

The Transient Name Server

- “Name server”
- Fully searchable
- Citable (ADS indexed)

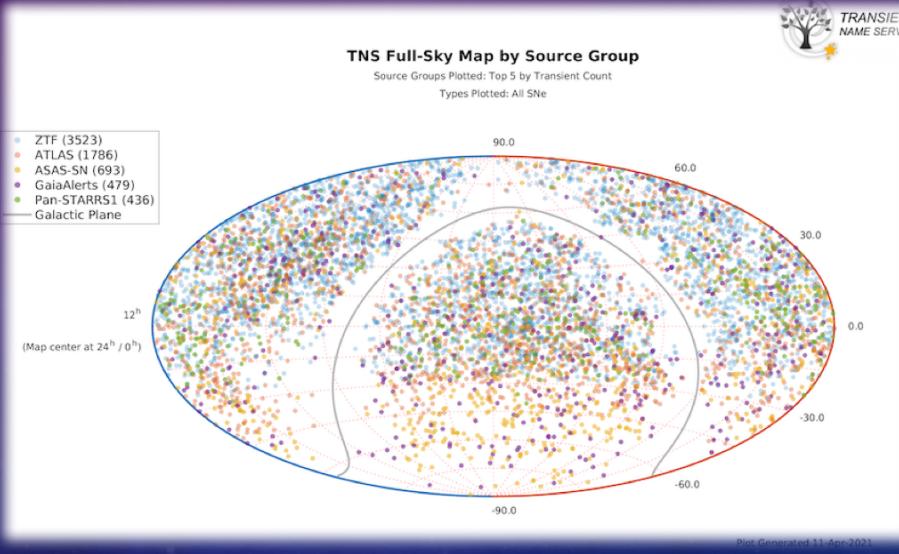
Reports

- “Manual” [forms] (including amateurs)
- Automatic [bots] (most surveys)
- Brokers

[Overview for the LSSTC brokers workshop]

Apr 2021

Ofer Yaron



The Official IAU transient reporting mechanism

The team: Avishay Gal-Yam (PI, chair of IAU SN WG),

Avner Sass, Eran Ofek, Nikola Knezevic

Weizmann Institute for Science

Alerts on
Transients (AT)

Classifications (SN...)

FRBs

(GW events, GRBs...)

AstroNotes



The TNS is dynamic – constantly adjusted to meet the changing needs



Modifications to the treatment of the Discovery (Source) Group
2019-12-01 - Dr. Ofer Yaron (WIS)

In order to adapt the TNS for both the present and future needs, and in particular to the activity of transient brokers as significant sources that report discoveries of transients that are observed and publicly released by the observing surveys/facilities, we will deploy next week - on Monday, Dec 2nd, 2019 - small adjustments to the handling of the "discovery group/s", by introducing instead two distinct group identifications: the Reporting group and the Discovery Data Source group.

The changes affect the AT Report JSON/TSV formats (and clearly the AT Report Form), the search page, the object page, the discovery certificate and the statistics pages.

Please refer to [AstroNote 2019-136](#) for additional clarifications on the essence of the revised treatments.

As mentioned, even if you did not revise your JSONs to the new format, your AT reports should not fail until Jan 31st, 2020.

However, if sending AT Reports via TSV, you should have the correct revised columns in place (reporting_group_id, discovery_data_source_id - instead of the single groupid).

AstroNote 2019-136

[AstroNotes](#) [My Draft AstroNotes](#) [Add an AstroNote](#) [My Templates](#) [Stats](#) [ADS Test](#) [Notifications Test](#) [Edit AstroNote](#) [View](#) [Edit](#) [Devel](#)

Bookmark
2019-11-24 11:28:24 Type: Announcement-Tool/Utility Bibcode: [2019TNSAN.136....1Y](#)

Modifications to the TNS treatment of the "Discovery Group" - to be deployed on Dec 2nd, 2019.

Authors: Ofer Yaron, Avishay Gal-Yam, Avner Sass (Weizmann)

Keywords: [Surveys](#), [Transient](#), [Astronomical Databases](#)

Abstract: In order to adapt the TNS for both the present and future needs, and in particular to the activity of transient brokers as significant sources that report discoveries of transients that are observed and publicly released by the observing surveys/facilities, we will deploy next week - on Monday, Dec 2nd, 2019 - small adjustments to the handling of the "discovery group/s", by introducing instead two distinct group identifications: the Reporting group and the Discovery Data Source group. Bot owners should apply these changes in the scripts for the Bulk AT Reports, whether via JSON or TSV submissions, as described below.



The Transient Name Server - overview

- In operation since Jan 1st 2016. The official IAU mechanism for reporting new astronomical (extra galactic) transients and specifically for official name designation. (Set up by the IAU in order to provide a modern, automatic mechanism to archive and distribute alerts about transients, replacing the manual defunct CBAT system.)
- [As of Apr 2021] holds >70k reported transient candidates (“ATs”), ~7k (10%) classified SNe (including a full catalog of all pre-2016 SNe); >1k registered users, >100 groups.
- The basic TNS object is an Astronomical Transient (AT) with a unique identifier of the form AT YYYYx (x=A..Z, aa..zz, aaa..zzz,...). The prefix “AT” can be later changed to indicate a classification (e.g., “SN”) but the unique identifier is always kept.
- Most reports are submitted automatically by “bots” of the major surveys & brokers (PS1, ZTF, Gaia, ATLAS...), but it is also possible to submit reports interactively using forms. Discovery reports are called *AT-reps* whereas classification reports (supported by a spectrum, for the “normal” transients) are called *Class-reps*.
- The system naturally handles multiple reports on the same event (e.g., discoveries of the same object by different surveys) and keeps a (fully searchable) record of “internal names” that are associated with each ATrep.
- The system supports a service for short astronomical announcements (*AstroNotes*) which is a superior version of the ATEL system (e.g., searchable; hyperlinked to specific objects).
- All reports and AstroNotes are indexed by the ADS and are citable.



