

The OMEGA Key Project : detection of cold planets and stellar remnants in the entire Milky Way automatically

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and

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Lukasz Wyrzykowski (Warsaw University)*

11th OPTICON Gaia Science Alerts Workshop - 20/01/2021

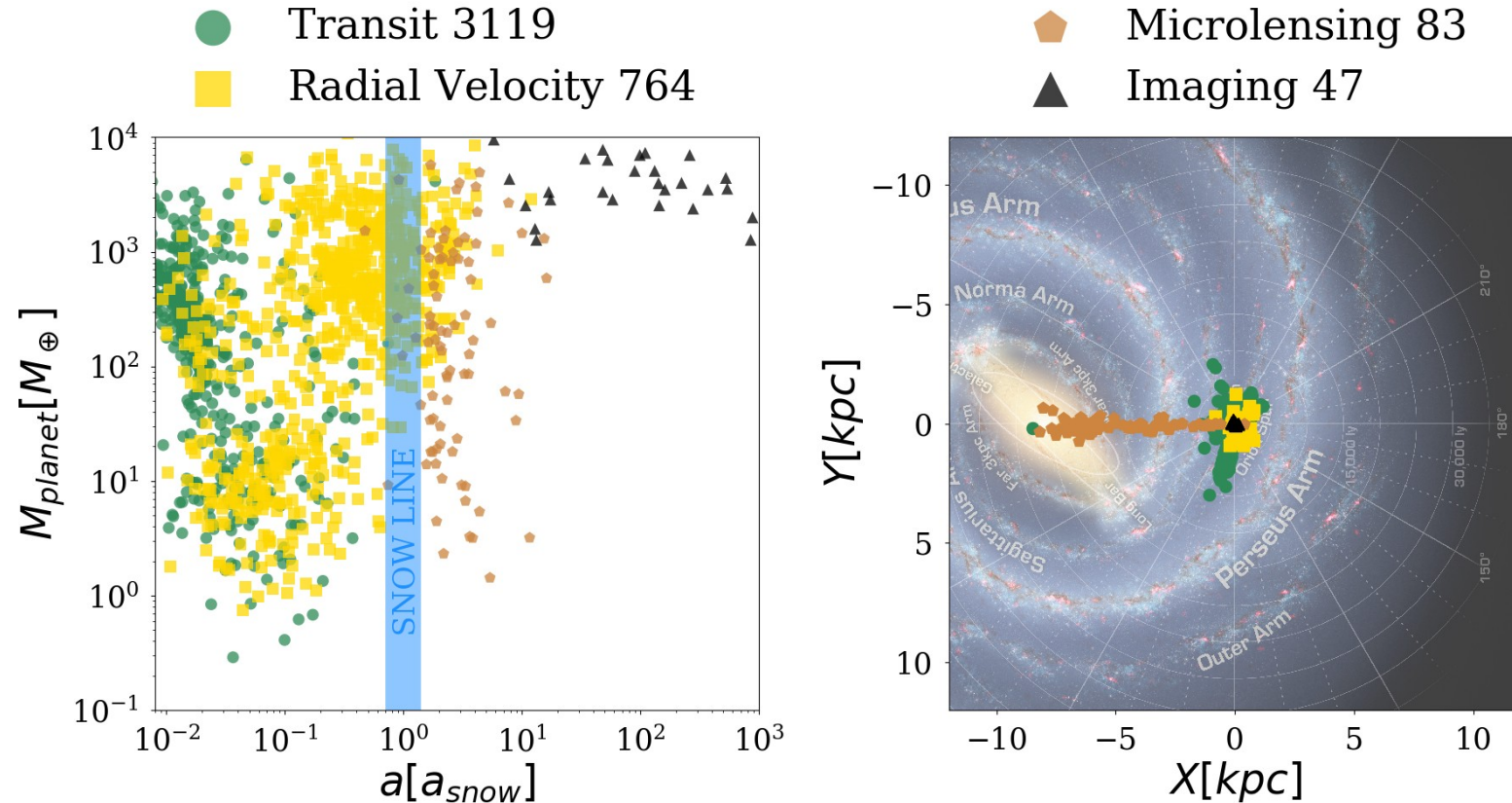


NASA grant 80NSSC19K0291



