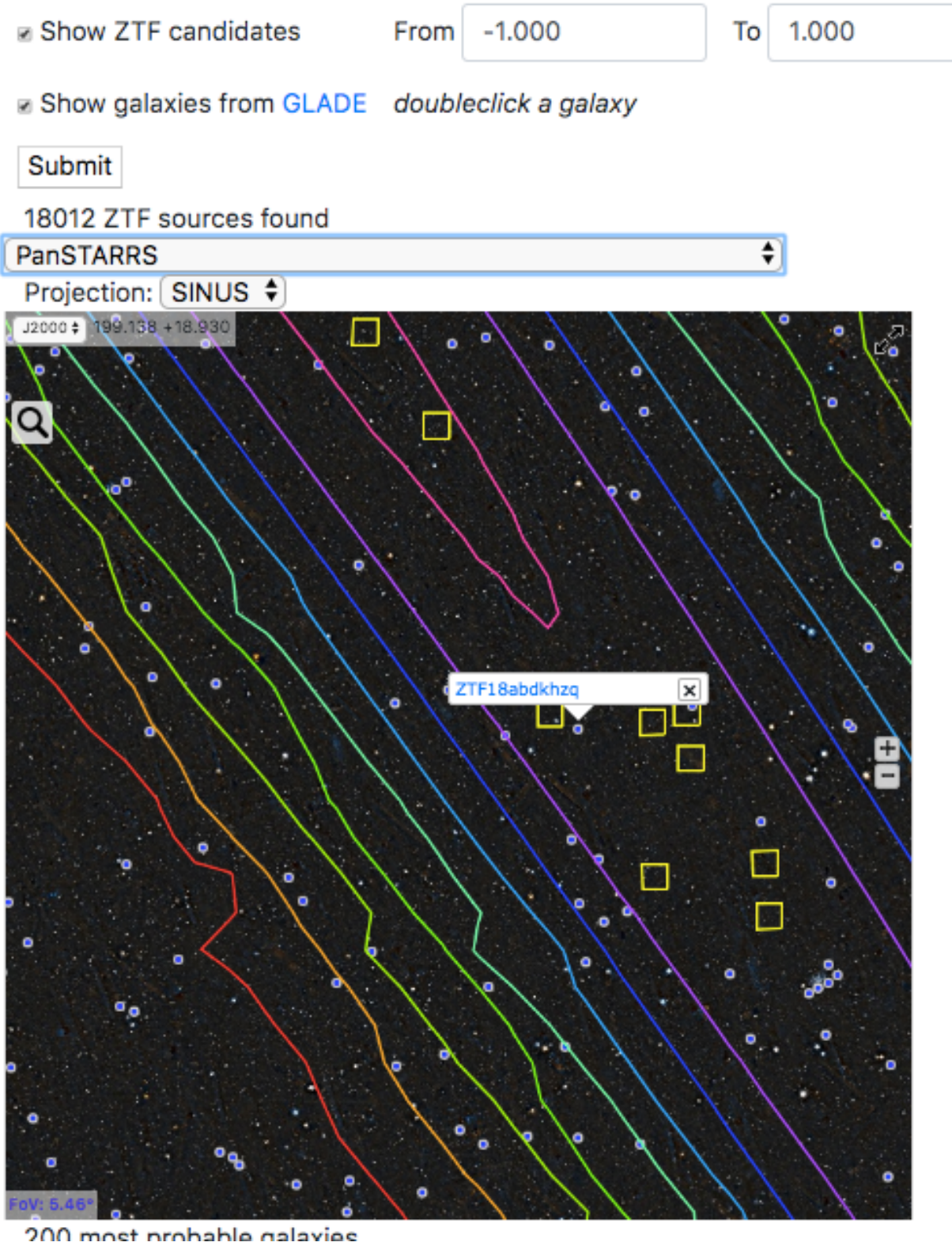
The lower display shows the probability distribution of where in the sky the GW source was. The AladinLite display allows arbitrary zoom and many different sky layers from gamma to radio. The contour lines of the probability are percentiles. Red outside: 90%, and violet inside: 10%. There is also a list of galaxies and the probability each has the counterpart. This is great for the nearby event (50 Mpc) but when the event is at 1000 Mpc, there are galaxies

everywhere, and the list is no help.



