UNVEILING RARE ASTROPHYSICAL EVENTS IN THE FINK BROKER

Maria Pruzhinskaya
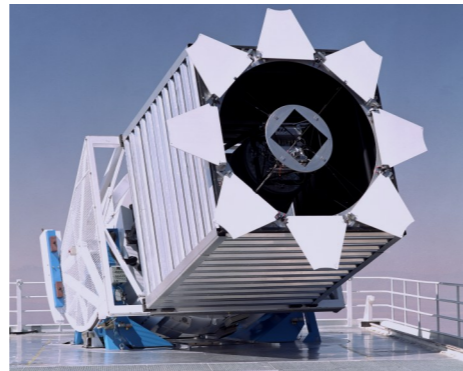
on behalf of the Fink team

Laboratoire de Physique de Clermont

Fink-Brazil, May 8 2024

BIG DATA IN ASTRONOMY

- **SDSS (Sloan Digital Sky Survey)**

  - ~500 million of objects

  - ~3 million with spectra

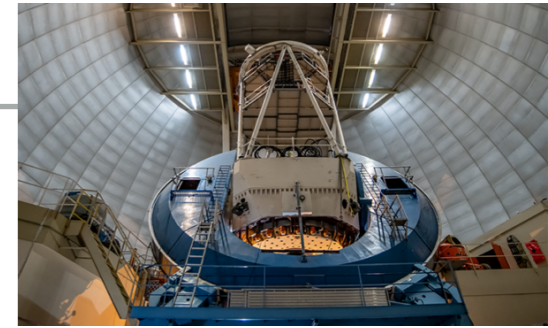- **ZTF (Zwicky Transient Facility)**

  - transients (supernovae, kilonovae, TDE, etc.)

  - Milky Way (variable stars, asteroids)

  - DR20: ~$4.75*10^9$ light curves

  - Alert rate ~ $2*10^5$ per night

- **DESI (Dark Energy Spectroscopic Instrument)**

  - 3D map of the Universe

  - 35 million of galaxies and quasars

- **LSST (Legacy Survey of Space and Time)**

  - Solar System, stars, Milky Way, Magellanic Clouds, galaxies, AGNs, transients, supernovae, etc.

  - 20 billion galaxies, 17 billion stars, 10 million supernovae, 6 million asteroids and comets, 10^5 NEO, etc.
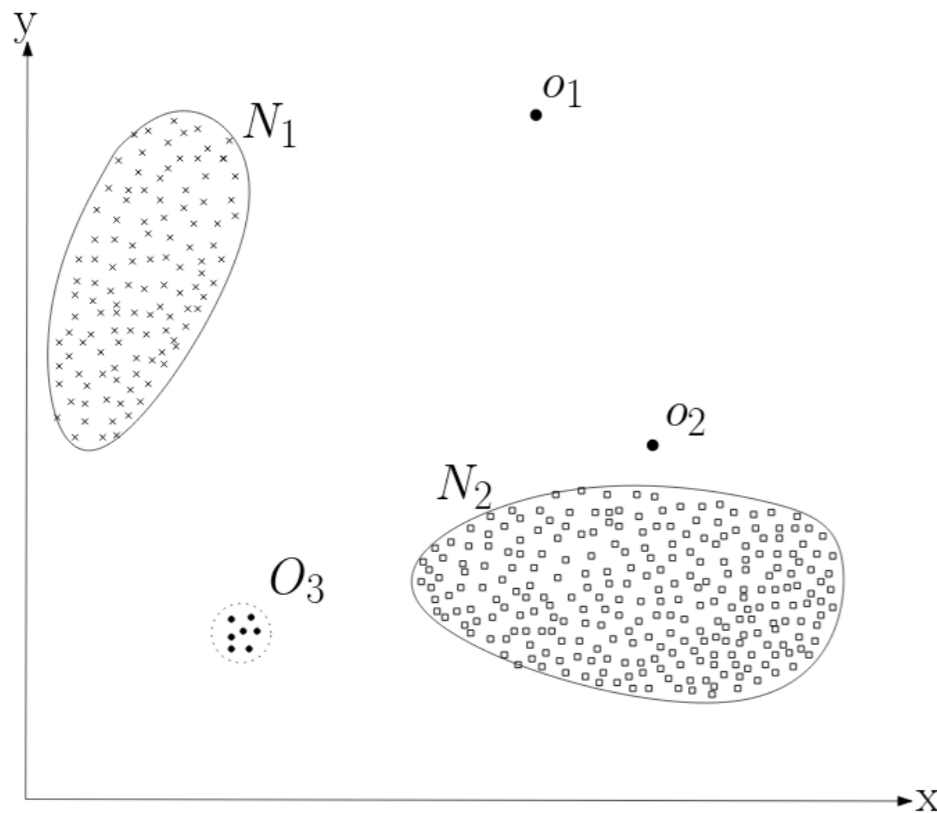
  - 15 TB per night

FINK BROKER

ZTF/FINK STATISTICS

2019-2021
75,925,464 alerts
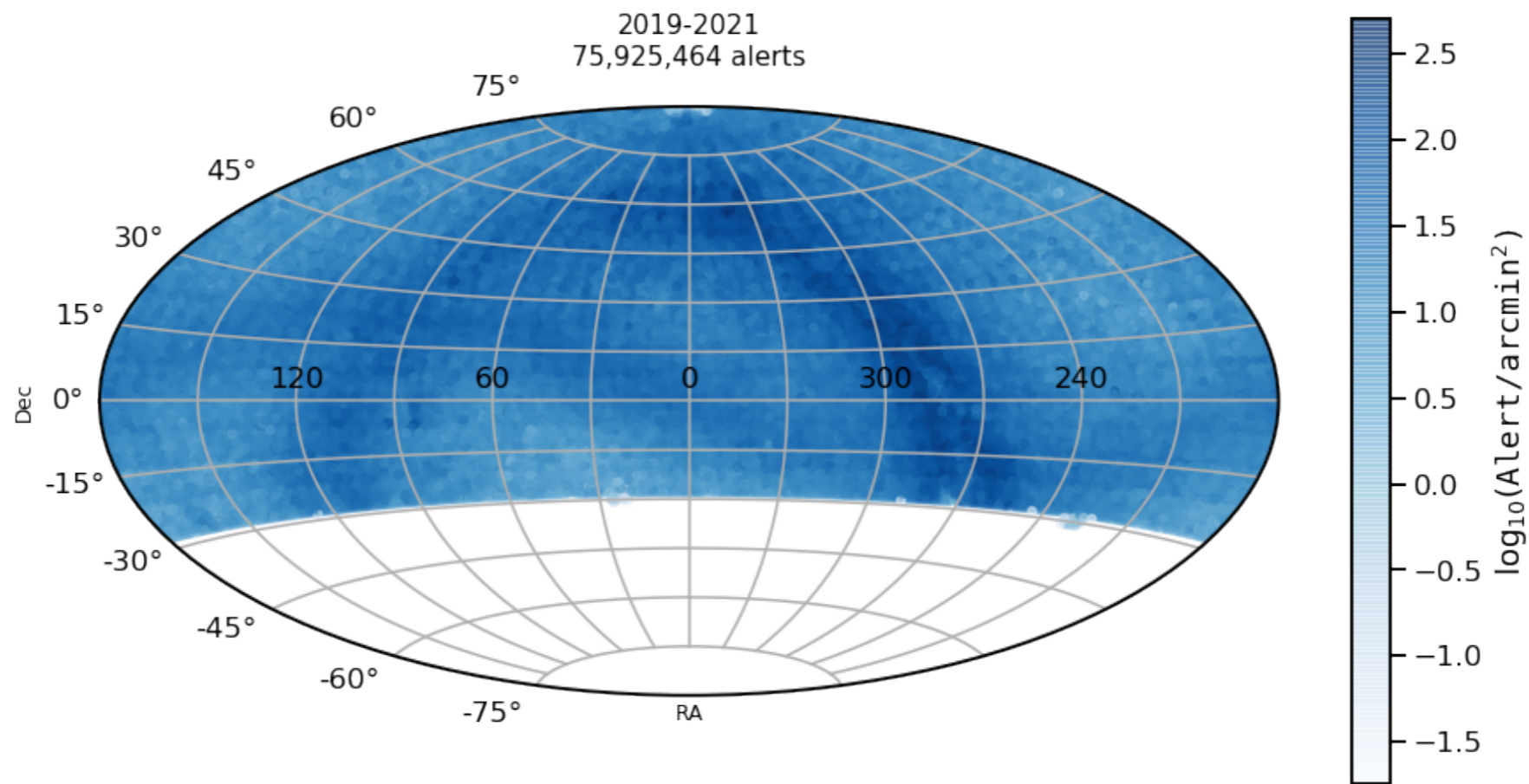
- 221 million alerts received, 150 million processed (https://fink-portal.org/stats)

- Typical nightly rates (200,000 alerts)
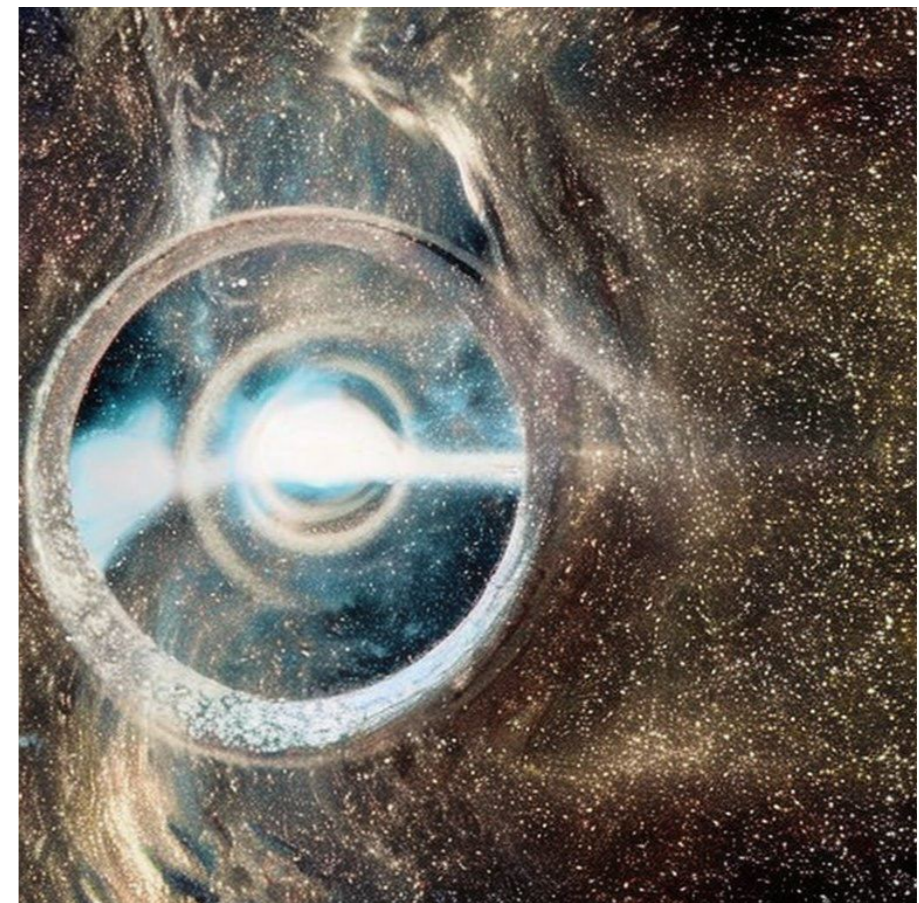
WHAT DO YOU MEAN BY ANOMALY?