The Transient Name Server - overview

- Currently all alerts/notifications from the TNS (discoveries/classifications/AstroNotes) are distributed via emails to the registered users, according to their defined preferences. (Additional staging/alerting mechanisms (e.g. Kafka streams) may be added.)
- Some data can be reported as **proprietary** for a certain period of time; e.g. securing a name designation without official release of the details yet, or not exposing a classification spectrum.
- Groups, Bots and memberships are all self-managed (by the users/group-owners), thus enabling flexible handling of access permissions, controlling the discovery credits etc.
- The system has recently been migrated to the **AWS** cloud, increasing its H/A capacity, and is designed to ingest the LSST streams and to be online ~99.999% of the time.
- Recently the **FRB community** joined the TNS.
 - An additional subsystem was developed for handling the specific requirements of FRBs – including a separate naming engine (FRB YYYYMMDDx), a separate report form (for the specific FRB properties), and enabling specification of area localizations ("*area transients*").
 - The system was tailored to meet the wishes of the FRB community.



UV/visible/IR surveys



Real-time
transient
Alerts

since 2016

Radio surveys



Joined 2020

Discussion initiated

Gravitational Wave Detectors



Potential

High energy surveys (χ/γ)



All
data



Robotic follow-up facilities



Major follow-up
collaborations



NASA data system



Data queries

Data contributions

Global
Astrophysics
Community

Pan-Starrs (Hawaii)



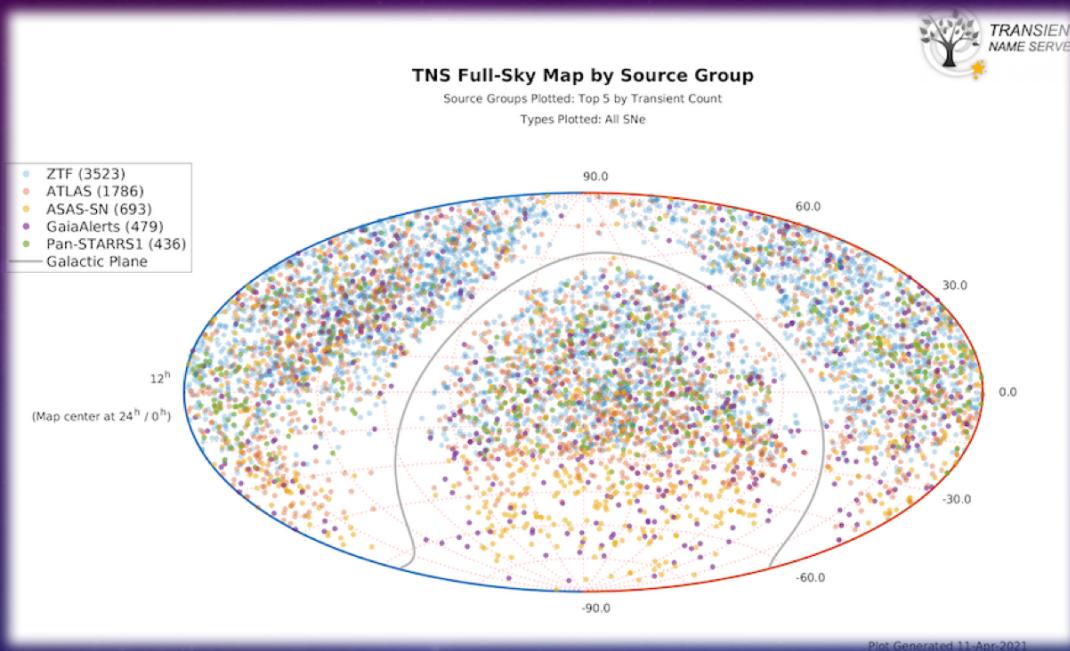
ZTF, iPTF (Palomar, CA)



CHIME-FRB (Canada)



Some of the major surveys reporting to the TNS

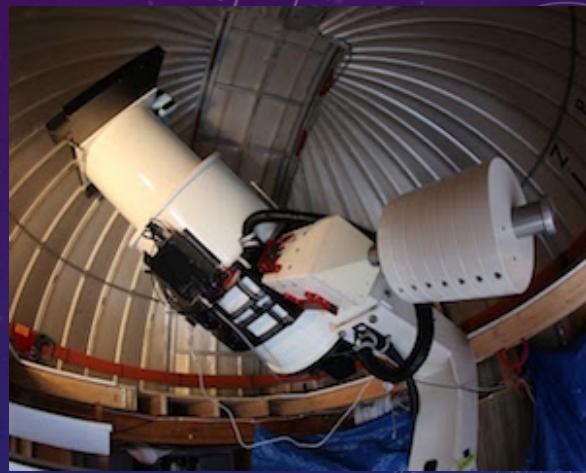


Soon...

