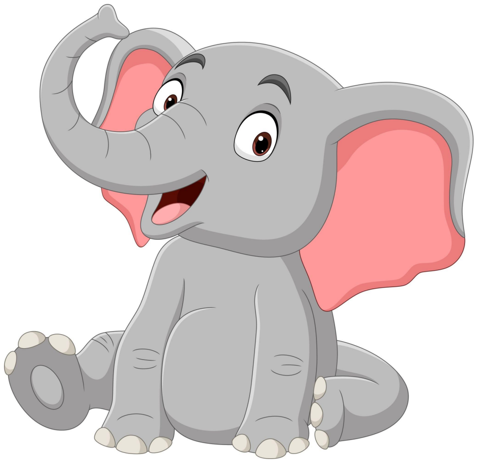


ELEPHANT: Hostless transient detection in Fink

2025 Fink collaboration meeting, Clermont-Ferrand
17th of July 2025

FH
@FINK_HOSTLESS

Rupesh Durgesh on behalf of the ELEPHANT team

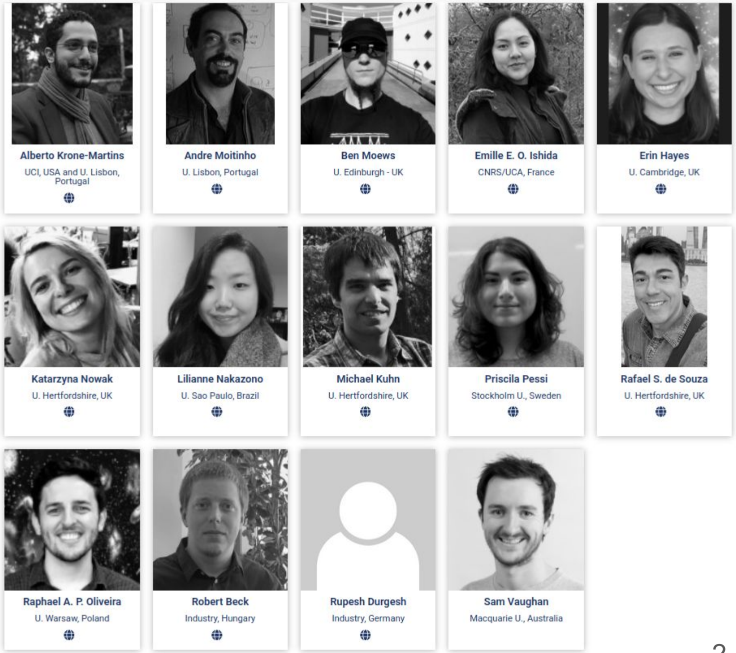
ELEPHANT

COIN Residence Program #7, 2023, Portugal

ELEPHANT: ExtragaLactic alErt Pipeline for Hostless AstroNomical Transients

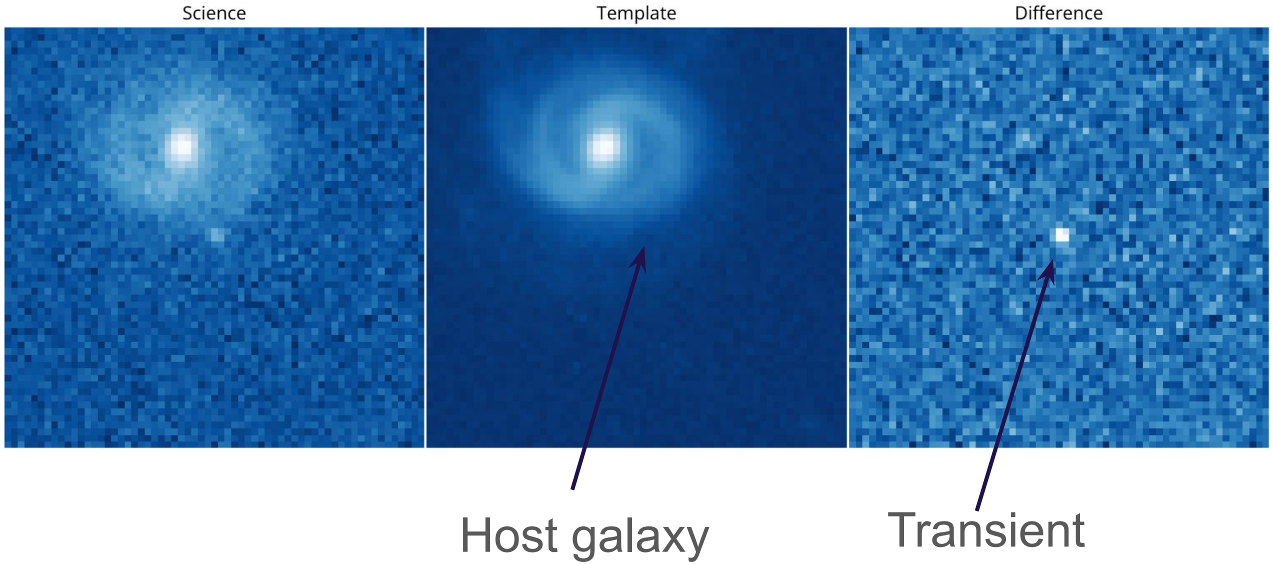
A&A, 691, A181 (2024)
https://doi.org/10.1051/0004-6361/202450535

coin
cosmostatistics initiative

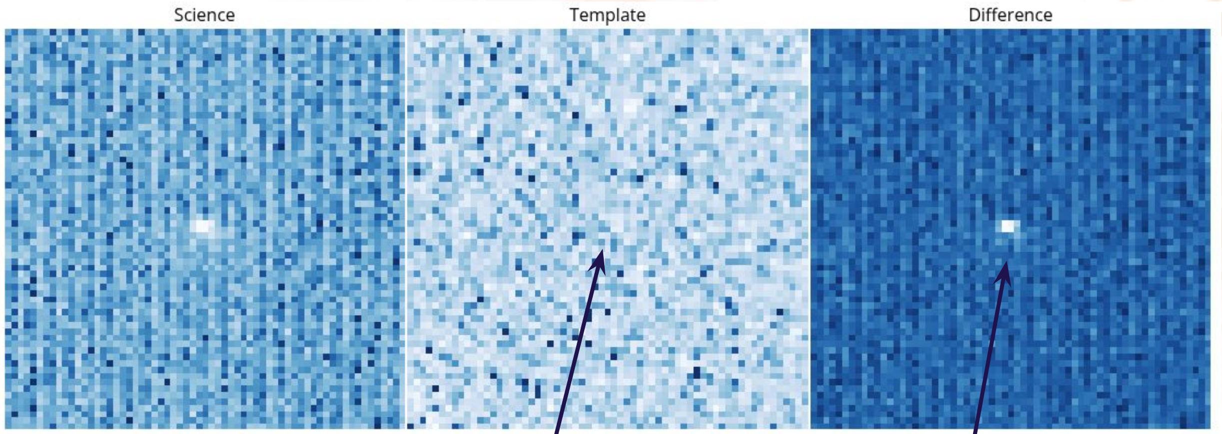


https://cosmostatistics-initiative.org/residence-programs/coin-residence-program-7-portugal-9-16-september-2023/