MACHINE DEFINITION

▸ Objects with high anomaly score ⟶ not necessary interesting for the expert
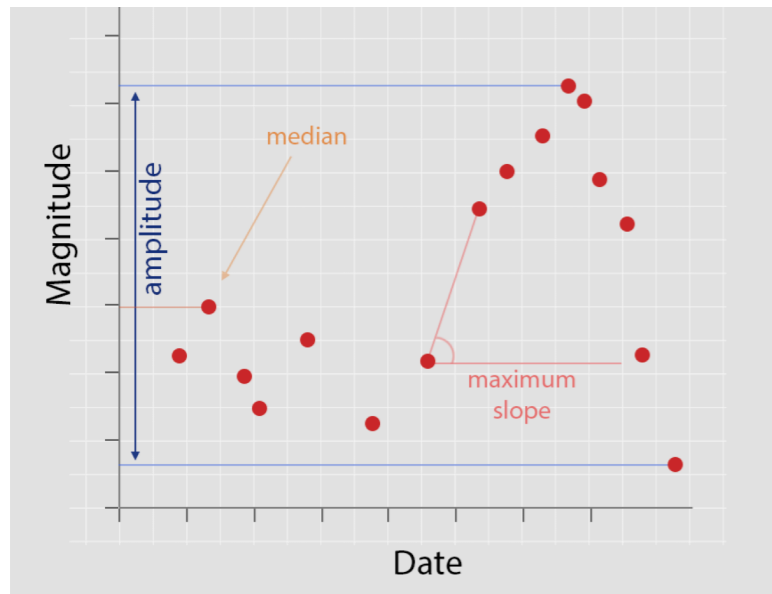

Chandola V., et al. 2009

HUMAN DEFINITION

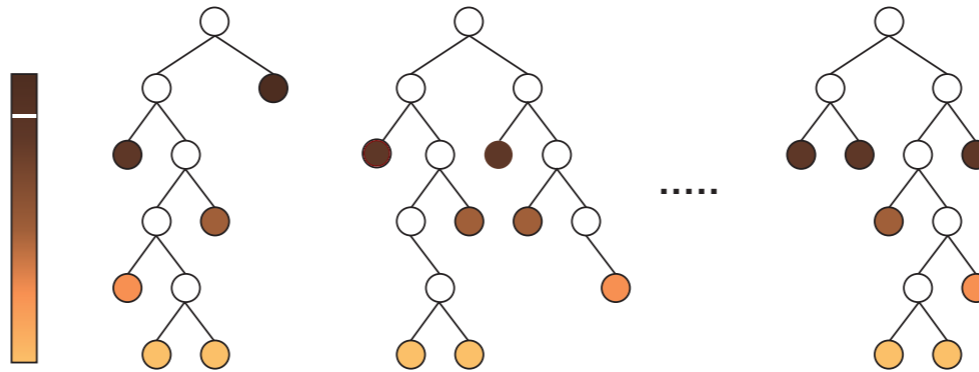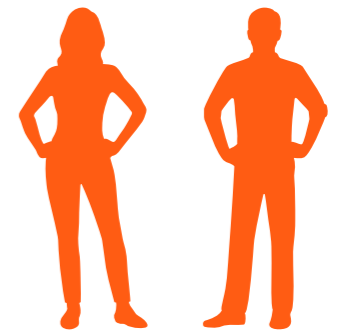▸ Astrophysically interesting anomalies ⟶ depends on the task

FINK ANOMALY DETECTION

**ad features
module**

**anomaly detection
module**

**anomaly notification
module**

FINK ANOMALY DETECTION

ad features module

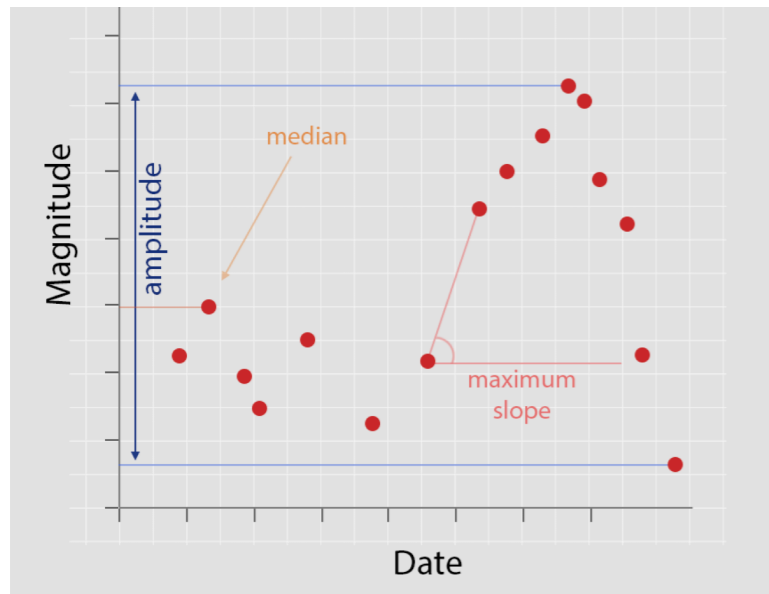**anomaly detection module**

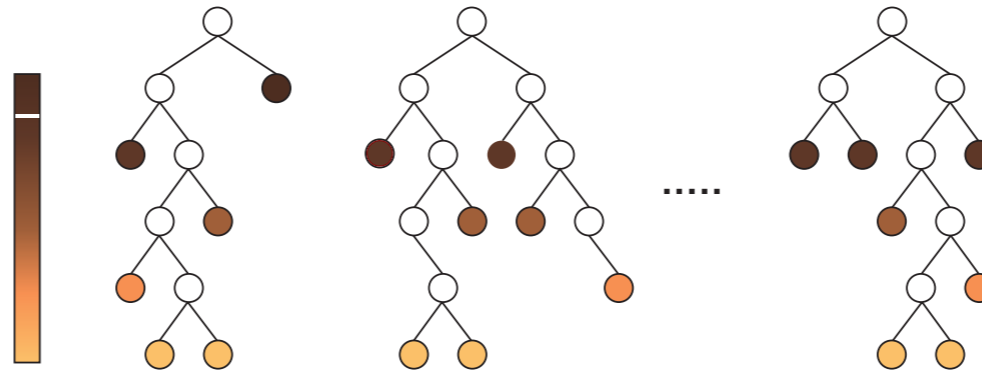**anomaly notification module**

- ▸ 26 features (Malanchev et al., 2021 SИAD)

- ▸ ztf_g and ztf_r passbands

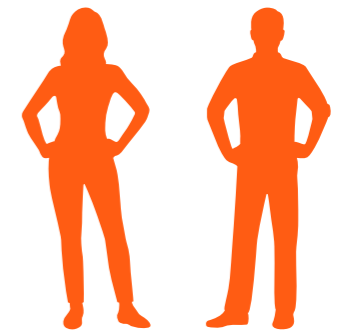# FINK ANOMALY DETECTION

ad features module

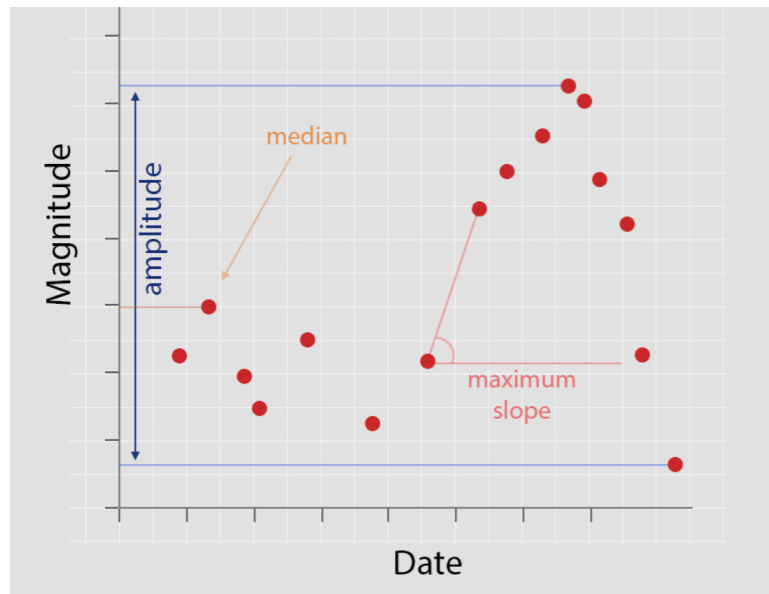
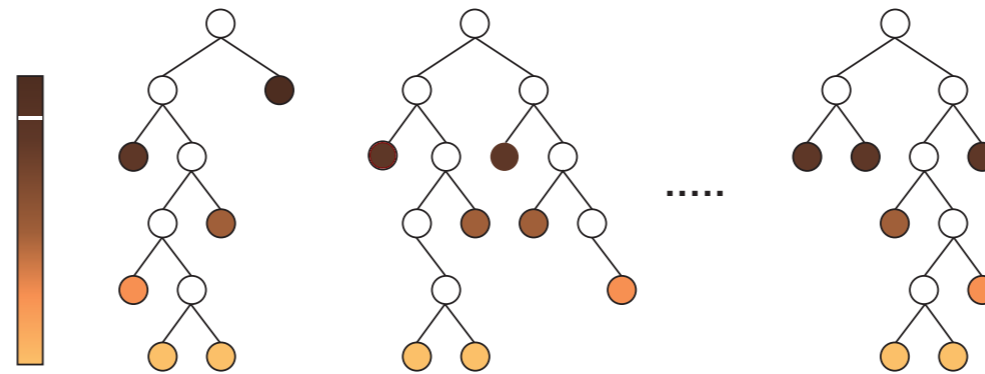**anomaly detection module**

anomaly notification module

▸ Isolation forest applied to the LC features in both bands

▸ Resulting anomaly scores is averaged
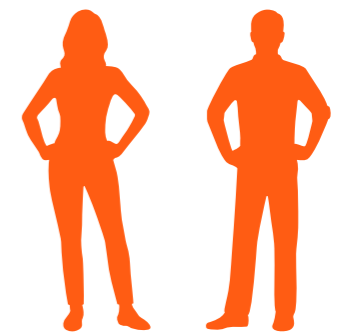
FINK ANOMALY DETECTION
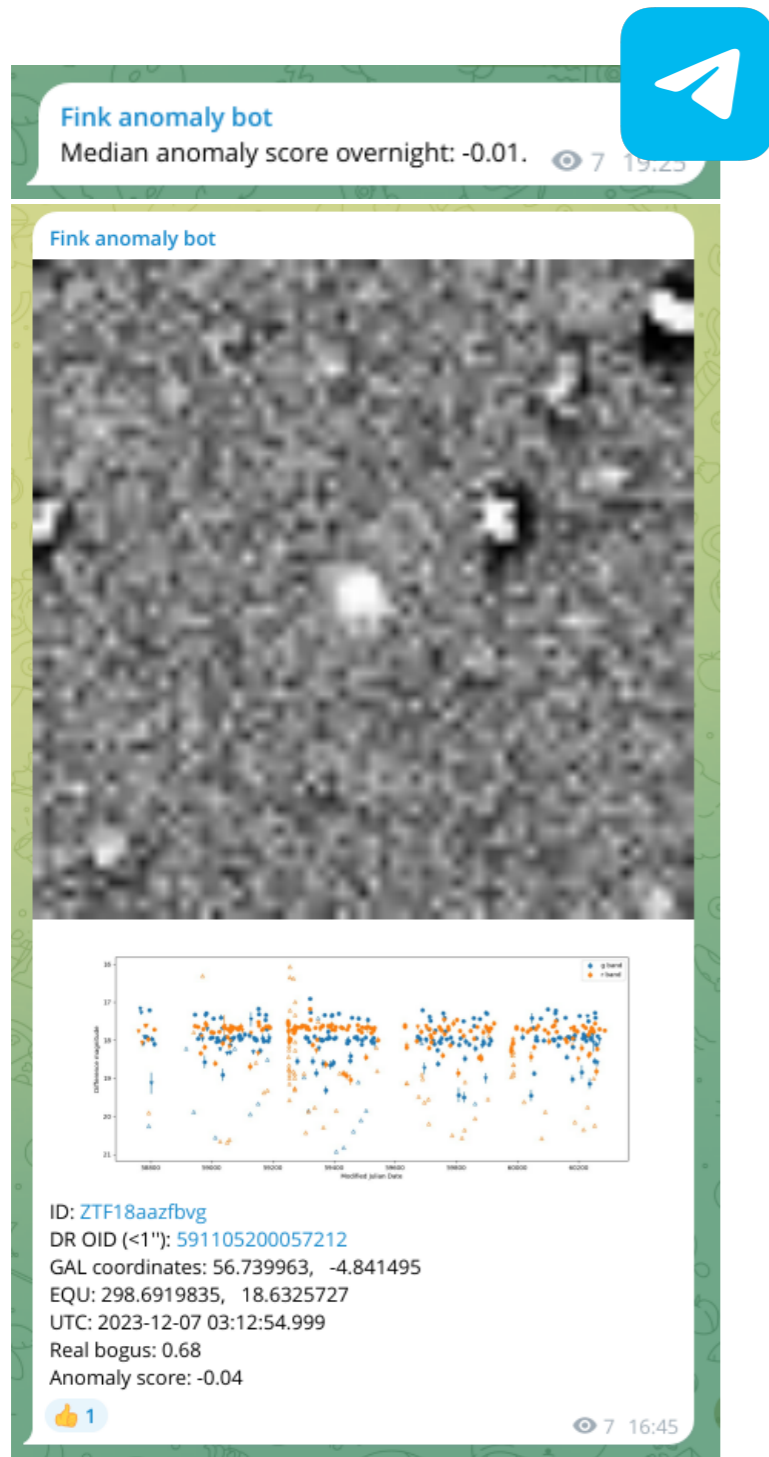
ad features module