The checkbox “Show galaxies from GLADE” puts a yellow square around each galaxy where the GW counterpart might be found. From the GLADE catalogue, they are selected for sky probability and the distance estimate in the skymap. However a maximum of 200 galaxies are shown, there may be many more for a distant source. Choose the PanSTARRS layer, and zoom in. Doubleclick in a yellow square to centre the image in the source, then use the “+” zoom icon at the right. There is also a link to the galaxy data next to the checkbox.





The checkbox about ZTF candidates show all candidates in the 90%, and are within the given time constraint in the form - days before and days after the GW event. It may be slow when you click submit as there may be 1000s of candidates. You can zoom in and click on one of them, and a link pops up that can take you to that object's page.

Once you know your way around Lasair, start digging deeper to become a power-user and see what great science you can get done.

## ALERT STREAMS

---

**Todo:**

- Flesh out how to use the alert streams ... text below is from old pages
- 

By providing Kafka streams, Lasair provides a machine-readable packet of data that can cause action at your site. See the FAQ article on how to create a stream using the Lasair web environment. This page is about how to read it on your side. There is a [blog post](#) about why Kafka is a good way to deal with streaming data.

- We recommend [Confluent Kafka](#), the python install being “pip install confluent\_kafka”.
- You will be connecting to kafka.lsst.ac.uk on port 9092
- For coding details, please see the [accompanying notebook](#).

You will need to understand two concepts: Topic and GroupID. The Topic is a string to identify which stream of alerts you want, which derives from the name of a Lasair streaming query. For example, the query defined [here](#) is named “SN-like candidates”, and its output collected [here](#). Its Kafka topic is “lasair\_2SN-likecandidates”. The GroupID tells Kafka where to start delivery to you. It is just a string that you can make up, for example “Susan3456”. The Kafka server remembers which GroupIds it has seen before, and which was the last alert it delivered. When you start your code again with the same GroupID, you only get alerts that arrived since last time you used that GroupId. If you use a new GroupID, you get the alerts from the start of the Kafka cache, which is about 7 days.





**Table of Contents**

- *A Python Wrapper*

## 6.1 A Python Wrapper



## PYTHON NOTEBOOKS

### Table of Contents

Below are some Google colab notebooks that use Lasair API, which has a token authentication scheme. The notebooks below have a “free sample” token that allows only 10 calls to the API in an hour. You can get a much better token by

- get a Lasair account [here](#)
- follow the instructions in the [API documentation](#)
- then copy the notebook to your own Google account.

---

This notebook does not require an API key.

Please [Contact us](#) with any notebooks that you would like to share.



---

**Todo:**

- Clean up these FAQs after web refresh
- 

**Table of Contents**

- *What are Lasair-ZTF and Lasair-LSST?*
- *What data does Lasair offer?*
- *What is here for an amateur astronomer?*
- *How can I ask a question to the Lasair team?*
- *How can I use my knowledge of SQL to use Lasair?*
- *How can I query the Lasair database?*
- *What is the difference between a Query and a Filter?*
- *What is the schema of the Lasair database?*
- *How do I choose which alerts are interesting to me?*
- *Why should I register on the Lasair website?*
- *Besides Lasair, what other websites carry astronomical transients?*
- *How long has Lasair been operating?*
- *Can Lasair alert me about supernovae and kilonovae?*
- *Can Lasair alert me about gravitational-wave events?*
- *How can I find out about the LSST survey and the Vera Rubin Observatory?*
- *How can I write code and notebooks that use the Lasair database?*
- *How can I mine a million Lasair light curves?*
- *Does Lasair classify alerts into classes?*
- *Does Lasair have an API?*
- *What is difference magnitude compare to apparent magnitude?*
- *What is an exponential moving average?*
- *What is a cone-search and can Lasair do this?*
- *How can I do 1000 cone searches all at once?*