Transients in galaxies



Transients in galaxies



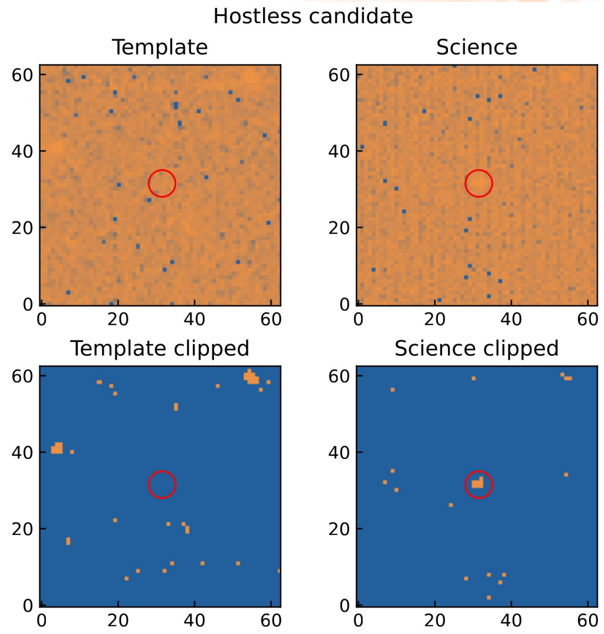
Missing host galaxy?

Transient

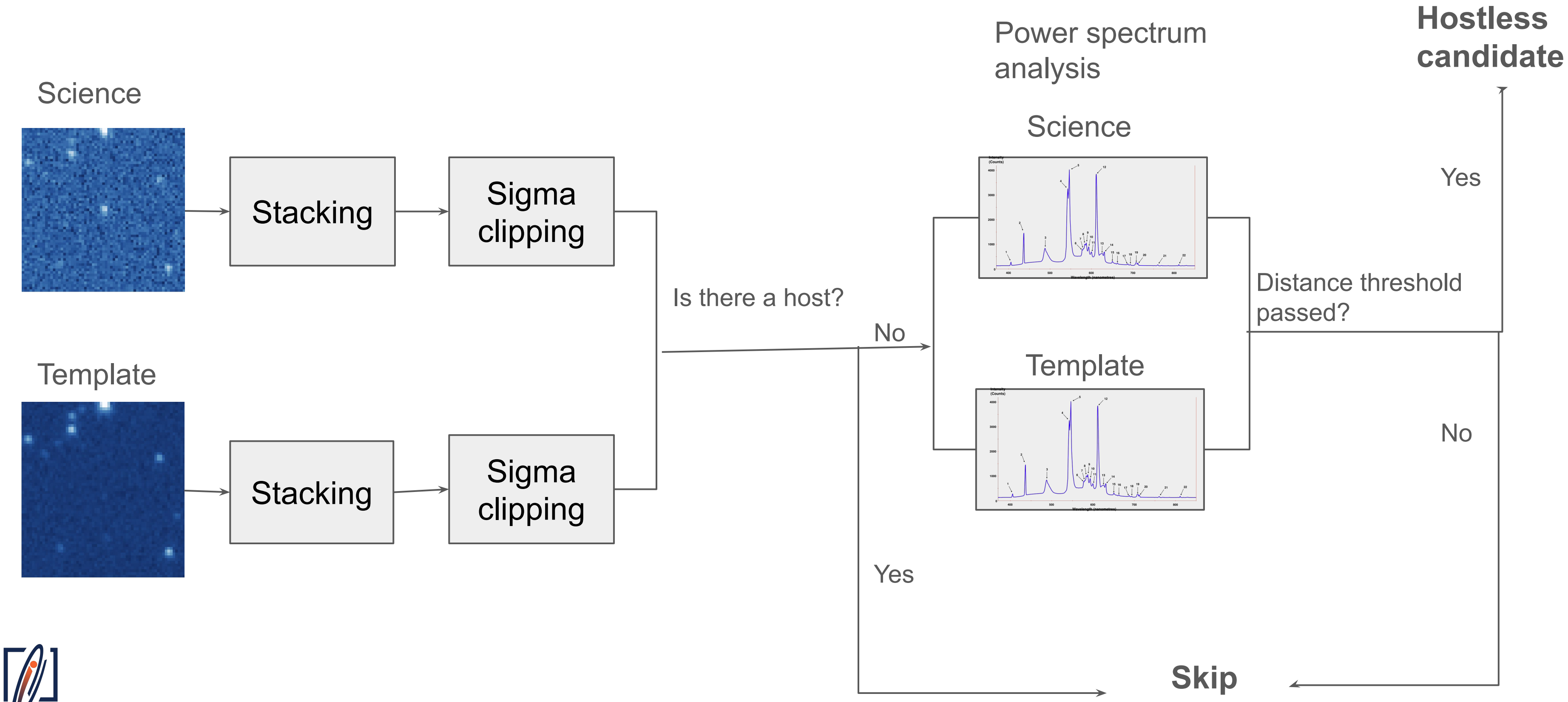
Transients in galaxies

- Most SN happens in galaxies (hosts)
- If the host is not detected, we can use the transient to detect very faint galaxies
- We can use hostless to identify runaway stars (very rare, which process creates them?)
- We used Zwicky Transient Facility alerts

We wanted to find hostless SLSN



A statistical pipeline



Distributing candidates

- Modifications in bot:
  - No stacking Magnitude thresholds
  - Updation of minimum number of light curve points and analysis thresholds values
- Run time: ~6.5 seconds per 100 alerts on a one-core M2 laptop