- LIGO-Virgo-KAGRA
- GRBs



ATLAS (Hawaii)



Gaia (Space)



TNS Statistics (as of 2021-04-14)

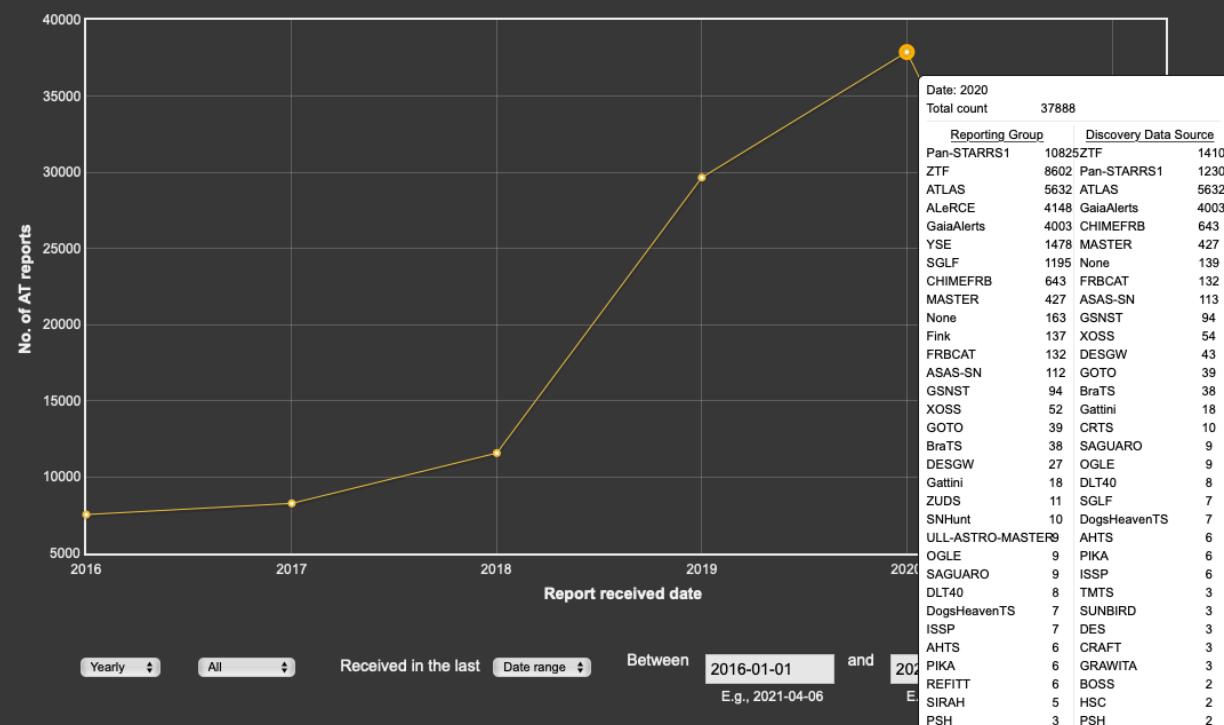
ALL transients reported since Jan 1, 2016	71691	
PUBLIC transients reported since Jan 1, 2016	71186	
PUBLIC transients for the top 5 reporting groups	Pan-STARRS1 GaiaAlerts ZTF ATLAS ALeRCE	22021 12257 11395 8541 8066
PUBLIC transients for the top 5 data source groups	Pan-STARRS1 ZTF GaiaAlerts ATLAS iPTF	23209 20933 12257 8541 1635
PUBLIC classified SNe reported since Jan 1, 2016	7664	
PUBLIC classified SNe for the top 5 reporting groups	ZTF ATLAS ALeRCE ASAS-SN GaiaAlerts	2365 1803 1075 698 480
PUBLIC classified SNe for the top 5 data source groups	ZTF ATLAS ASAS-SN GaiaAlerts Pan-STARRS1	3569 1803 698 480 439
ALL spectra reported to the TNS	9310	
PUBLIC spectra reported to the TNS	8612	
PUBLIC classifications for the top 5 contributing groups	ZTF ePESSTO ePESSTO+ SCAT PESSTO	3691 723 684 388 277
PUBLIC classified SNe by type		
		SN Ia 5045
		SN II 1135
		SN IIn 221
		SN Ia-91T-like 199
		SN Ic 178
		SN IIP 165
		SN Ib 122
		SN I Ib 104
		SLSN-I 86
		SN Ic-BL 72
		SN Ia-91bg-like 60
		SN Ia-pec 48
		SLSN-II 40
		SN Ib/c 38
		SN I 31
		SN Ib/n 26
		SN Iax[02cx-like] 23
		SN Ia-CSM 10
		SN Ib-Ca-rich 9
		SN Ib-pec 8
		SN II-pec 7
		SN Icn 3
		SN IIn-pec 3
		SN IIL 3
		SN Ic-pec 2



TNS Reports Yearly Timeline (2021-04-06)

