

MOA-II 2011 season

- MOA-II 2011 season
- Analysis reports from previous years

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the MOA collaboration



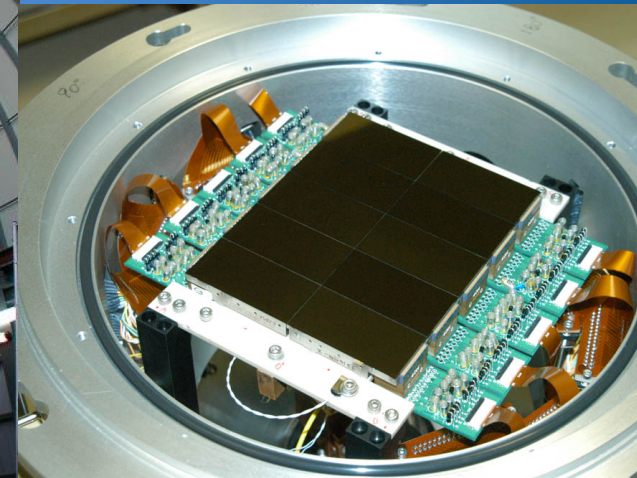
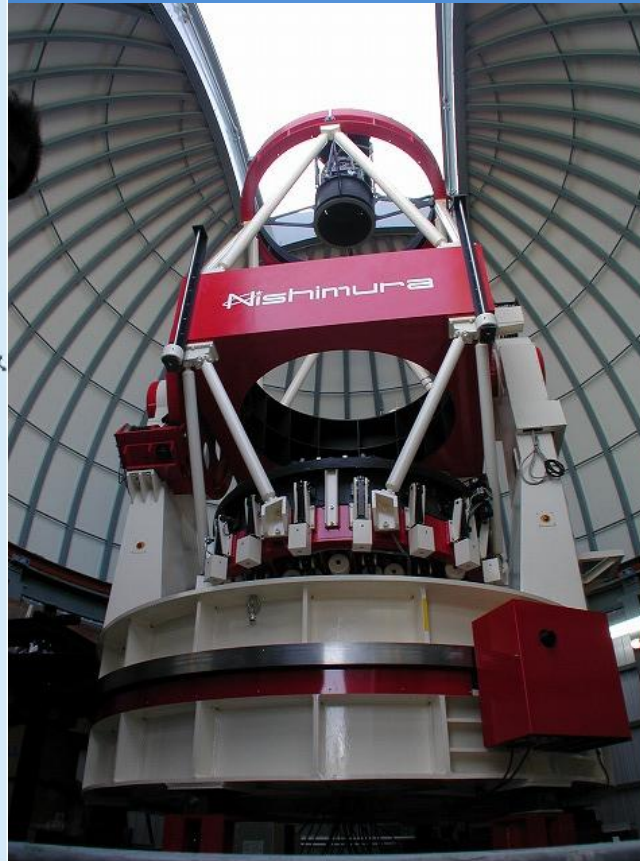
MOA (since 1995)



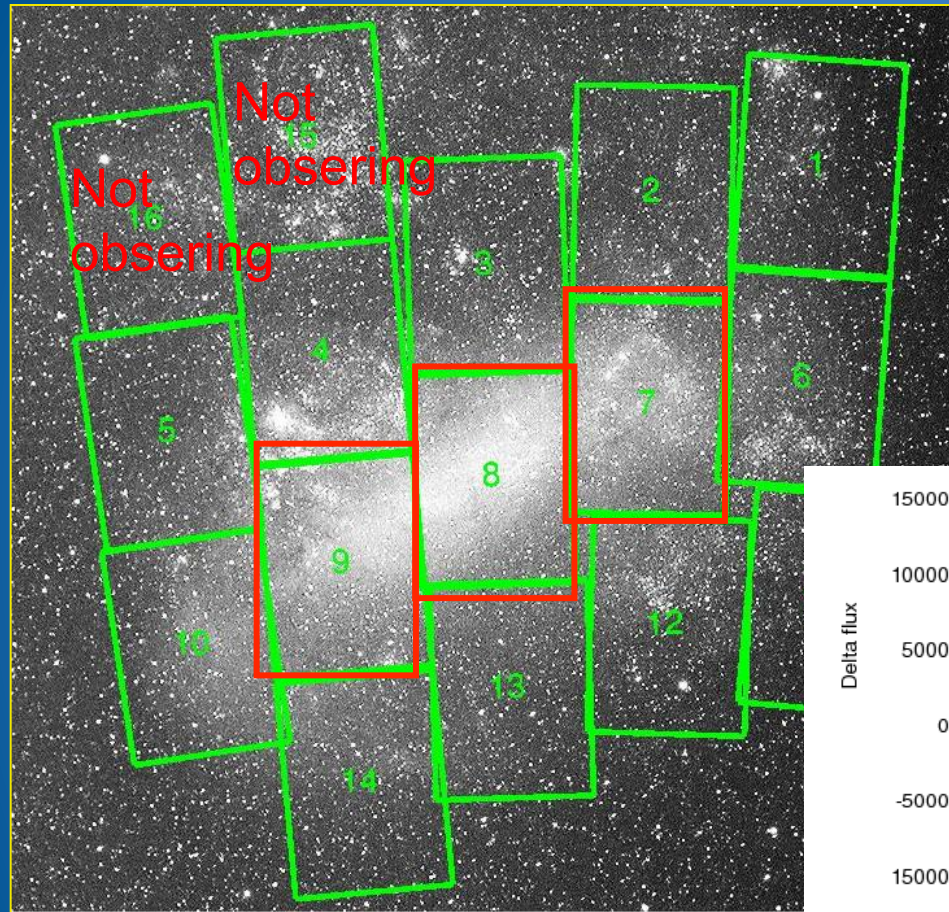
(Microlensing Observation in Astrophysics)

(New Zealand/Mt. John Observatory, Latitude : 44°S, Alt: 1029m)

Mirror : 1.8m
CCD : 80M pix.
FOV : 2.2 deg.²

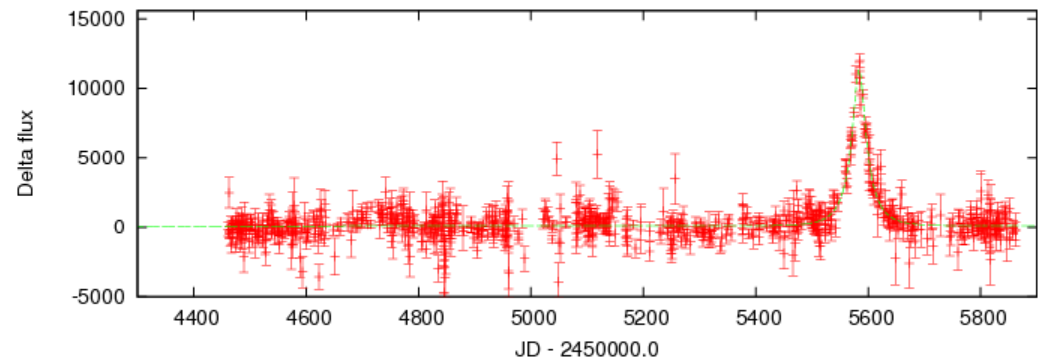
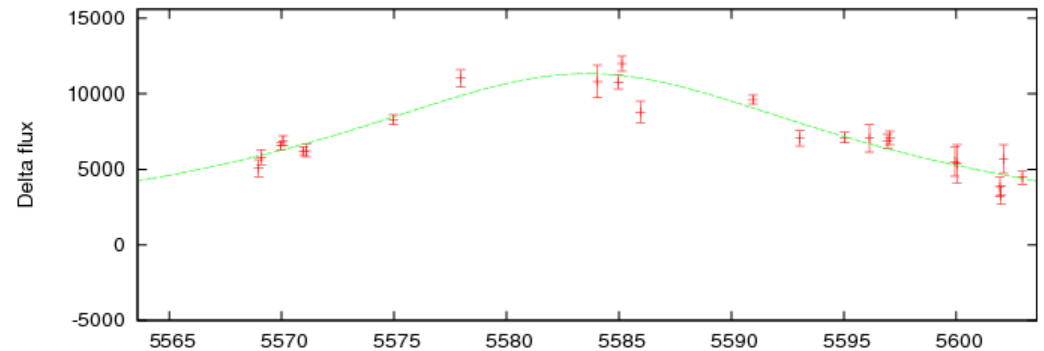


Observation towards LMC by MOA-II

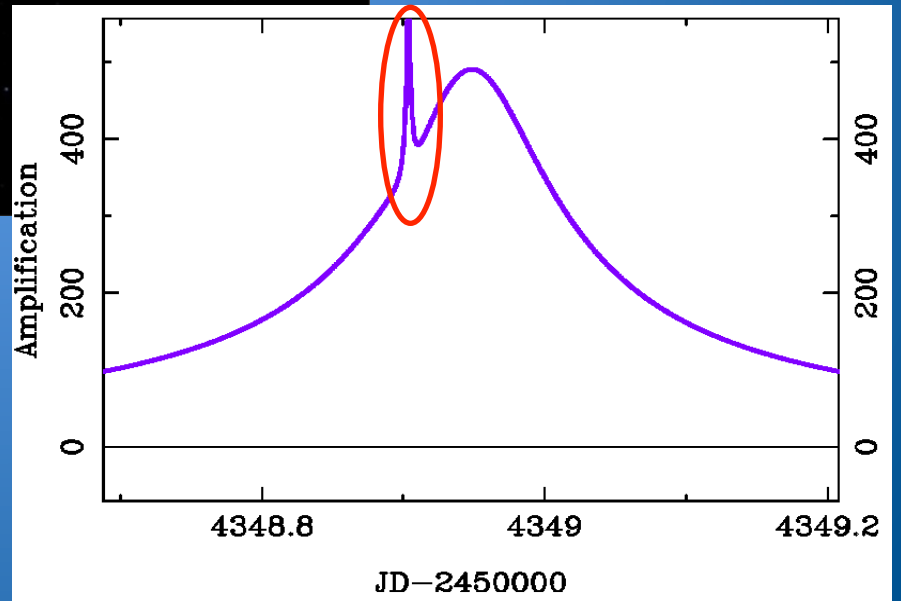
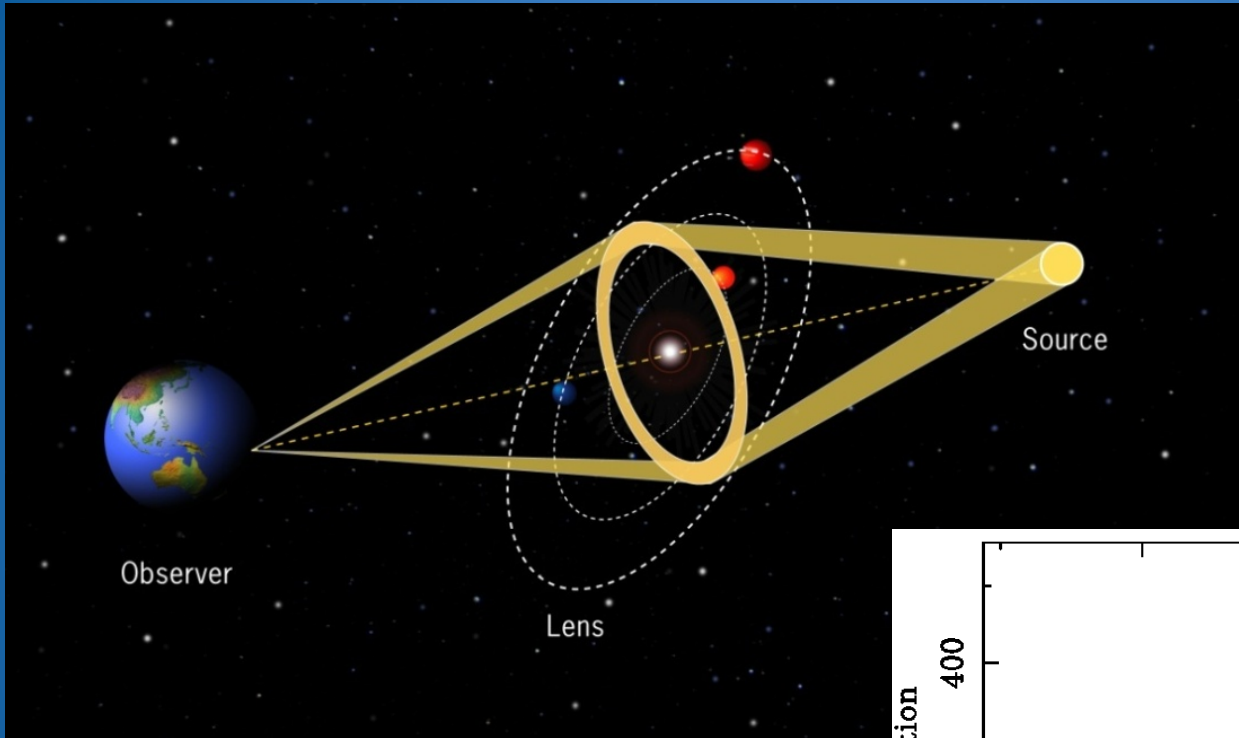


