Fink Microlensing Case Study: AT 2021uey

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Brief overview

- Fink (Möller et al. 2020) classified 4391 events as microlensing candidates via the Lens Identification Algorithm (Godines et al. 2019).
- 2 teams:
  - Team Fink: P. Voloshyn, E. Bachelet, J. Peloton
  - Team OAUW: M. Ban, R. Poleski, L. Wyrzykowski, P. Zielinski
- Fink team used pyLIMA (Bachelet et al., 2017) for the lightcurve fit while the OAUW team used MulensModel (Poleski and Yee, 2018)

Microlensing event alert in Fink

https://fink-portal.org/ZTF18abktckv

Fink Science Portal

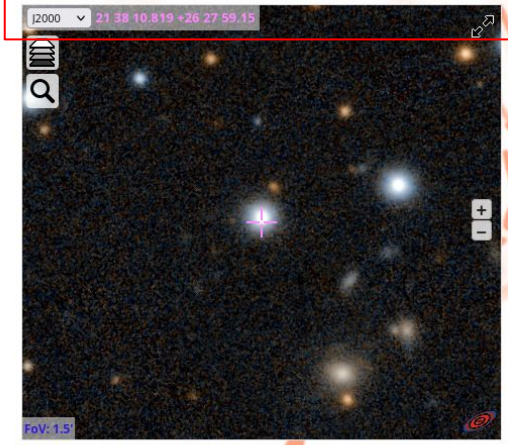
Summary | Supernovae | Variable stars | Microlensing | Solar System | Tracklets | GRB

ZTF18abktckv

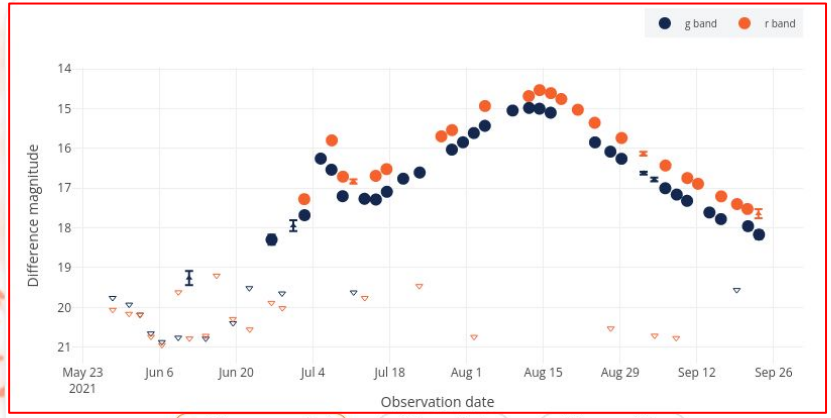
MICROLENSING CANDIDATE · UNKNOWN

Discovery date: 2021-06-26 10:24:09.000
Last detection: 2021-09-23 07:27:24.998
Number of detections: 49
Number of low quality alerts: 7
Number of upper limits: 31