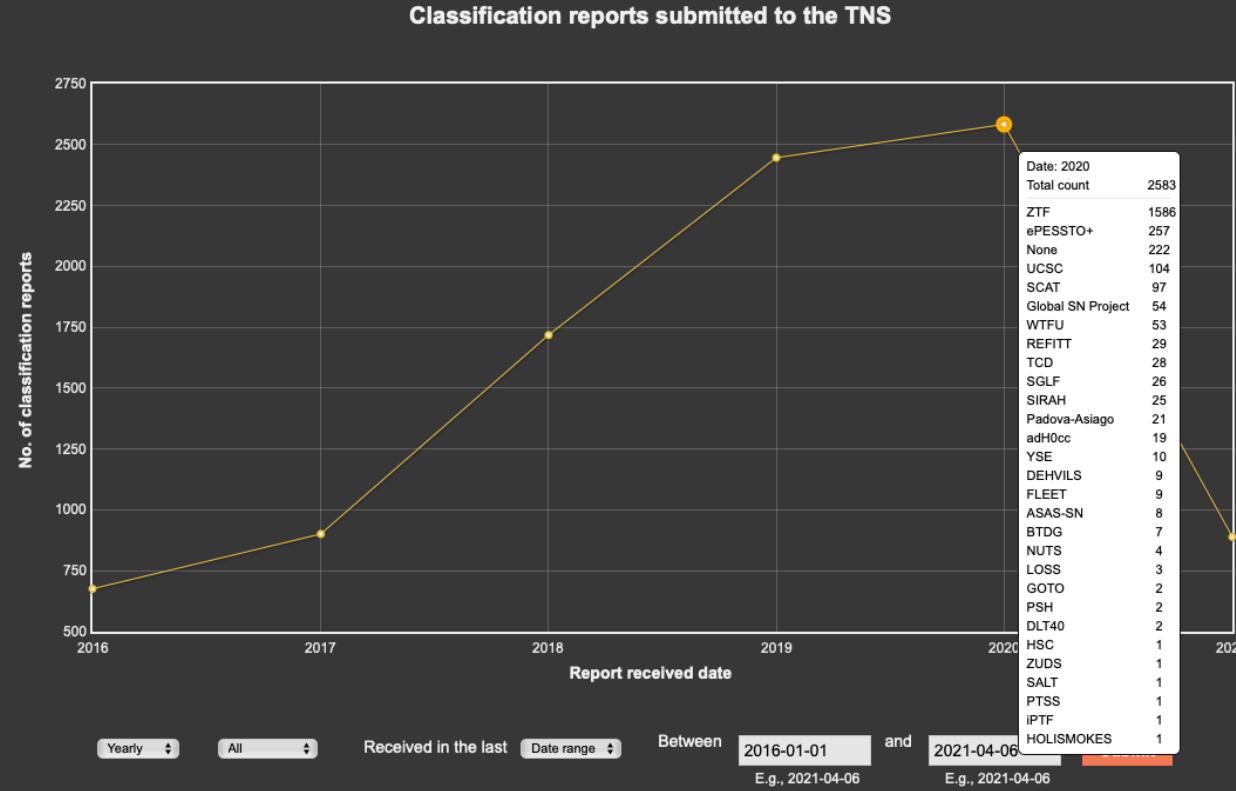
Discovery reports

AT reports submitted to the TNS



Classification reports

Classification reports submitted to the TNS



Brokers activity

An example of AT reports for ZTF/PS discoveries reported by various groups (as of 2021-04-12)

All AT Reports

name	count(*)
ZTF	23430
ALeRCE	8218
SGLF	1374
Fink	365
AMPEL	171
ZUDS	11
REFITT	10
ULL-ASTRO-MASTER	9
None	4
SIRAH	4
ePESSTO+	1
HOLISMOKES	1
IMSNG	1

ATs classified as SNe

name	count(*)
ZTF	8305
ALeRCE	1133
Fink	239
SGLF	116
AMPEL	28
REFITT	7
SIRAH	4
ULL-ASTRO-MASTER	2
None	1
HOLISMOKES	1

All AT Reports

name	count(*)
Pan-STARRS1	31891
YSE	1735
None	3

ATs classified as SNe

name	count(*)
Pan-STARRS1	3993
YSE	248



TNS NewsFeed + Help Page

- Important updates/revisions are presented on the NewsFeed
- Use the help page, where also sample codes and examples are provided...

TNS Newsfeed

Here we will notify about new features, modifications, open issues, and any general news and remarks...

Daily staging of all TNS public objects as CSV text files
2021-03-15 - Dr. Ofer Yaron (WIS)

We are glad to announce a new feature we have deployed, to enable easier and quicker mass download of information about TNS public objects.

Staging the CSV files will fulfil requests by TNS users, as well as encourage performing time-consuming operations locally by users, reducing the load on the system.

For example, if you need to cross-match entire catalogs or long object lists, we request that this would be done locally, against the csv (or a locally managed copy).

Calling the APIs for a limited number of objects is clearly fine, but we ask that our users apply appropriate caution and sensibility when using the TNS resources.

Every day after UT midnight, two CSV files are created and are accessible for download under: https://www.wis-tns.org/system/files/tns_public_objects/

1. **tns_public_objects.csv.zip** - holds the entire catalog of TNS public objects (AT/SN/FRB/... ~70,000 currently). This file is overwritten daily.
The date and time when the list of objects was created is specified in the first line; e.g. "2021-03-15 00:00:00"
2. **tns_public_objects_YYYYMMDD.csv.zip** - holds only those entries (objects) that were either added or modified during the specified day.
So, e.g. during Mar 15, 2021 it is possible to download this latest CSV for the previous day: `tns_public_objects_20210314.csv.zip`
The first line in the CSV will contain the exact duration covering the entries in the file; e.g. for the above example: "2021-03-14 00:00:00 - 23:59:59"

The separate daily files remain in place for 1 month backwards.