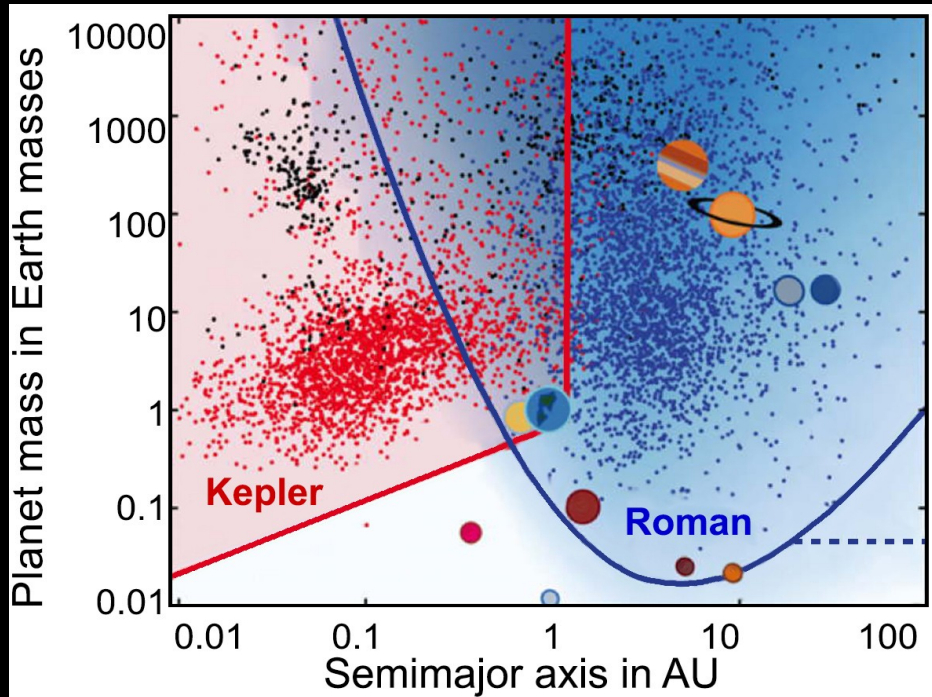
Las Cumbres Observatory

Microlensing: (Cold) Planets

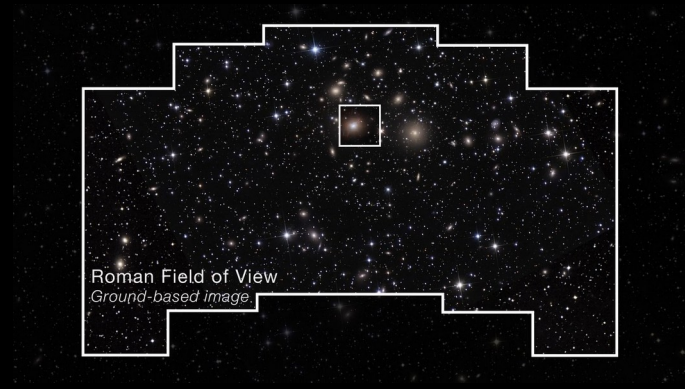


From NASA Exoplanet Archive, 27/07/2020

Microlensing: (Cold) Planets

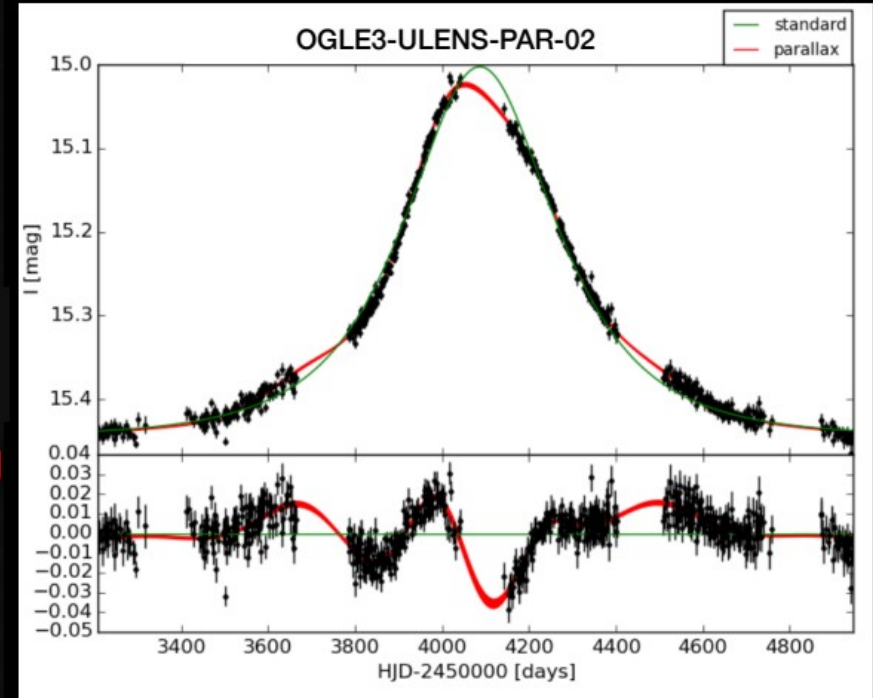
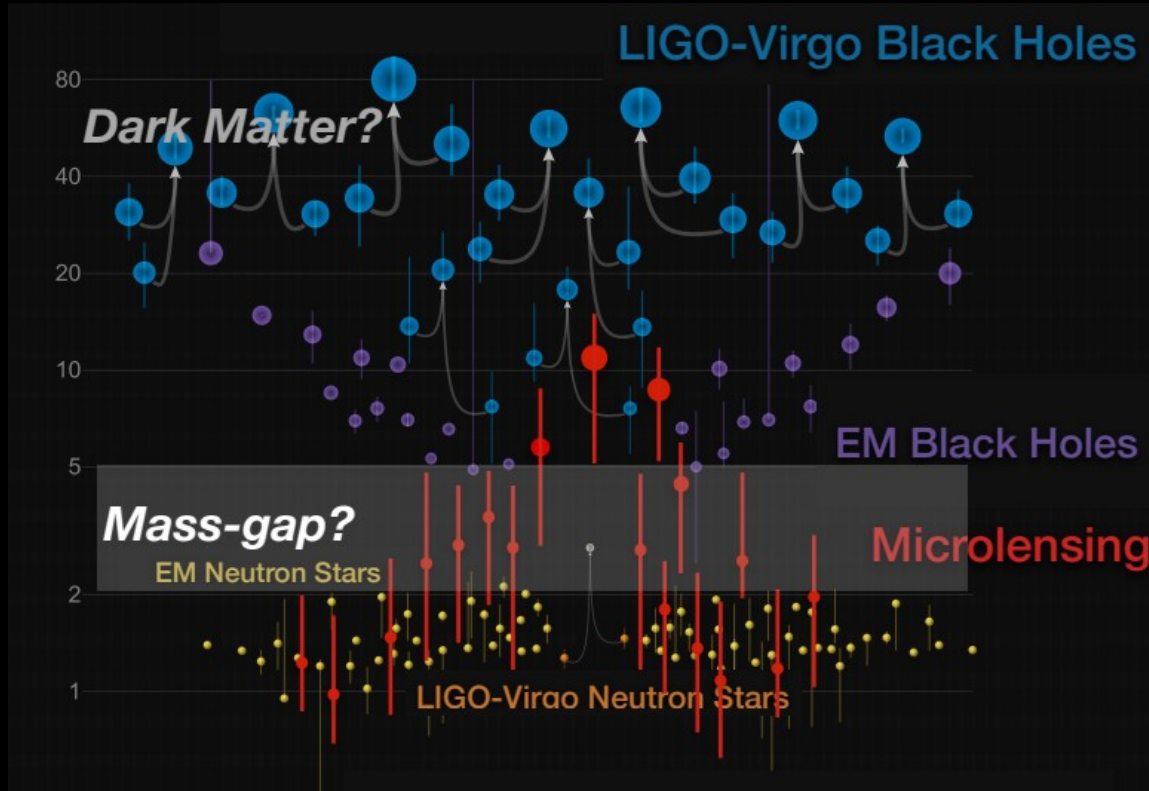


Penny et al. ApJS. 2019



- > 1500 cold planets
- dozens of free-floating planets
- stellar physics, variables