- *What is associated (cross-matched) with a Lasair source?*
- *Can I see sky images in different wavelengths around a Lasair alert?*
- *When I make a query, can I share it with my colleagues?*
- *Can I get immediate notification of interesting alerts?*

## 8.1 What are Lasair-ZTF and Lasair-LSST?

Lasair is an evolving platform. The current Lasair-ZTF is our prototype broker based on the ZTF alert stream, but we have started an intensive planning and technical reviews of the requirements for LSST. We are basing our future requirements on two key LSST documents: [Data Products Definition Document](#) (Juric et al. 2019) and [LSST Alerts: Key Numbers](#) (Graham et al.).

We envisage the following major differences between Lasair-ZTF and Lasair-LSST :

- the increase in rate of the number of alerts, by a factor 50
- the multi-colour filter nature of LSST of *ugrizy*,
- the different surveys : deep drilling fields, wide-fast deep (which may end up splitting the Milky Way from the extragalactic sky), and any additional approved mini-surveys (e.g. target of opportunity observations of gravitational wave sky maps).
- access to forced photometry and the timescales for that access a deep image of the whole survey footprint which has photometric redshifts and accurate star-galaxy separation for all objects
- expected large increase in the user base
- provision to link public spectroscopic data to the LSST transients. Both the information derived from the spectra such as type and redshift, but also the data itself.

Given these differences, within Lasair we are reviewing the database architecture and how the lightcurve data are annotated, stored and made available to users. We have developed detailed Science Requirements from the perspective of expert users within the UK and are working particularly with the LSST Science Collaborations (DESC and TVS) to review these. Our main focus is to provide a broker that will allow users to find their transients and eruptive variables of choice and to run filters or analysis code on them. This may be on the Lasair computing platform (the UK's IRIS system) but we will also provide means to bulk download lightcurve data for users to work with locally on their own machines.

This work is intensifying as of April 2020, and we look forward to working with our international colleagues across the LSST community and within the LSST Science Collaborations to define Lasair's functionality for LSST. With this in mind, we are drafting our broker proposal for the June call.

What can I get from this web site?

The Lasair alert broker gives access to millions of astronomical transient detections: when a star or galaxy becomes brighter or fainter than it was at an earlier time.

## 8.2 What data does Lasair offer?

Whenever a star or galaxy in the sky changes brightness, it is given an “objectId”, which can be used to see all the data about that object. Data includes a “light curve” of brightness measurements at different times, in different filters; crossmatching with existing source catalogs, and other data.

## 8.3 What is here for an amateur astronomer?

A serious amateur telescope would have a 500 mm aperture, with a limiting magnitude of about 16, costing over \$40,000. In any year there will be a few supernovae visible to this system.

## 8.4 How can I ask a question to the Lasair team?

Write to the help email: [lasair-help@lists.lasair.roe.ac.uk](mailto:lasair-help@lists.lasair.roe.ac.uk).

## 8.5 How can I use my knowledge of SQL to use Lasair?

Each query/filter/stream in Lasair is an SQL SELECT query. The syntax is “SELECT <attributes> FROM <tables> WHERE <conditions>” The attributes come from the schema – shown to the right in the query builder page, and can include renaming, for example “mag<sub>g</sub>-mag<sub>r</sub> as mag<sub>difference</sub>”, but no sub-queries. The tables are selected from objects, sherlock\_classifications, crossmatch\_tns, as well as any watchlists or areas you choose. The conditions in the WHERE clause allow a simplified SQL, using just comparison operators, without operators such as “group” and “having”.

## 8.6 How can I query the Lasair database?

You can type SQL into the query builder as above, and you can run a query somebody else has made that is public. If you sign up and login to Lasair, you can save your queries and you can copy somebody else’s query then modify it.

