Automatic detection
of hostless transients in the FINK broker

Priscila J. Pessi
on behalf of the
COIN Residence Program #7
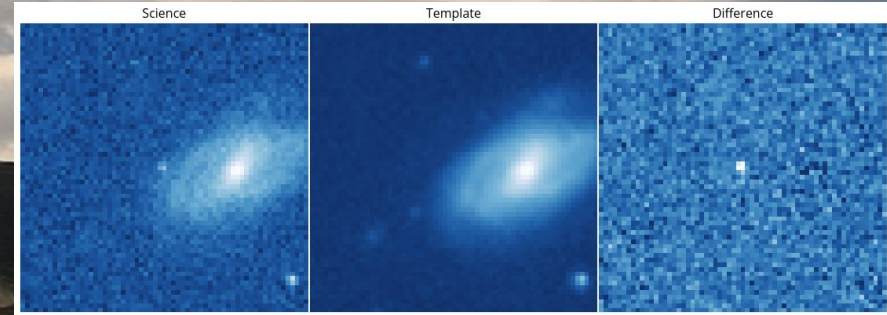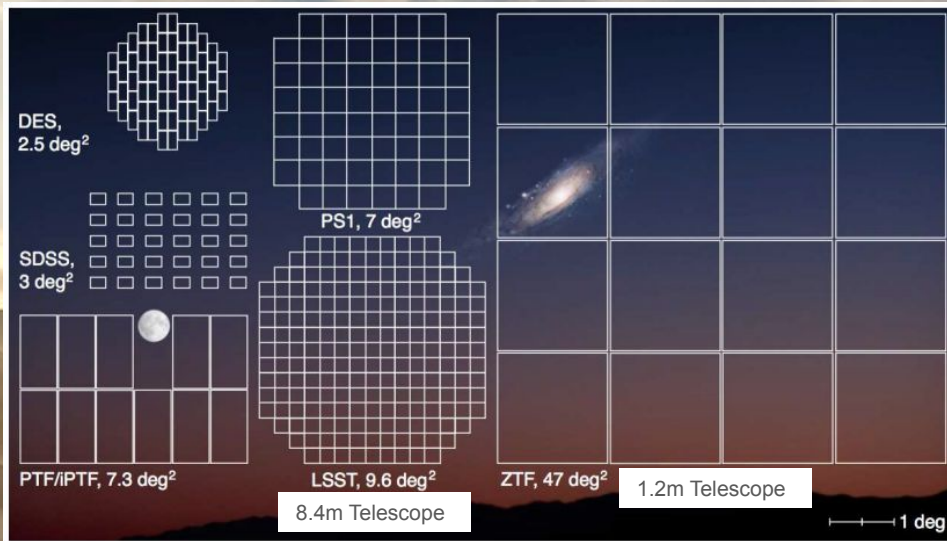
Astronomical transients