AstroNote 2025-159 Type: Object/s-Discovery/Classification Released: **2025-05-27 14:37:01**

Hostless candidates detected by ELEPHANT

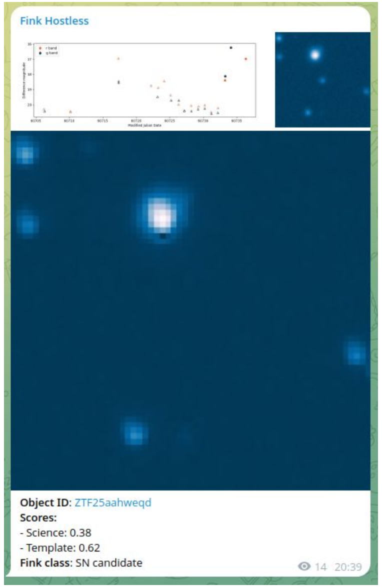
R. Durgesh (independent), P. Pessi (OKC), E. E. O. Ishida (CNRS), E. E. Hayes (KIC), L. Nakazono (USP), R. A. P. Olivei…

Source Group: COIN
Keywords: Time-domain , Transient , Surveys
Related Objects: 2025kyx [ZTF25aaqzjoy] , 2025kkb [ZTF25aaofttb] , 2025izy [ZTF25aanxtou] , 2025lfj [ZTF25aaqowtn] , 2025idz [ZTF25aanikpq]

We report 5 hostless candidates selected by the ELEPHANT pipeline.

FH

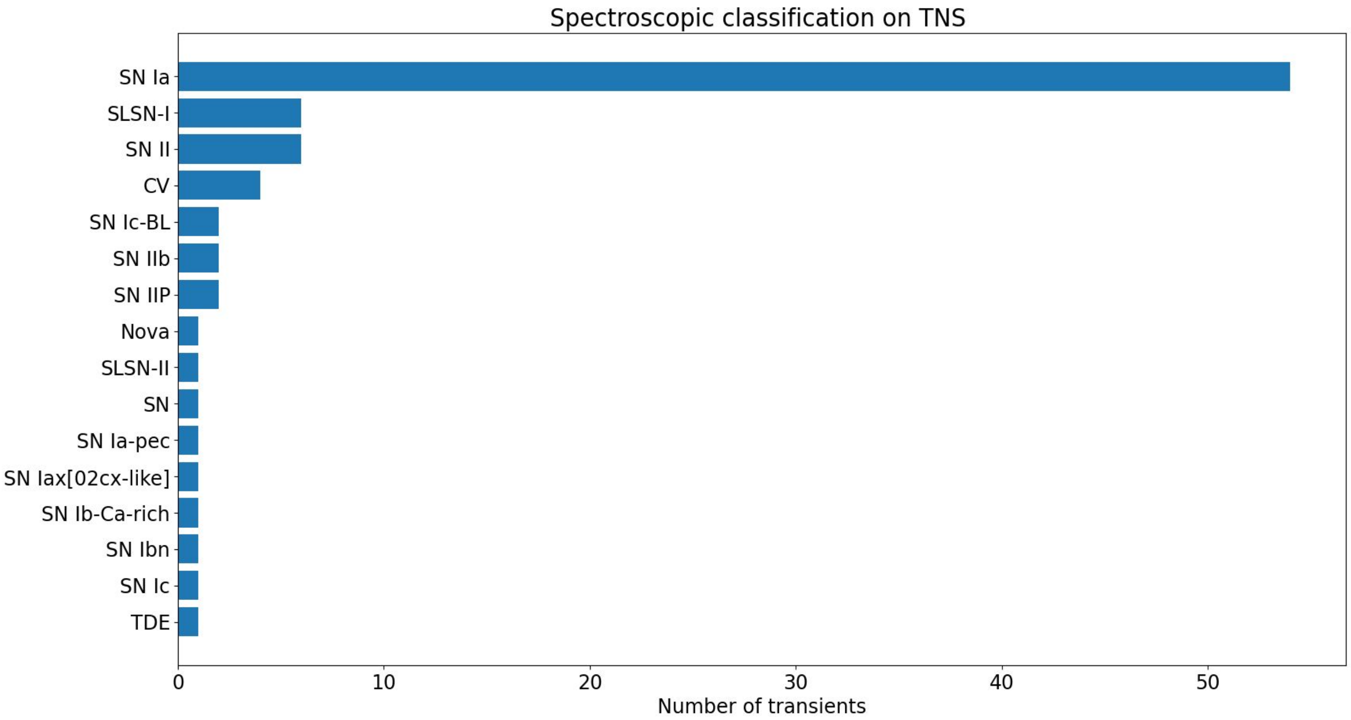
@FINK_HOSTLESS



Distributing candidates

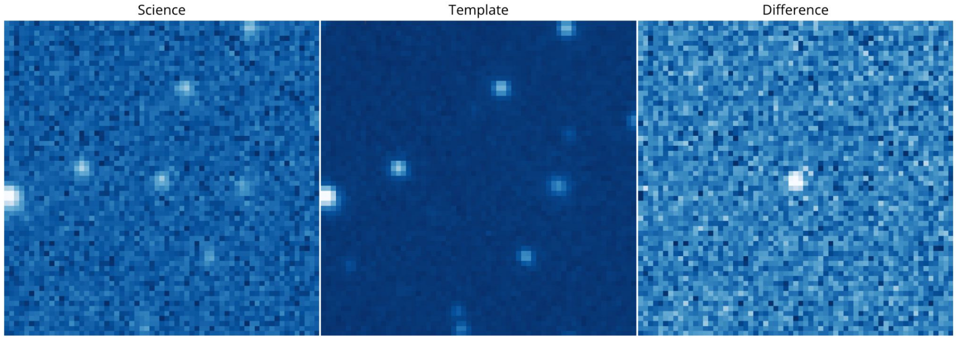
Report on Telegram with spectroscopic classification