anomaly detection module

anomaly notification module

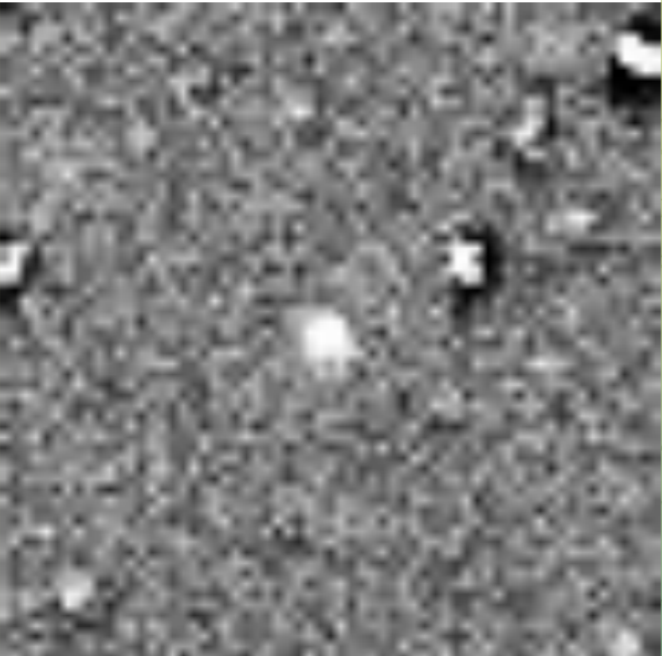▸ Domain expert analysis to discover and to debug

SLACK AND TELEGRAM BOTS
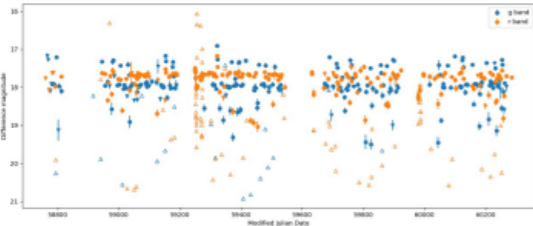
▸ TOP-10 anomalies each night

Credit: Timofey Pshenichniy

ACTIVE ANOMALY DISCOVERY IN FINK

NEW!

Active anomaly discovery in the alert stream
for **personalized** anomaly detection models

ANOMALY MODEL-1

ANOMALY MODEL-2

ANOMALY MODEL-3

ACTIVE ANOMALY DISCOVERY IN FINK

Your anomalies 🕵️

Hello tg_data! You have 132 reactions now

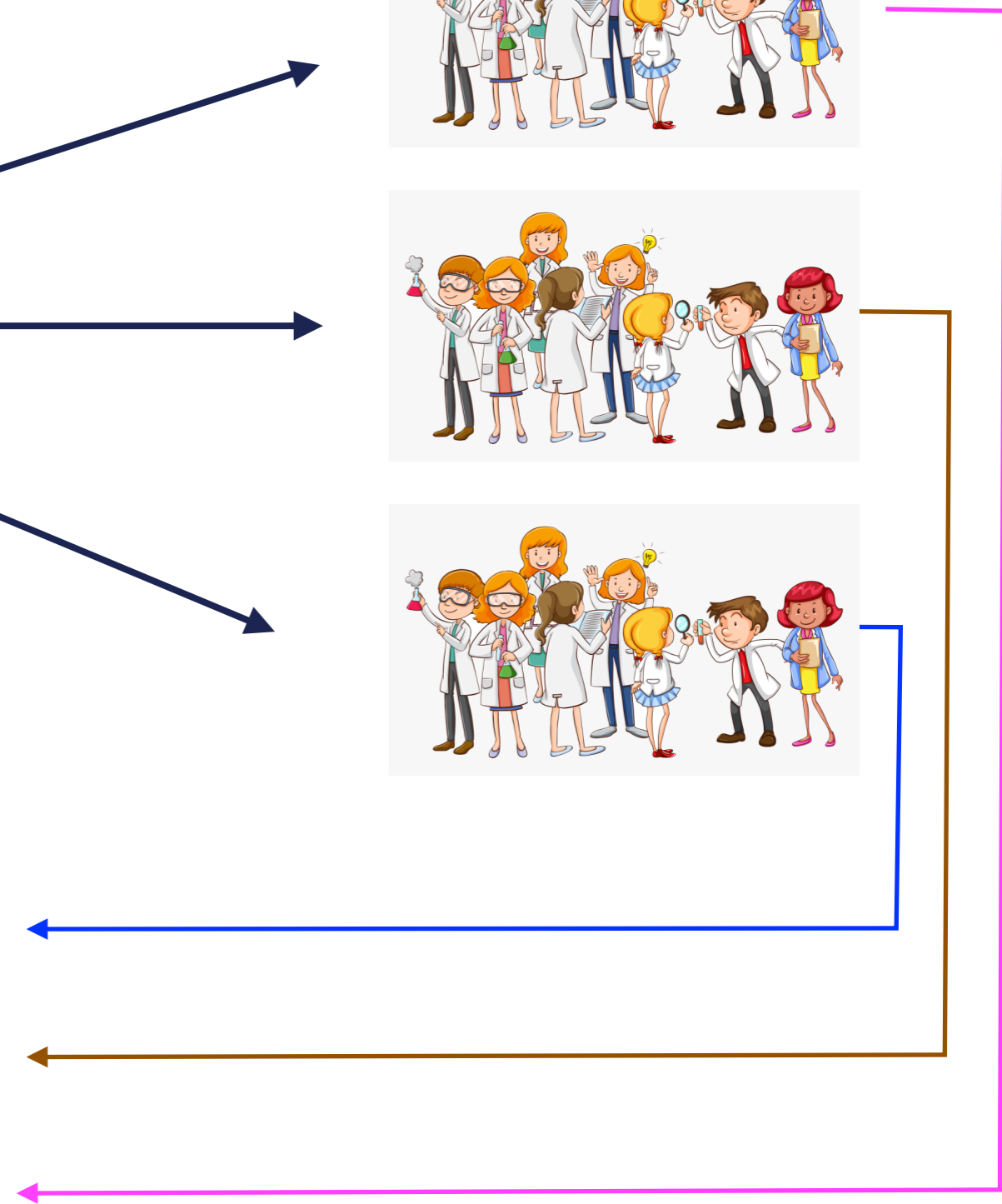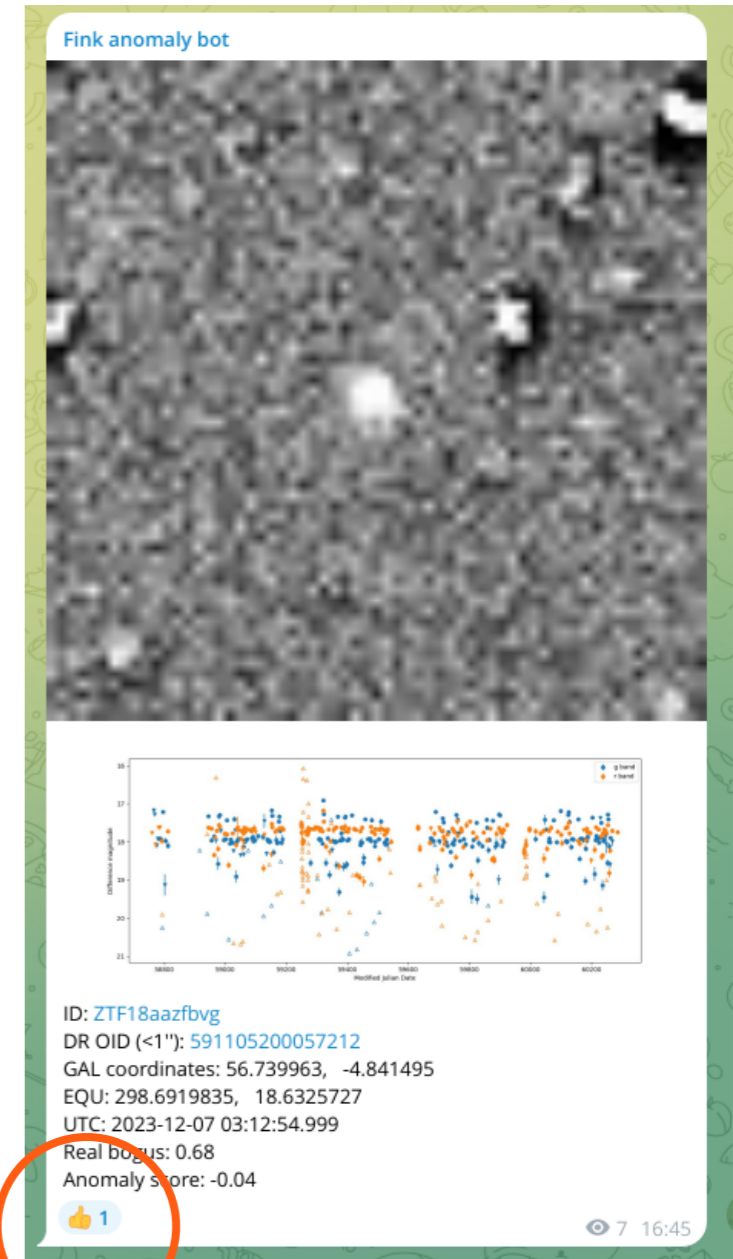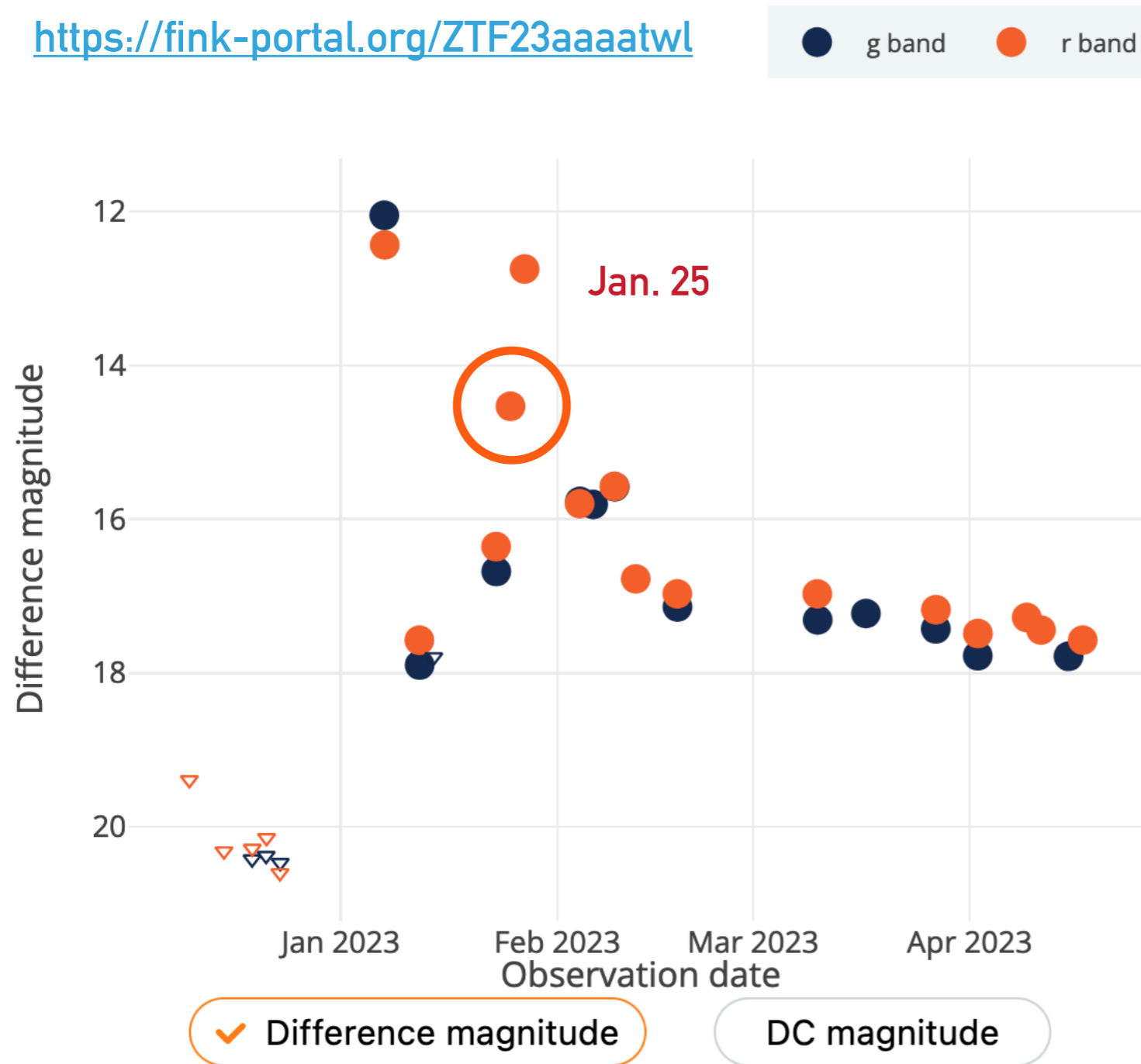| ztf_id	tag	user	changed_at	
ZTF17aaajhzf>	ANOMALY	tg_data	2024-04-01 14:07:36.275380	Delete
ZTF24aahbsoa>	ANOMALY	tg_data	2024-04-01 14:07:37.230114	Delete
ZTF24aahbqpk>	ANOMALY	tg_data	2024-04-01 14:07:37.389123	Delete
ZTF18aanbiig>	NOT ANOMALY	tg_data	2024-04-01 14:07:37.554644	Delete
ZTF18abwblgn>	NOT ANOMALY	tg_data	2024-04-01 14:07:37.721600	Delete
ZTF18acydvjn>	NOT ANOMALY	tg_data	2024-04-01 14:07:37.883204	Delete
ZTF24aafskkk>	ANOMALY	tg_data	2024-04-01 14:07:38.047819	Delete
ZTF17aaadasj>	NOT ANOMALY	tg_data	2024-04-01 14:07:38.211718	Delete
ZTF18aaapivw>	NOT ANOMALY	tg_data	2024-04-01 14:07:38.380586	Delete
ZTF18aaagsjn>	NOT ANOMALY	tg_data	2024-04-01 14:07:38.547515	Delete
ZTF19aakrzro>	NOT ANOMALY	tg_data	2024-04-01 14:07:38.709600	Delete
ZTF18actbmen>	NOT ANOMALY	tg_data	2024-04-01 14:07:38.870361	Delete
ZTF18aczdmti>	NOT ANOMALY	tg_data	2024-04-01 14:07:39.229647	Delete
ZTF18ababjtc>	NOT ANOMALY	tg_data	2024-04-01 14:07:39.556769	Delete
ZTF17aabshnt>	NOT ANOMALY	tg_data	2024-04-01 14:07:39.715357	Delete
ZTF18aagrhuk>	NOT ANOMALY	tg_data	2024-04-01 14:07:40.246506	Delete
ZTF18abgufms>	ANOMALY	tg_data	2024-04-01 14:07:40.405752	Delete
ZTF18abchhea>	ANOMALY	tg_data	2024-04-01 14:07:40.565232	Delete
ZTF24aadttcz>	ANOMALY	tg_data	2024-04-01 14:07:40.729832	Delete
ZTF18adkuohk>	NOT ANOMALY	tg_data	2024-04-01 14:07:41.287526	Delete
ZTF18admbvvp>	NOT ANOMALY	tg_data	2024-04-01 14:07:41.453602	Delete
ZTF18abfxgkj>	NOT ANOMALY	tg_data	2024-04-01 14:07:41.614971	Delete
ZTF18aayeipd>	NOT ANOMALY	tg_data	2024-04-01 14:07:41.781613	Delete

