Microlensing planets in wide orbits - a few interesting cases

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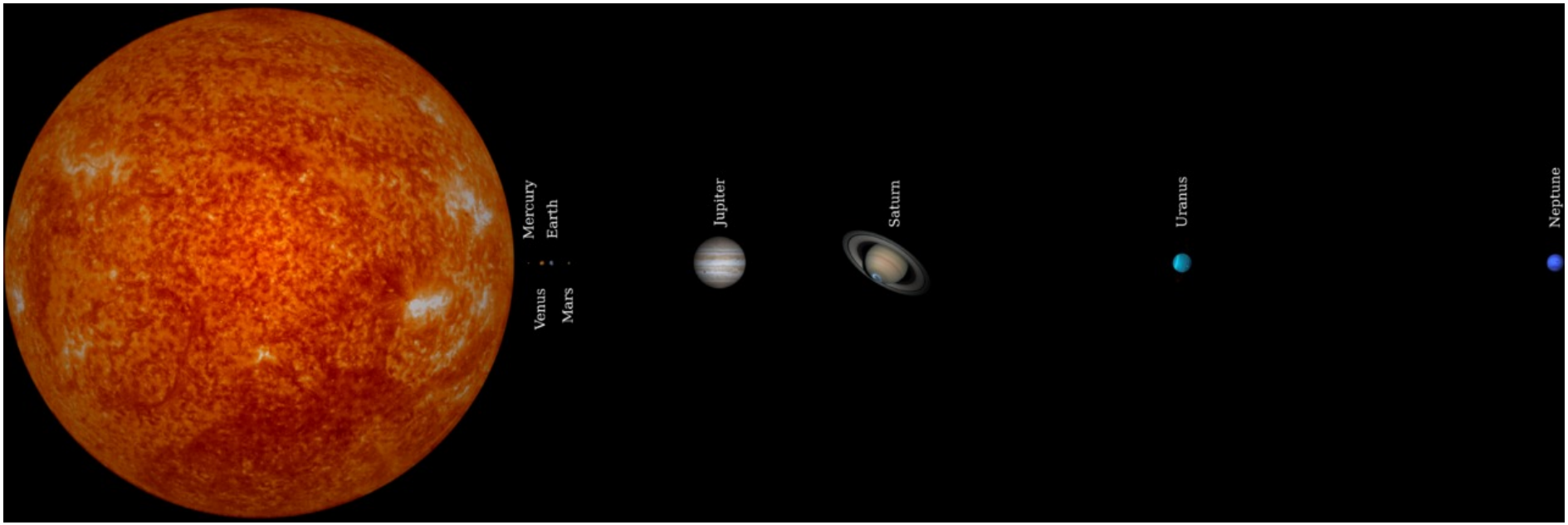
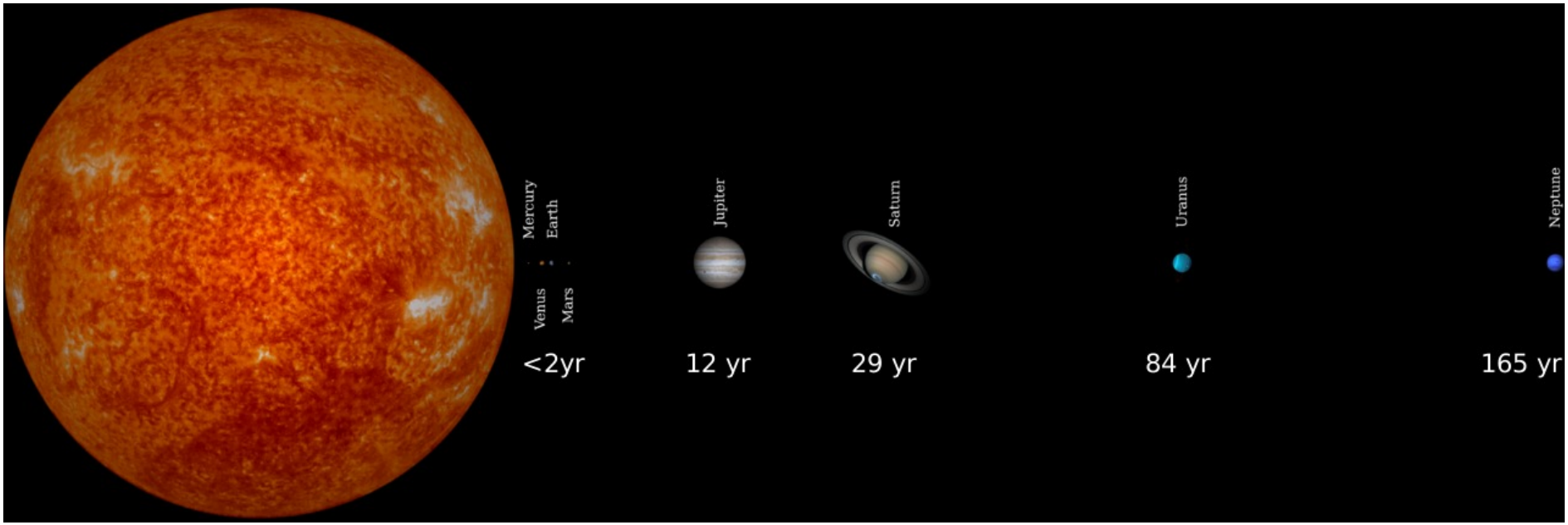
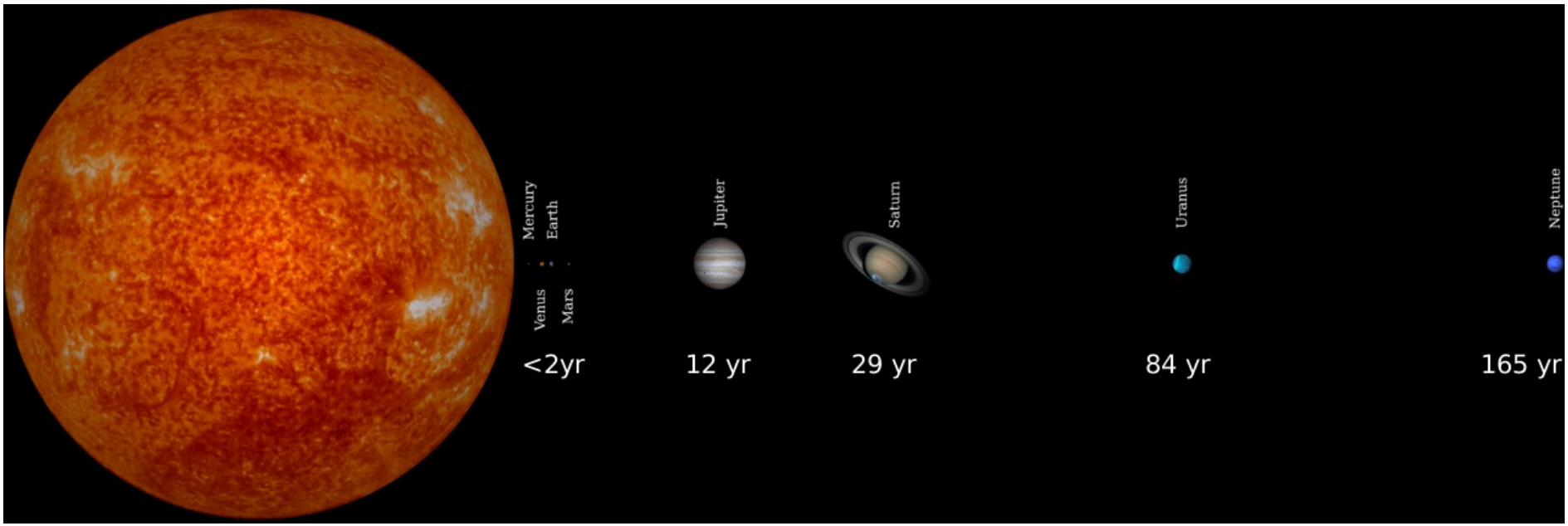
Solar System