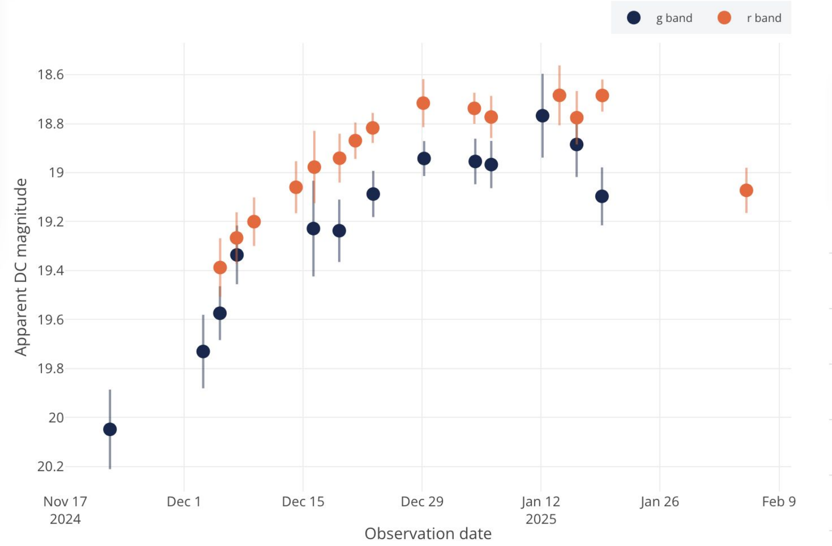
August 2024 - March 2025



Distributing candidates

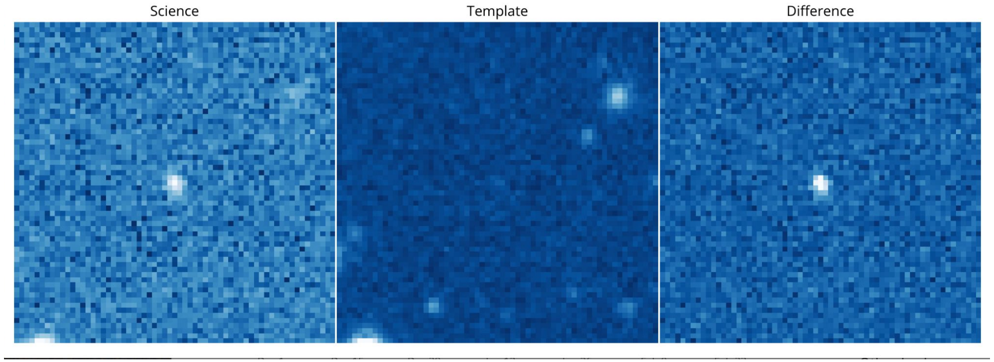
ZTF24abtlppf (SLSN-I)

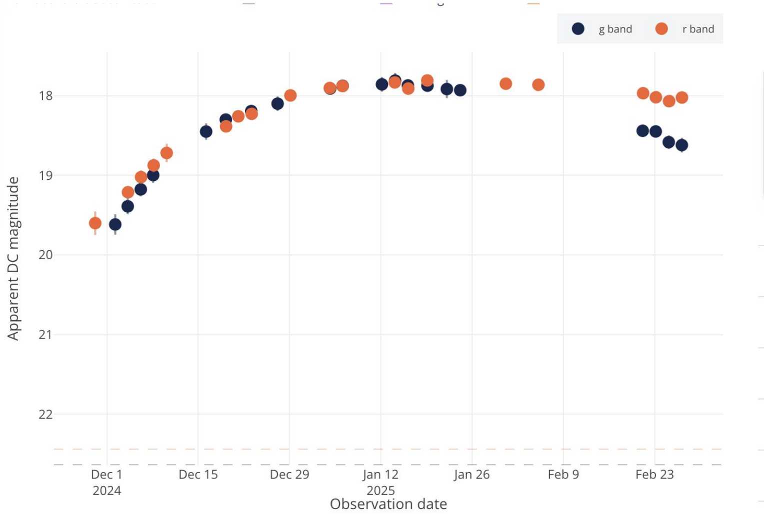




Distributing candidates

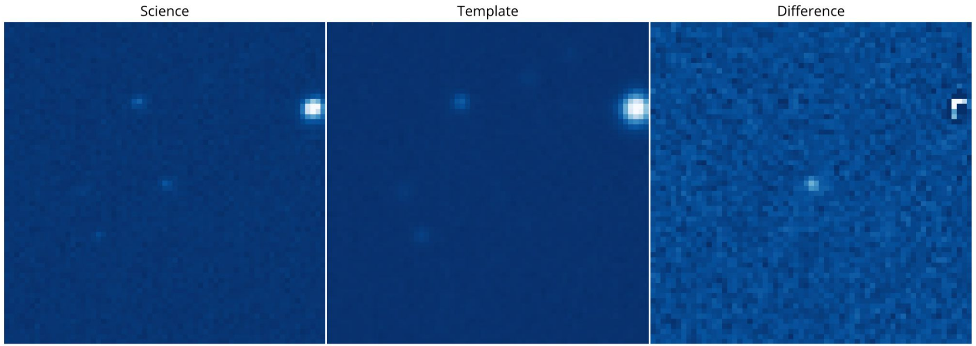
ZTF24abtmueg (SLSN-I)

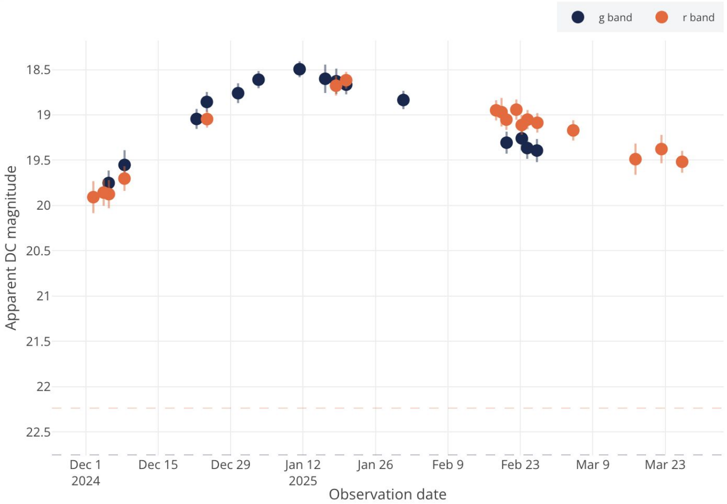




Distributing candidates

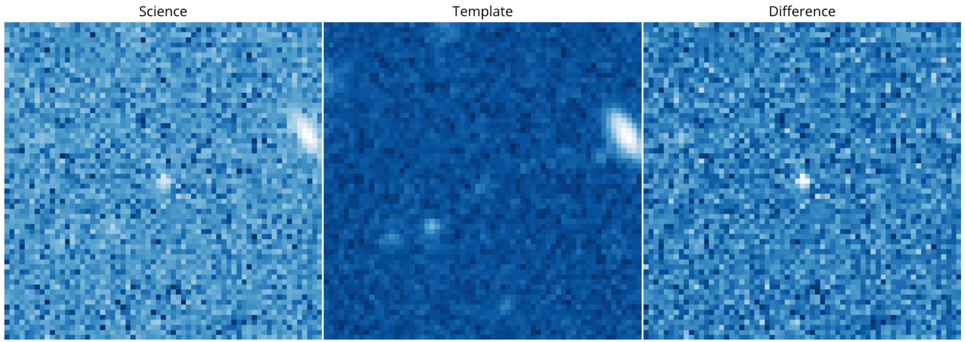
ZTF24abvftmi (SLSN-II)