- ‣ User input through reactions
- ‣ Database maintenance
- ‣ User authentication
- ‣ Version control

Fink anomaly bot

ID: ZTF18aazfbvg
DR OID (<1"): 591105200057212
GAL coordinates: 56.739963, -4.841495
EQU: 298.6919835, 18.6325727
UTC: 2023-12-07 03:12:54.999
Real bogus: 0.68
Anomaly score: -0.04

👍 1

Initial tests are promising!

FIRST NIGHT – FIRST ANOMALY

https://fink-portal.org/ZTF23aaaatwl

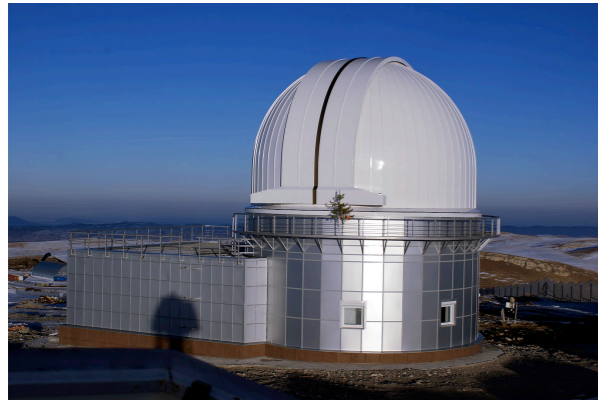- ASASSN-23ac/PNV J06245297+0208207
- Simbad: WD candidate
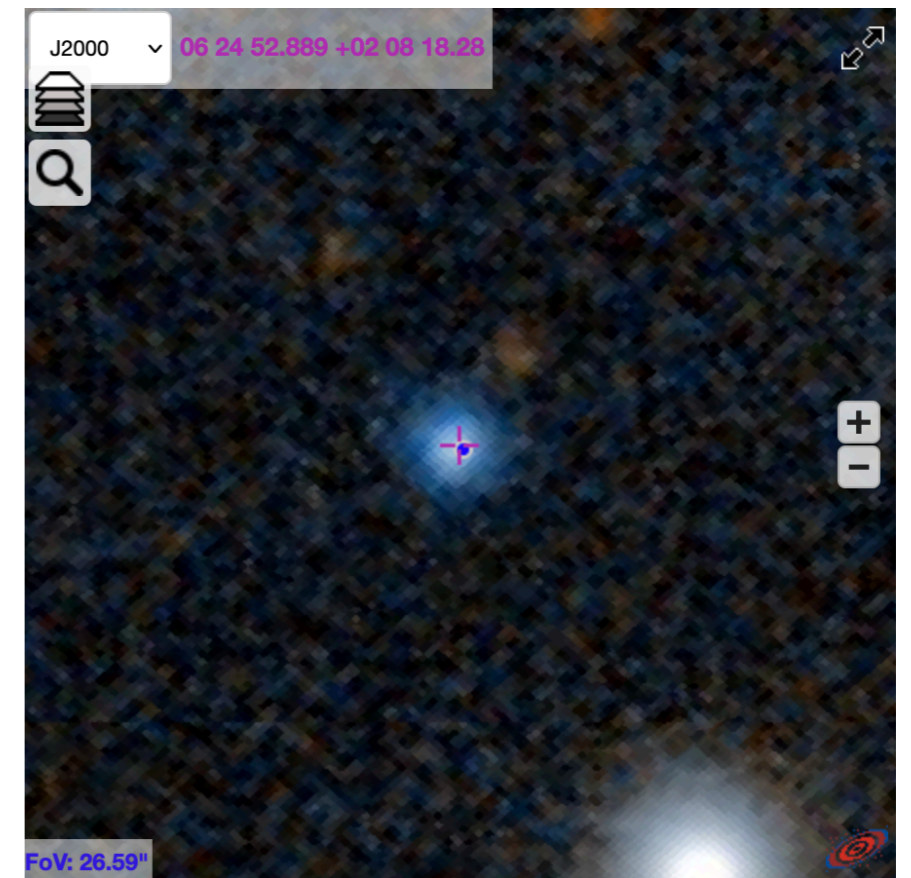
REPORTED IN TNS AS AT 2023AWT