LMC:
31 deg²
N_{*} ~ 50M stars
~3obs/night
~10obs/night

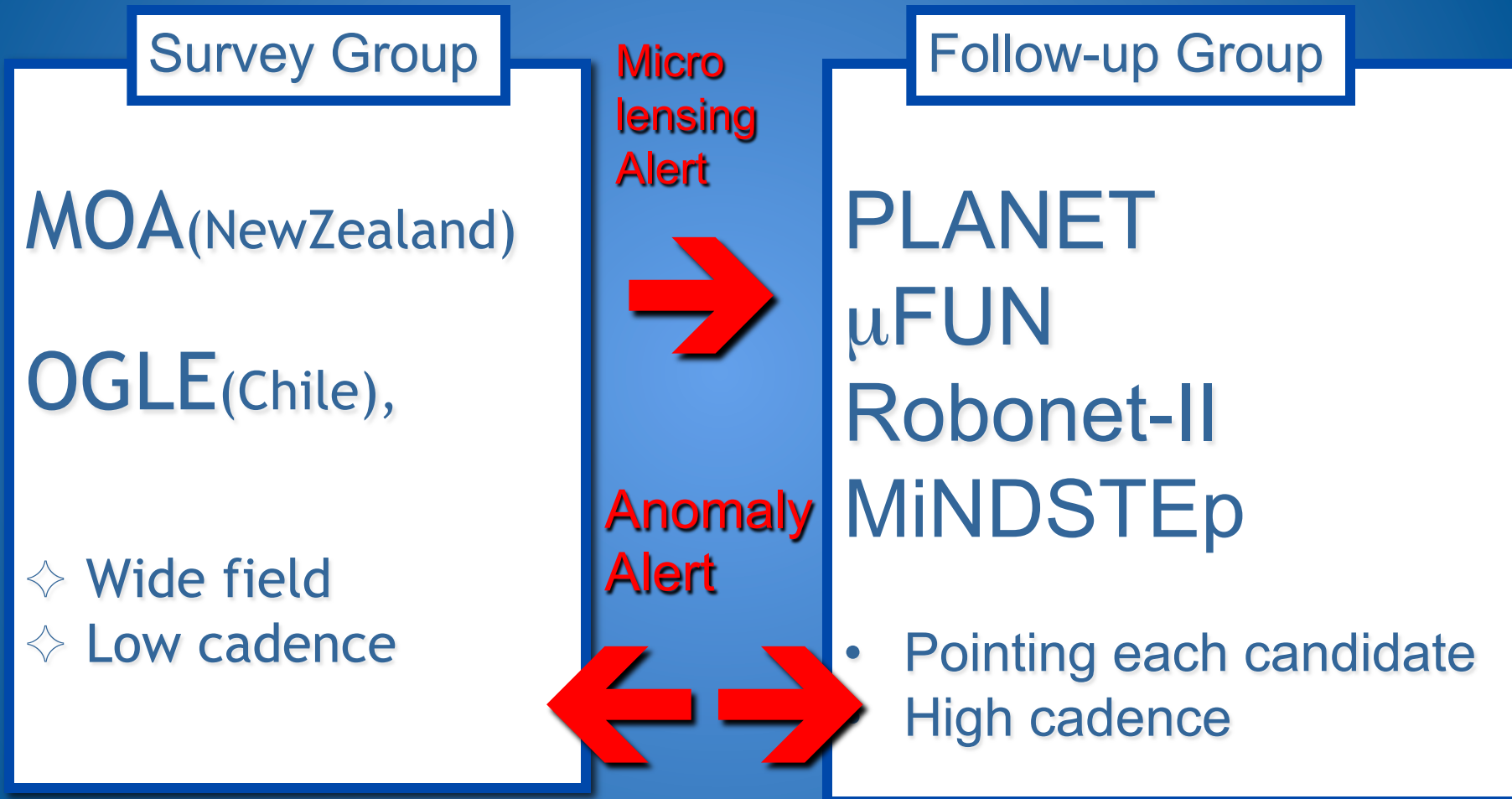
SMC:
4.4 deg²
N_{*} ~ 5M stars
~1obs/night



planetary microlensing



Microlensing observation global network

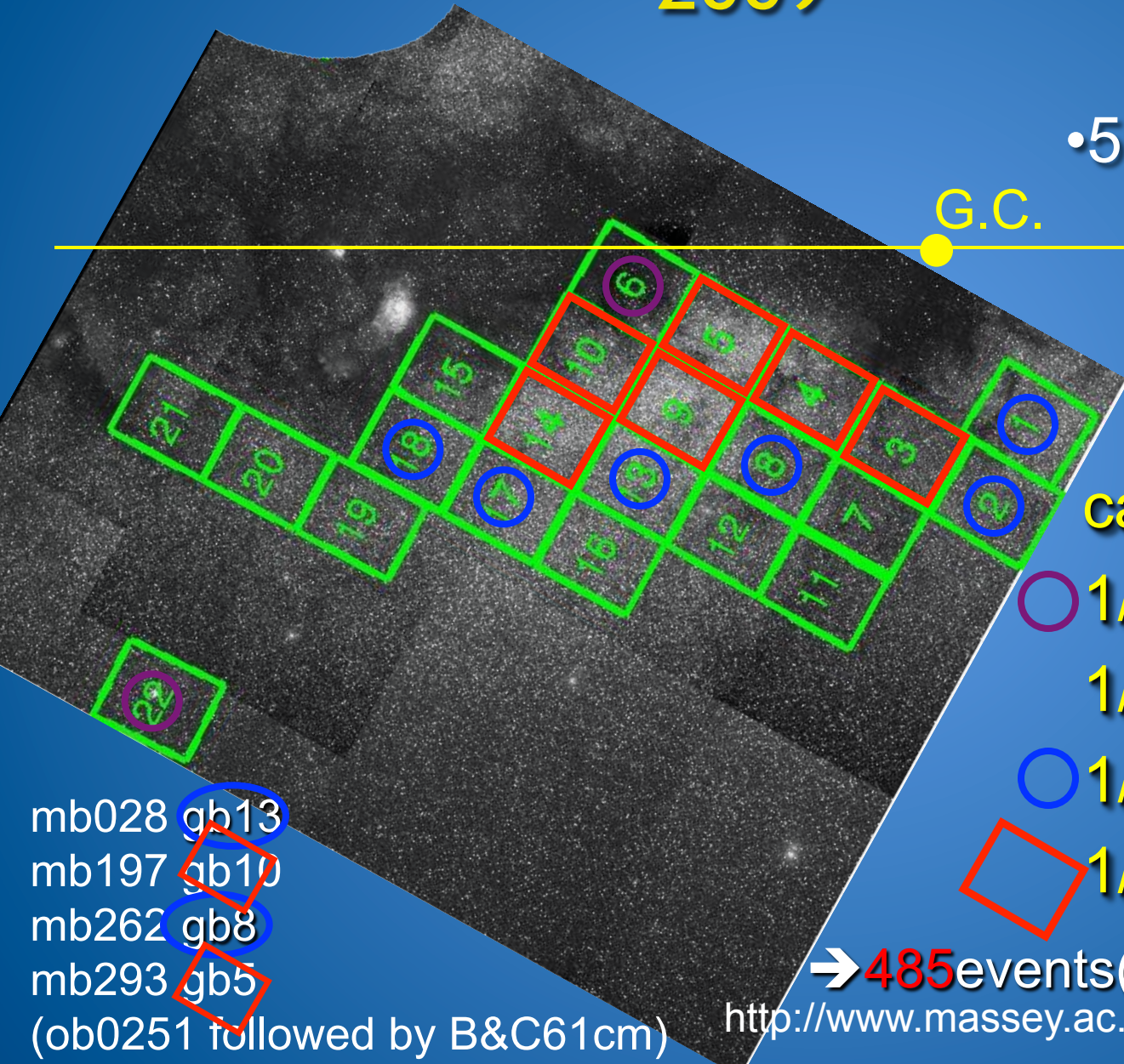


Observation by MOA 2009~



•50 deg.²(50Mstars)

G.C.



cadence event fraction

○ 1/night. ($>M_{Jup}$) (2%)

1/95min. (M_{Jup}) (19%)

○ 1/47min. (M_{nep}) (25%)

□ 1/15min. (M_{\oplus}) (54%)

mb028 gb13

mb197 gb10

mb262 gb8

mb293 gb5

(ob0251 followed by B&C61cm)

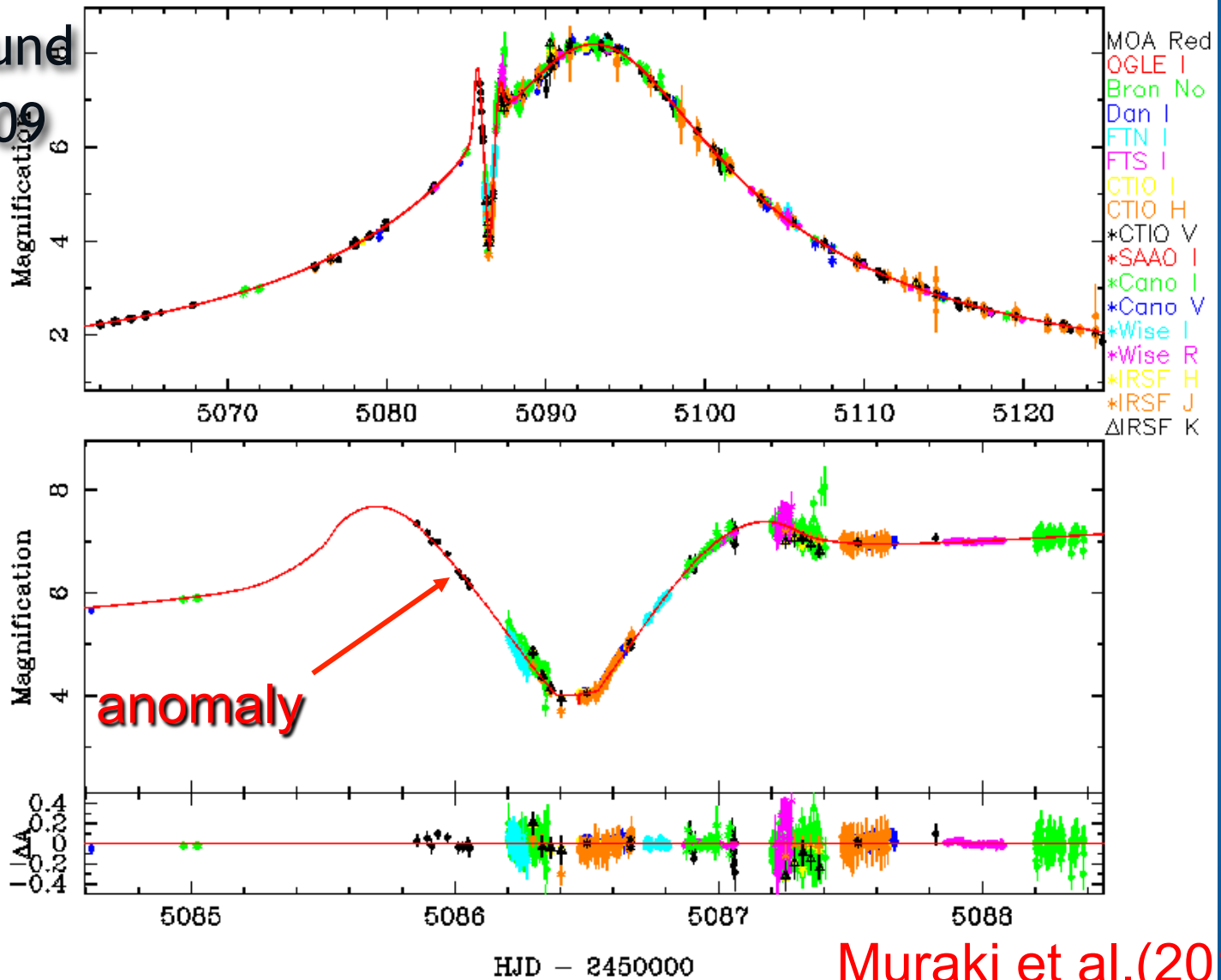
→ 485 events (4 planets + 2 BD)