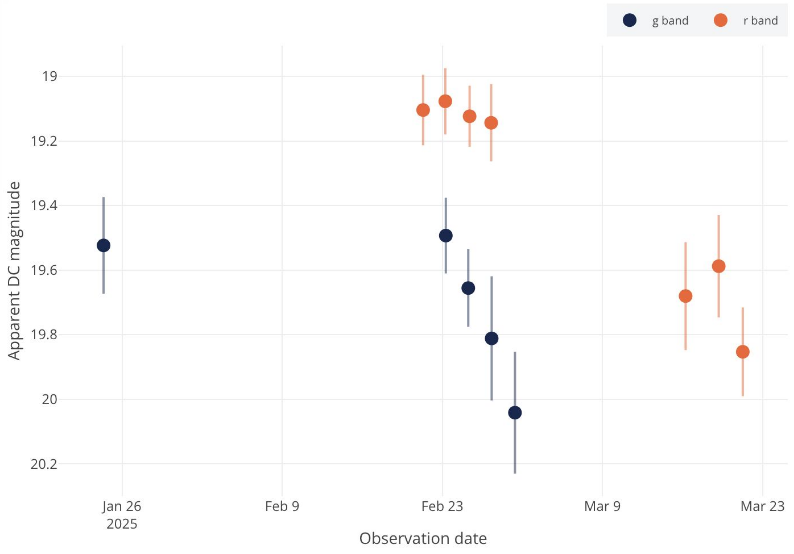




Distributing candidates

ZTF25aaczsit (SN IIB)





Next steps

- Evaluate how good the pipeline is
- In progress: Refinement of hostless candidates list using catalog crossmatch
- Cross-matching with Sherlock, Pröst
- Analyse interesting transients

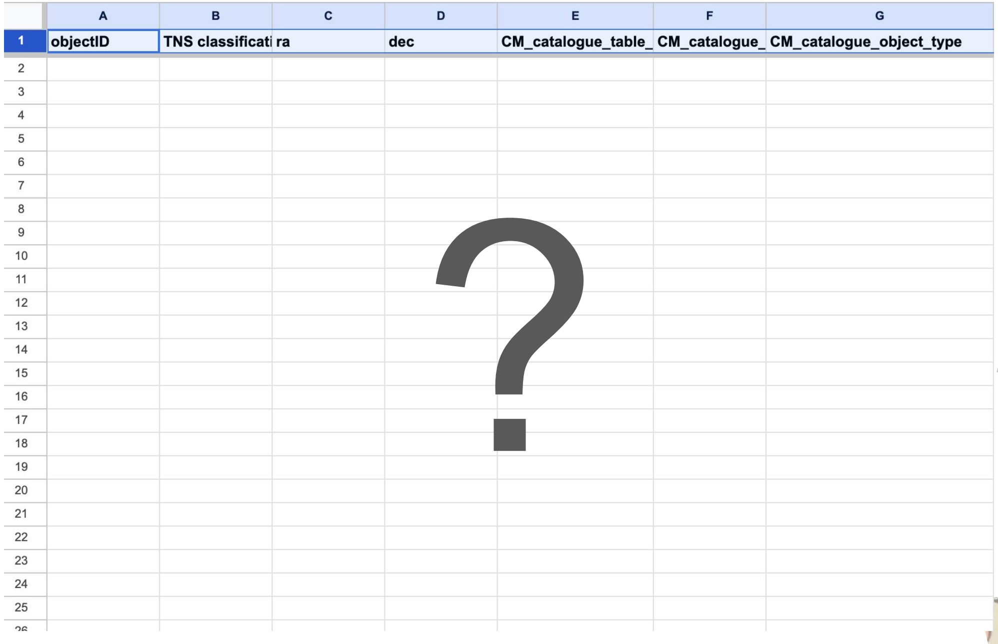
	A	B	C	D	E	F	G
1	objectID	TNS classificati	ra	dec	CM_catalogue_table_	CM_catalogue_	CM_catalogue_object_type
28	ZTF24aaervkt	SN Ia	196.8401266	-27.3752484	NED/LASR	ESO508-G008	galaxy
29	ZTF24abqwodi	SN II	174.8035653	48.8979073	NED	SDSSJ113912.7	galaxy
30	ZTF24aadecbb	SN II	186.1997901	-0.989909	SDSS	1237648720159	galaxy
31	ZTF23abbzdoj	SN II	2.4879958	37.0742132	SDSS	1237666185112	galaxy
32	ZTF24abokdnf	SN II	146.5871189	-9.7288966	2MASS/LASR	09462226-0943	galaxy
33	ZTF24aaezido	SN II	190.30655	20.6699964	SDSS/2MASS/LASR/P	1237667916496	galaxy
34	ZTF24abqlxaf	SN IIP	76.941196	16.1004361	SDSS	1237673474717	galaxy
35	ZTF24aafedkt	Varstar	111.1265431	73.1821324	PS1	1958111112660	galaxy
36	ZTF24abbvhxw	CV	262.9989834	5.667437	PS1	1148026299895	uncertain
37	ZTF24abbggnw	SLSN-I	23.2286698	-27.7566988	PS1	7469023228684	uncertain
38	ZTF24aaedlew	SLSN-I	169.8768603	22.1747936	PS1	1346116987670	uncertain
39	ZTF24aaaldzu	SLSN-I	183.5463885	-25.1319449	PS1	7784183546383	uncertain
40	ZTF23abjqxbe	SN Ia	67.1141027	-17.8909055	PS1	8653067114169	uncertain
41	ZTF23abavpyk	SN Ia	352.7757065	-27.0156789	PS1	7558352775689	uncertain
42	ZTF23abccont	SN Ia	55.922605	11.4173786	PS1	1217005592242	uncertain
43	ZTF24abkegqp	SN Ia	253.5319808	61.8077067	SDSS/PS1	1237651211211	uncertain
44	ZTF24abzgggz	SN Ic	170.4473179	46.1284203	PS1	1633517044748	uncertain
45	ZTF24abmtnee	SN II	116.8199034	-3.9933537	PS1	1032011681986	uncertain
46	ZTF23aaznguj	CV	318.0644686	36.8699995			
47	ZTF24aalbxfh	CV	160.7937031	82.6834327			
48	ZTF24abqbavo	CV	55.6095103	9.2053951			
49	ZTF24aaejnbx	SLSN-I	167.1427825	-0.5066118			
50	ZTF24abvzgqt	SLSN-I	131.6776349	-16.6069139			
51	ZTF24abwsvtj	SLSN-I	201.0711264	27.7170018			
52	ZTF23abofwba	SLSN-I	346.9486026	43.8510415			