FOLLOW-UP OBSERVATIONS

2.5M KGO

9.2M SALT
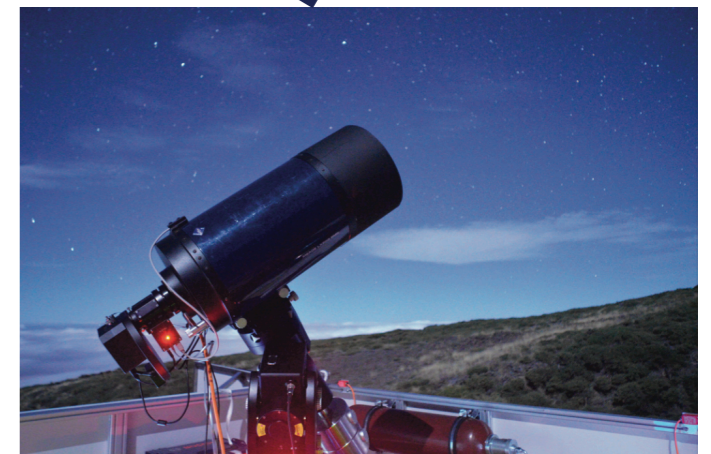
AT 2023AWT

~40 spectra
~hundreds observations in B,V,R,r
AM CVn of WZ Sge-type (very rare)
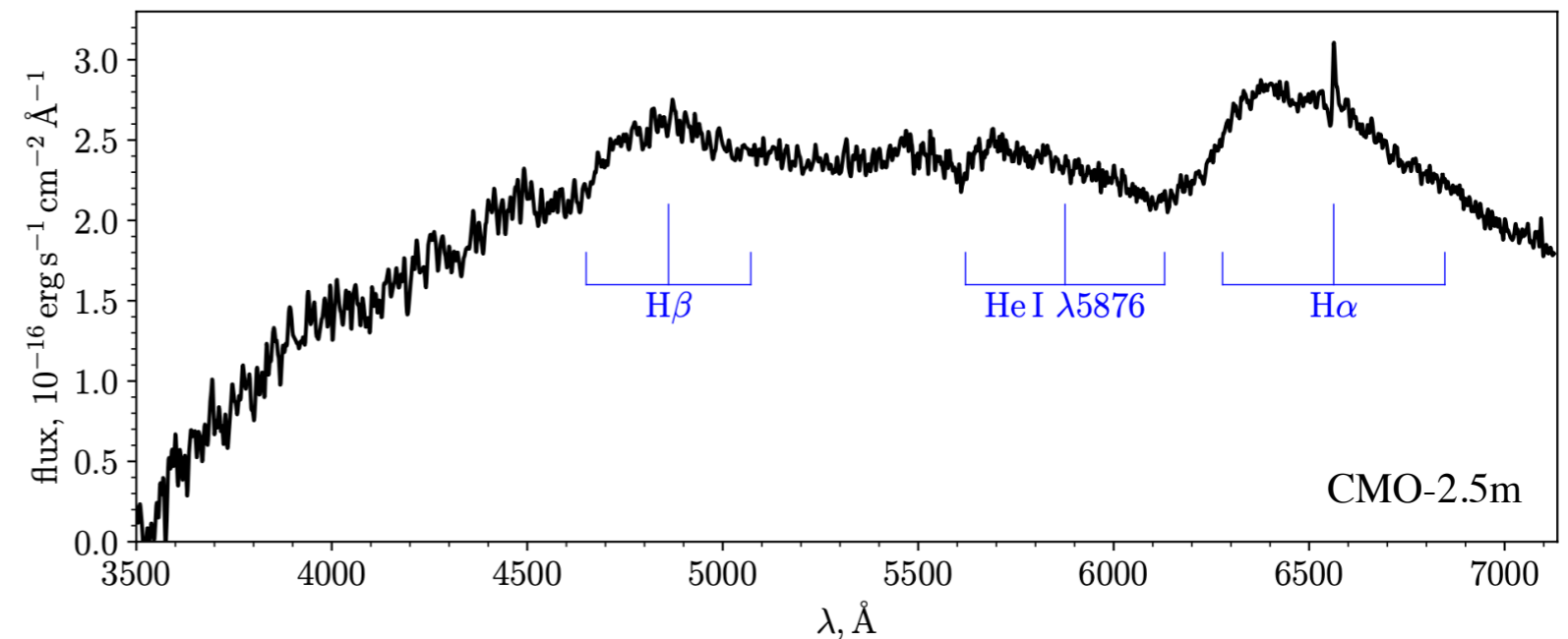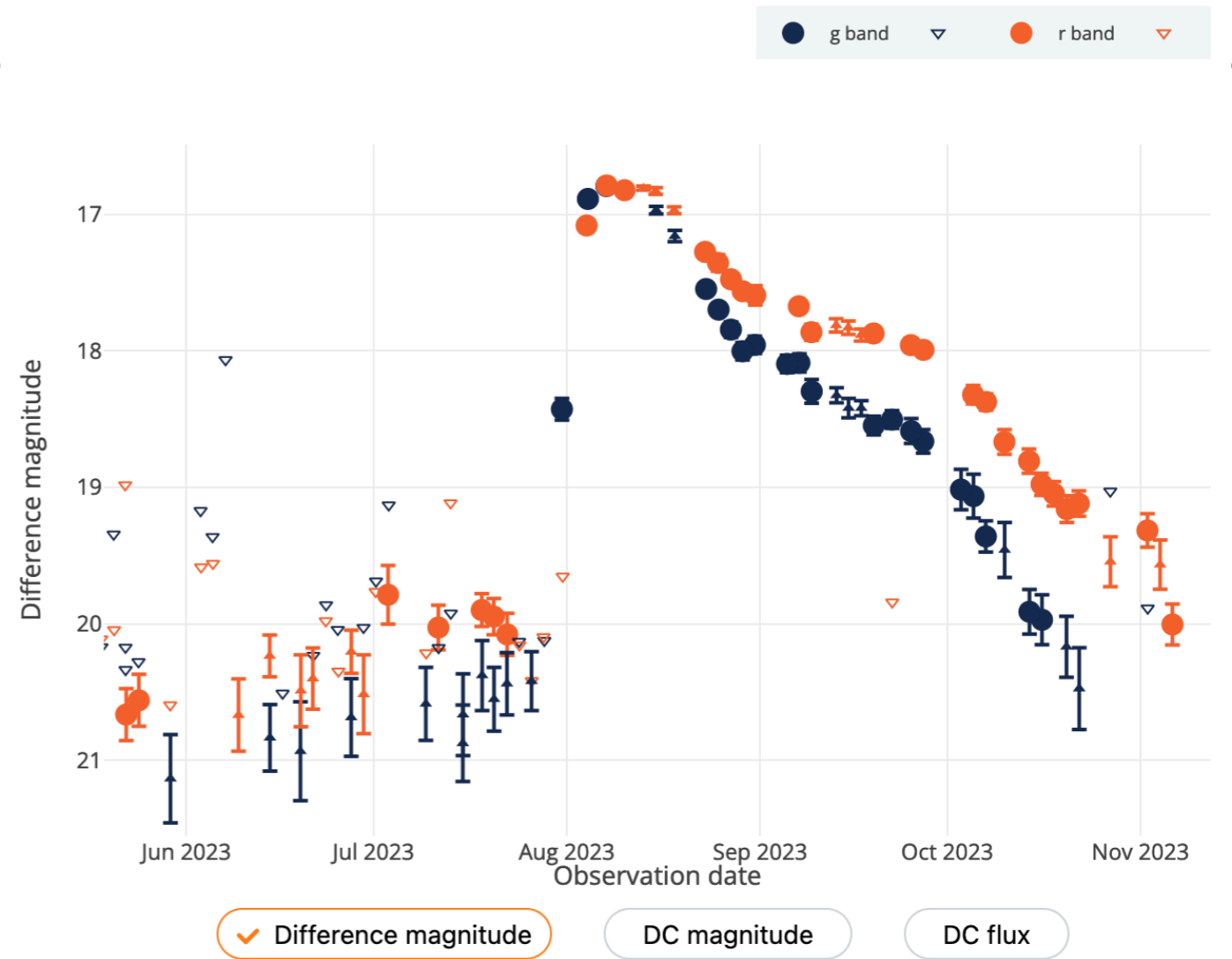
0.2M FOSC-ES32
[2023TNSCR.231....1B]