The study of variable (human timescales)
events in the sky:
- Undetected to detected messenger:
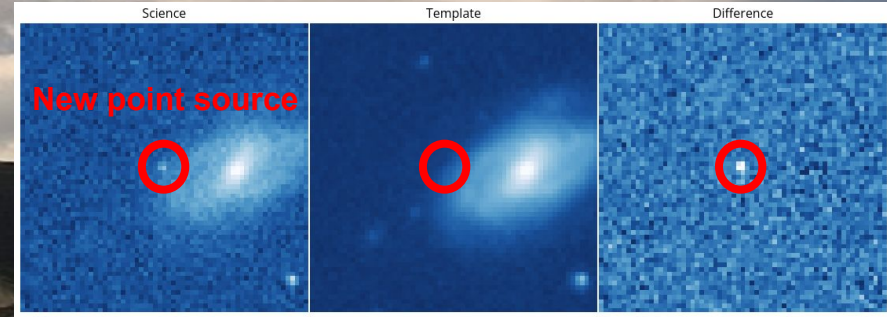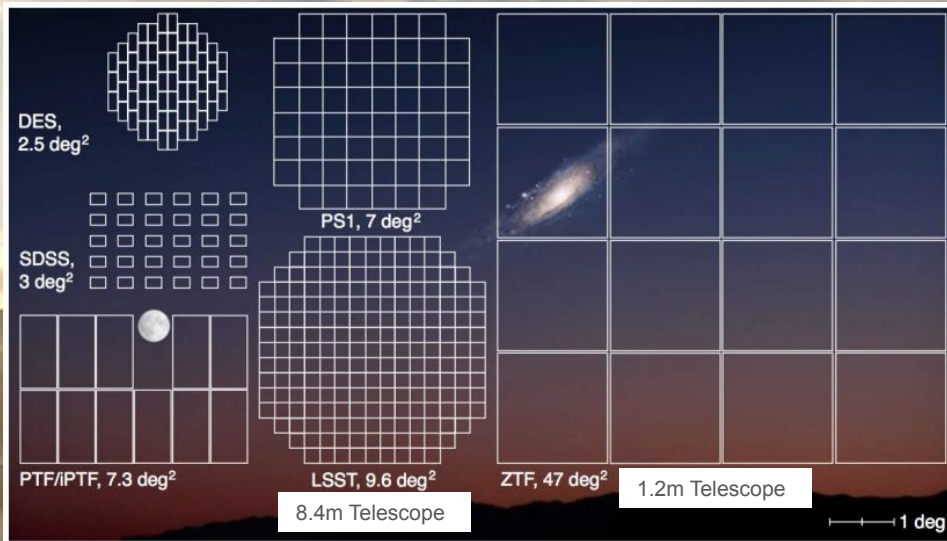 - Photons, gravitational waves, neutrinos.
Detections due to:
- Motion:
  - Planets, exoplanets, asteroids, etc.
- Physical processes:
  - Gamma ray bursts, tidal disruption events, supernovae, etc.

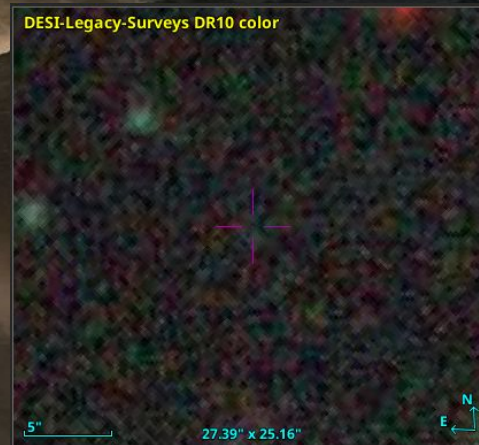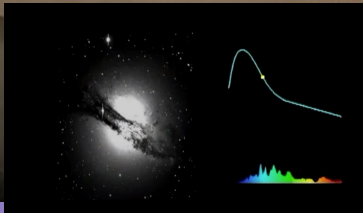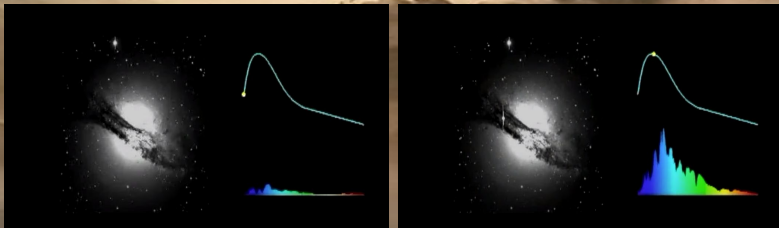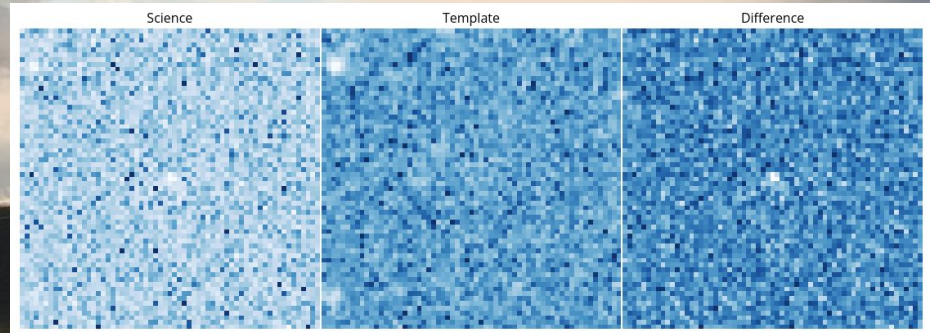# Detection of astronomical transients