Next steps: ZTF

- ZTF to continue operations in 2025 & 2026
- Improve and optimize the pipeline further
- Automatic cross-matching in Fink would be beneficial

Next steps: LSST

- Update the pipeline for LSST alerts

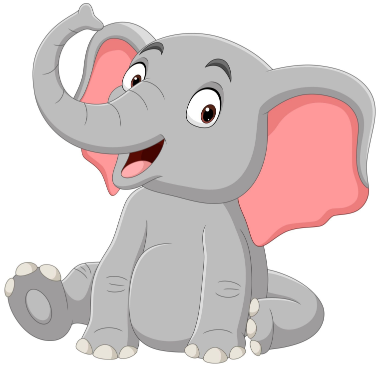


objectID	TNS classificati	ra	dec	CM_catalogue_table_	CM_catalogue_	CM_catalogue_object_type

Conclusion

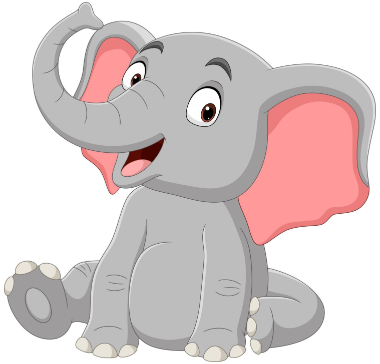
- A Simple and fast python pipeline for hostless transient detection
- The potential hostless transients are being reported on the Telegram bot
- The pipeline can be transferred to other surveys
- Fine-tuning of the pipeline will be necessary to process LSST alerts

Conclusion



Thank you! Questions?

Extra slides



Extra slides

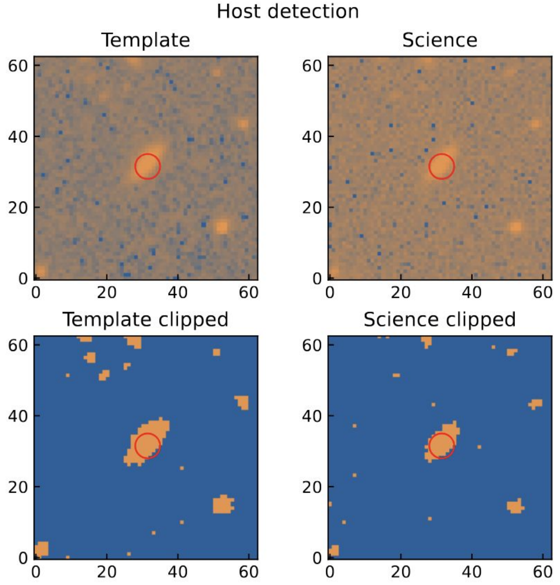


Fig. 1: Example of the *template* (left) and *science* (right) stamps for a transient associated with a host galaxy. The top row shows the original stamps and the bottom row shows the masks produced from sigma clipping. At the center of the stamps, we display a red circle of 7 pix radius that indicates the aperture radius of the associated photometry.

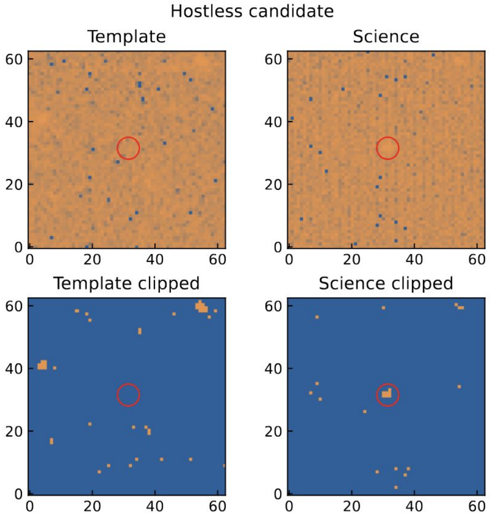


Fig. 2: Example of the *template* (left) and *science* (right) stamps of a hostless transient candidate. The top row shows the original stamps, and the bottom row shows the masks produced by sigma clipping. We can see that the *science* stamp shows a mask at the center of the stamp that is absent in the *template* stamp. The absence of a mask is considered as the absence of a host. At the center of the stamps, we display a red circle of 7 pix radius that indicates the aperture radius of the associated photometry.

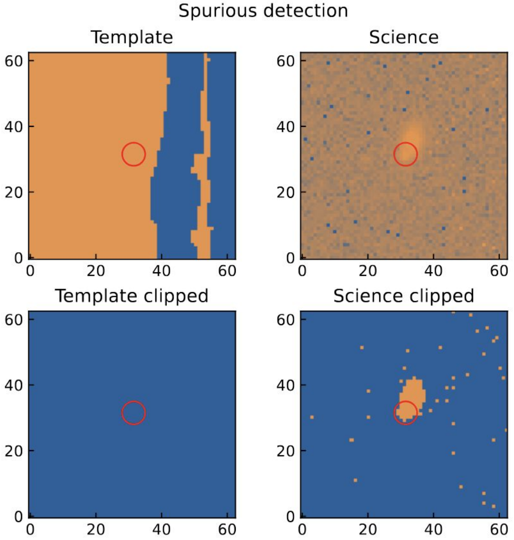


Fig. 3: Example of the *template* (left) and *science* (right) stamps of a spurious hostless candidate detection. The top row shows the original stamps and the bottom row shows the masks produced from sigma clipping. We can see that the erroneous detection is driven by artifacts present in the original *template* stamp. As a result, sigma clipped *template* shown on the bottom left panel shows no signal. At the center of the stamps, we display a red circle of 7 pix radius that indicates the aperture radius of the associated photometry.