<http://www.massey.ac.nz/~iabond/alert/alert.html>

Real-time Anomaly alert system

$q \sim 5 \times 10^{-5}$

anomaly found
on 11/9/2009



Muraki et al.(2011)

2011 season

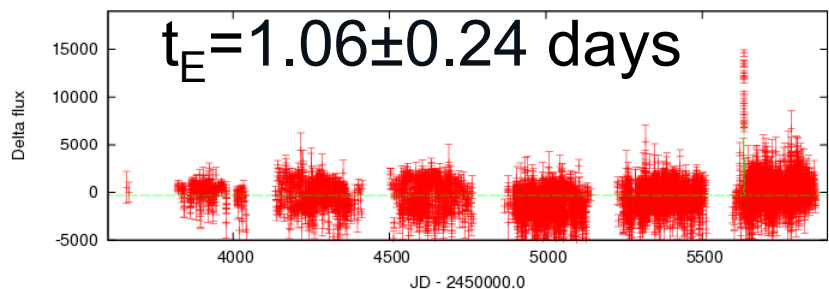
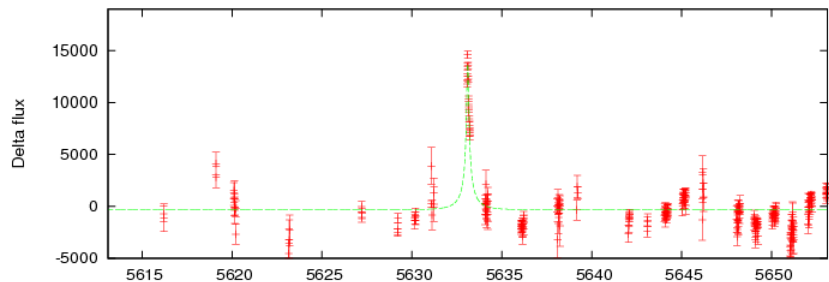
● 485(607) alerts

- 105(124) anomaly events
 - 38(39) Binary
 - 20(50) CV
 - 35(24) Binary or CV
 - 4(4) planet
 - 2(1) brown dwarf
 - 3(5) parallax
 - 4(1) finite source
 - 1 moving object
- ◆ 45(43) Internal anomaly alert
- ◆ 65(44) Anomaly alert
 - ◆ 25(25) binary
 - ◆ 3(3) planet (1 with high-mag alert)
 - ◆ 2(1) brown dwarf
 - ◆ 5(5) CV
 - ◆ 22(8) single lens
 - ◆ 5(7) binary or CV or ?
- ◆ 34(18) High mag alert:
 - ◆ 8(3) binary
 - ◆ 2(1) planet
 - ◆ 0(2) binary or CV
 - ◆ 22(11) single

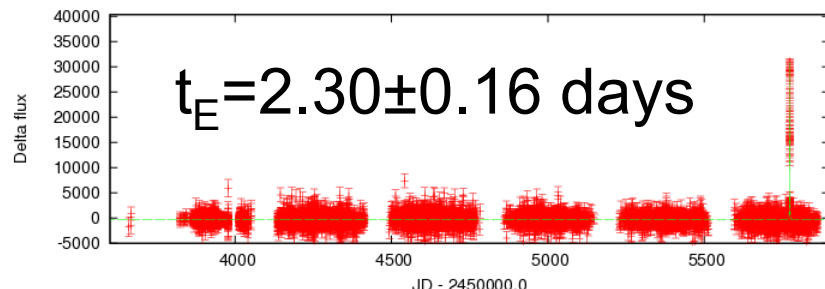
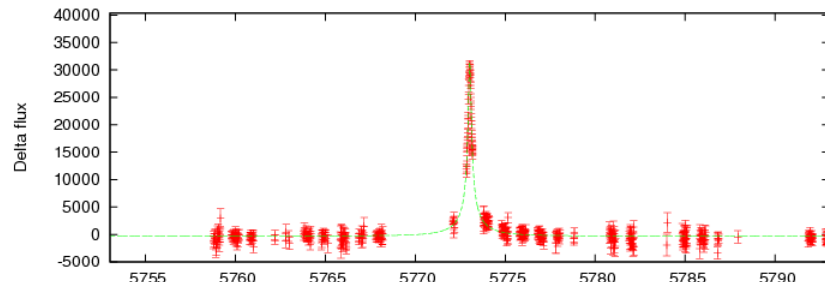
● ~5 Short events

Short event

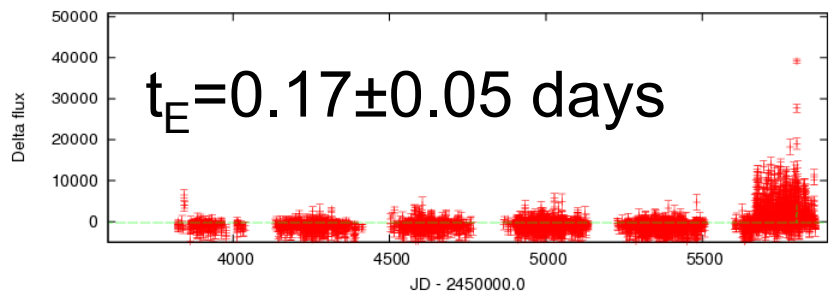
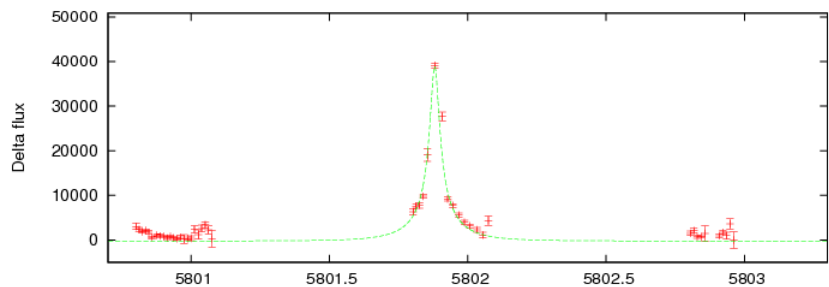
MOA 2011-BLG-30



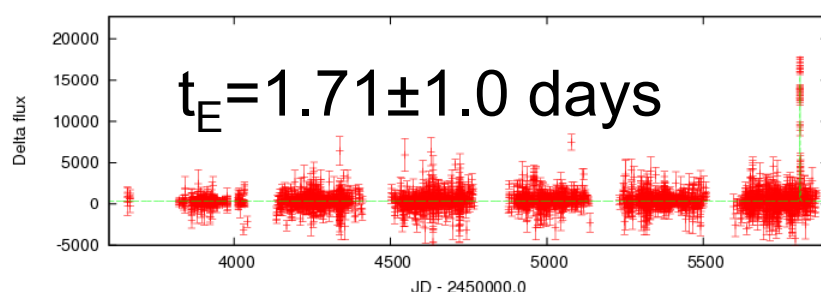
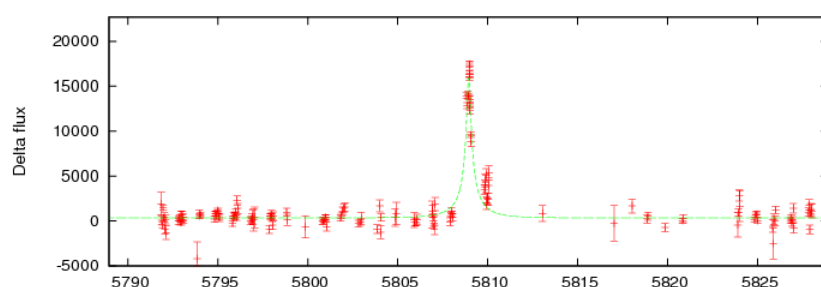
MOA 2011-BLG-318