Laher+17

Priscila J. Pessi on behalf of **CRP#7**
https://cosmostatistics-initiative.org/residence-programs/crp7/

Detection of astronomical transients

DES, 2.5 deg²

SDSS, 3 deg²

PS1, 7 deg²

PTF/iPTF, 7.3 deg²

LSST, 9.6 deg²

ZTF, 47 deg²

8.4m Telescope

1.2m Telescope

1 deg

Laher+17

Science | Template | Difference

New point source

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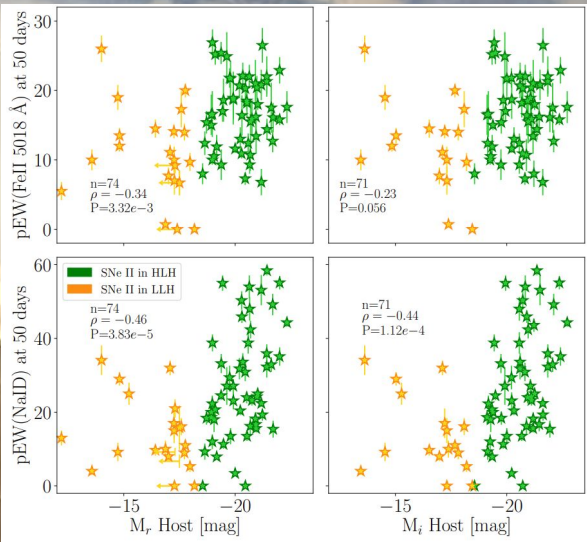
Hostless transients: the case of supernovae
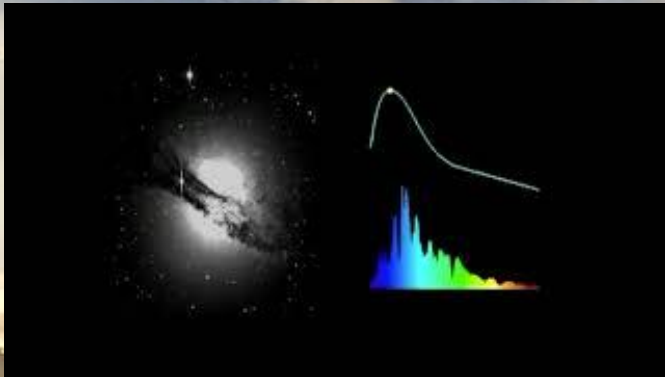
These are very rare ~5-10% of weekly alerts.

Small training sets make accurate ML classifications difficult.

DESI-Legacy-Surveys DR10 color

5"   27.39" x 25.16"

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Hostless supernovae

SNe characteristics correlate with their host properties.