Extra slides

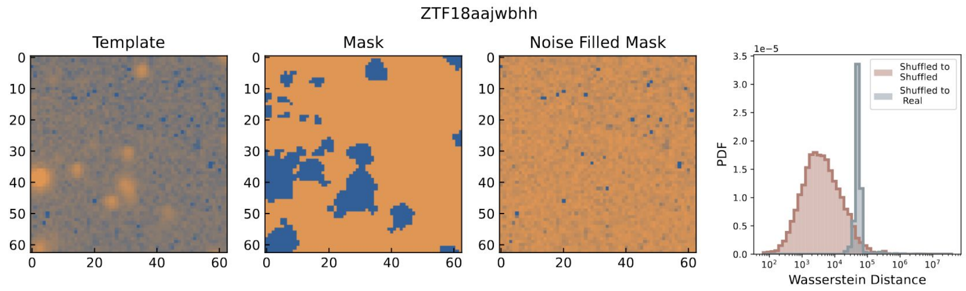


Fig. 4: Stages of the power spectrum analysis for a template with host (SN2017iuu / `ZTF18aajwbhh`). From left to right the panels show the template image, the mask and the mask populated with noise. The right-most panel shows the distribution of Wasserstein distances between the original template and shuffled noised masks (gray) and between random pairs of shuffled noised masks (rose). The distributions were generated using 1000 different shuffles of the noised masks within the central patch of 7×7 pixels.

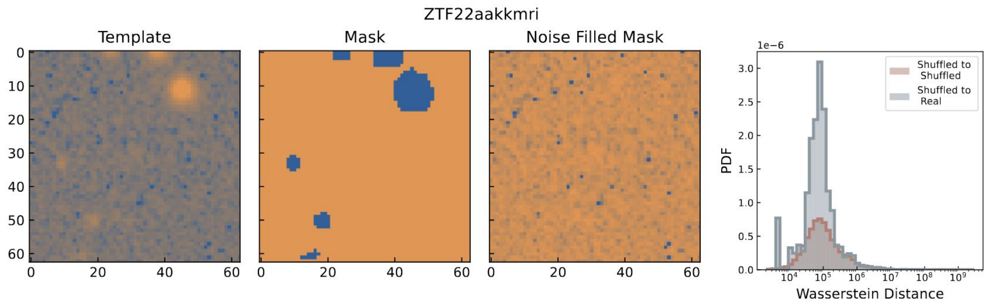
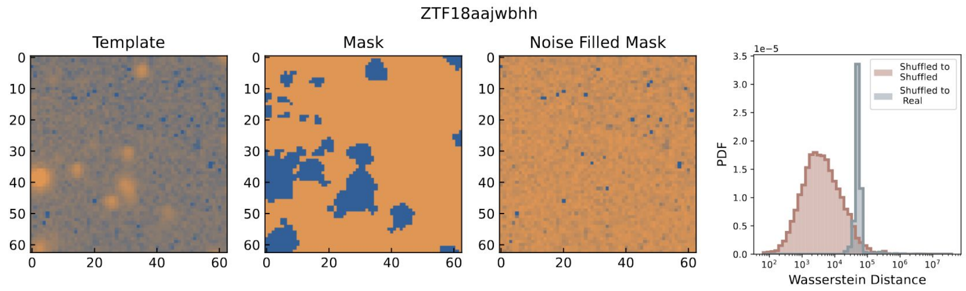


Fig. 5: Stages of the power spectrum analysis for a hostless template (SN2022knm / `ZTF22aakkmri`). Panel descriptions are equivalent to those described in Figure 4.

Extra slides



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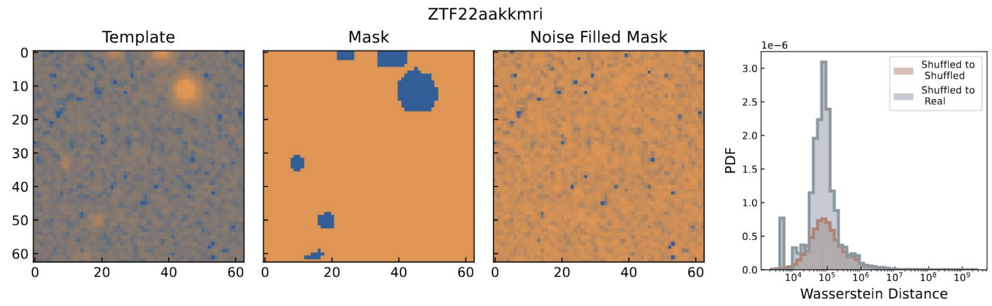

Fig. 5: Stages of the power spectrum analysis for a hostless template (SN2022knm / `ZTF22aakkmri`). Panel descriptions are equivalent to those described in Figure 4.

Extra slides

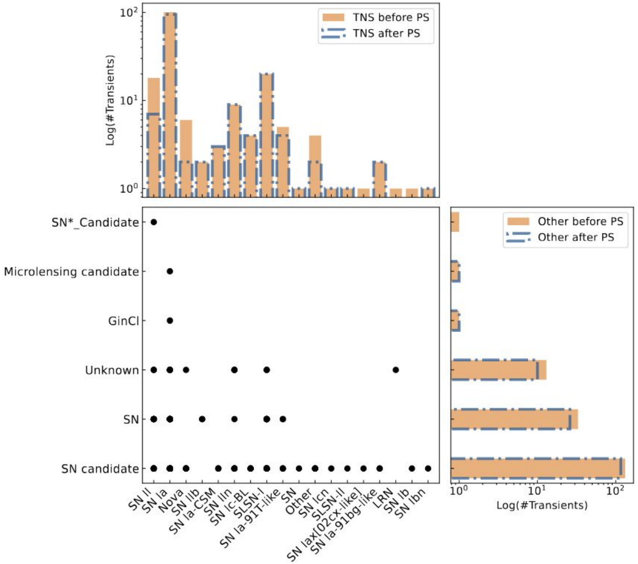

Fig. 6: Central panel: comparison between spectral classification reported on TNS (horizontal axis) and the classification reported by Fink obtained from other sources (vertical axis). The *x* and *y* axis side panels show the number of transients considered to be hostless by the sigma clipping method before applying the power spectrum (PS) analysis (orange), and the number of surviving hostless candidates after applying the PS analysis (blue).