TNS - Getting started

- General
- Registration, reporting methods
- Email notifications (*Immediate/Daily digests*)
- ADS indexing
- Report forms (*Discovery/Classification*)
- APIs
 - Bulk reports
 - Change prop. period
 - Search/Get Objects
- Groups, proprietary period
- Discoverer/Classifier
- Search page
- Statistics page
- LIGO GW Events
- Quick query links
- Daily CSV staging
- AstroNotes
- Funding and Support



APIs, Bulk downloads

- A Sandbox environment exists for experimentation with the APIs (both for submission and retrieval of info)

All API development must be performed against the sandbox!!!

<https://sandbox.wis-tns.org>

<https://sandbox.wis-tns.org/api>

- APIs are in place for:
 - the submission of Discovery (AT) and Classification reports.
 - Searching of objects (by coords, names – IAU/internal)
 - Retrieving object details
- CSV/TSV downloads are available from the Search page (also in a scriptable way)

e.g. https://www.wis-tns.org/search?&&classified_sne=1&date_start%5Bdate%5D=2021-01-01&format=csv&num_page=100&page=0 ←[0..N]

- A CSV of all public objects (as well as daily “delta” lists) are available for download, in order to allow for easy local managing of the TNS data and to perform “heavy” operations locally (such as cross-matching entire catalogs or long object lists)

https://www.wis-tns.org/system/files/tns_public_objects/tns_public_objects.csv.zip

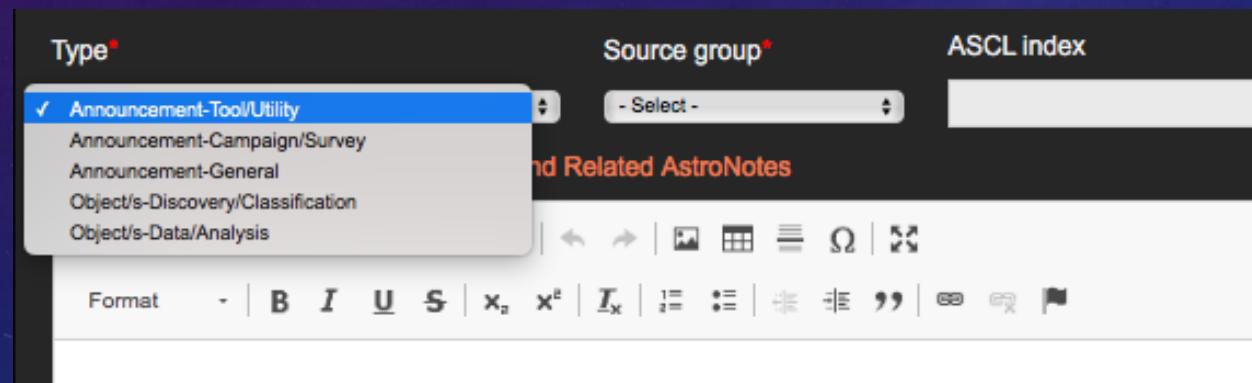
Or using curl (with api_key) for a daily csv:

```
curl -X POST -d 'api_key=YOUR-API-KEY' https://www.wis-tns.org/system/files/tns_public_objects/tns_public_objects_20210404.csv.zip > tns_public_objects_20210314.csv.zip
```



AstroNotes!!!

- A sub-system within the TNS (so no need to register to an additional service for creating and receiving these notifications).
- Enabling the distribution of notifications in a very flexible (yet accurate) way, directly coupled to the related objects, searchable and citable.
- Can create either an object-related (discovery, classification, analysis) or an “announcement” notification, **without any restrictions, limitations or penalties...**



Type*

- Announcement-Tool/Utility
- Announcement-Campaign/Survey
- Announcement-General
- Object/s-Discovery/Classification
- Object/s-Data/Analysis