0.6M KGO

0.25M FRAM-ORM

RARE SUPERNOVA

SN 2023mtp

- Featureless spectra

- Low-surface-brightness galaxy

- Redshift undefined

- Pre-cursor activity
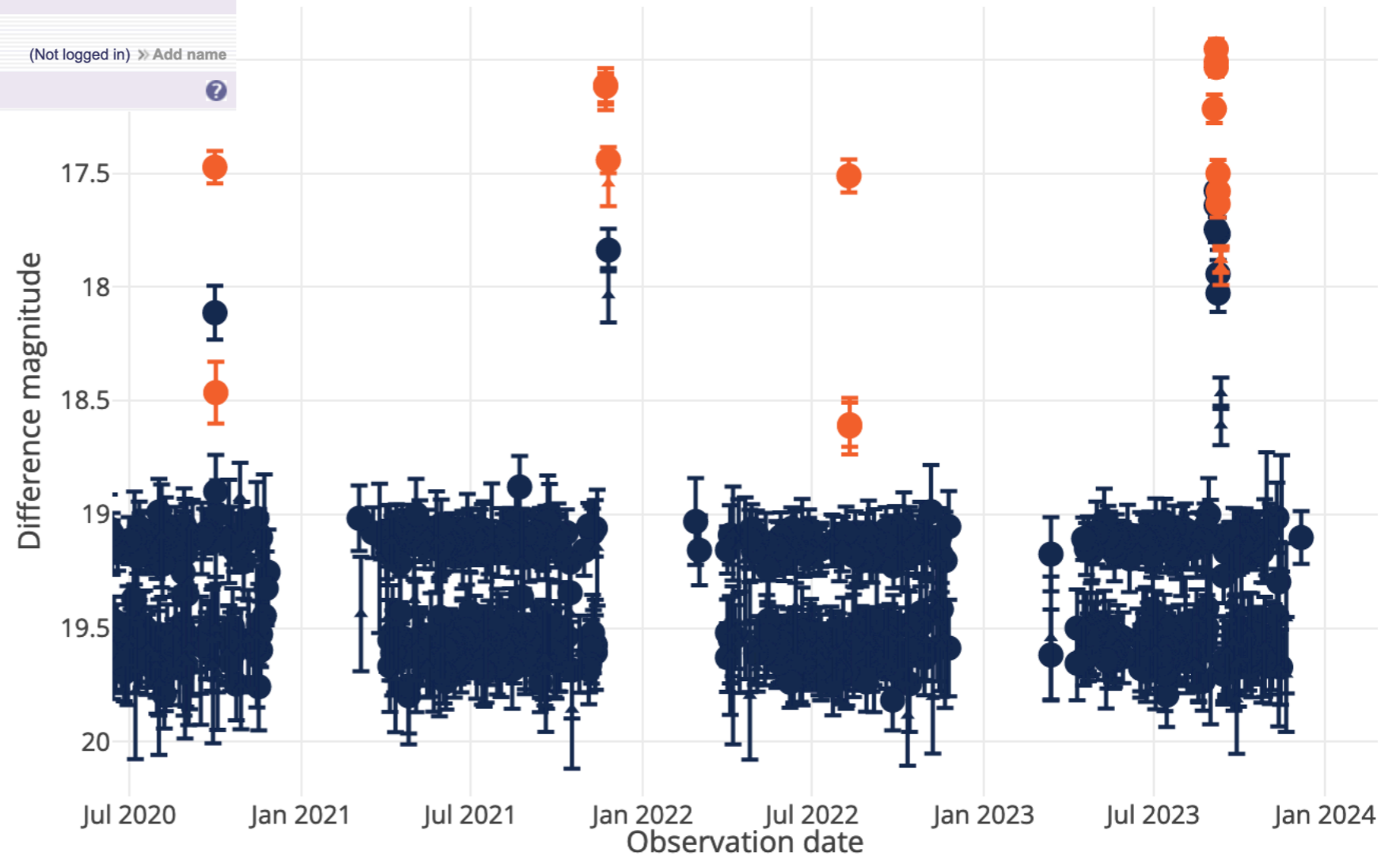

Credit: A. Dodin, A. Belinskii

CATACLYSMIC VARIABLES

https://fink-portal.org/FinkJ194741.57+223702.3

Latest Details		
Log in to retrieve additional aliases from SIMBAD.		
Name	V ZTF18aayoyvo	
AAVSO UID	000-BPS-433 (No observations)	
Constellation	Cygnus	» Sequence
J2000.0	20 34 40.21 +50 48 00.8 (308.66754 +50.80022)	» Search nearby
B1950.0	20 33 10.42 +50 37 37.1	
Galactic coord.	88.017 +6.227	
Other names (Internal only)	Fink J203440.21+504800.8	(Not logged in) » Add name
Variability type	UG	
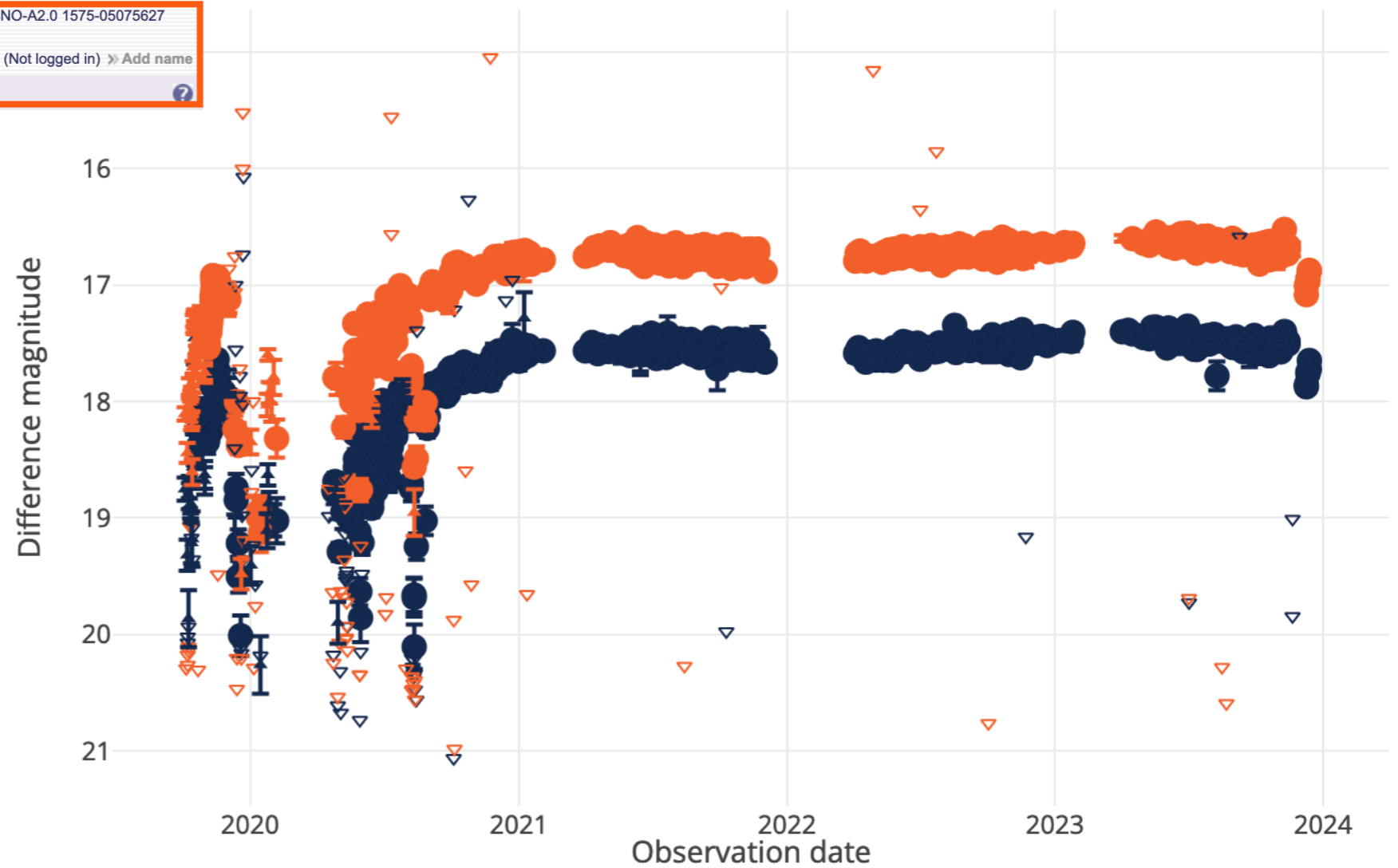
Credit: Anastasia Baluta

FUOR VARIABLES?