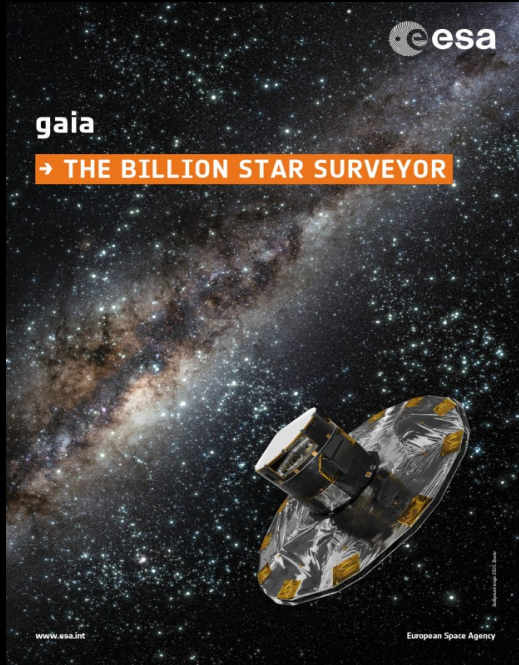
Microlensing: (Stellar Mass) Black Holes



Credit: LIGO-Virgo/Frank Elavsky, Aaron Geller/ Northwestern

Wyrzykowski et al. 2016,2020

Microlensing: a new potential



Many new transients every night in the entire sky ...

Microlensing: a new potential

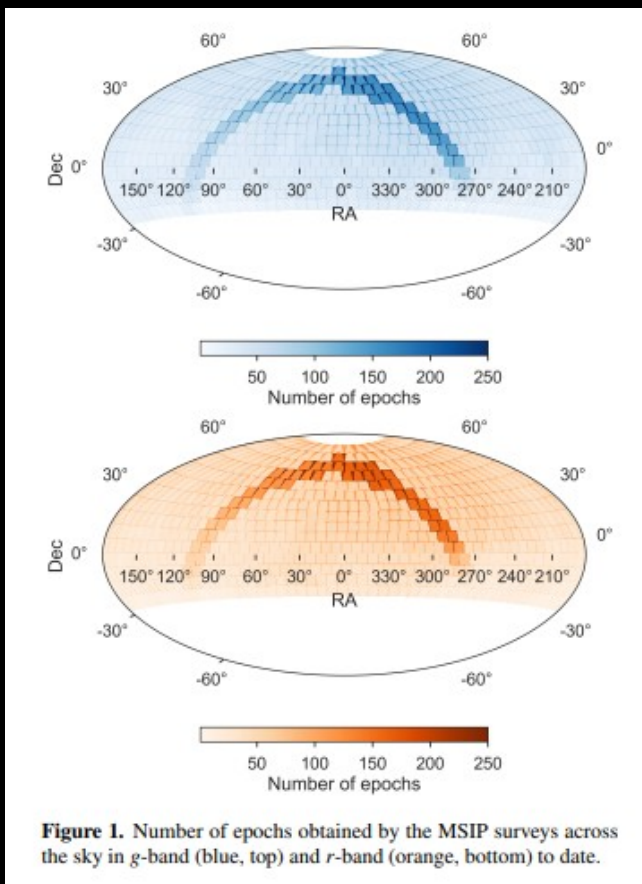


Figure 1. Number of epochs obtained by the MSIP surveys across the sky in g-band (blue, top) and r-band (orange, bottom) to date.

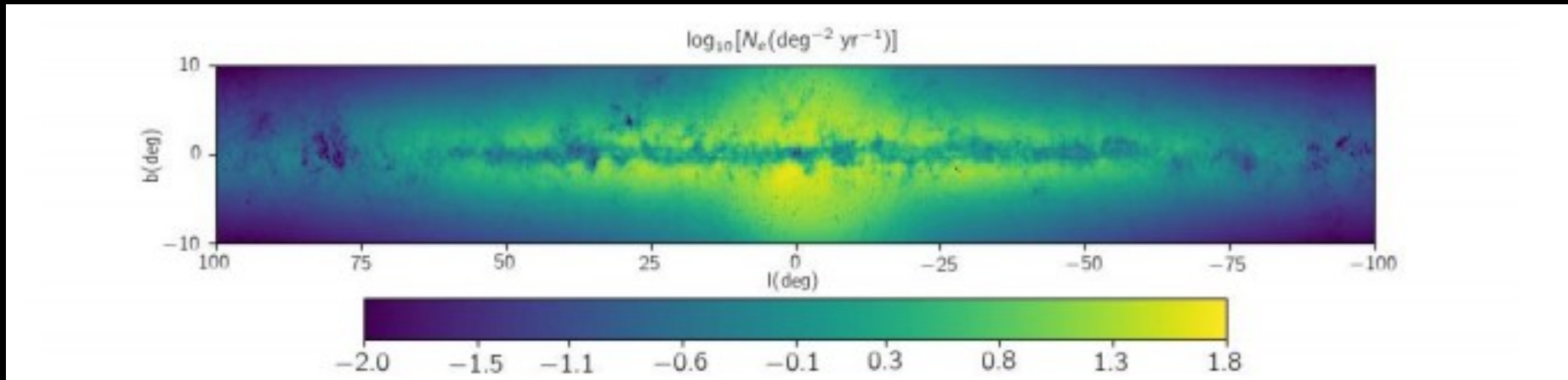
Bellm et al. PASP. 2019



Many new transients every night in the entire sky ...

... but with relatively low cadence.

Microlensing: a new potential



Sadijan et al. PASP. 2019



Many new transients every night in the entire sky ...
... but with relatively low cadence.

The OMEGA Key Project

Ensuring dense photometric and spectroscopic follow-up of most promising microlensing events.