Gutierrez+18
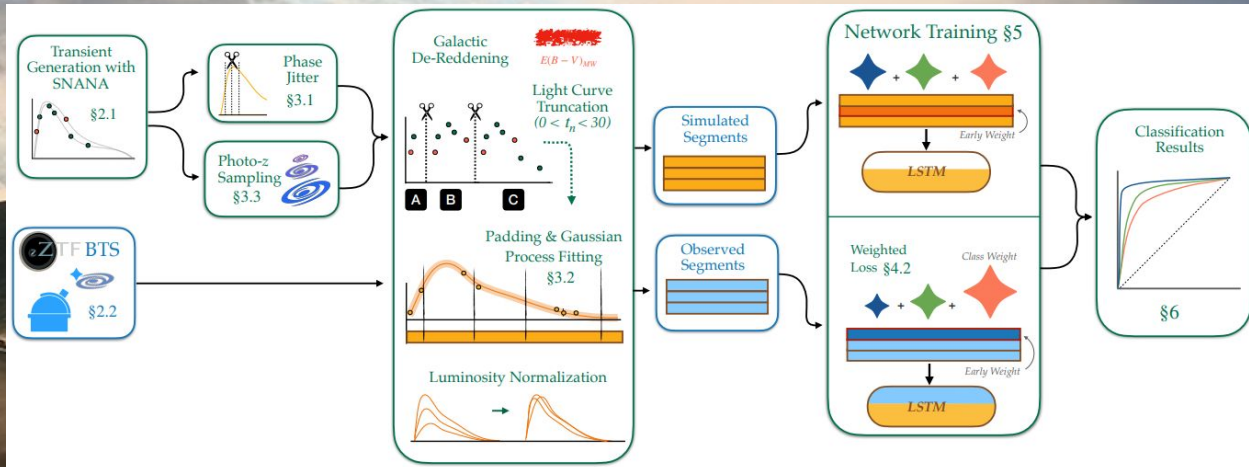
ML classifiers based on host association work beautifully but struggle when there is no host.

Gagliano+23

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The FINK broker: https://fink-broker.org/

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Pipeline
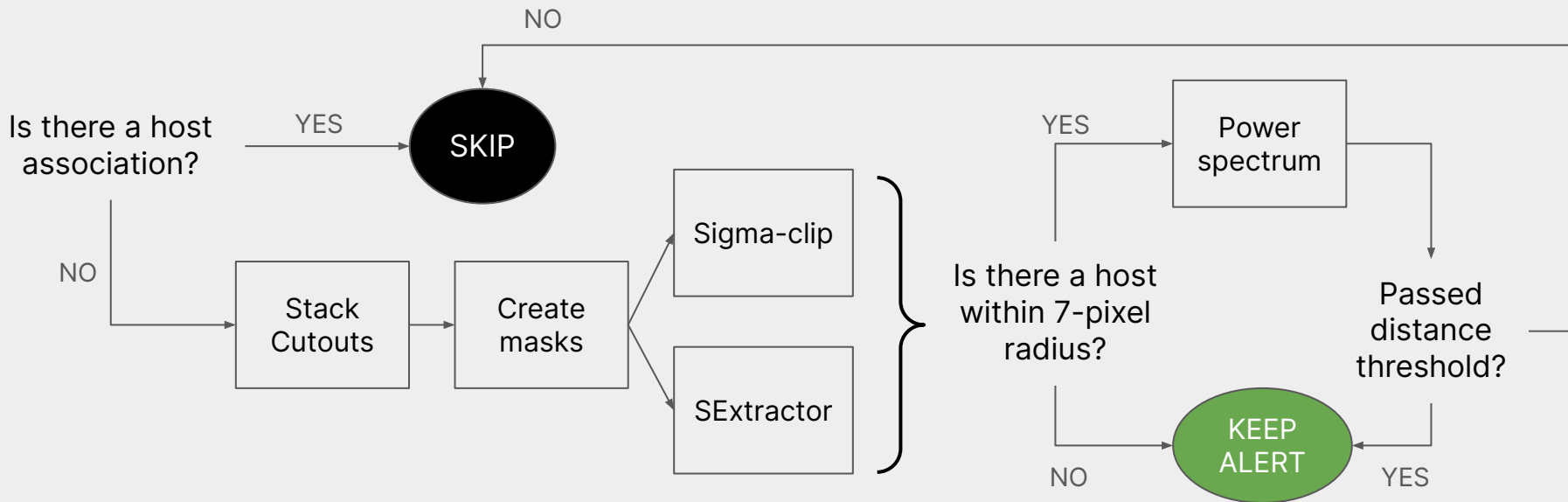
Ignore events with a clear host association.

Stack stamps to improve signal.

Image segmentation: Remove bright sources. Take a look at what remains.

Power spectrum analysis:
Shuffle the images, analyse the power spectrum and compare to the original to see if there are differences that indicate the presence of an extended source.