MOA 2011-BLG-392



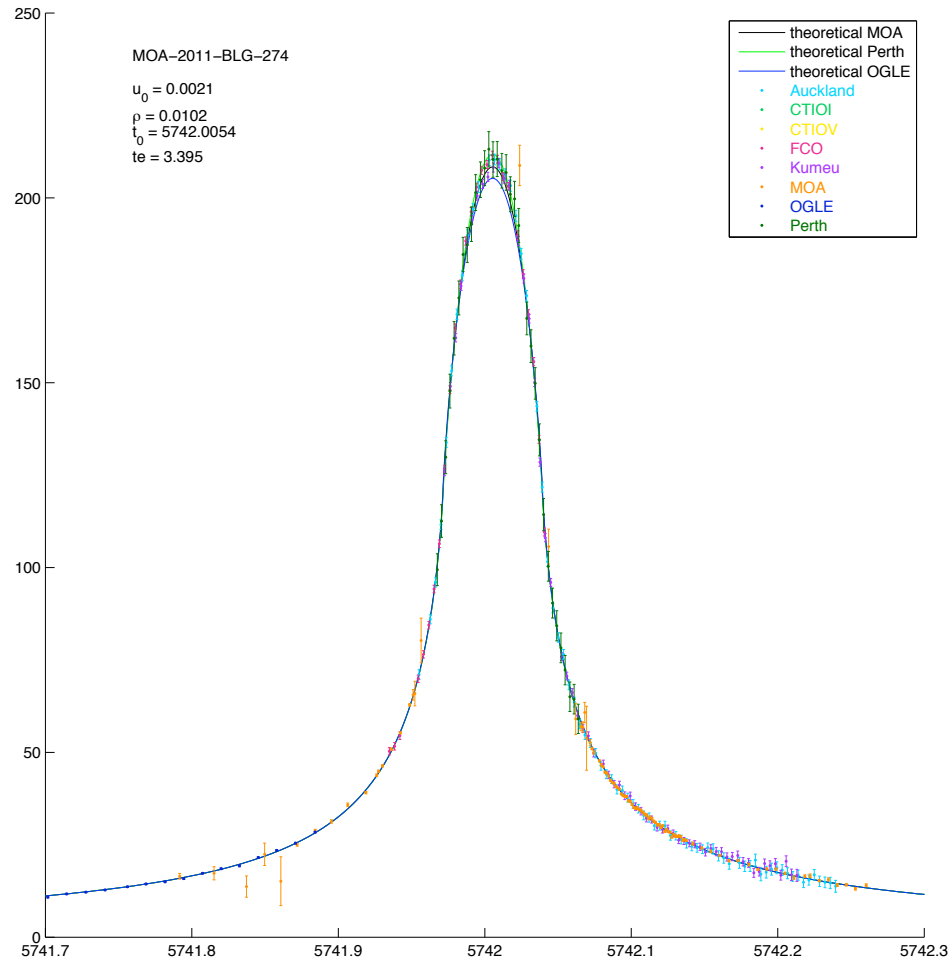
MOA 2011-BLG-422



High mag Short event

MOA 2011-BLG-274

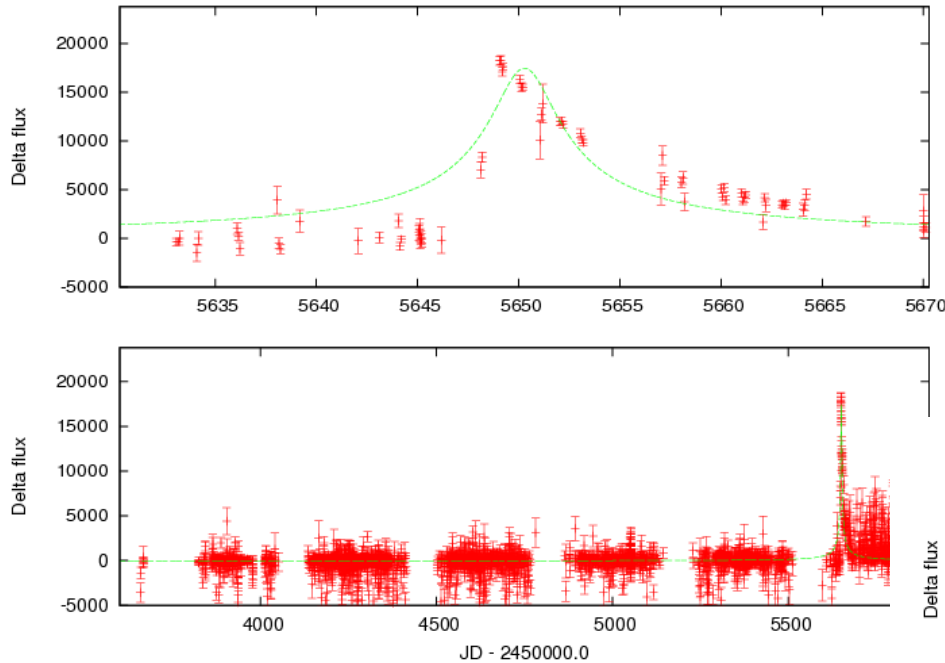
$t_E = 3.4$ day



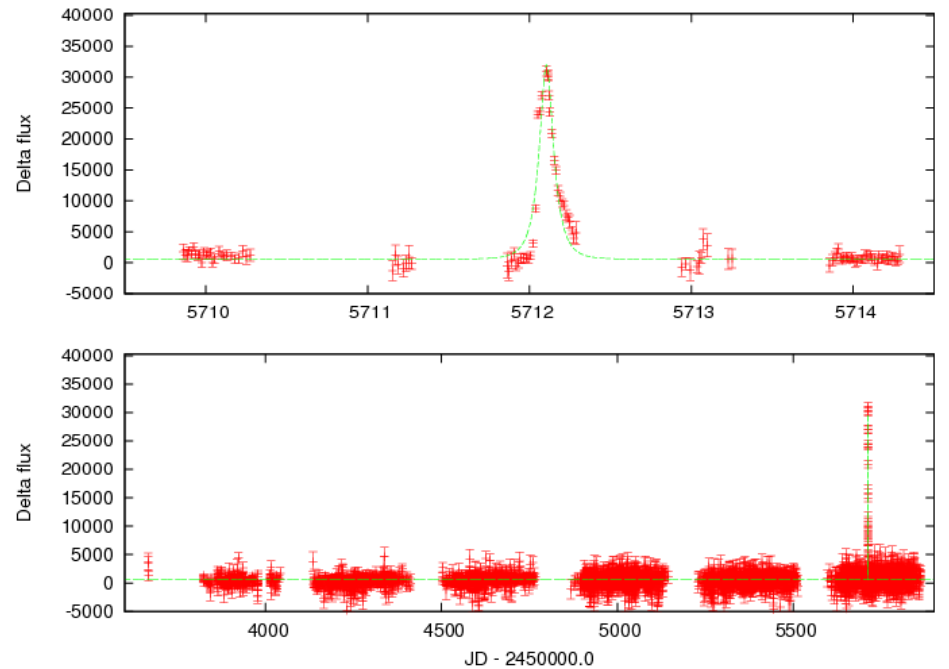
Parallax?
M. Freeman

Anomaly: Binary or CV?

MOA 2011-BLG-068



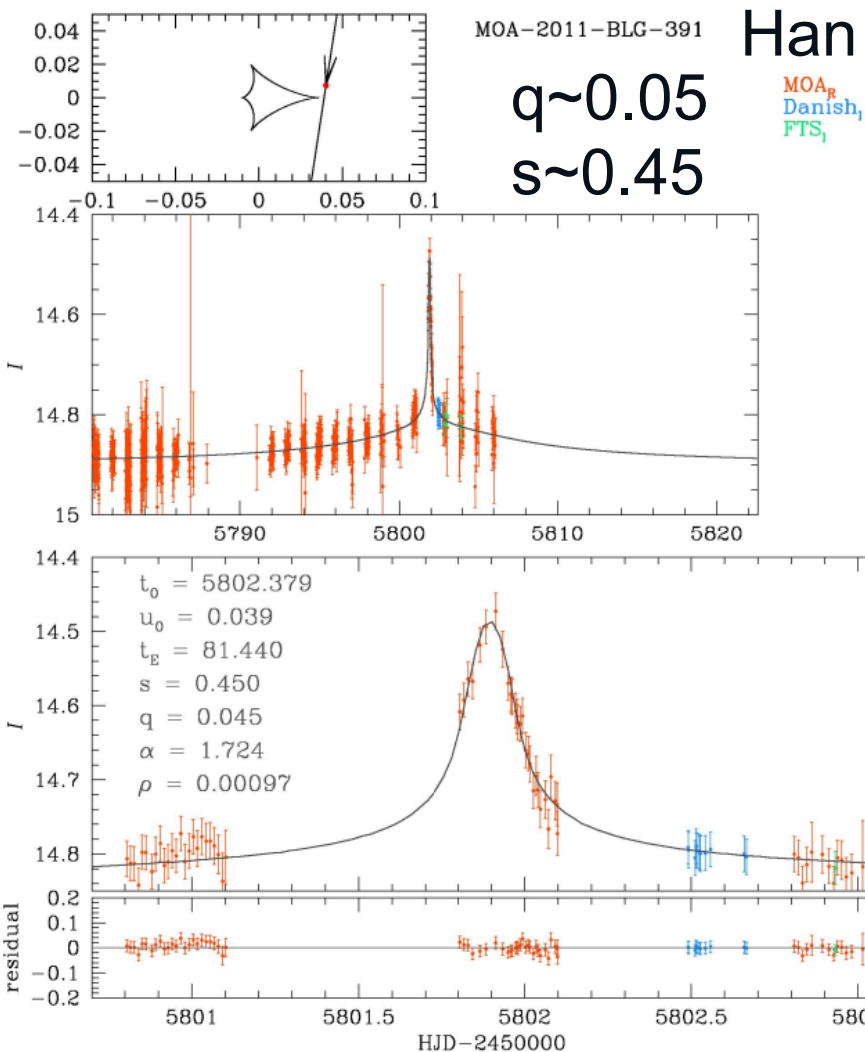
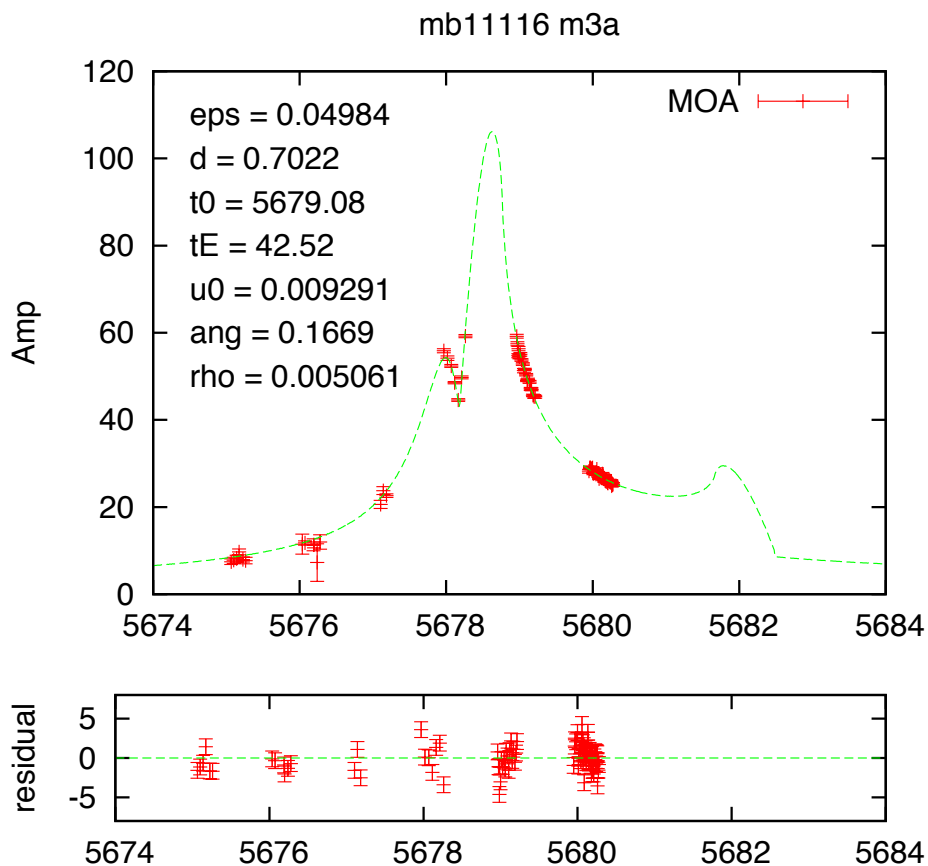
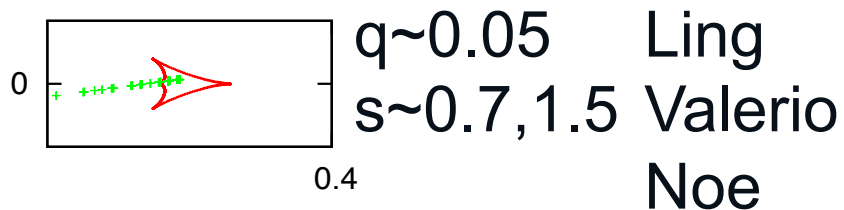
MOA 2011-BLG-177



Brown dwarf?

MOA 2011-BLG-116

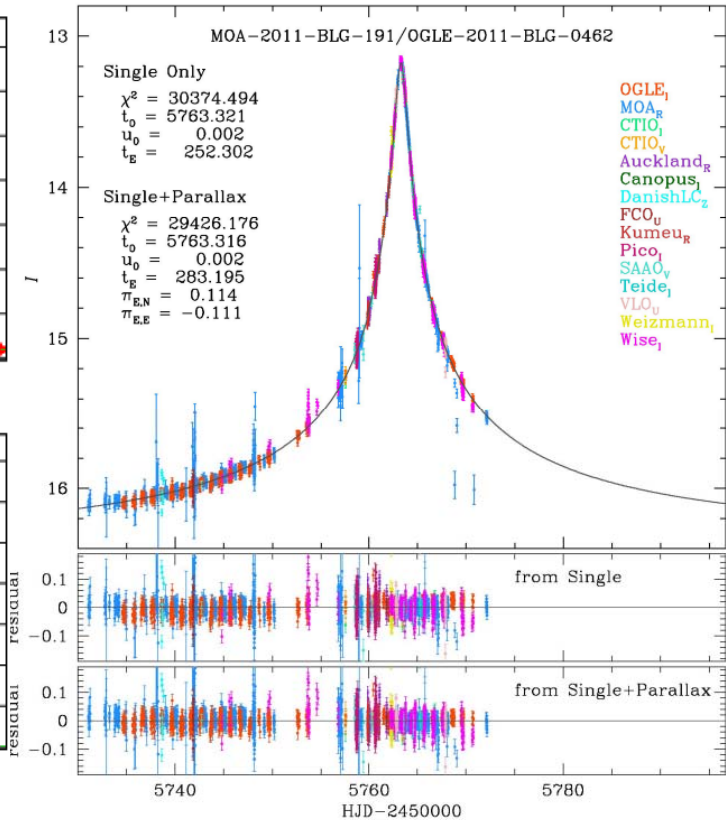
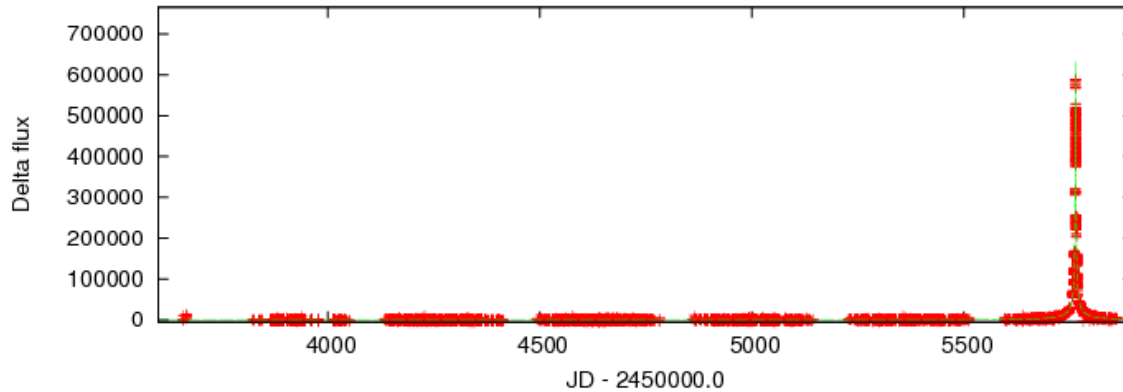
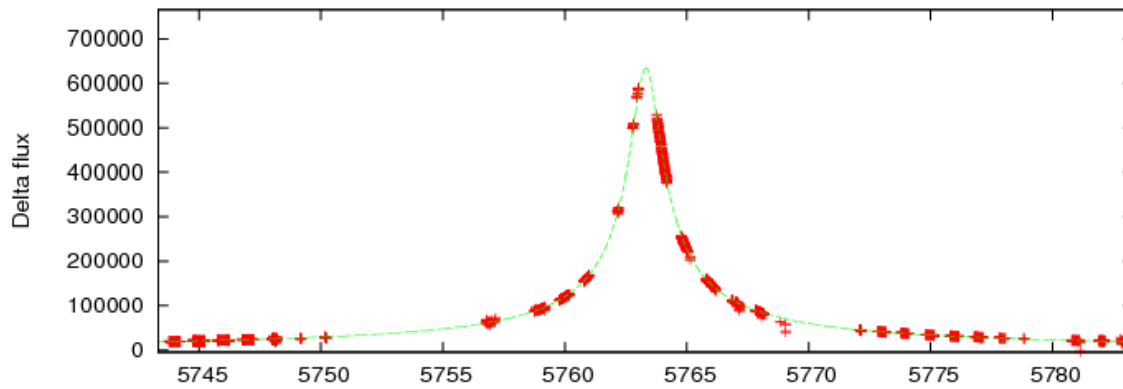
MOA 2011-BLG-391



Black hole candidate?