The OMEGA Key Project: strategy

- **SDSS-i and SDSS-g photometry with modes:**

- Regular: Daily cadence of ongoing events
- Priority: 30 min cadence for 3 days
- Anomalous: Intensive follow up for 48 h

- **Spectroscopy:**

- (At least) Two low-resolution ($R < 1000$) spectra
- High-resolution ($R \sim 55,000$) when possible ($V < 11$ mag)

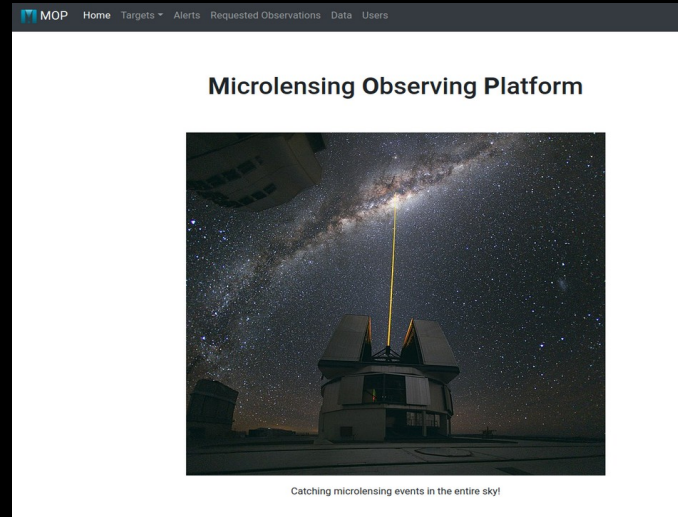
The OMEGA Key Project: MOP



+

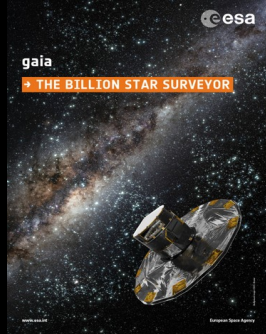


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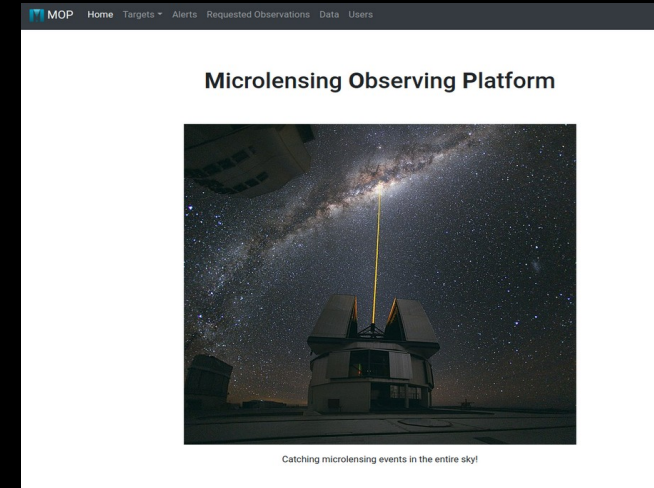


MOP : 1. Harvest events

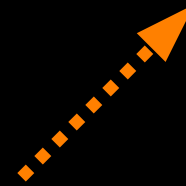
Currents



Harvesting events
at regular cadence
with crontab (i.e.
cronjobs)
~ 1 harvest/day



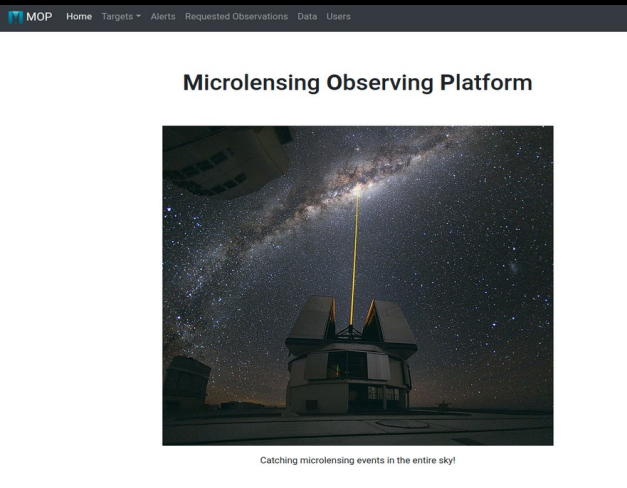
Future



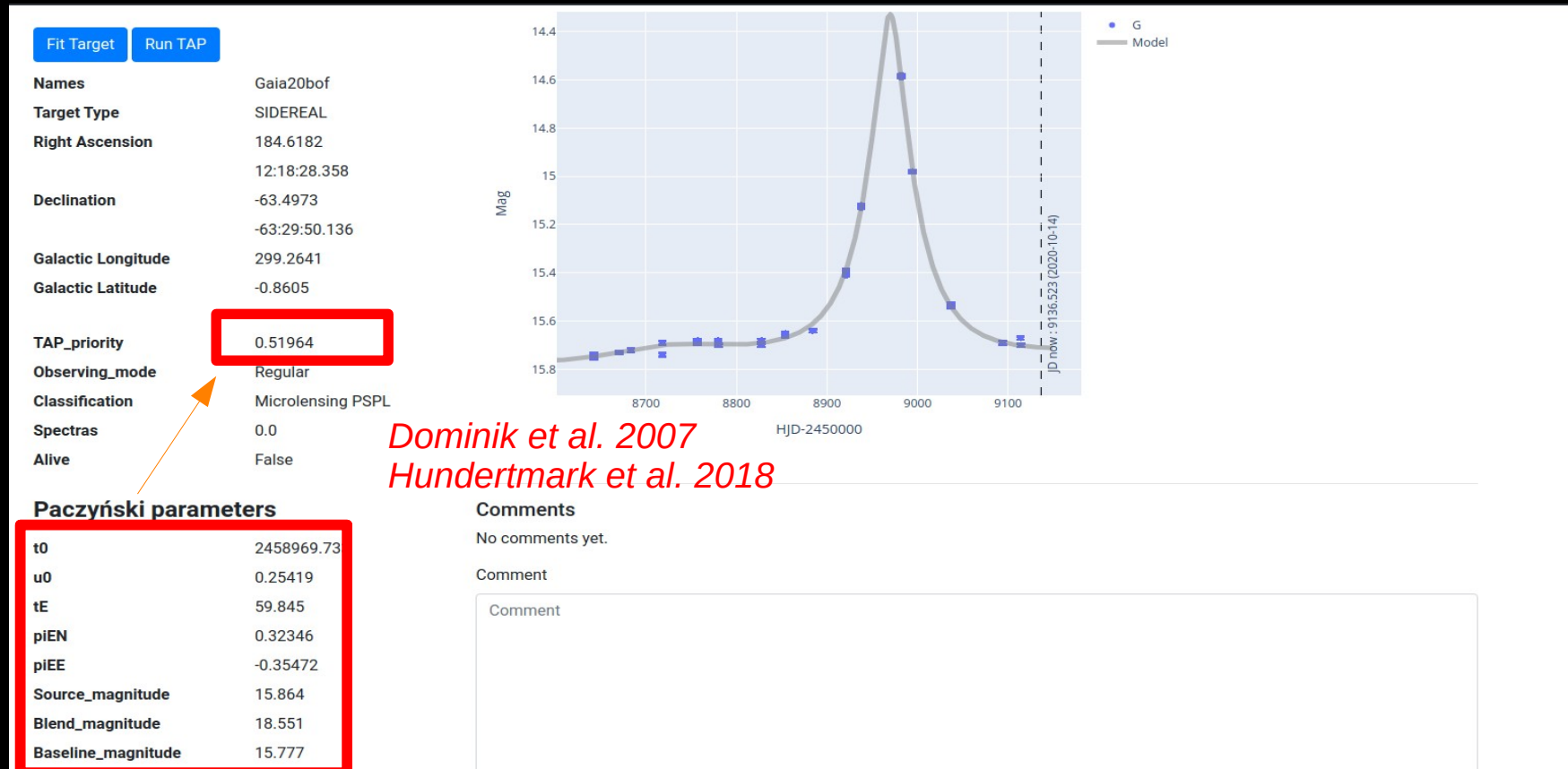
(under construction)