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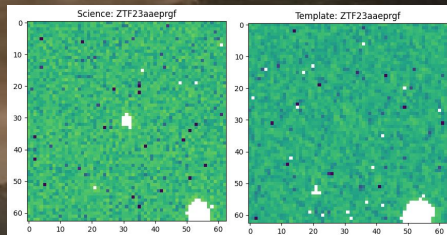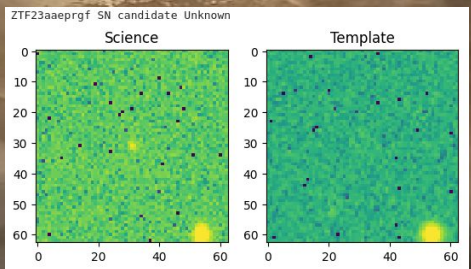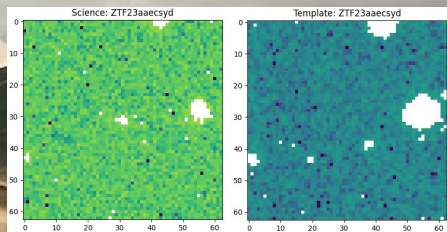https://cosmostatistics-initiative.org/residence-programs/crp7/

Results

Image segmentation: succes
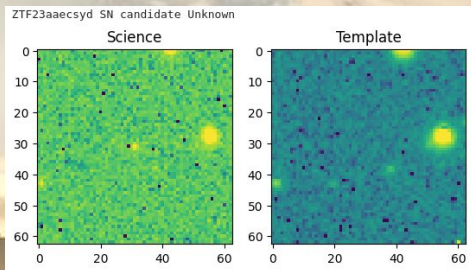
Image segmentation: failure
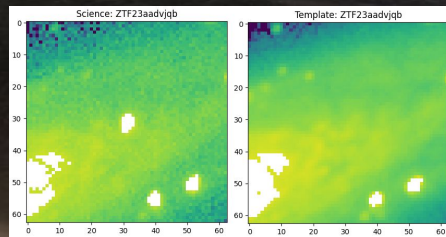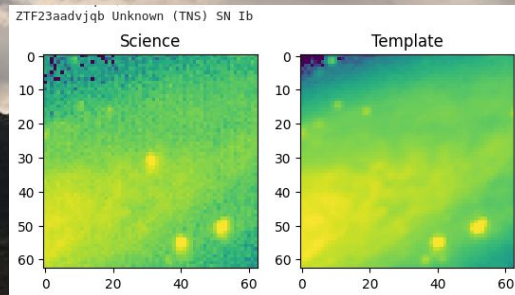
Thus: power spectrum

Results
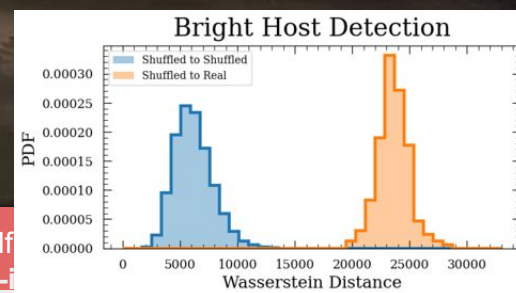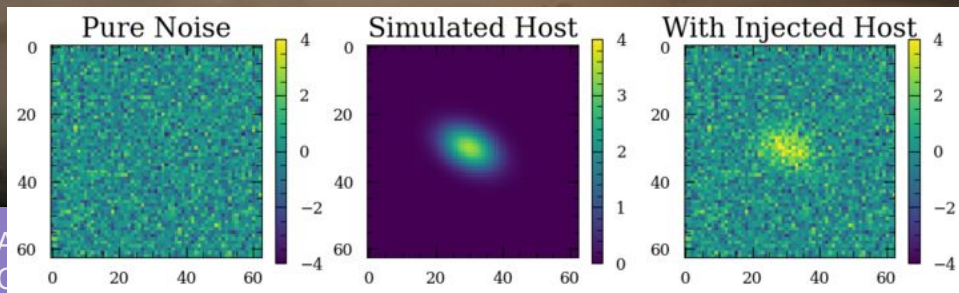
Results