## 8.7 What is the difference between a Query and a Filter?

A query operates on the whole database of alerts, but a Filter only runs on new alerts, as they stream from the telescope. You can convert a Query that you own to a Filter in the query builder page.

## 8.8 What is the schema of the Lasair database?

Can be found at the [schema page](#).

## 8.9 How do I choose which alerts are interesting to me?

Choosing interesting alerts can be based on several criteria: The characteristics of the light curve; coincidence of the alert with a galaxy or known variable star; coincidence of the alert with one of the sources in which you are interested (a watchlist); location of the alert in a given area of the sky, for example a gravitational wave skymap.

## 8.10 Why should I register on the Lasair website?

Registration is easy, and just requires a valid email (signup [here](#)). You can then build and save queries, watchlists, and sky areas, convert those to real-time alert streams, and use the Lasair API.

## 8.11 Besides Lasair, what other websites carry astronomical transients?

There are seven community brokers that will receive and process LSST alerts in real time: [ALeRCE](#), [AMPEL](#), [ANTARES](#), [BABAMUL](#), [Fink](#), [Lasair](#), and [Pitt-Google](#).

## 8.12 How long has Lasair been operating?

Lasair has been processing, storing, and distributing alerts from the ZTF survey since 2018.

Can I get alerts from a particular region of the sky?

Lasair supports “sky areas”, defined by a [MOC](#), that you build yourself.

Can I get alerts associated with my favourite sources?

You can build a “watchlist” of your favourite sources, and build a corresponding query that includes crossmatch with that watchlist. Instructions are [here](#).

## 8.13 Can Lasair alert me about supernovae and kilonovae?

There are some filters already built that find alerts in the outskirts of galaxies, see [here](#). There are also queries that find supernovae already reported to the [Transient Name Service](#).

## 8.14 Can Lasair alert me about gravitational-wave events?

Lasair receives immediate notification of gravitational wave alerts. See [here](#)

How can I find out about the ZTF survey?

The Zwicky Transient Factory (ZTF) is the source of the events to which Lasair provides access. It is well summarised with the following set of papers:

- *The Zwicky Transient Facility: Data Processing, Products, and Archive*, F. Masci et al [arXiv](#)
- *The Zwicky Transient Facility: System Overview, Performance, and First Results*, E. Bellm et al [arXiv](#)



- *A Morphological Classification Model to Identify Unresolved PanSTARRS1 Sources: Application in the ZTF Real-Time Pipeline*, Y. Tachibana et al, [arXiv](#)
- *Machine Learning for the Zwicky Transient Facility*, A. Mahabal et al, [arXiv](#)
- *The Zwicky Transient Facility: Science Objectives*, M. Graham et al, [arXiv](#)
- *The Zwicky Transient Facility Alert Distribution System*, M. Patterson et al [arXiv](#)

## 8.15 How can I find out about the LSST survey and the Vera Rubin Observatory?

General FAQ on LSST and Rubin is [here](#), about community alert brokers in particular [here](#)

## 8.16 How can I write code and notebooks that use the Lasair database?

The documentation is [here](#)

## 8.17 How can I mine a million Lasair light curves?

Lorem Ipsum

## 8.18 Does Lasair classify alerst into classes?

Lorem Ipsum

## 8.19 Does Lasair have an API?

Lorem Ipsum

## 8.20 What is difference magnitude compare to apparent magnitude?

Lorem Ipsum

## **8.21 What is an exponential moving average?**

Lorem Ipsum

## **8.22 What is a cone-search and can Lasair do this?**

Lorem Ipsum

## **8.23 How can I do 1000 cone searches all at once?**

Lorem Ipsum

## **8.24 What is associated (cross-matched) with a Lasair source?**

Lorem Ipsum

## **8.25 Can I see sky images in different wavelengths around a Lasair alert?**

Lorem Ipsum

## **8.26 When I make a query, can I share it with my colleagues?**

Lorem Ipsum

## **8.27 Can I get immediate notification of interesting alerts?**

Lorem Ipsum

## **CONTACT US**

We really value feedback, especially from our users. Please reach out to us with any issues, suggestions or feature requests by [raising an issue in our github repo](#). Alternatively, start a discussion with us on the [Rubin Community forum](#) under [Support > Lasair](#).