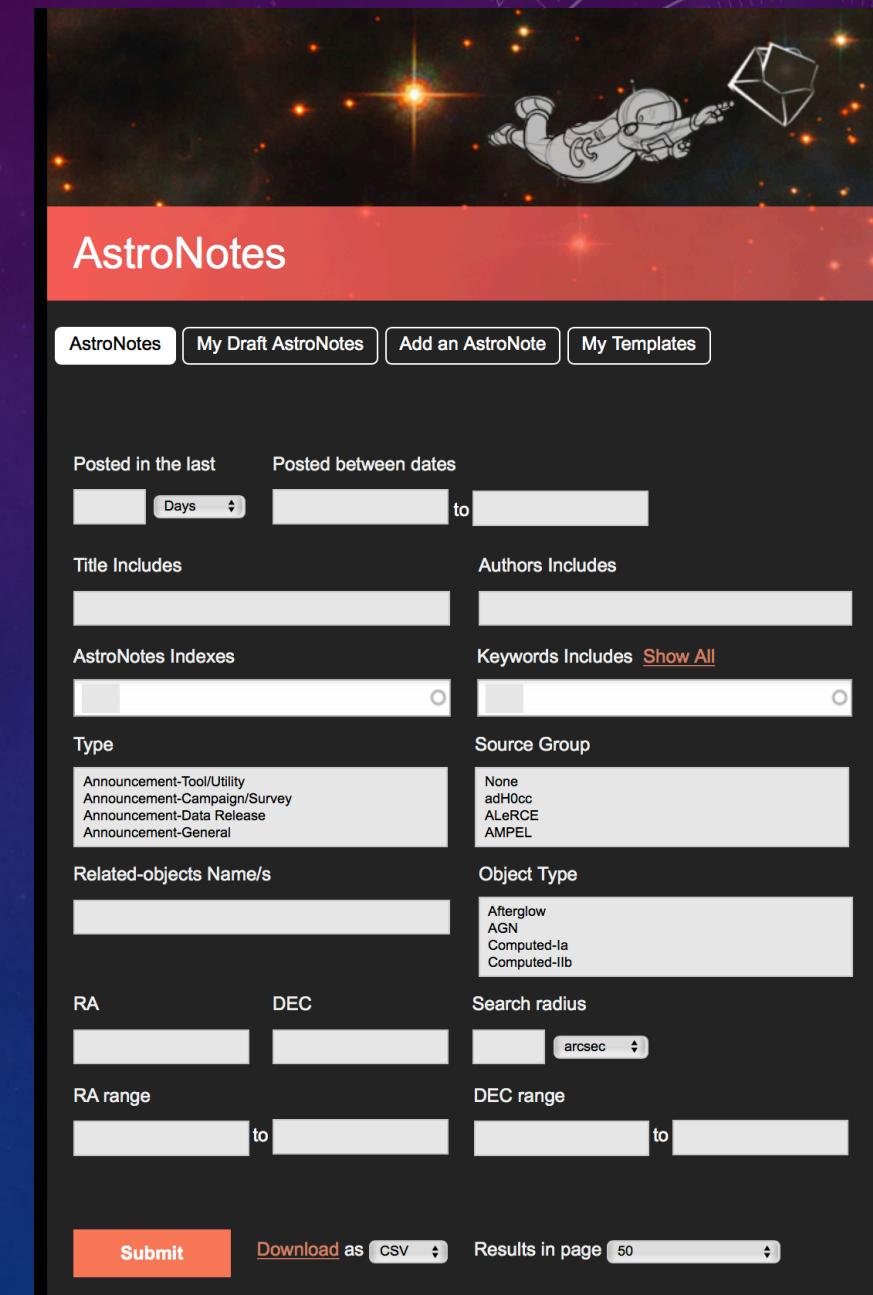
Source group*

- Select -

ASCL index

Find Related AstroNotes

Format B I U S x x² I_x : ; ,



AstroNotes

AstroNotes My Draft AstroNotes Add an AstroNote My Templates

Posted in the last Posted between dates

Days to

Title Includes Authors Includes

AstroNotes Indexes Keywords Includes Show All

Type Source Group

- Announcement-Tool/Utility
- Announcement-Campaign/Survey
- Announcement-Data Release
- Announcement-General

- None
- adHoc
- AleRCE
- AMPEL

Related-objects Name/s Object Type

RA DEC Search radius

RA range DEC range

Submit Download as CSV Results in page 50

AstroNotes!!!

- A “sub-system” within the TNS.
- Enabling the distribution of notifications in a very flexible way, directly coupled to the related objects, searchable and citable.
- Easy managing and use of **Templates**, for quicker writing of a new AstroNote.
- Easy sharing of **Drafts** with the colleagues; allowing definition of several editors to continue editing the draft until submission.

The screenshot shows the AstroNotes web interface. At the top, there's a navigation bar with tabs: 'AstroNotes' (which is active), 'My Draft AstroNotes', 'Add an AstroNote', and 'My Templates'. Below the navigation, a draft titled 'ATLAS20XXX (AT2020YYY)' is shown. A yellow circle highlights the 'Use template' section, which contains a dropdown menu with the same draft title. Another yellow circle highlights the 'Additional AstroNote editors' section, which contains four input fields for editor names. Below these sections, there are fields for 'Title' and 'Authors'.

AstroNotes

AstroNotes | My Draft AstroNotes | Add an AstroNote | My Templates

ATLAS20XXX (AT2020YYY) - discovery of a candidate supernova in NGC XXXX (XX Mpc) [ATLAS]

Use template

Template Instructions

This is a template for announcing ATLAS discoveries for use by QUB and collaborating team.

You need to change

- Title : put in the ATLAS, AT names and the host galaxy and distance
- The first paragraph does not need adjusted
- Adjust all the parameters of the object in the 2nd paragraph - name, discovery time, mag, last non-detection, host galaxy, absolute mag etc.
- For foreground reddening : $A_0 \sim (A_r + A_i)/2$ and $A_c \sim (A_g + A_r)/2$
- Author order : the discoverer should write and submit the AstroNote. Put yourself first and leave the rest as they are
- Adjust the Abstract appropriately, as above. This is what gets sent out in an email shot.
- For now you can use the Generate ATel button on the ATLAS object page to generate some of these numbers. **But double and triple check** they are correct - sometimes the automated cross-matching in Sherlock does not pick up the right object
- You can then select the object from the TNS database - no need to paste in details. The object, by definition will have been registered on the TNS and will be found.