SUPERNOVAE

LCs are generated with SNAD ZTF Viewer

HOSTLESS TRANSIENTS

https://fink-portal.org/ZTF23aajaimx
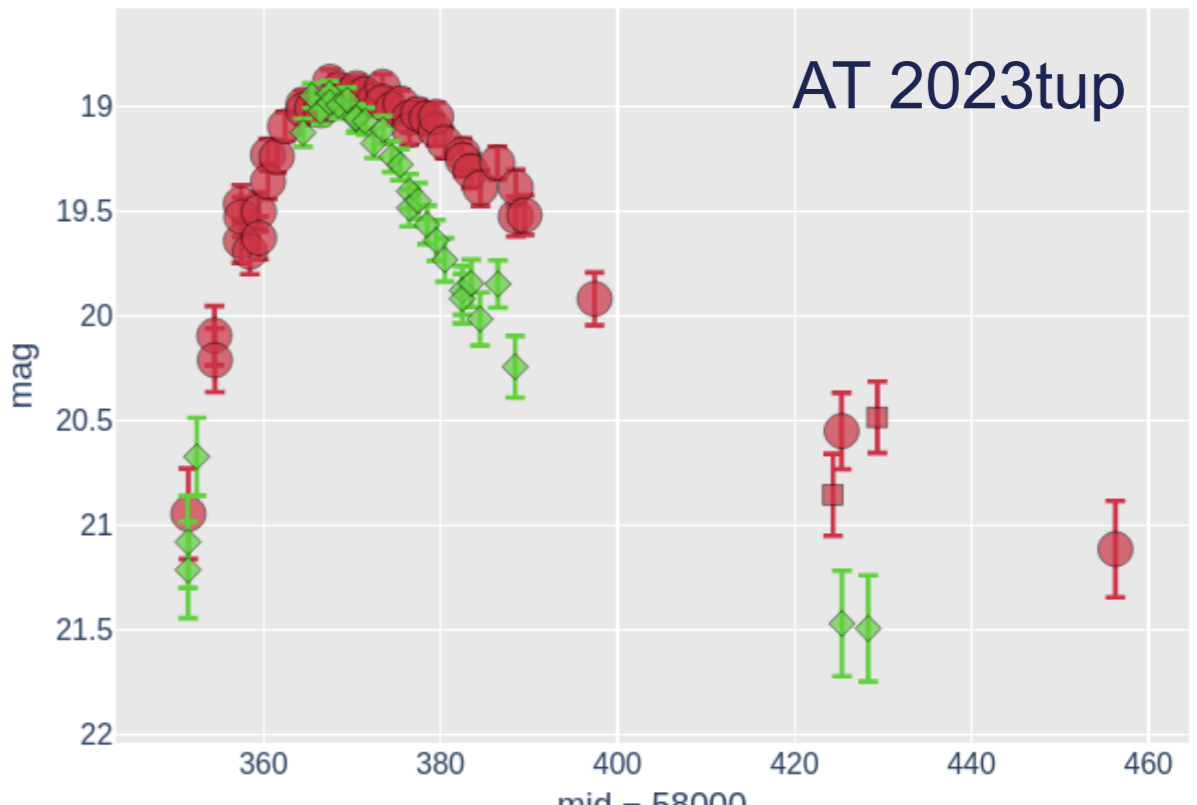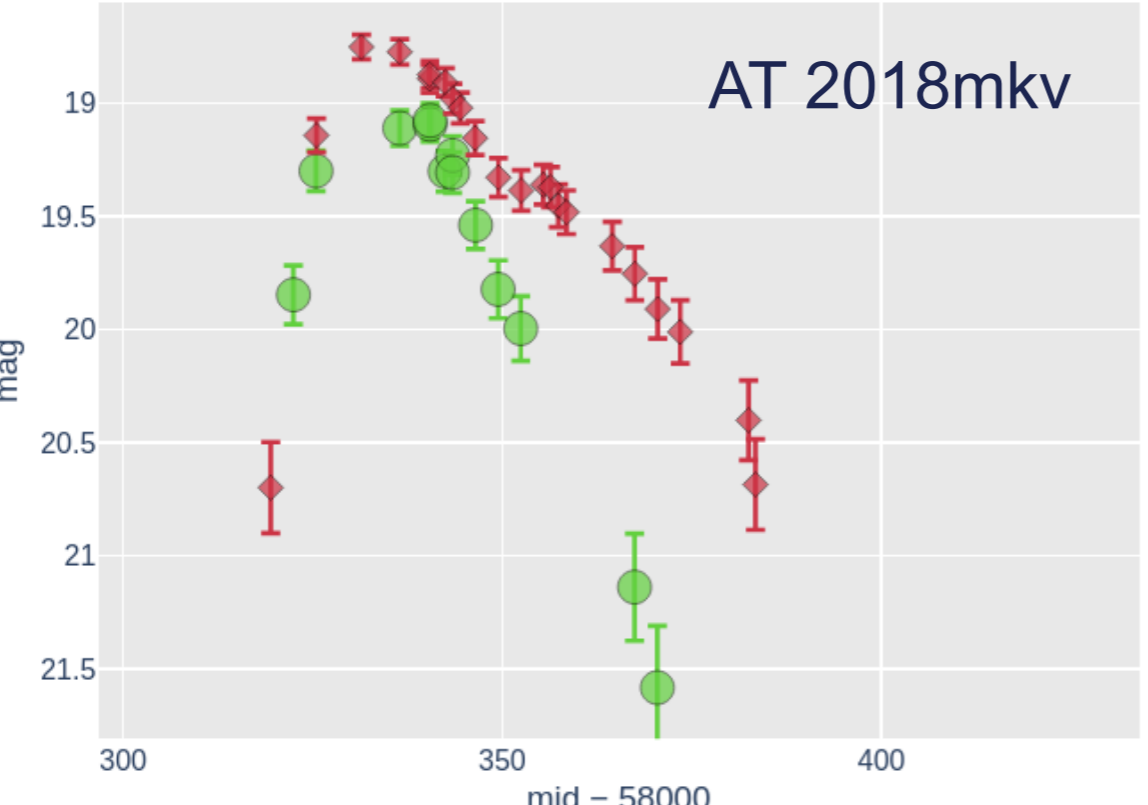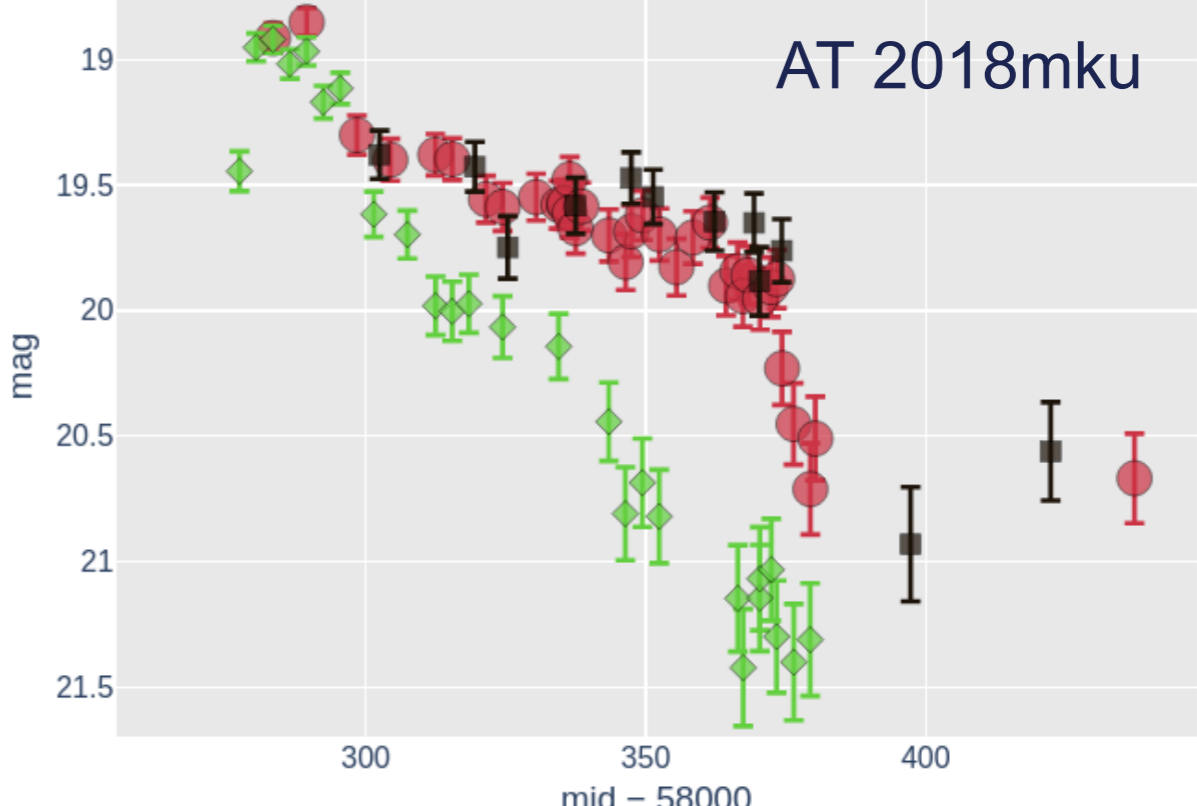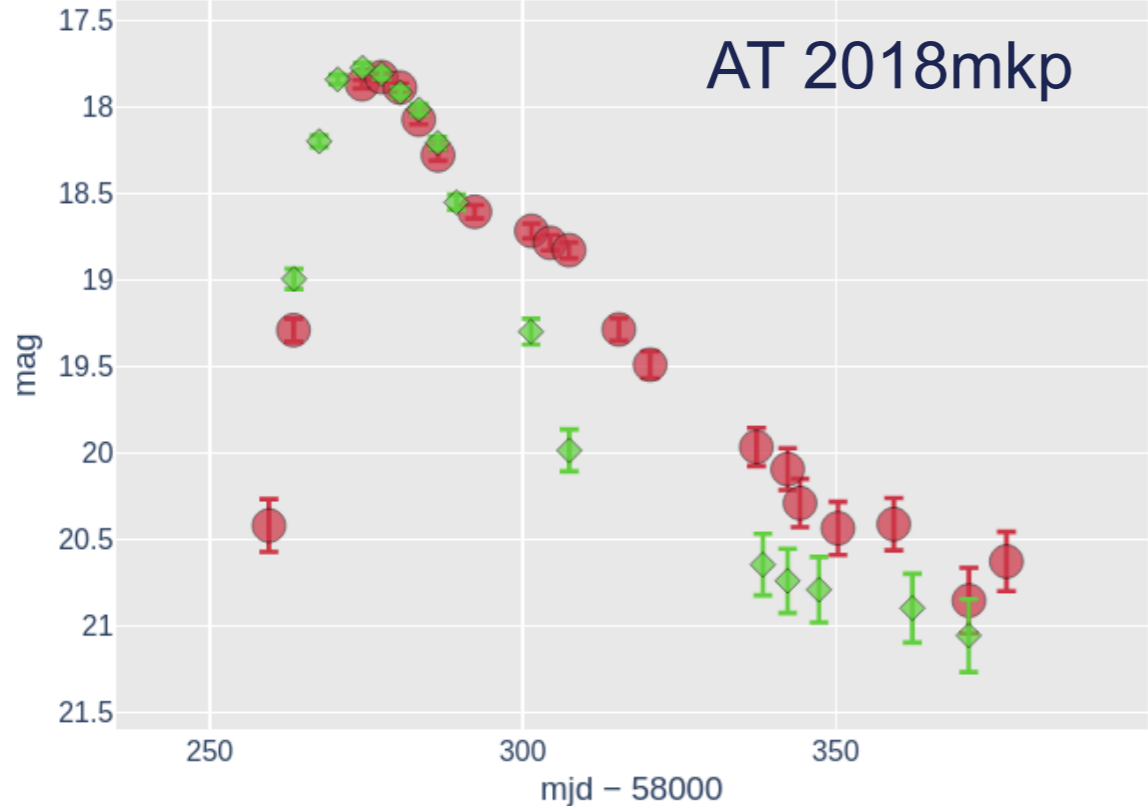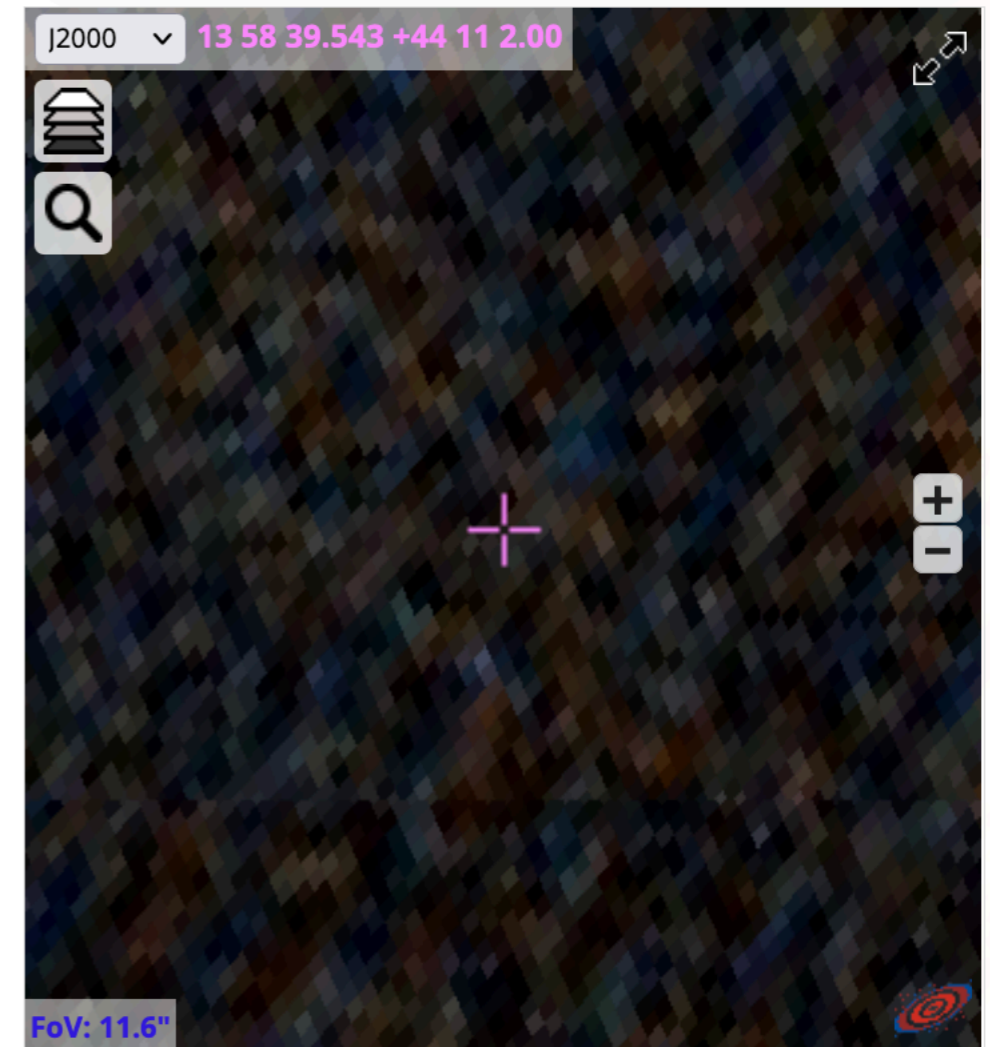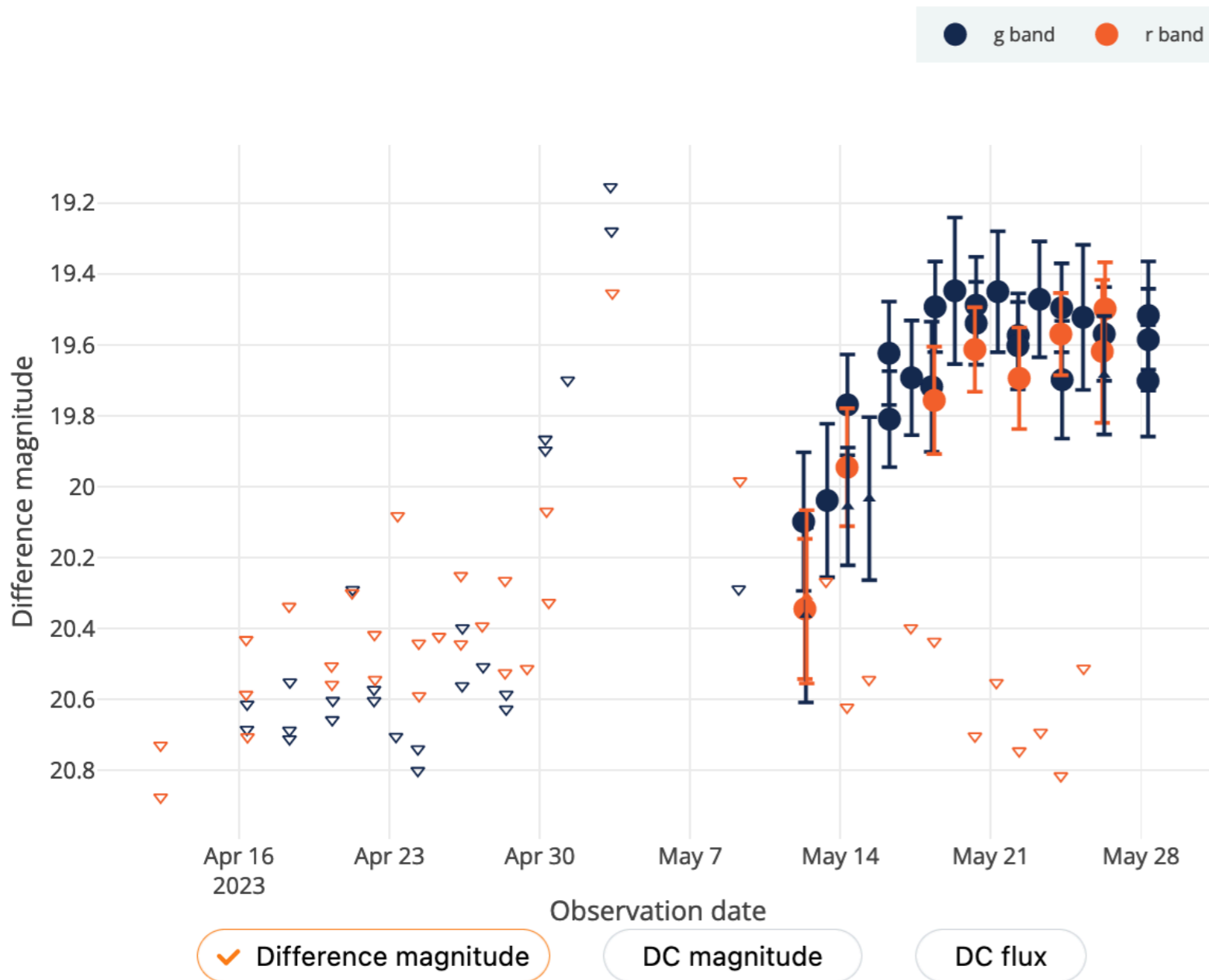
REPORTED IN TNS AS AT 2023IRO