MOA 2011-BLG-191

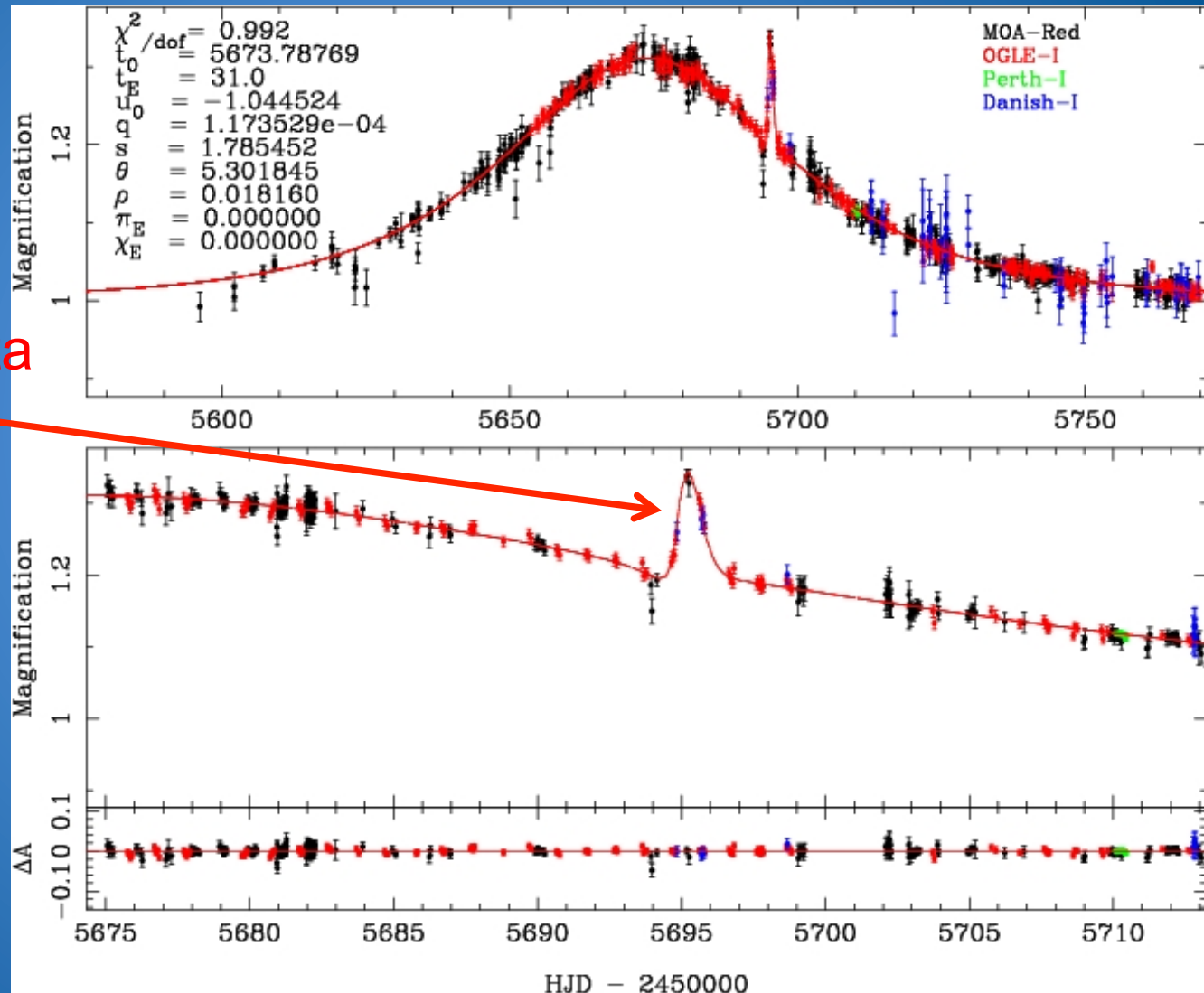
$t_E = 218.94 \pm 0.36$ days



Han

MOA 2011-BLG-028/ OGLE 2011-BLG-203

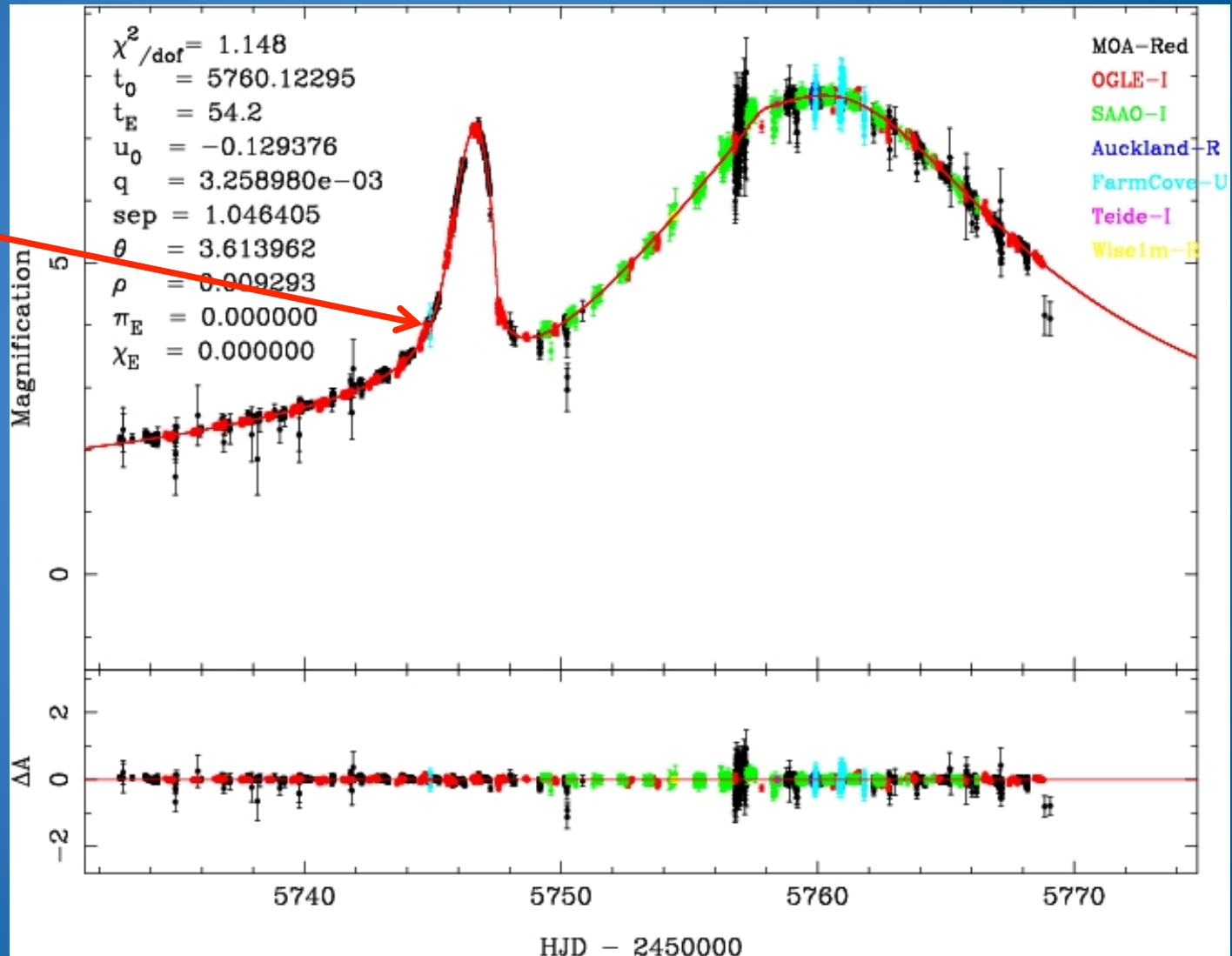
Anomaly alert
by MOA
based on MOA data



$q \sim 10^{-4}$
 $s \sim 1.8$

OGLE 2011-BLG-0265/ MOA 2011-BLG-197

Anomaly alert
by MOA
based on
MOA data

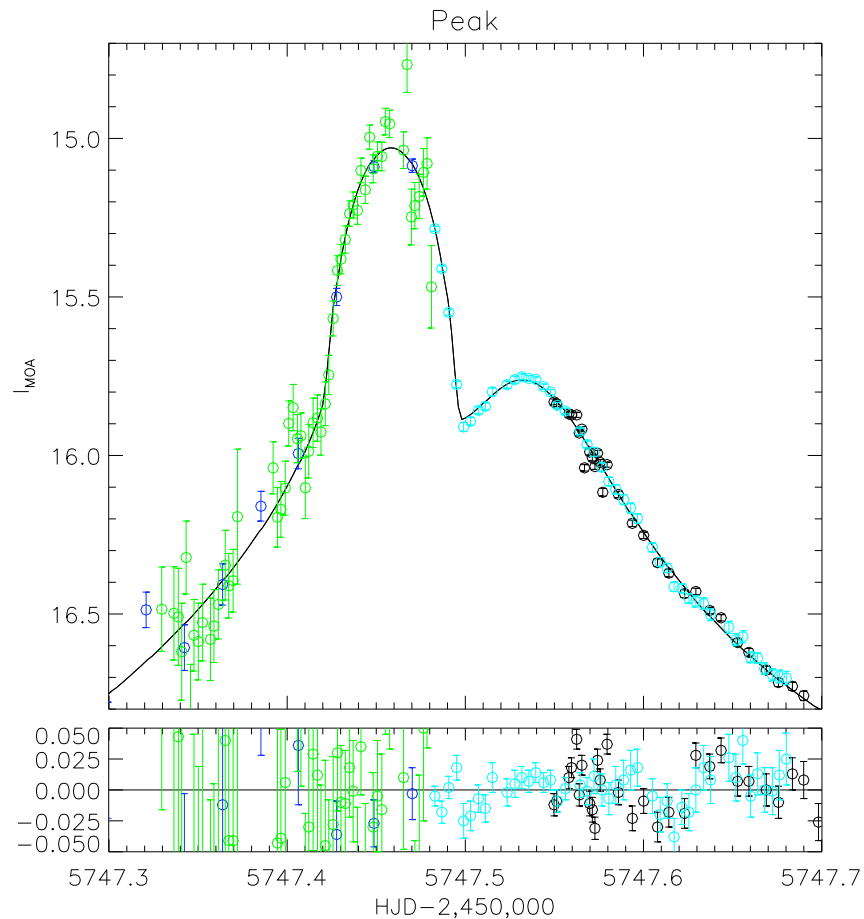
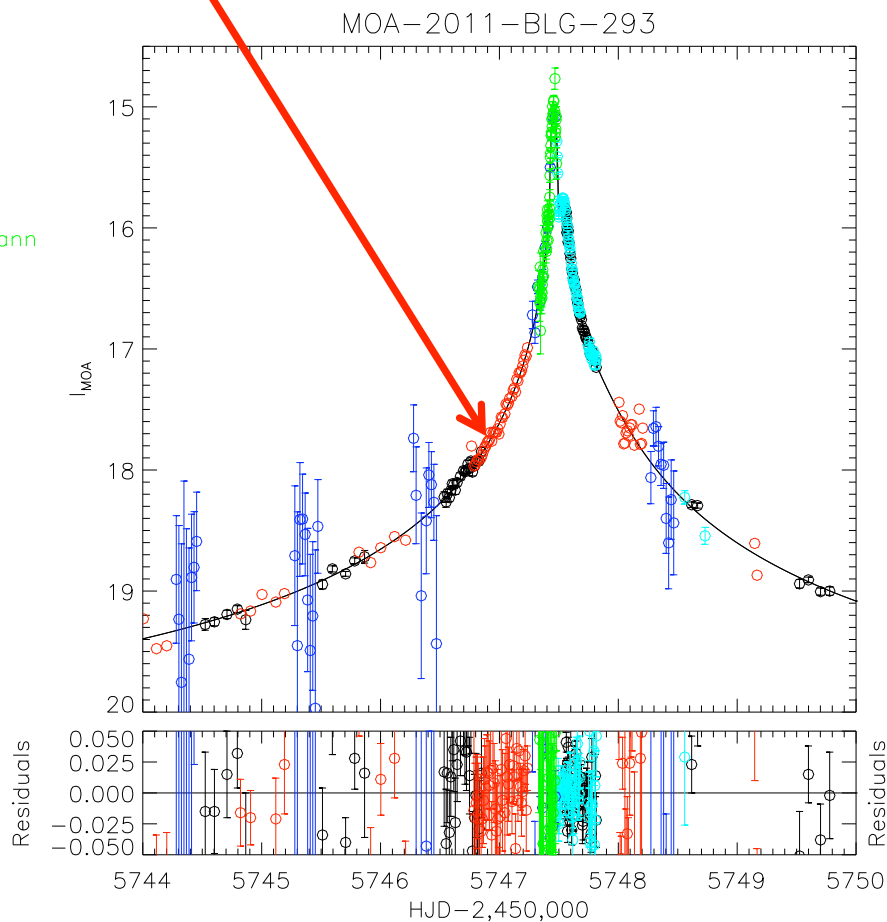