l, b = 77.913744, -19.064196

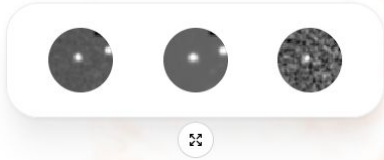


Individual alert classification — Microlensing candidate: 6% — Unknown: 94%



Difference magnitude | DC magnitude | DC apparent flux

Last alert cutouts

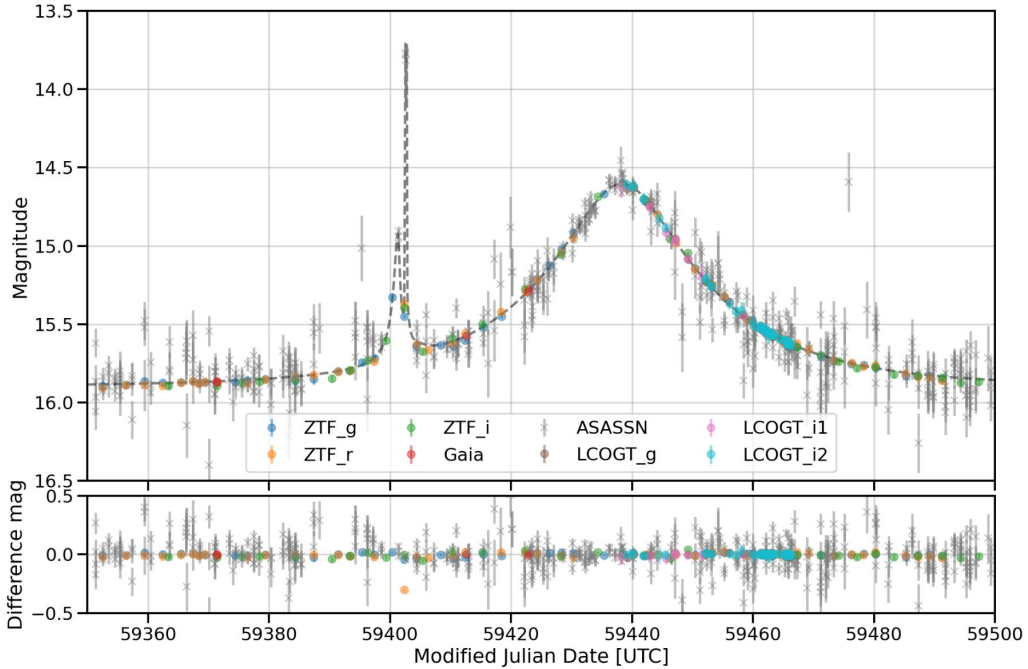


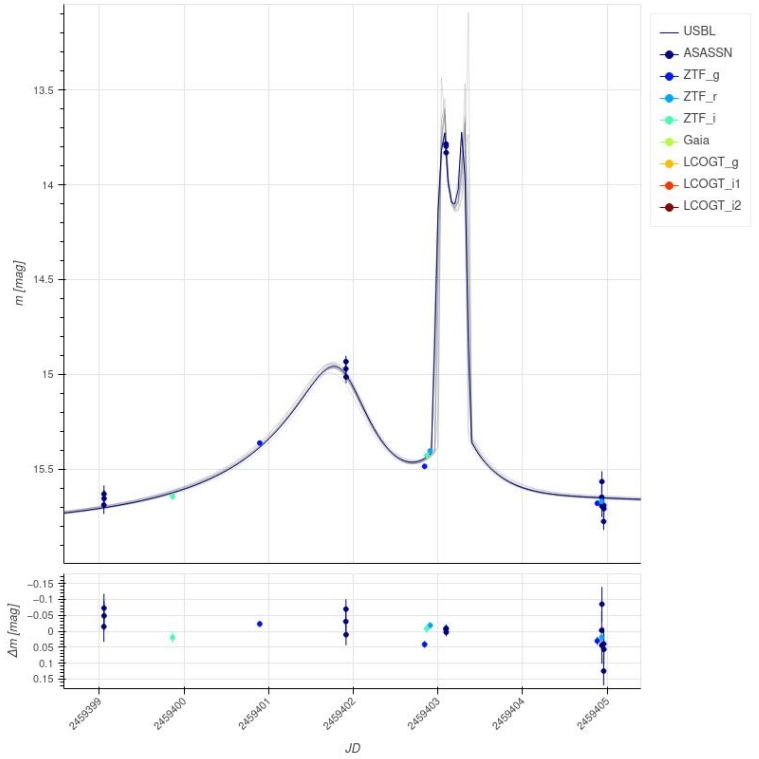
Information

Circles (●) with error bars show valid alerts that pass the Fink quality cuts. In addition, the *Difference magnitude* view shows:

- upper triangles with errors (▲), representing alert measurements that do not satisfy Fink quality cuts, but are nevetheless contained in the history of valid alerts and used by classifiers.
- lower triangles (▽), representing 5-sigma mag limit in difference image based on PSF-fit photometry contained in the history of valid alerts.