Additional AstroNote editors

Title: ATLAS20XXX (AT2020YYY): discovery of a candidate supernova in NGC XXXX (XX Mpc)

Authors: K. W. Smith, S. Srivastav, O. McBrien, S. J. Smartt, J. Gillanders, P. Clark, M. Fulton, D. O'Neill, D. R. Y.

AstroNotes!!!

- A “sub-system” within the TNS.
- Enabling the distribution of notifications in a very flexible way, directly coupled to the related objects, searchable and citable.
- Easy managing and use of Templates, for quicker writing of a new AstroNote.
- Easy sharing of Drafts with the colleagues; allowing definition of several editors to continue editing the draft until submission.
- Many **Search options**, including by object names, types and coords.

AstroNotes

AstroNotes My Draft AstroNotes Add an AstroNote My Templates

Posted in the last Posted between dates
[Days] to [Days]

Title Includes Authors Includes

AstroNotes Indexes Keywords Includes [Show All](#)

Type Source Group

Announcement-Tool/Utility
Announcement-Campaign/Survey
Announcement-Data Release
Announcement-General

None
adH0cc
ALERCE
AMPEL

Related-objects Name/s Object Type
[Text Input]
Afterglow
AGN
Computed-1a
Computed-1bb

RA DEC Search radius
[Text Input] [Text Input] [Text Input] arcsec

RA range DEC range
[Text Input] to [Text Input] [Text Input] to [Text Input]

Submit Download as CSV Results in page 50

AstroNotes!!!

- A “sub-system” within the TNS.
- Enabling the distribution of notifications in a very flexible way, directly coupled to the related objects, searchable and citable.
- Easy managing and use of Templates, for quicker writing of a new AstroNote.
- Easy sharing of Drafts with the colleagues; allowing definition of several editors to continue editing the draft until submission.
- Many Search options, including by object names, types and coords.
- Possible to define on your **My Account** page which notifications types to receive, and in which manner.

General Notification settings

Immediate notification

Notify on

Discovery

Classification

Discovery magnitude cut

Mag ≤ 19

Notify on new transients coincident with sources/pointings from the following catalogs/missions

TESS-active sector/s (19,20)

AstroNotes notifications

Notification Type	Frequency
All (the following and future types)	Immediate
Announcement-Tool/Utility	Daily
Announcement-Campaign/Survey	Daily
Announcement-Data Release	Daily
Announcement-General	Never
Object/s-Discovery/Classification	Immediate
Object/s-Data/Analysis	Immediate

AstroNotes!!

A query for ZTF AstroNotes:

- Major surveys and groups of the Transients community have already moved to using solely AstroNotes – ATLAS, Pan-Starrs, PESSTO, ZTF...

Clicking on an object name overlays its basic details, with a link directly to the object page

Showing results 1 to 9 out of 9	
AstroNote 2020-8	Type: Object/s-Data/Analysis
Released: 2020-01-08 22:08:33	
Early ZTF and UVOT Observations of ZTF20aaelulu, a Supernova Candidate in M100	
A. Y. Q. Ho (Caltech), S. Schulze (Weizmann), D. Perley (LJMU), J. Sollerman (OKC), Y. Yang (Weizmann), O. Yaron (Wei...	
Source Group: ZTF	
Keywords: Transient , Supernova , Time-domain , Photometry	
Related Objects: 2020oi [ZTF20aaelulu]	
We report early photometry of ZTF20aaelulu (AT2020oi) from the Zwicky Transient Facility (ZTF; ATel #11266) and Swift/UVOT. ZTF20aaelulu is a rapidly rising transient coincident with M100 (z=0.0052...	
AstroNote 2019-131	Type: Object/s-Data/Analysis
Released: 2019-11-14 23:22:21	
ZTF early discovery and rapid follow-up of the infant SN AT2019ust (ZTF19acryurj)	
Rachel Bruch, Steve Schulze, Ofer Yaron, Yi Yang (WIS), Mattia Bulla (OKC, Nordita) and Avishay Gal-Yam (WIS) on beha...	
Source Group: ZTF	
Keywords: Supernova , Transient	
Related Objects: 2019ust	
AstroNote 2019-124	Type: Announcement-Campaign/Survey
Released: 2019-11-05 20:41:27	
Public reports of transients from the Zwicky Transient Facility volume limit	
RA, DEC: 06:25:52.312, +64:44:38.40 K. De (Caltech), S. Schulze (Weizmann), D. Perley (LJMU), C. Fremling (OKC), A. Y. Q. Ho (Caltech), O. Yaron (Weizmann), Y. Yang (Weizmann)	
Redshift: Type: See object 2019ubr	
Source Group: ZTF	
Keywords: Transient , Supernova , Time-domain , Photometry	
Related Objects: 2019ubs , 2019ubr , 2019tyf , 2019tui , 2019tkn	
Related Notes: 2019-11-05	
We announce the beginning of public reports to the Transient Name Sever (TNS) of transients saved as a part of the volume	

Recent Released Tools

[AstroNote 2020-1](#) Released: **2020-01-01** Views Count: **49**
A bash shell utility to query and download classified SNe from TNS
S. R. Kulkarni

[AstroNote 2019-136](#) Released: **2019-11-24** Views Count: **93**
Modifications to the TNS treatment of the "Discovery Group" - to be deployed on Dec 2nd, 2019.
Ofer Yaron, Avishay Gal-Yam, Avner Sass (Weizmann)

[AstroNote 2019-60](#) Released: **2019-08-01** Views Count: **96**
Revising the astrometric accuracy values on the TNS and merging of objects
Ofer Yaron (Weizmann)

Clarifications / to summarize

- The TNS manages discovery & classification information (data), NOT extended LCs, spectral sequences etc... For this, data repositories such as WISeREP are relevant.
- Initiated mainly for SN candidates, the TNS also handles other extra-galactic transients, including novae (CVs), AGN flares, TDEs, Kilonovae... BUT NOT variable stars, asteroids or other such galactic/local variable/moving sources.