MOP : 2. Fit and rank events

Fit events in
parallel using
pyLIMA software on
AWS cloud

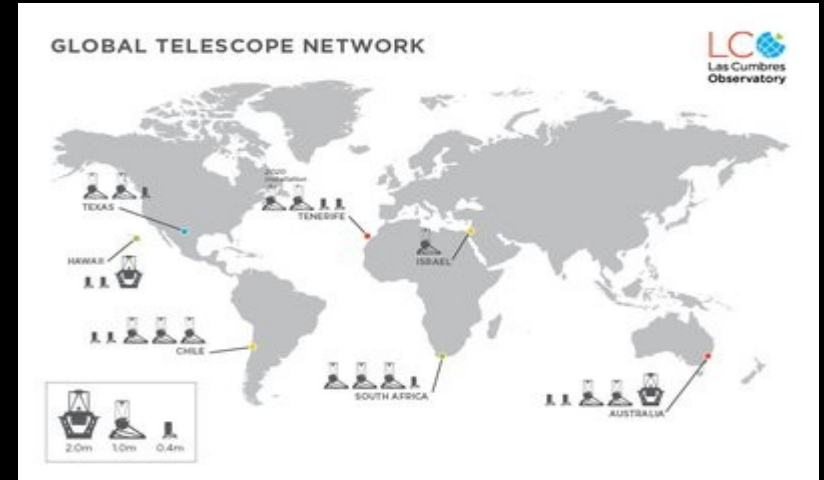
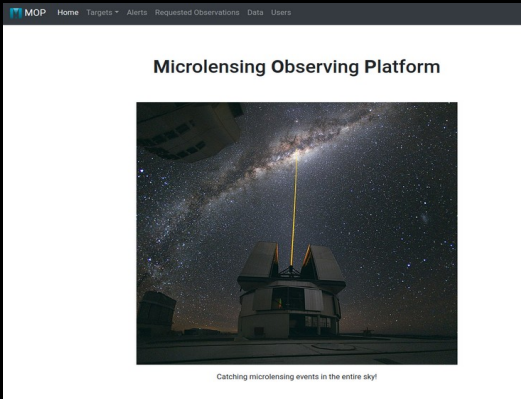


MOP : 2. Fit and rank events



MOP : 3. Submit observations

Submitting
observations
automatically



(currently manual)



MOP : 4. Example

Gaia21ahr

Details

Follow-up



TNS ID
AT2021atb

RA - DEC
176.39854 -62.43771
11:45:35.65 -62:26:15.76
Galactic coords.
295.39757 -0.53306

Alerting date
2021-01-16 23:12:36
Julian date
2459231.47

Alerting magnitude
15.99
Historic magnitude
16.38
Historic StdDev
0.07
Class
unknown
Publication date
Jan. 18, 2021, 11:03 a.m.

Other surveys detections

None

Comments

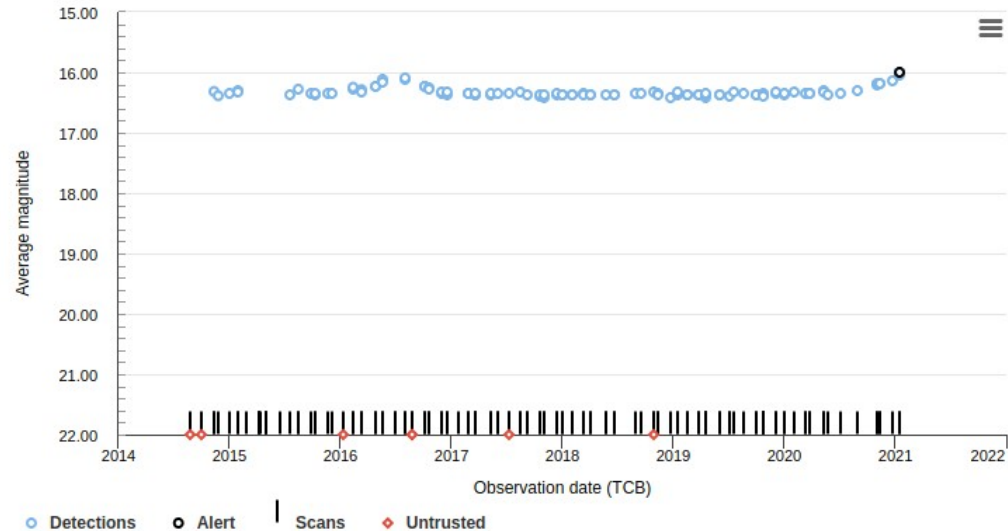
bright red gal.plane source candidate microlensing event or Be-type outburst rises by 0.4 mag