Some Numbers:

Considering only the month of **April 2023** (start of this project)

- **Total number of alerts:** 3 390 021
- **Number of alerts with classification in SIMBAD OR TNS OR Fink machine learning classifiers:** 2 113 334 (62.34%)
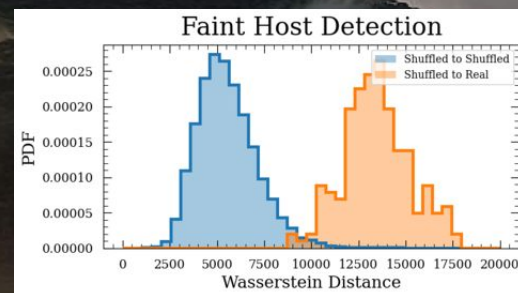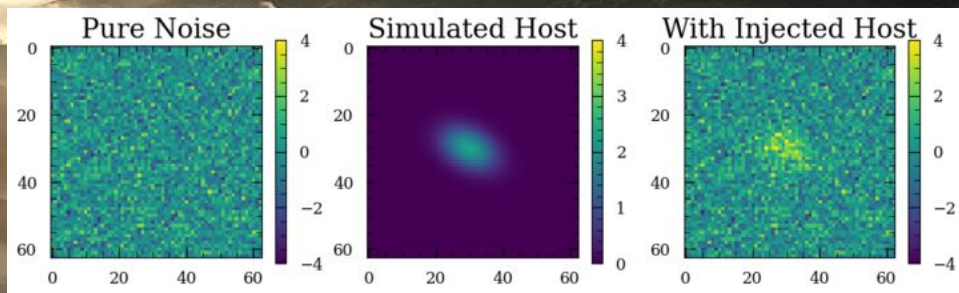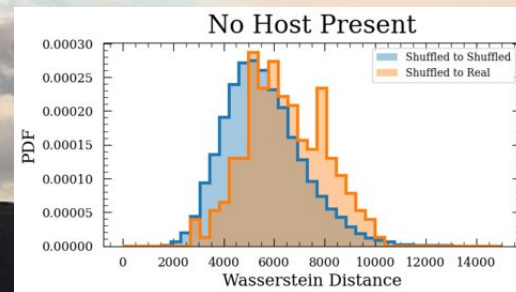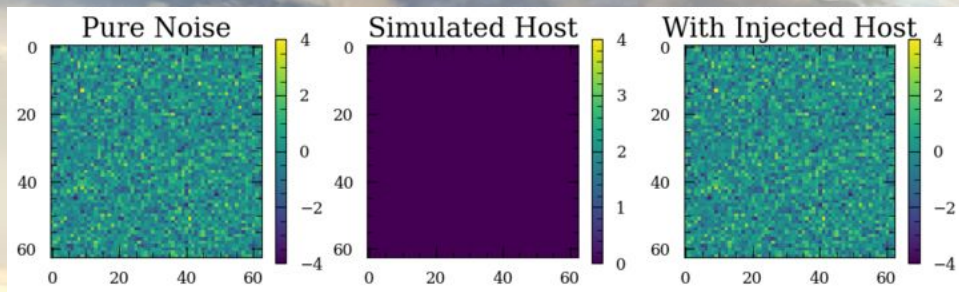- After removing objects of no interest (galactic): 2 112 752 (62.32%)
- After selecting the chosen SIMBAD classes: 202 539 (0.06 %)
- **After selecting those which do not have a mangrove host:** 195 263