$q \sim 0.003$
 $s \sim 1.05$

MOA 2011-BLG-293

High-mag alert by Gould
based on MOA data

$q \sim 5 \times 10^{-3}$
 $s \sim 0.547$



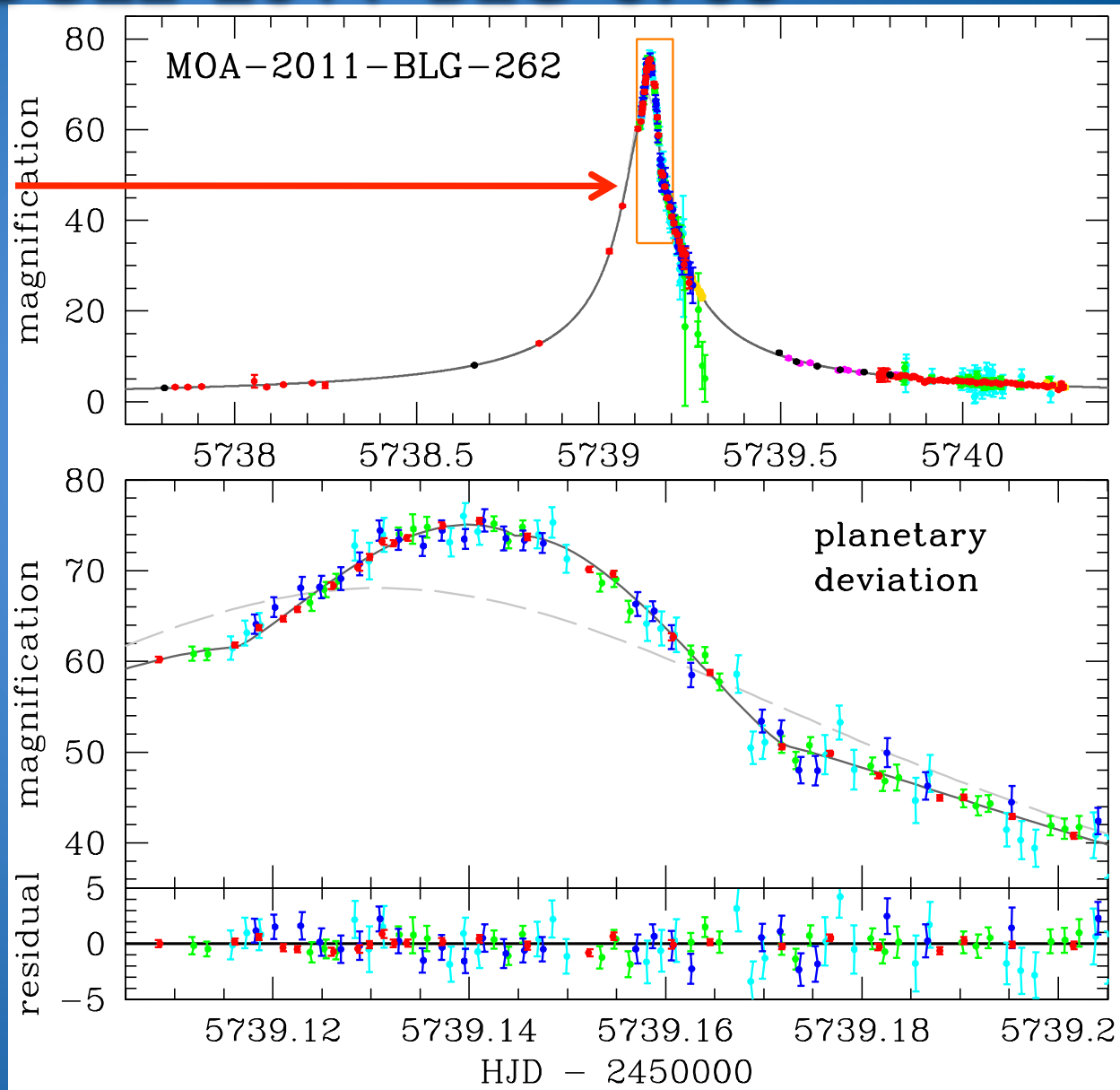
Yee et al. (2012)

MOA 2011-BLG-262/ OGLE-2011-BLG-0703

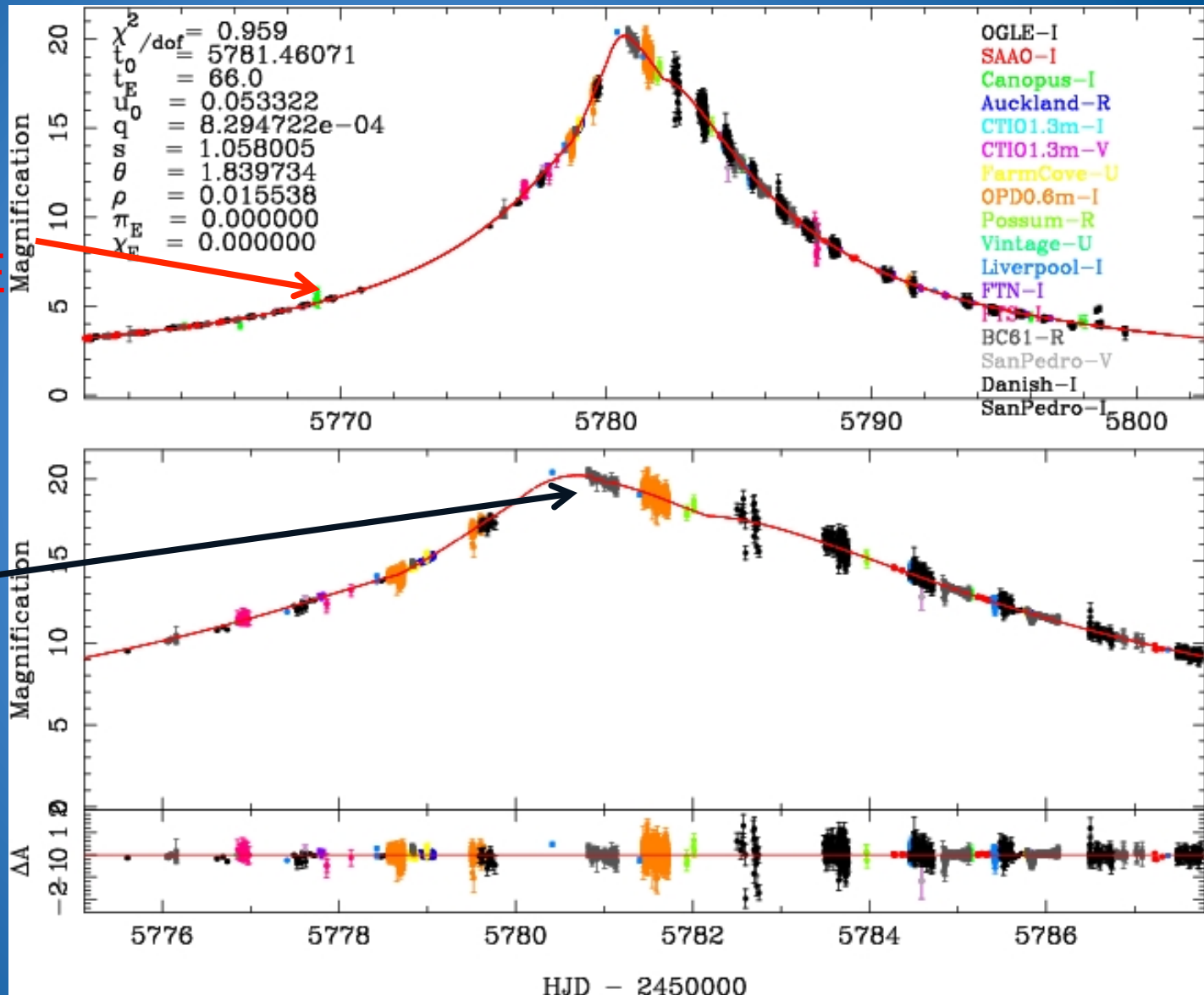
Short High-mag alert
by Gould
Internal Alert
by Bennett
based on MOA data

$q \sim 4.7 \times 10^{-4}$
 $s \sim 1.1$
 $t_E = 3.8$ days

Bennett



OGLE-2011-BLG-0251



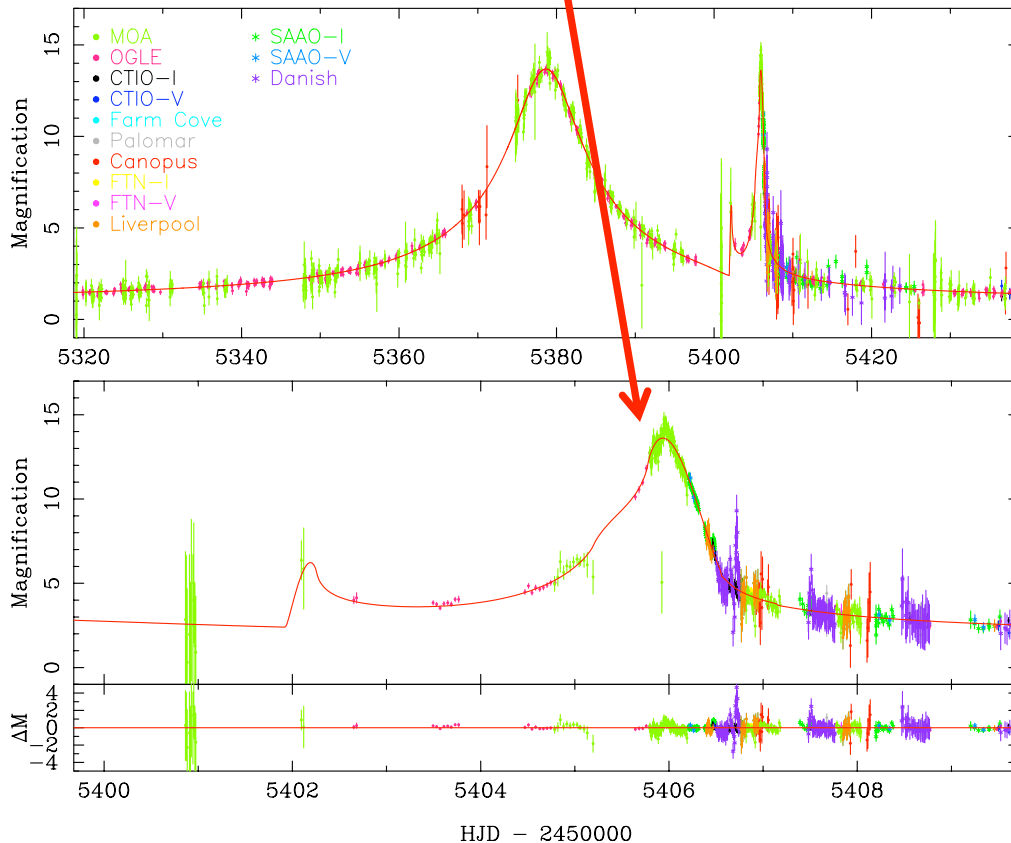
High-mag alert
by Gould
based on OGLE
data