Solar System

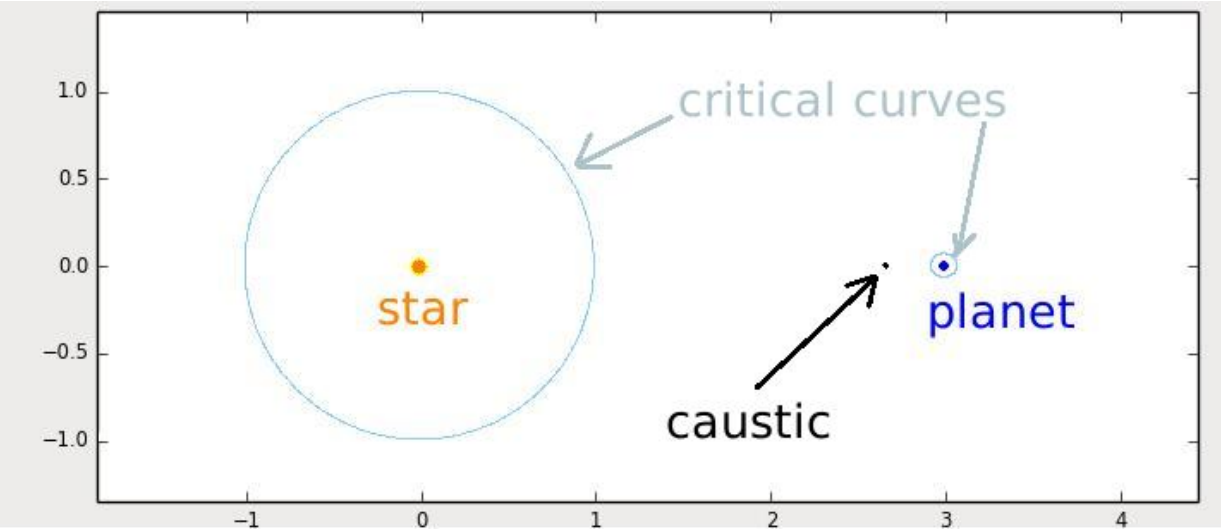


Solar System



Microlensing is unique technique to study ice giants.