FAST TRANSIENTS

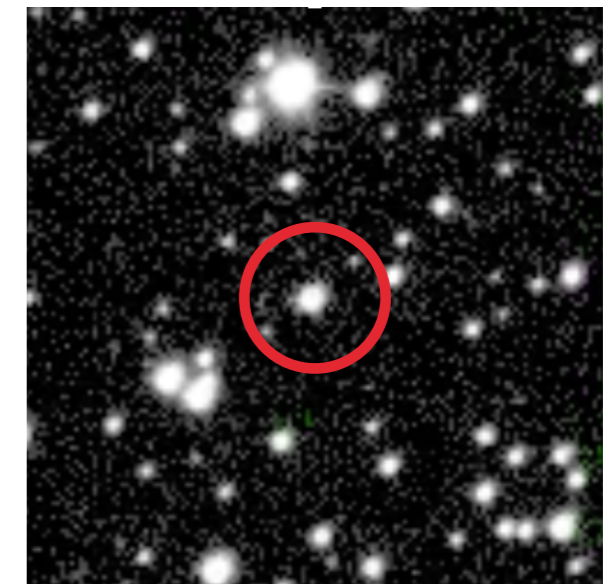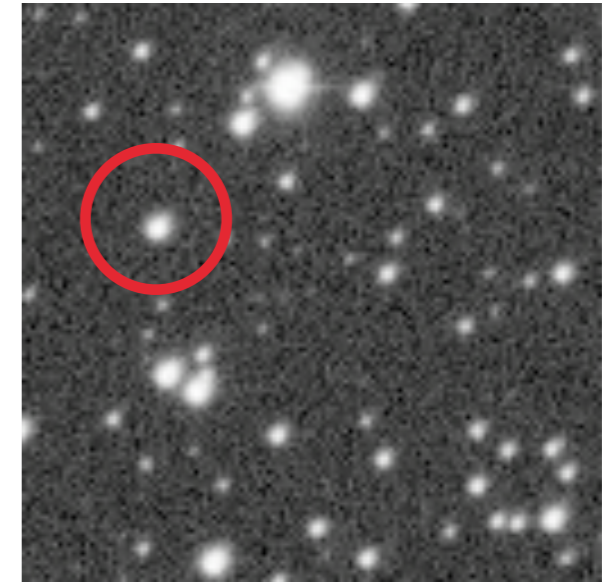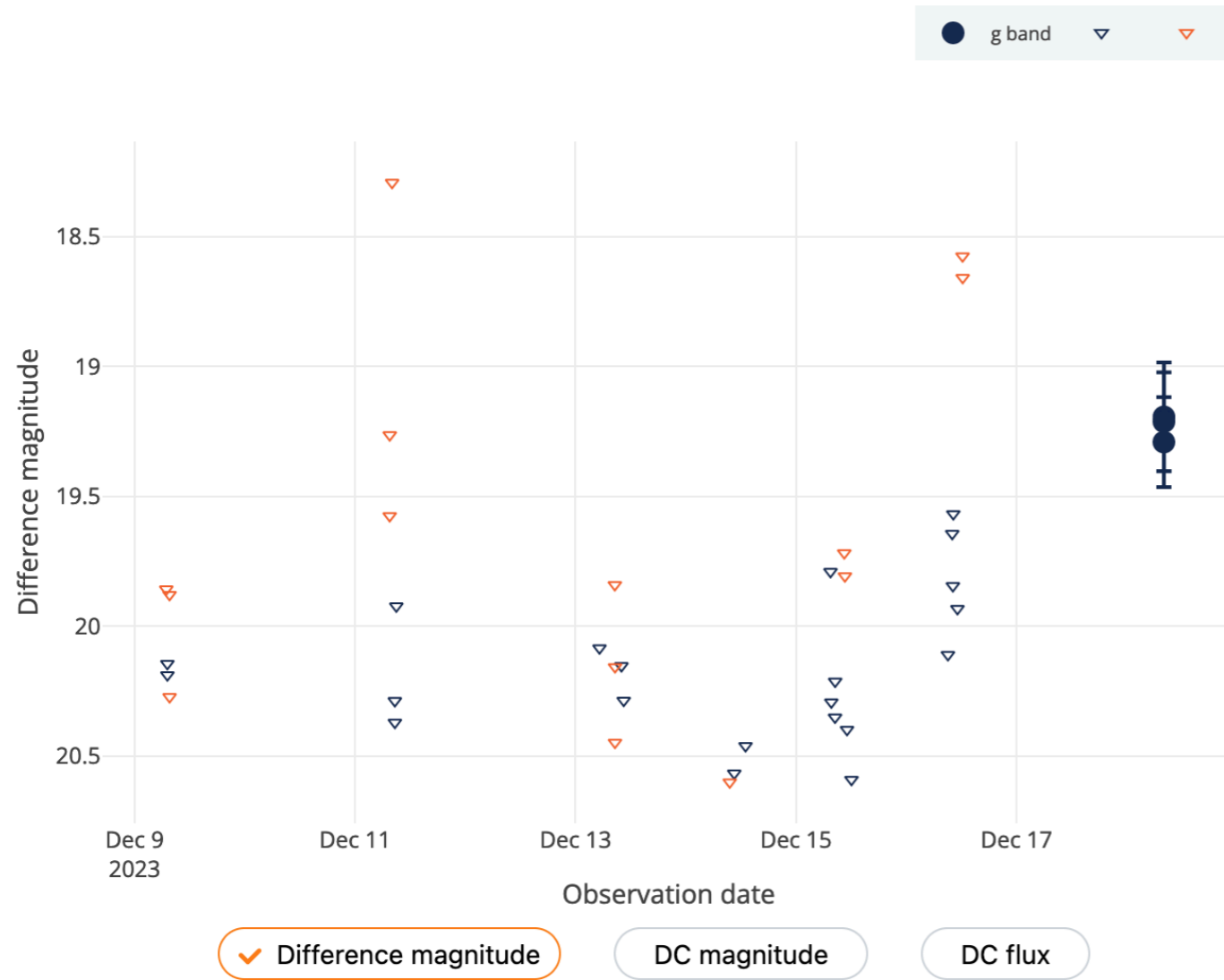https://fink-portal.org/ZTF23aamcbjv

MOVING OBJECTS

https://fink-portal.org/ZTF23abvdiaf
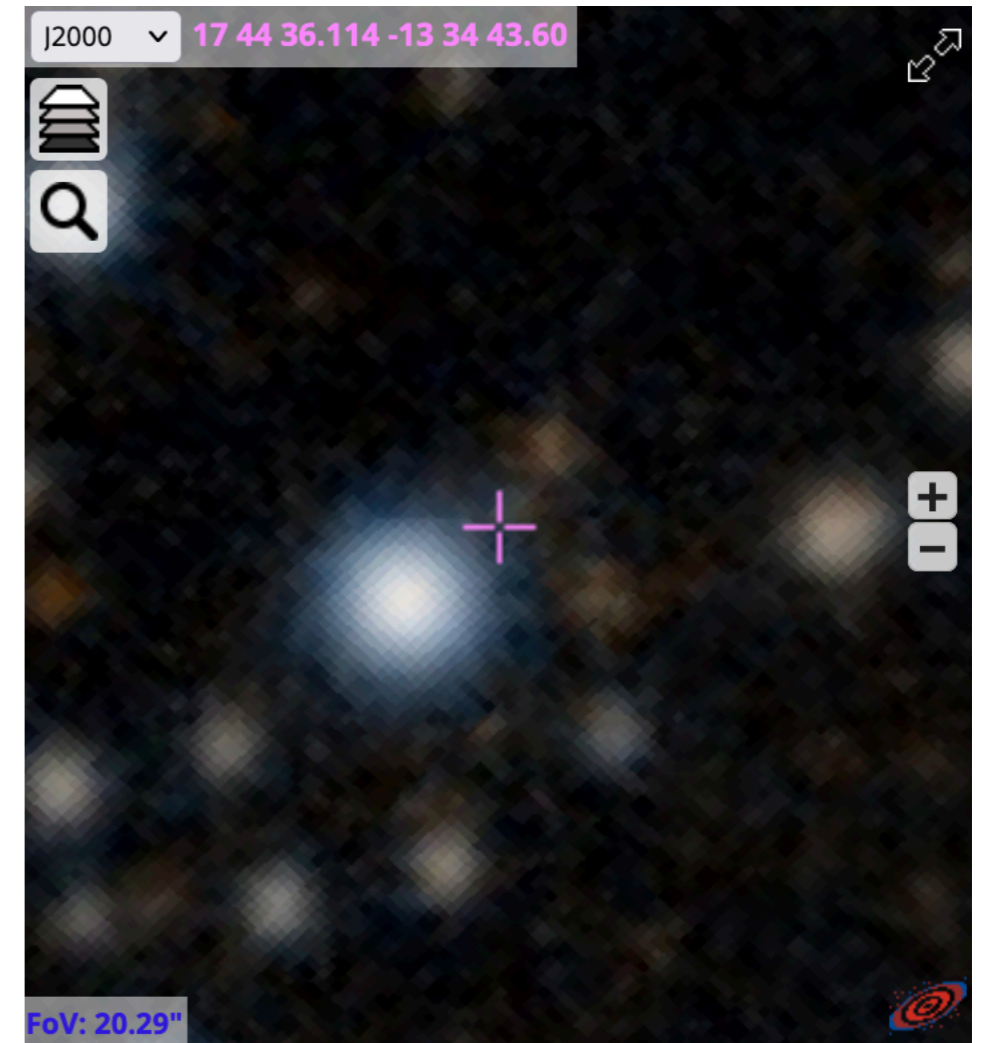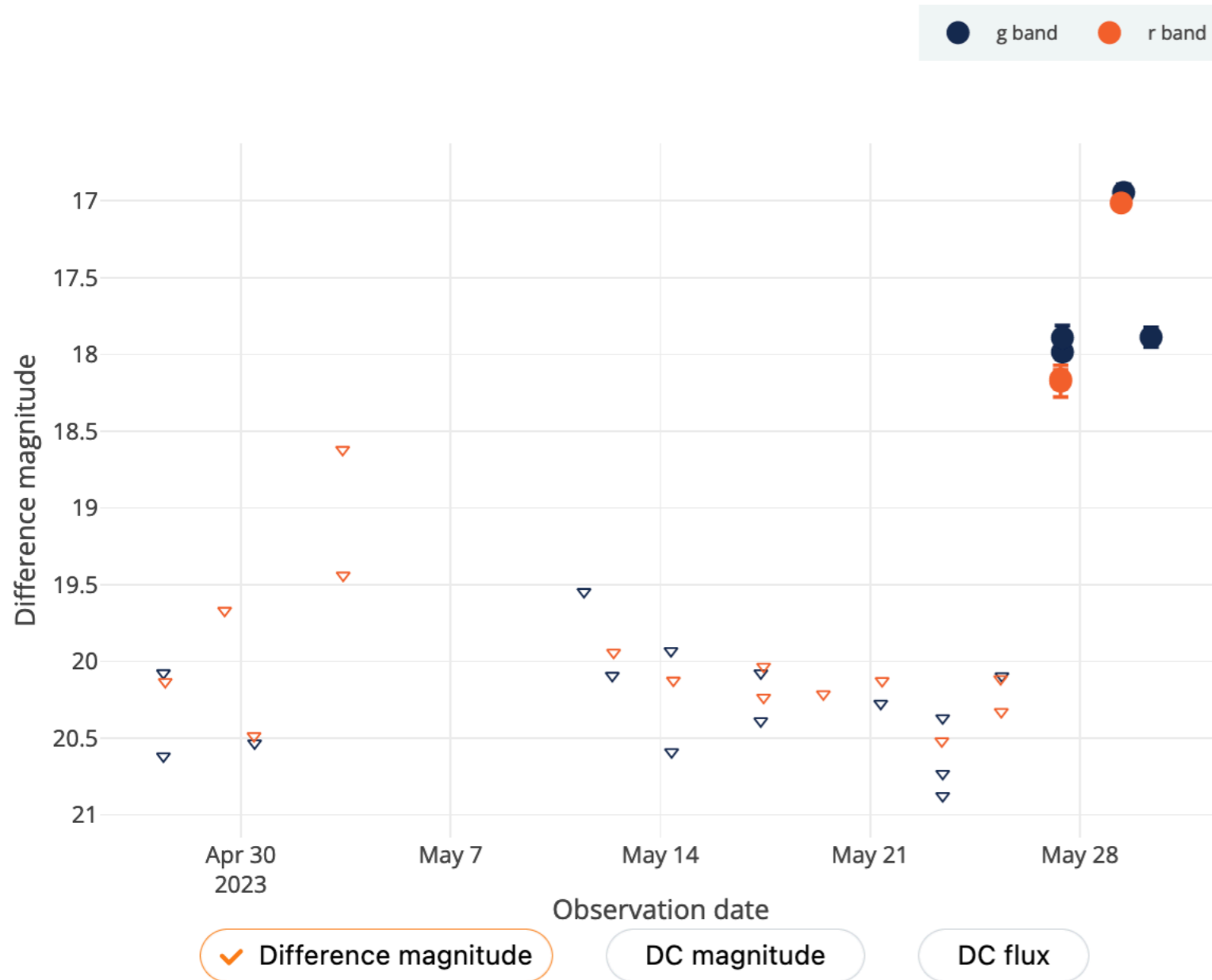
2000 YS68

SUMMARY

- Fink anomaly detection module is working and producing results

- Giving meaning to anomalies requires context

- A lot of infrastructure is necessary to allow coherent incorporation of expert's opinion

- Fink has been actively engaging community follow-up for exciting anomalies:

    - AT2023awt: 9.2m SALT (South Africa), 0.6m and 2.5m KGO (Russia), 0.25m FRAM-ORM (Spain)

    - SN 2023mtp: 2.5m KGO (Russia)

- In the era of the V. Rubin Observatory LSST, serendipitous discoveries will not happen

@ZTF_ANOMALY_BOT

Stay tuned and join the channels!