Lightcurve fit

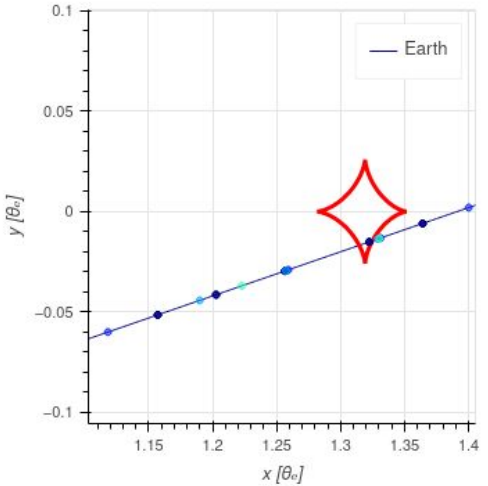




Total: 1220 epochs. Uniform-Source Binary Lens (USBL) model.

Results of the fit

t_0 (MJD)	$59\,438.193 \pm 0.034$
t_E (day)	27.63 ± 0.11
u_0	0.2988 ± 0.0011
ρ	$0.001\,66 \pm 0.000\,69$
$\log s$	0.2695 ± 0.0092
$\log q$	-2.581 ± 0.015
α	-2.9251 ± 0.0011
χ^2/dof	1.137



	Source (mag)	Blend (mag)
ZTF		
g-band	15.9627 ± 0.0054	18.9984 ± 0.0946
r-band	15.4425 ± 0.0042	18.1563 ± 0.0530
i-band	15.2942 ± 0.0056	17.3904 ± 0.0462
ASASSN	15.9721 ± 0.0068	20.1979 ± 0.4361
Gaia	15.5363 ± 0.0085	18.6470 ± 0.1599
LCOGT		
g-band	15.9805 ± 0.0093	19.1247 ± 0.2482
i1-band	15.2848 ± 0.0097	17.4947 ± 0.0971
i2-band	15.3183 ± 0.0095	17.4155 ± 0.0954

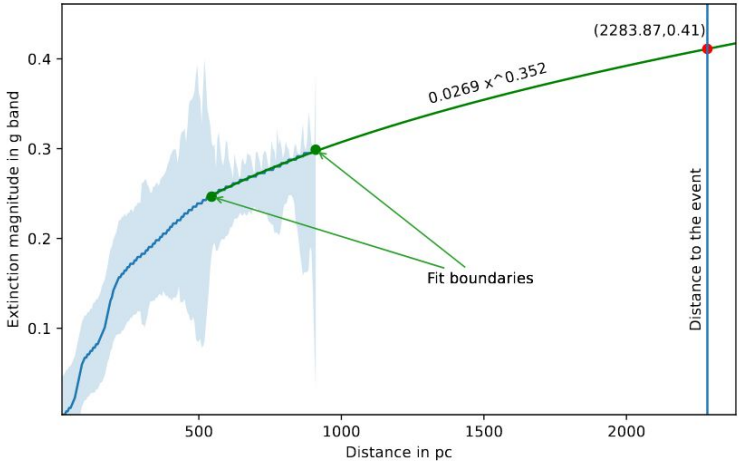
Further analysis

Preliminary analysis has been done by both groups:

- Fink team's analysis: extinction and black body fitting
- OAUW team's analysis: event simulation (see Makiko's talk QR code)

For now we consider the source to be a red giant and the lens to be a Jupiter-mass exoplanet orbiting an M-dwarf beyond the snow line.

A high resolution spectrum of the foreground star is planned to be taken in December.



Summary

Among Fink's candidates for microlensing, one with an exoplanetary anomaly has been chosen. The event has been thoroughly analyzed and was given an explanation, which will be improved by spectroscopic analysis. This case stands as an example of what kind of exoplanetary microlensing research might be done on LSST via Fink broker.

Conclusions

- There is a clear need to improve the microlensing module of Fink.
- It was shown that telescopes such as ZTF may be used to detect exoplanets.
- Even if the follow-up is late, exoplanetary peak may be analyzed to good precision on ZTF telescope (more so for the LSST).

References

- Fink: Möller, A., et al., 2020, Monthly Notices of the Royal Astronomical Society, 501, 3272
- MicroLIA: Godines, D., et al., 2019, Astronomy and Computing, 28, 100298
- pyLIMA: Bachelet, E., et al., 2017, The Astrophysical Journal, 154, 203
- MulensModel: Poleski, R. & Yee, J., 2019, Astronomy and Computing, 26, 35