PLEASE DO NOT submit varstars/moving objects but only secure extra-galactic transient candidates!!!

- “Area Transients” are also officially joining the TNS: FRBs, and soon also GRBs, GW events.
(In future more sophisticated cross-matching and association capabilities should be implemented – both on the TNS, and hopefully also by the additional utilities being developed.)
- Classifications must be supported by a spectrum (not relevant for the area transients), and currently the TNS only switches the prefixes from **AT** to **SN**. (TDEs, Kilonovae... remain AT until an official decision will be made.)
- API sample codes are available for download on the help page.
- For any questions/feedback/suggestions related to the use of the TNS, its APIs, AstroNotes, please do not hesitate to contact us: www.wis-tns.org/content/contact-us (or me in person)



The new guys in town... FRBs (*Area Transients*)

- Main coordination with CHIME and representatives of the FRB community
- A separate engine for designation of names: (FRB)YYYYMMDDabc, to coexist with the AT/SN names
- FRB-Catalog to be ingested to the TNS in the coming weeks

Photometry

Burst Properties

TopocentricDatetime*	Peak Flux*	Flux-Err	Limiting Flux	Units*	Filter*	Instrument*
				-Select-	-Select-	-Select-
SNR*	Fluence	Fluence-Err		Units	Exp-time (sec)	Observer
				Jy ms		
Burst Width	Burst Width-Err	Units	Burst BandWidth	Burst BandWidth-Err	Units	
		ms			MHz	
Scattering time	Scattering Time-Err	Units	DM Struct	DM Struct-Err	Units	
		ms			pc/cc	
RM	RM-Err	Units	Lin. Polarization Frac.	Lin. Pol.-Err	Circ. Polarization Frac.	Circ. Pol.-Err
		rad/m ²				
Ref. (Central) Freq.*	Units*	Instrument Bandwidth*	Units*	No. Freq. Channels*	Sampling Time*	Units*
	MHz	MHz	MHz		ms	

FRB Report Form

AT Report Form Classification Report Form **FRB Report Form**

RA*	Error	Err units	DEC*	Error	Err units
		arcsec			arcsec
Reporting Group*	Discovery Data Source*	Internal name	AT type		
- Select -	- Select -		FRB		
Reporter/s (Authors list)*					
Nikola Knezevic					
Discovery Datetime / JD (UT)*	Barycentric Datetime / JD (UT)	End prop. period	Associate with group/s		
			adH0cc ALeRCE AMPEL ASAS-SN		
Redshift	Host name	Host redshift			
Repeater of Primary Burst	Public Webpage				
Region - Ellipse	Semi-major/minor axes Units				
e.g. [[11.1, -22.2, 20,15, 30.0, 2.0], [11.2, -22.3, 16,11, 30.0, 3.0]]	arcsec				
Region - Polygon	Region - filename				
e.g. [[[1,2],[3,4]],[[5,6],[7,8]]]	Choose File no file selected				
DM*	DM-Err	Units*	Gal. DM Limit	Gal. DM Model	
		pc/cc		NE2001	

Fast Radio Bursts

FRB Advanced Search

Repeater Repeater of

Repeater FRB with measured redshift

DM Range RM Range

to to

SNR Range Flux Range

to to

Show main query Explain main query

Submit **Download as CSV** **Download as TSV** Results in page 50

Columns to display

Showing results 1 to 2 out of 2

ID	Name	Reps	Class	RA	DEC	Obj. Type	Repeater of Primary Burst	DM (Err)	Galactic DM Limit	Barycentric Datetime
51465	FRB 20191202A	1		02:15:60.000	+33:00:00.00	FRB	FRB 20191202A	680 (68) pc/cc	24 (NE2001)	
51466	FRB 20190807A	1		00:08:00.000	+02:00:00.00	FRB	FRB 20191202A	430 (43) pc/cc	23 (YMW16)	

- Repeaters are distinct objects on the TNS, allowing flexible associations of multiple bursts with the Primary Burst.

CHIME/FRB Discovery of Eight New Repeating Fast Radio Burst Sources
 THE CHIME/FRB COLLABORATION, B. C. ANDERSEN,^{1,2} K. BANDURA,^{3,4} M. BHARDWAJ,^{1,2} P. BOUBEL,^{1,2} M. M. BOYCE,⁵ P. J. BOYLE,^{1,2} C. BRAR,^{1,2} T. CASSANELLI,^{6,7} P. CHAWLA,^{1,2}

The discovery of the first repeating FRB source, FRB 121102, at a dispersion measure $DM \simeq 560 \text{ pc cm}^{-3}$ (Spitler et al. 2014, 2016), eliminated cataclysmic models as the only means for producing FRB emission. The repetitive nature of FRB 121102 enabled sub-arcsecond localization of the source via radio interferometry and subsequent optical identification of the low-metallicity host galaxy