Initial number of objects: 34 970
Number of hostless candidates: 125

- 10 confirmed spectral classifications: 6 SNe Ia, 2 SNe Ia-CSM, 1 SLSN I, 1 SN IIn
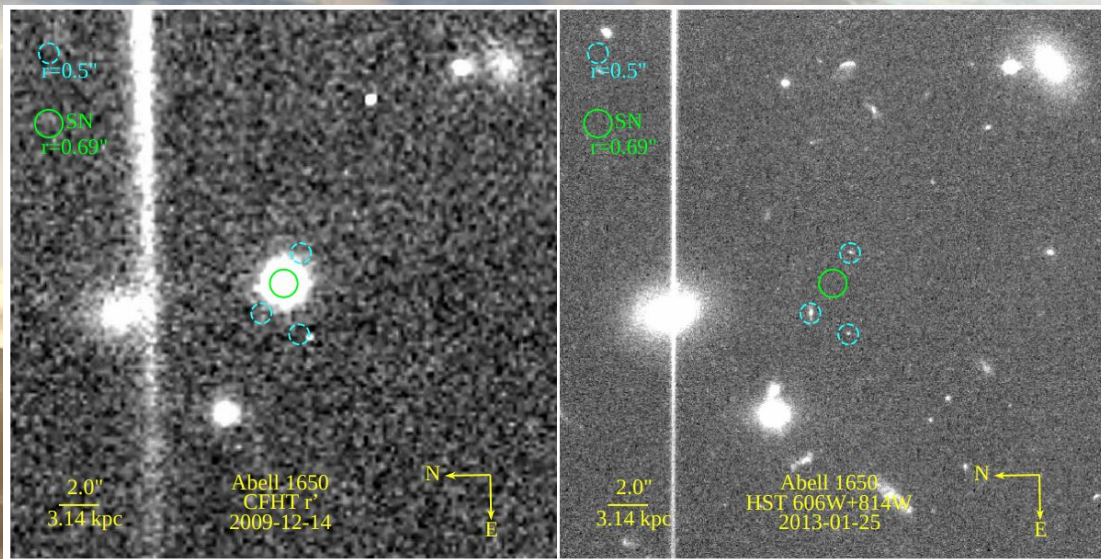
Conclusions and next steps

- **Interesting candidates can be found applying fairly simple techniques in a low number of steps.**

- **Our pipeline was written in Python and is flexible enough to include more (or more sophisticated) steps.**

- **The pipeline will be included in the Fink broker to give users the option to retrieve hostless candidates.**

- **Our techniques are completely transferable to LSST alerts, although an additional scaling step may be needed to account for the difference is the size of the alert stamps** (61"x61" vs 6"x6").

- **We expect to find many more exciting hostless transients!**

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EXTRAS

Priscila J. Pessi on behalf of **CRP#7**
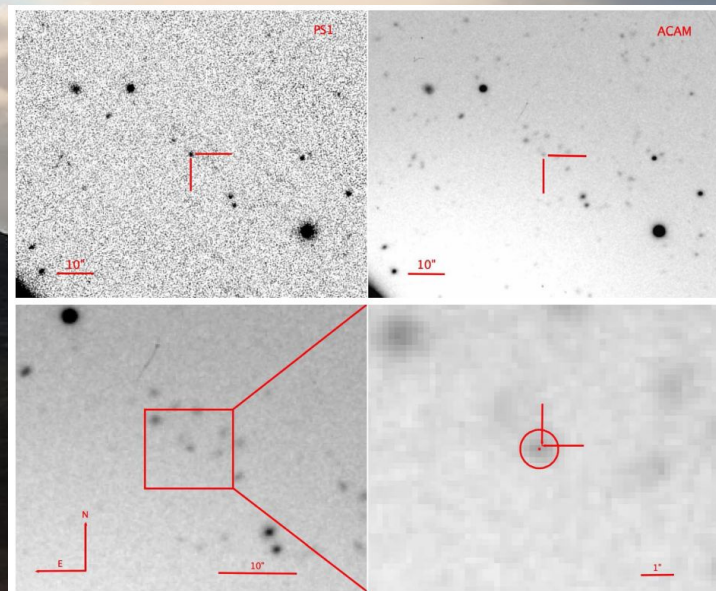**https://cosmostatistics-initiative.org/residence-programs/crp7/**

Hostless supernovae

Actual hostless SN probe intracluster stellar population.

Graham+15

Faint hosts associated to extreme SN.