ATels

None

AstroNotes

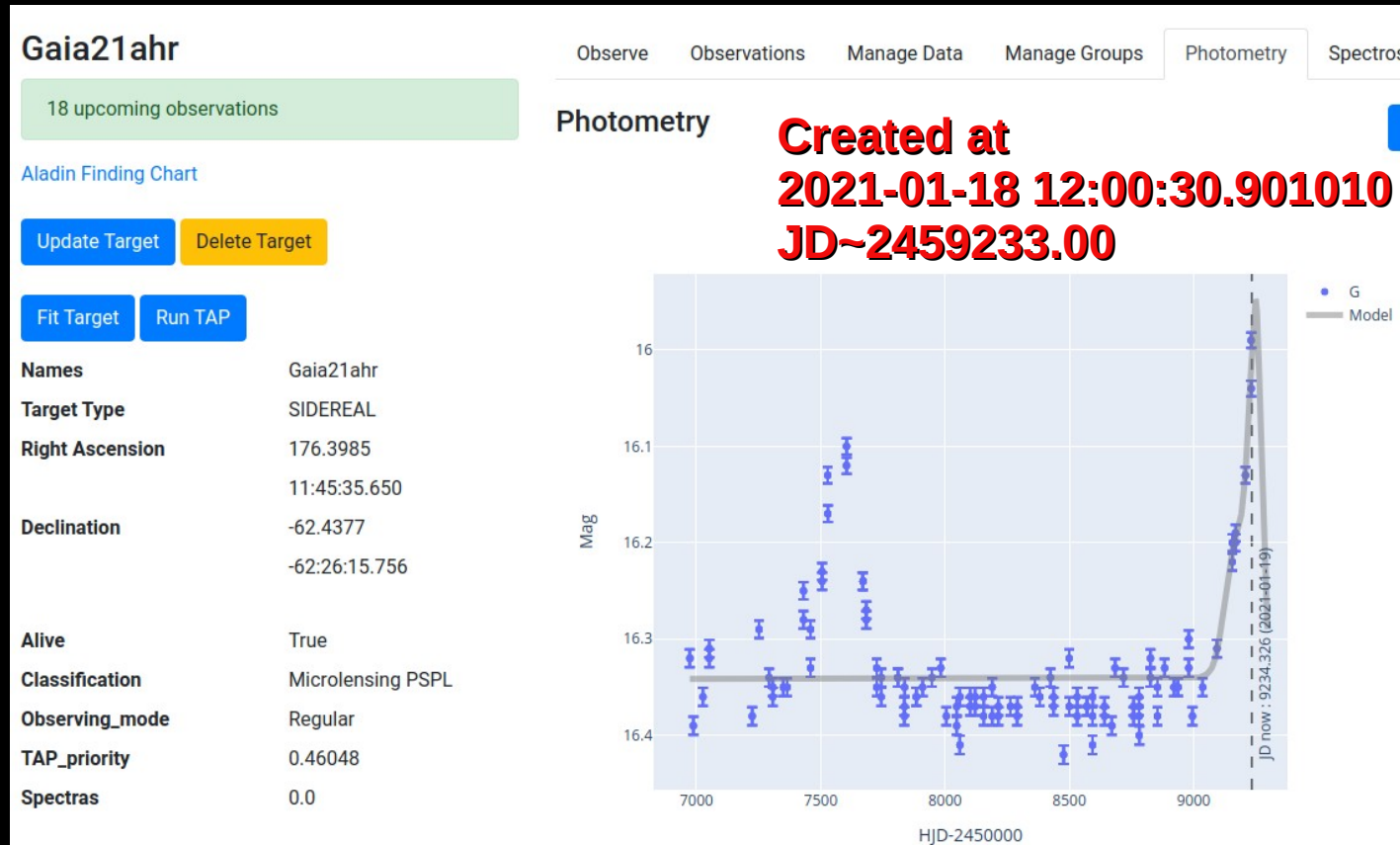
None



See [here](#) for an explanation of lightcurves.