Follow-up by
B&C61cm

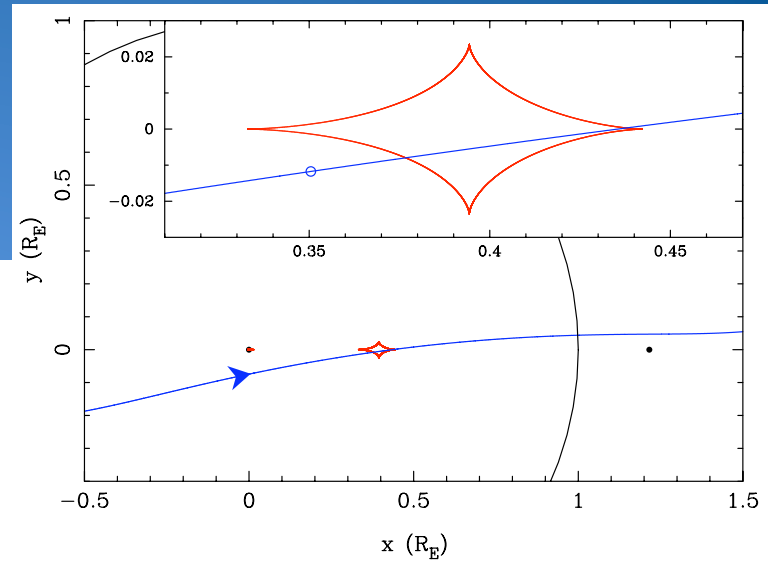
$q \sim 6-9 \times 10^{-4}$
 $s \sim 0.8-1.2$

MOA 2010-BLG-328

Anomaly alert



Furusawa



Xallarap is favored, but cannot distinguish from Parallax+lens orbital motion

Bayesian analysis:

$$M_p = 112^{+40}_{-59} M_{\oplus} = 1.18^{+0.42}_{-0.62} M_{\text{Saturn}}$$

$$M_* = 0.67^{+0.24}_{-0.35} M_{\odot}$$

$$D_L = 4.5^{+1.1}_{-1.7} \text{ kpc.}$$

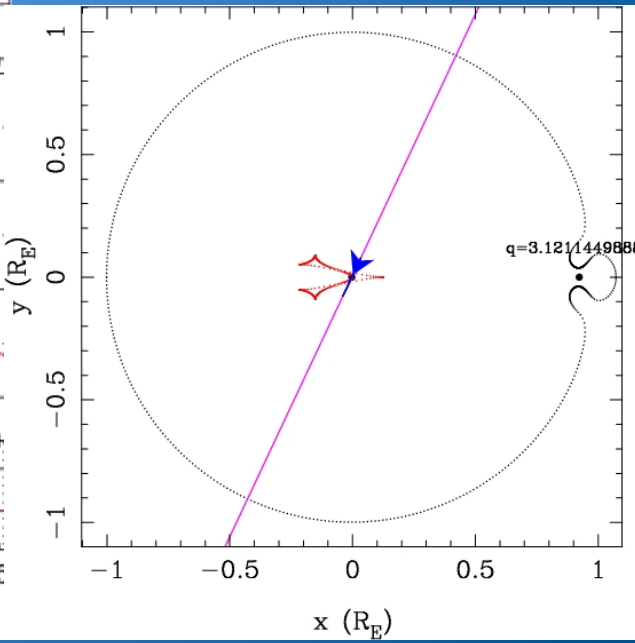
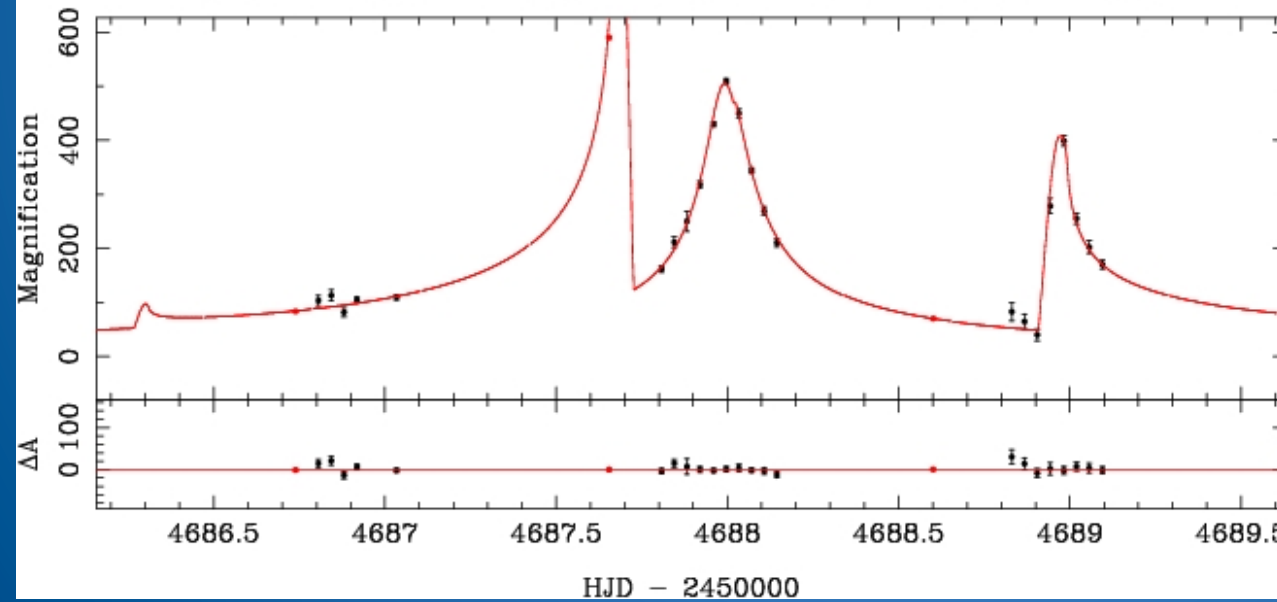
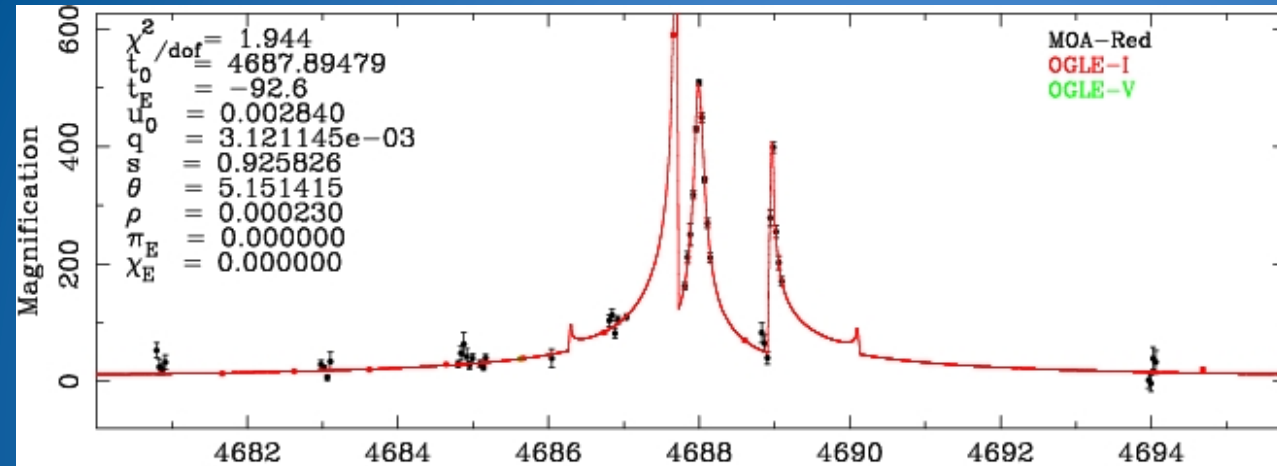
MOA-2008-BLG-379 /

Missed planet

OGLE-2008-BLG-570

Fit 113 binary events
in 2006-2010

$$q = 3.1 \times 10^{-3}$$
$$s = 0.93$$

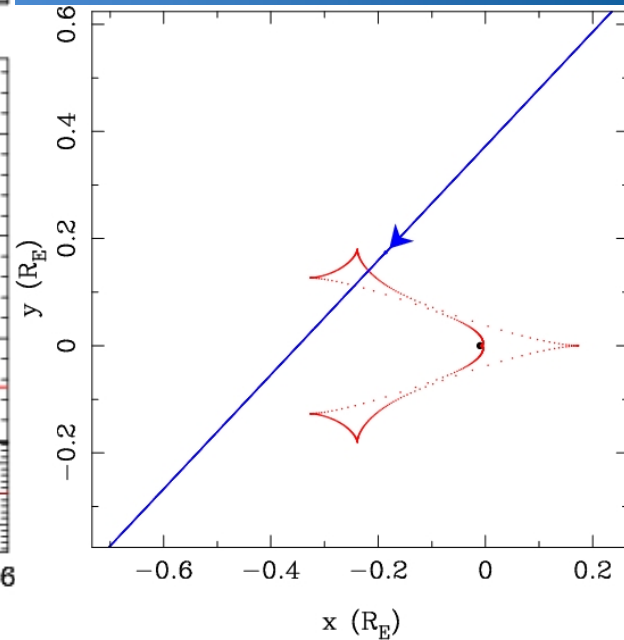
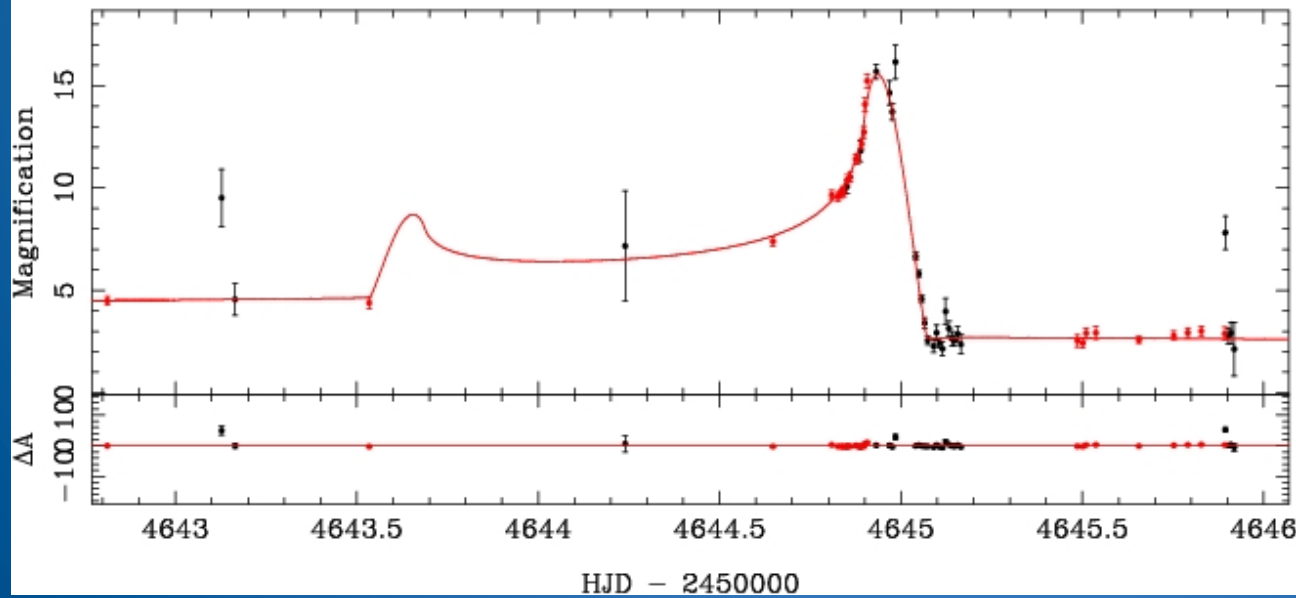
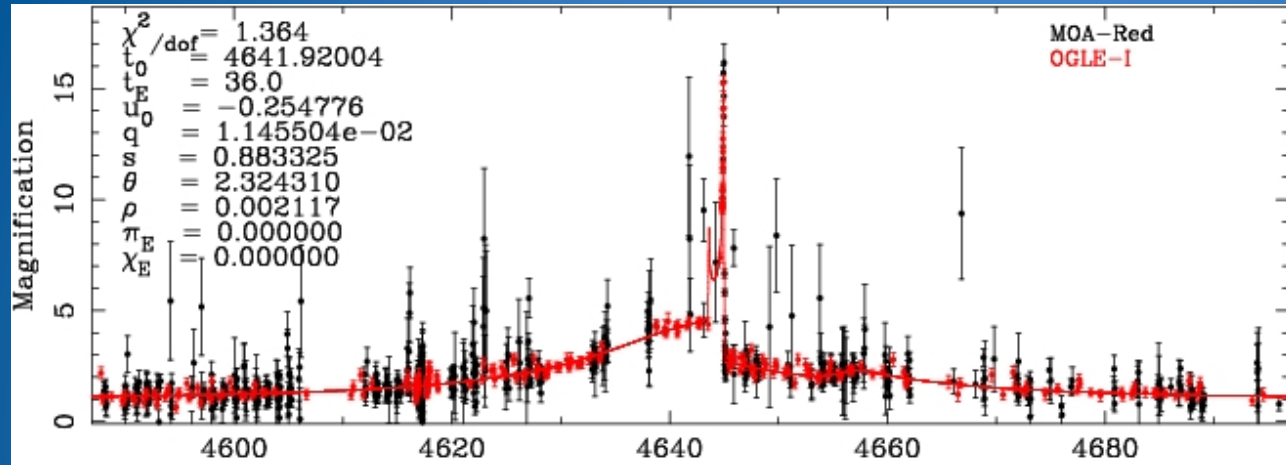