McCrum+15

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ZTF23aadaxfn

● SN CANDIDATE ● UNKNOWN

```
Discovery date: 2023-03-17 05:13:16.000
Last detection: 2023-06-10 06:09:55.996
Number of detections: 20
Number of low quality alerts: 2
Number of upper limits: 34
```

J2000 ▾ 11 11 39.214 +55 40 29.07

FoV: 3.01'
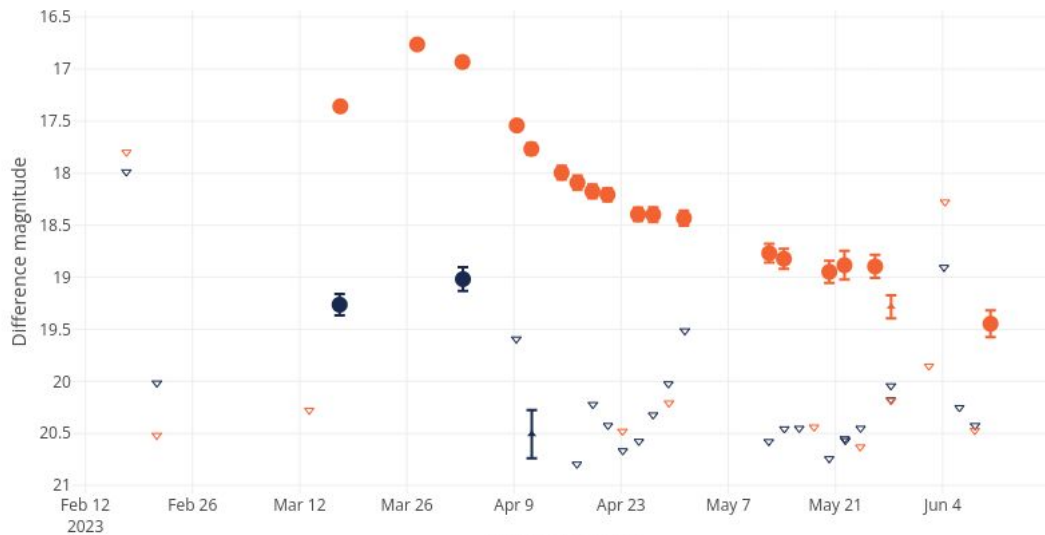
Individual alert classification   ■ SN candidate: 40%   ■ Unknown: 60%

It looks like there is a source behind. You might want to check the DC magnitude instead.   ✕

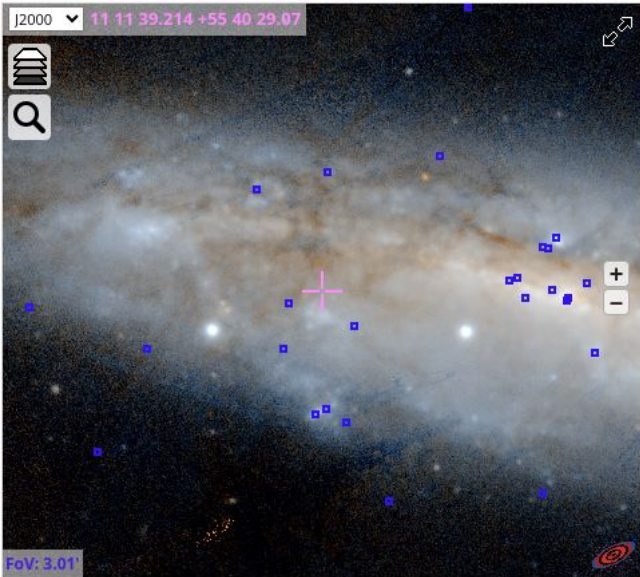● g band   ● r band

Difference magnitude

Observation date

Feb 12 2023 — Feb 26 — Mar 12 — Mar 26 — Apr 9 — Apr 23 — May 7 — May 21 — Jun 4

✔ Difference magnitude   DC magnitude   DC flux

Information   ⌄

https://cosmostatistics-initiative.org/residence-programs/crp7/