Get lightcurve data

MOP : 4. Example



MOP : 4. Example

Gaia21ahr

Details Follow-up

J2000 **11 45 35.650 -62 26 15.76**

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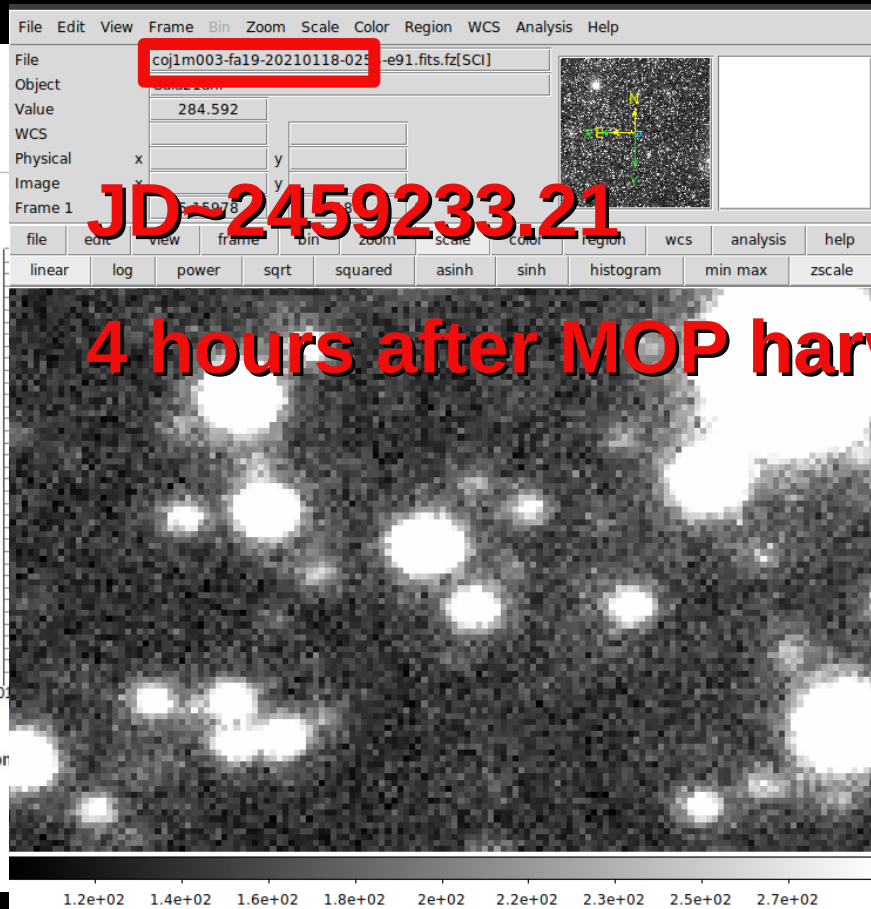
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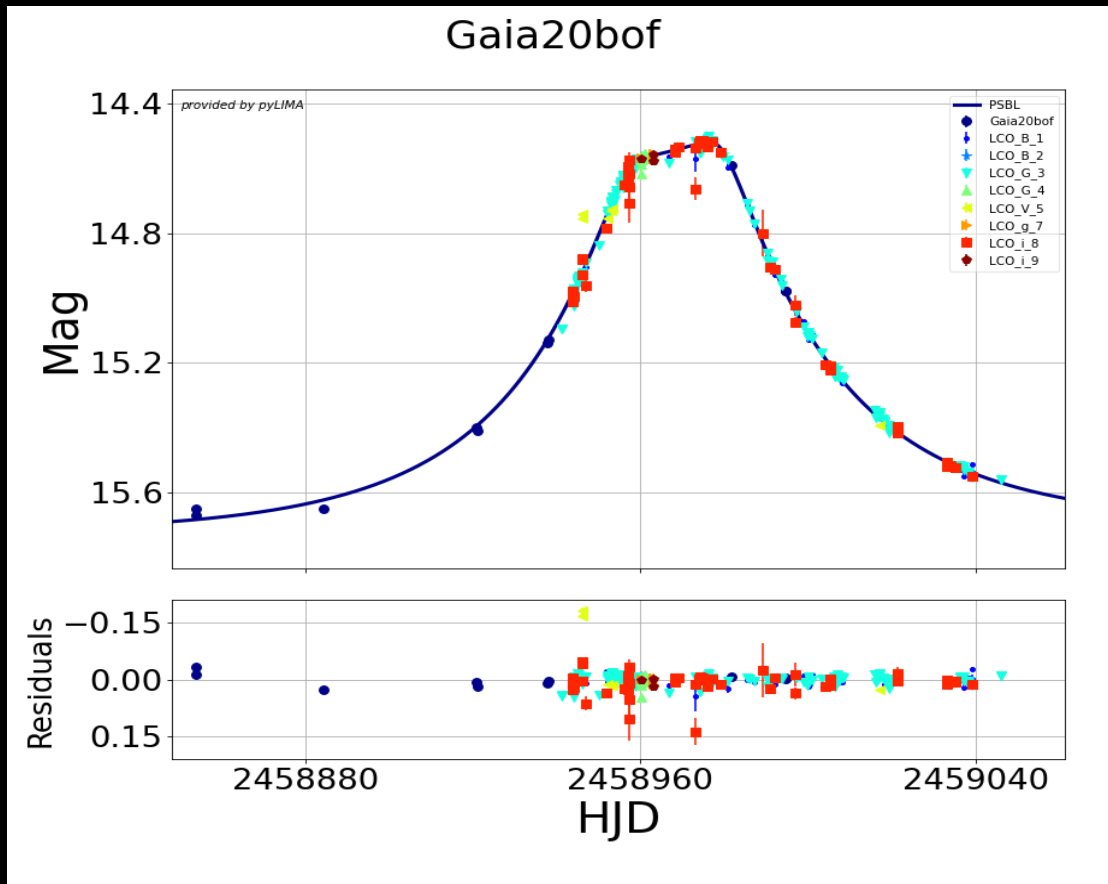
ATels
None

AstroNotes
None

FoV: 44.09"



OMEGA results : Gaia20bof

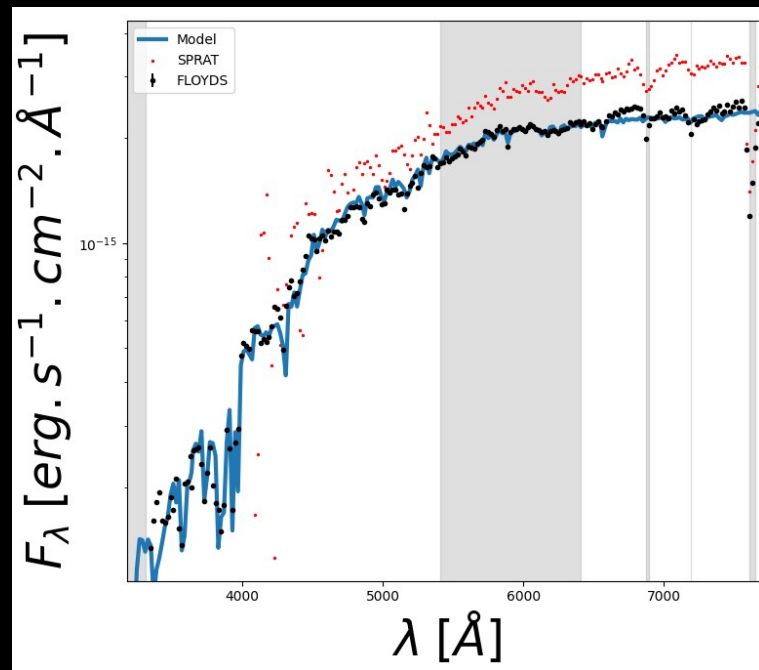
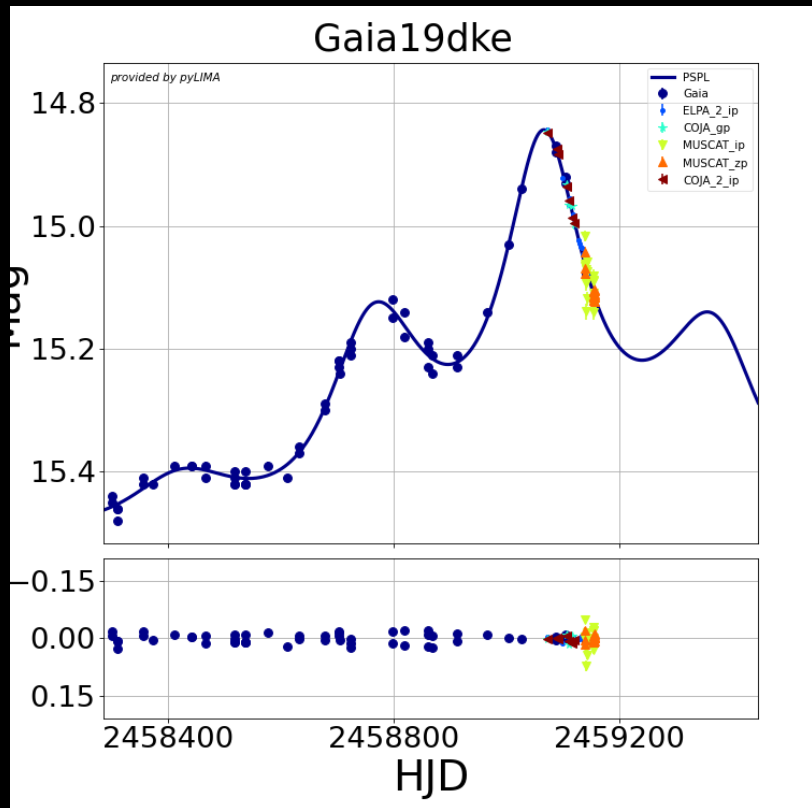