OGLE-2008-BLG-355/ MOA-2008-BLG-288

Missed planet

Anomaly alert
by OGLE

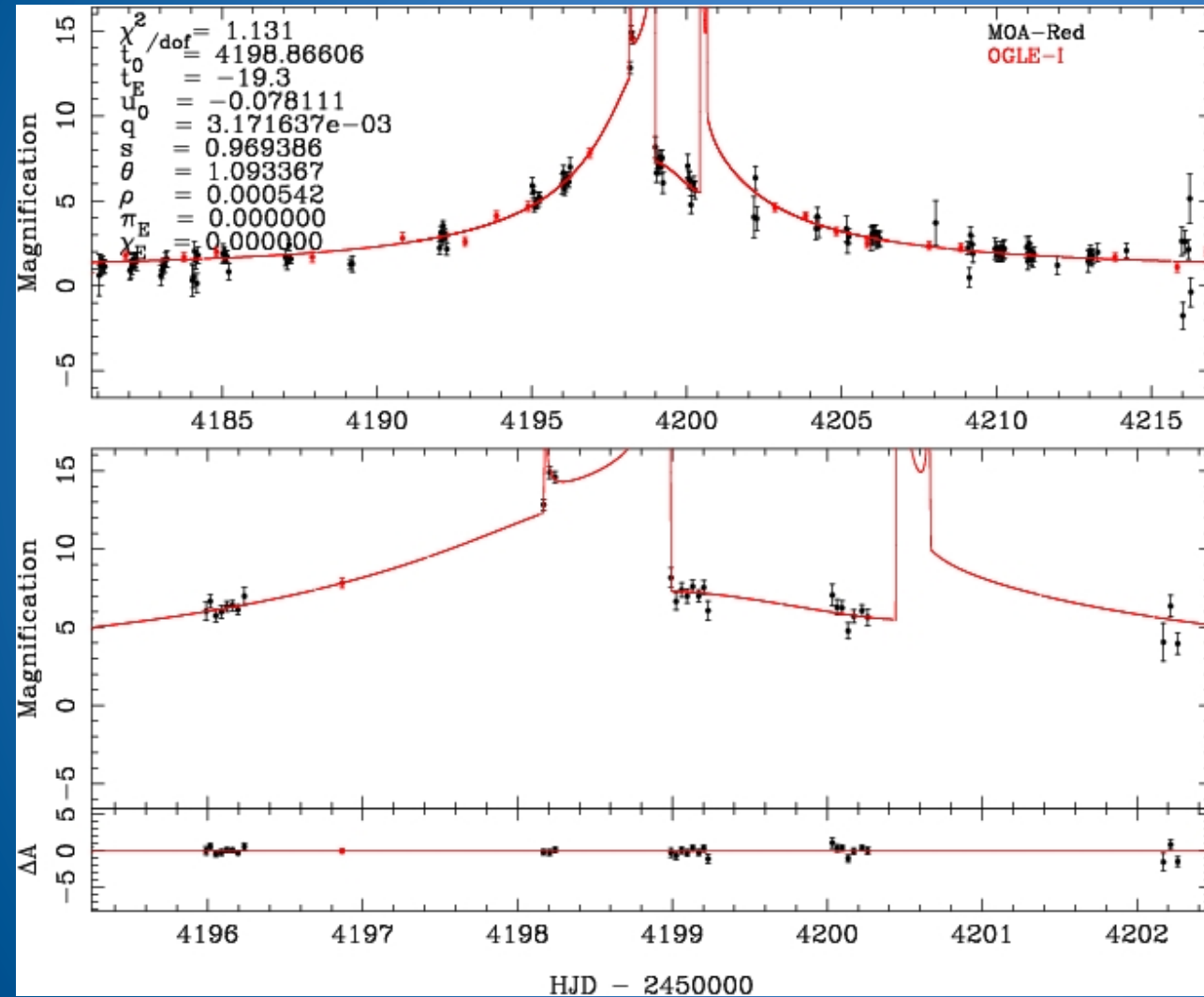
$q=0.011$
 $s=0.88$



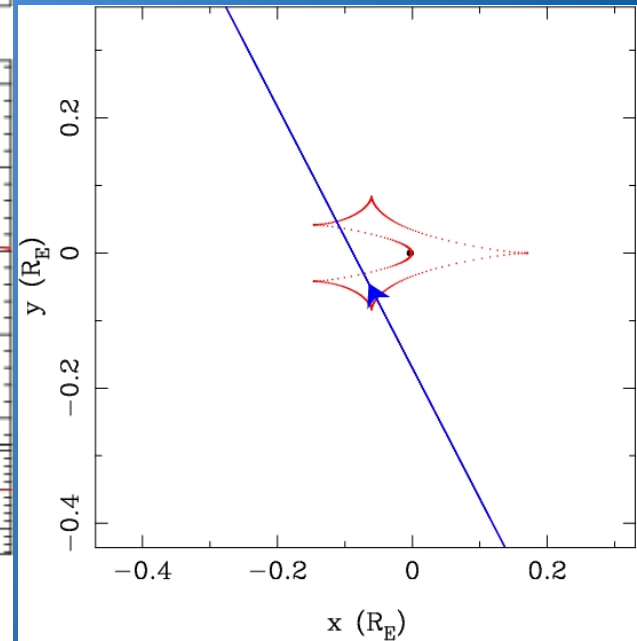
MOA-2007-BLG-089 /

OGLE-2007-BLG-141

Missed weak planet candidate



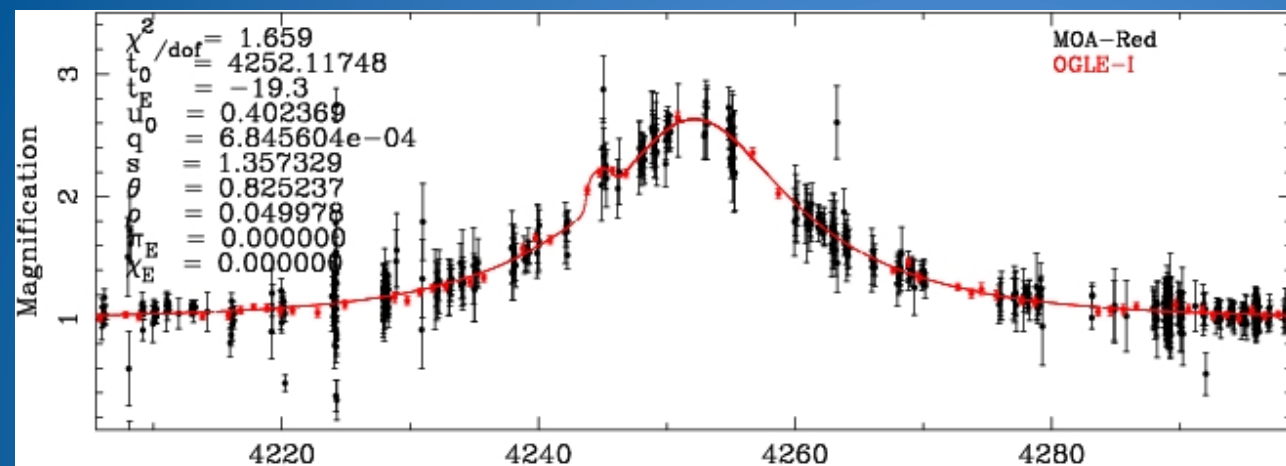
$q = 3.2 \times 10^{-3}$
 $s = 0.97$



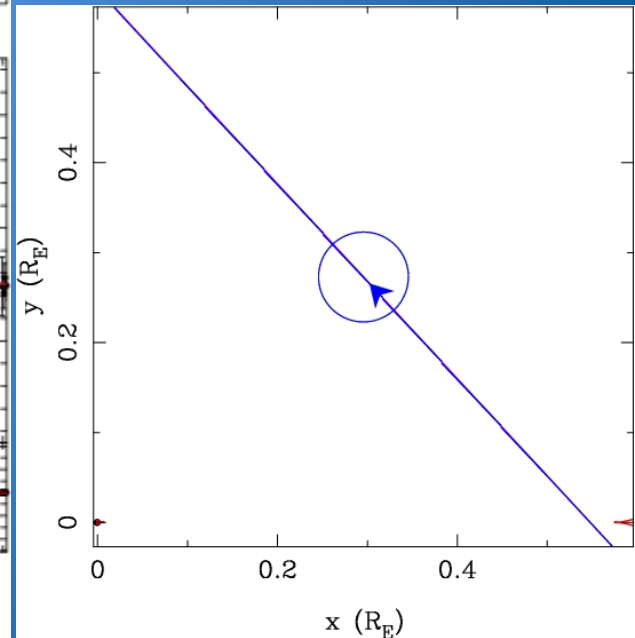
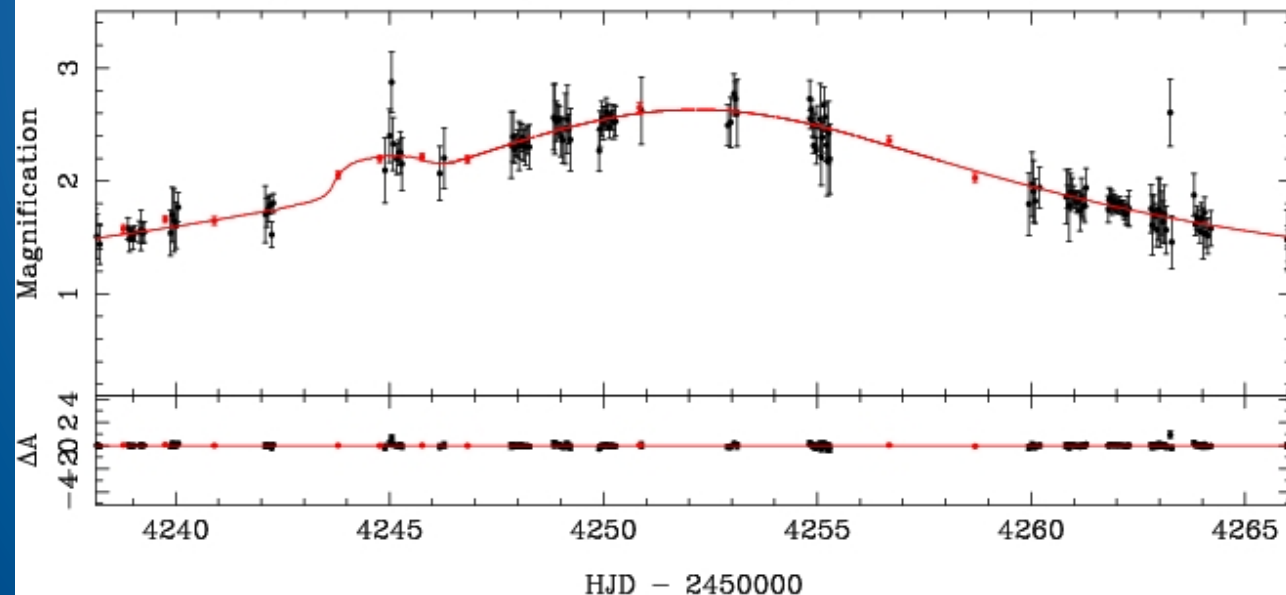
MOA-2007-BLG-190 /

OGLE-2007-BLG-292

Missed weak planet candidate



$q = 3.2 \times 10^{-3}$
 $s = 0.97$



summary

- MOA-II issued **485** alerts in 2011
- **5** planets in collaboration with other groups
- **2 Missed planetary events** in 2008
(+2 weak planetary candidates)
- Real-time modeling started
 - <http://www.stelab.nagoya-u.ac.jp/~sumi/anomaly>