Extra slides

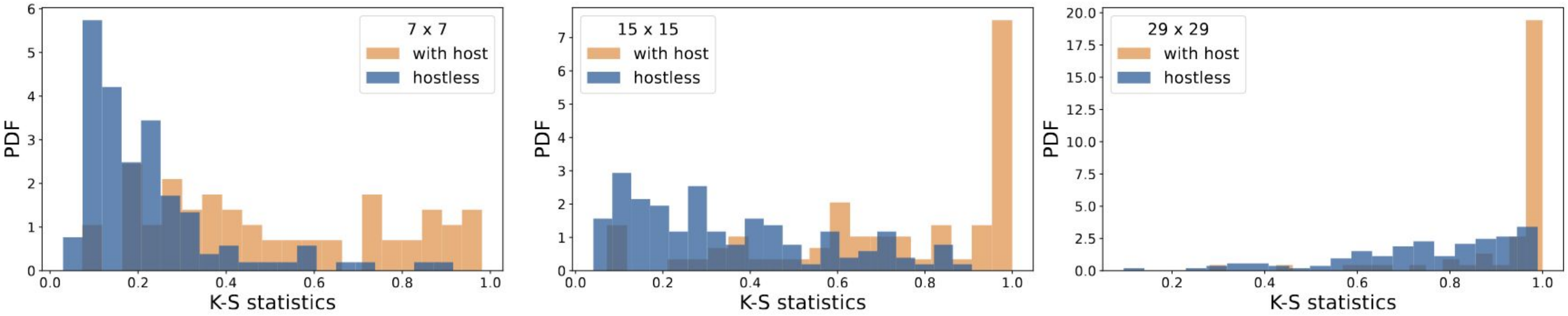

Fig. 7: Distributions of the Kolmogorov-Smirnov statistic for the 181 objects with TNS classifications. The two categories, with host (orange) and hostless (blue) were identified through visual inspection. Panels show distributions obtained through the power spectrum analysis (Section 3.3) for different image sizes.

Extra slides

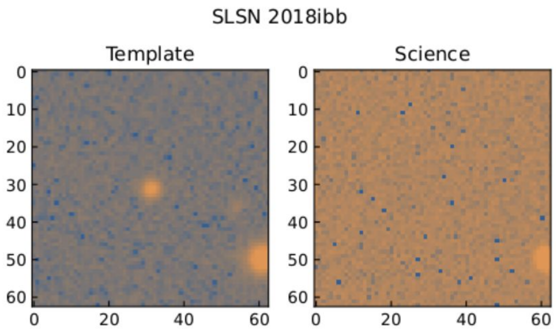

Fig. 8: Stacked *template* (left) and *science* (right) stamps for SLSN2018ibb (`ZTF18acenqto`, `ZTF18adovhai`).

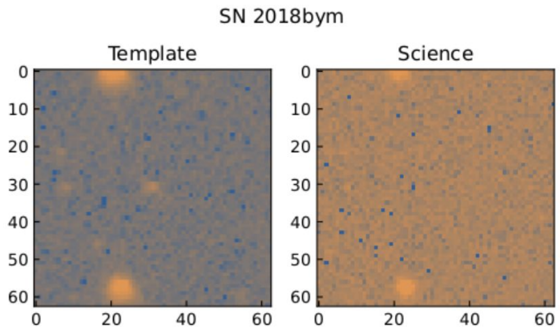

Fig. 9: Stacked *template* (left) and *science* (right) stamps for SN2018bym (`ZTF18aapgrxo`).

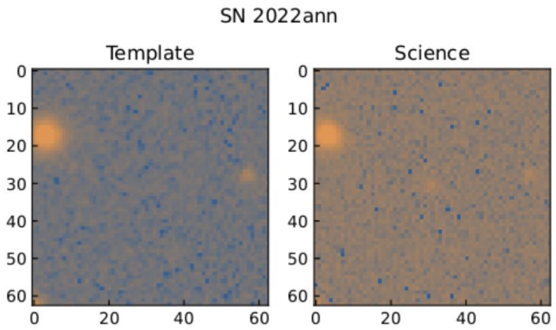

Fig. 10: Stacked *template* (left) and *science* (right) stamps for SN2022ann (`ZTF22aaaihet`).

Extra slides

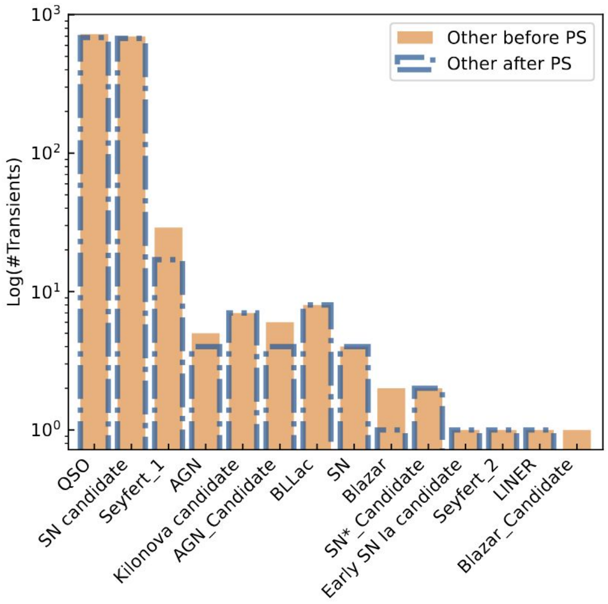

Fig. 11: Number of transients without a reported classification on TNS considered to be hostless by the sigma clipping method before applying the power spectrum (PS) analysis (orange), and the number of surviving hostless candidates after applying the PS analysis (blue).

Extra slides

Image size (pix)	K-S threshold	Contamination (%)
7×7	0.25	27.01
15×15	0.50	25.97
29×29	0.90	27.33

Table 1: Kolmogorov-Smirnov statistic thresholds and corresponding contamination levels for different cutout sizes. The threshold was determined using only visually confirmed hostless objects with TNS classification and requiring completeness of 75%.