Gaia20bof observations by the OMEGA Key Project. The lens is located at <2.6 kpc and the binary mass ratio is $q \sim 0.04$. Therefore the companion is likely at the brown dwarf/planet boundary (paper in prep.).

$l = 299.2641$ deg
 $b = -0.8605$ deg

First GAIA planetary Candidate!

OMEGA results : Gaia19dke



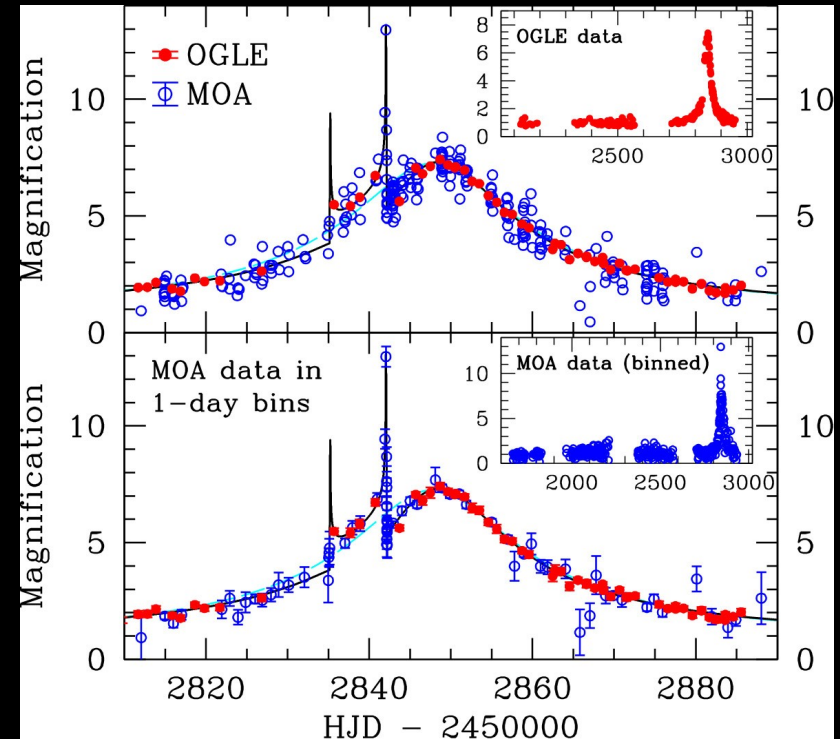
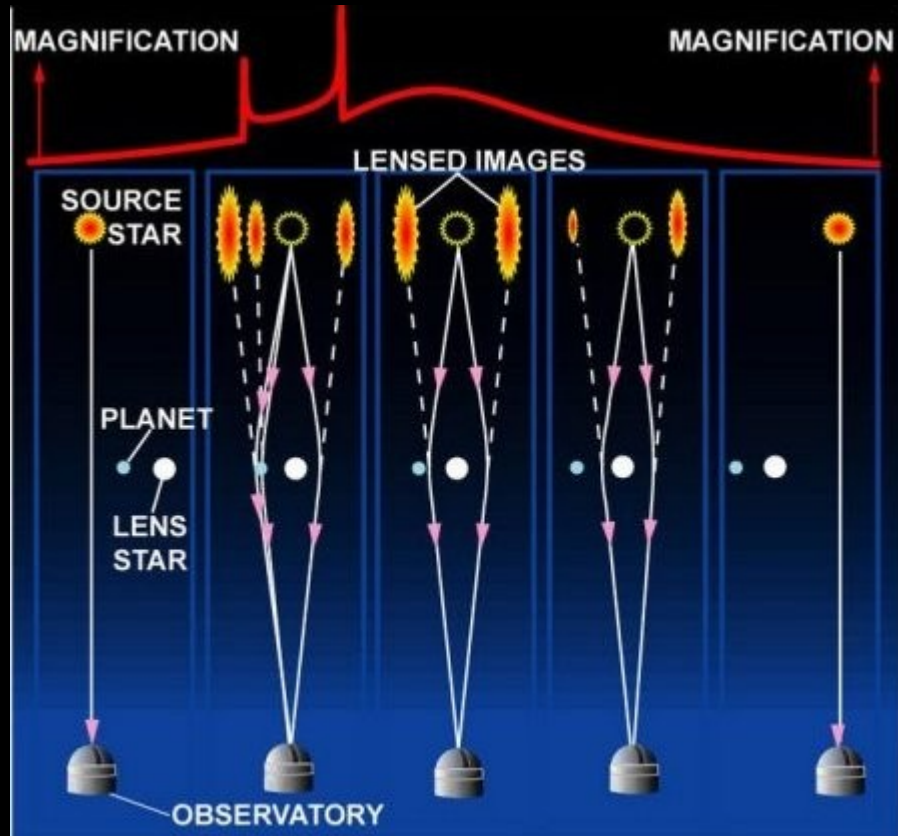
Gaia19dke observations by the OMEGA Key Project.

$$t_E \propto M^{0.5} \sim 160 \text{ d}$$

$$\pi_E \propto M^{-0.5} \sim 0.22$$

THANKS!

Microlensing: (Cold) Planets



OGLE-2003-BLG-0235Lb

Bond et al. ApJL. 2004