---

**Todo:**

- Add button image to raise github issue and another to be directed to Rubin community forum
-



## LASAIR TALKS

---

**Todo:**

- Make sure list of this list of talks is up-to-date
- 

- **August 2019**, *Matt Nicholl at “Hot-wiring the Transient Universe” Northwestern University, Illinois*. [Talk and Demo session on LASAIR](#)
- **June 2019**, *Andy Lawrence at LSST Community Brokers Workshop, Seattle*. [Lasair presentation](#)
- **June 2019**, *Roy Williams and Ken Smith*. [Report on Lasair from LSST:UK phase A](#)
- **April 2019**, *Ken Smith, at STScI meeting*. [Lasair: The UK: LSST Transient Server](#)
- **April 2019**, *Roy Williams at the LSST:UK allhands meeting, Cardiff*. [Lasair: a ZTF broker and prototype LSST broker](#)
- **Feb 2019**, *Ken Smith, at DESC workshop, Berkeley*. [Lasair: a ZTF broker and prototype LSST broker](#)
- **January 2019**, *Ken Smith and the Lasair Team, Research Notes of the AAS, 3, 1*. [Lasair: The Transient Alert Broker for LSST:UK](#)



## TODO LIST

---

**Todo:**

- Flesh out how to use the alert streams ... text below is from old pages

---

(The [original entry](#) is located in /home/docs/checkouts/readthedocs.org/user\_builds/lasair/checkouts/feature-adding-docs/docs/source/alert-streams.md, line 1.)

---

**Todo:**

- Add button image to raise github issue and another to be directed to Rubin community forum

---

(The [original entry](#) is located in /home/docs/checkouts/readthedocs.org/user\_builds/lasair/checkouts/feature-adding-docs/docs/source/contact.md, line 1.)

---

**Todo:**

- Clean up these FAQs after web refresh

---

(The [original entry](#) is located in /home/docs/checkouts/readthedocs.org/user\_builds/lasair/checkouts/feature-adding-docs/docs/source/faqs.md, line 1.)

---

**Todo:**

- Make sure list of this list of talks is up-to-date

---

(The [original entry](#) is located in /home/docs/checkouts/readthedocs.org/user\_builds/lasair/checkouts/feature-adding-docs/docs/source/lasair-presentations.md, line 1.)

---

**Todo:**

- Flesh out how to use the lasair search bar ... text below is from old pages

---

(The [original entry](#) is located in /home/docs/checkouts/readthedocs.org/user\_builds/lasair/checkouts/feature-adding-docs/docs/source/lasair-search.md, line 1.)

---

**Todo:**

- Flesh out how to use the lasair deep search/watchlists ... text below is from old pages

---

(The [original entry](#) is located in /home/docs/checkouts/readthedocs.org/user\_builds/lasair/checkouts/feature-adding-docs/docs/source/lasair-search.md, line 1.)

---

**Todo:**

- Clean up this metadata tag page ... text below is from old pages
- 

(The [original entry](#) is located in /home/docs/checkouts/readthedocs.org/user\_builds/lasair/checkouts/feature-adding-docs/docs/source/metadata-tags.md, line 1.)

---

**Todo:**

- Flesh out how to use the sky region maps ... text below is from old pages
- 

(The [original entry](#) is located in /home/docs/checkouts/readthedocs.org/user\_builds/lasair/checkouts/feature-adding-docs/docs/source/sky-regions.md, line 1.)

---

**Todo:**

- Flesh out how to use static watchlists ... text below is from old pages
- 

(The [original entry](#) is located in /home/docs/checkouts/readthedocs.org/user\_builds/lasair/checkouts/feature-adding-docs/docs/source/watchlists.md, line 1.)