Microlensing by star with distant planet



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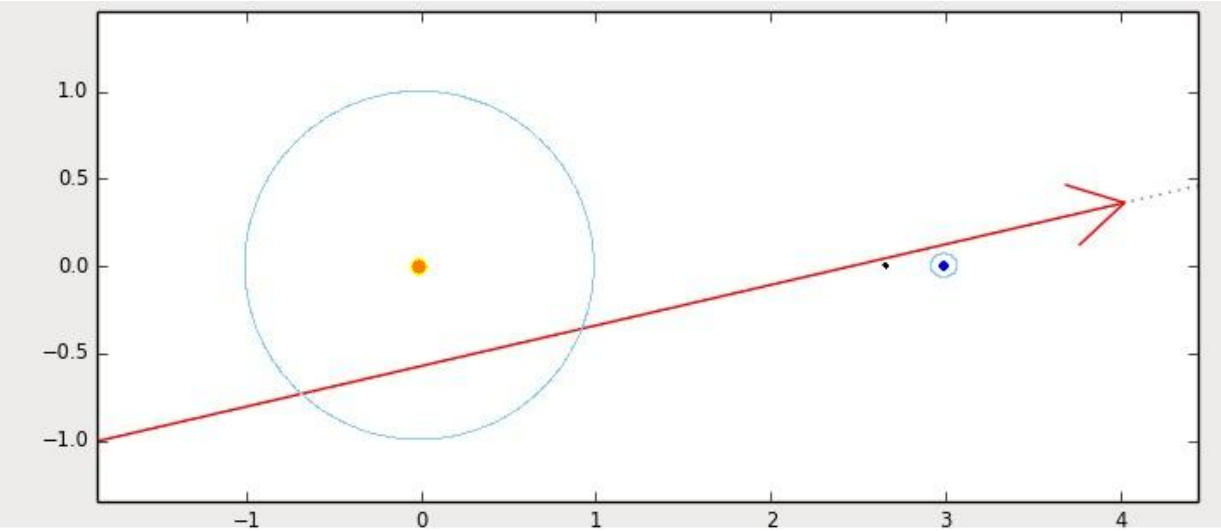
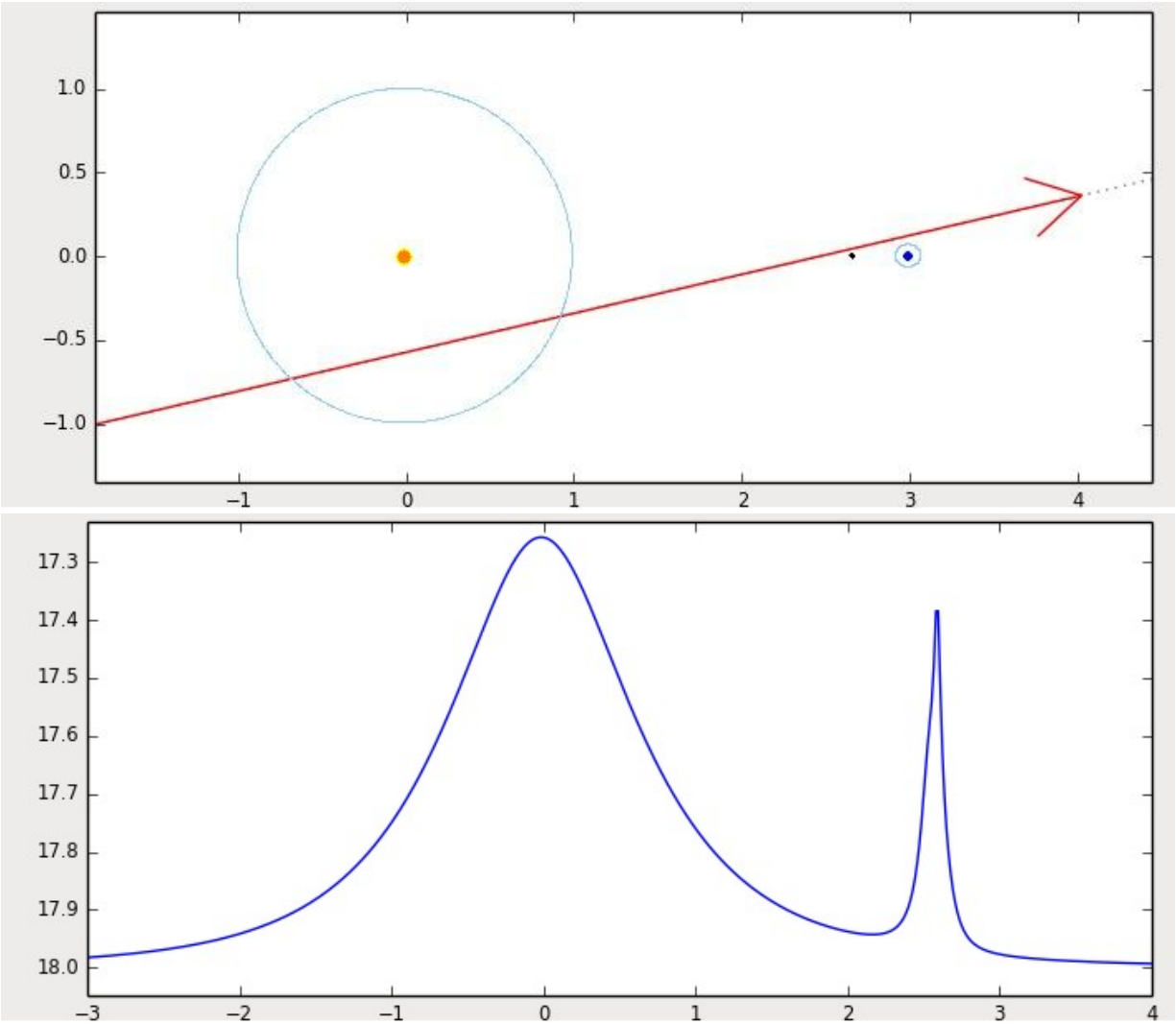
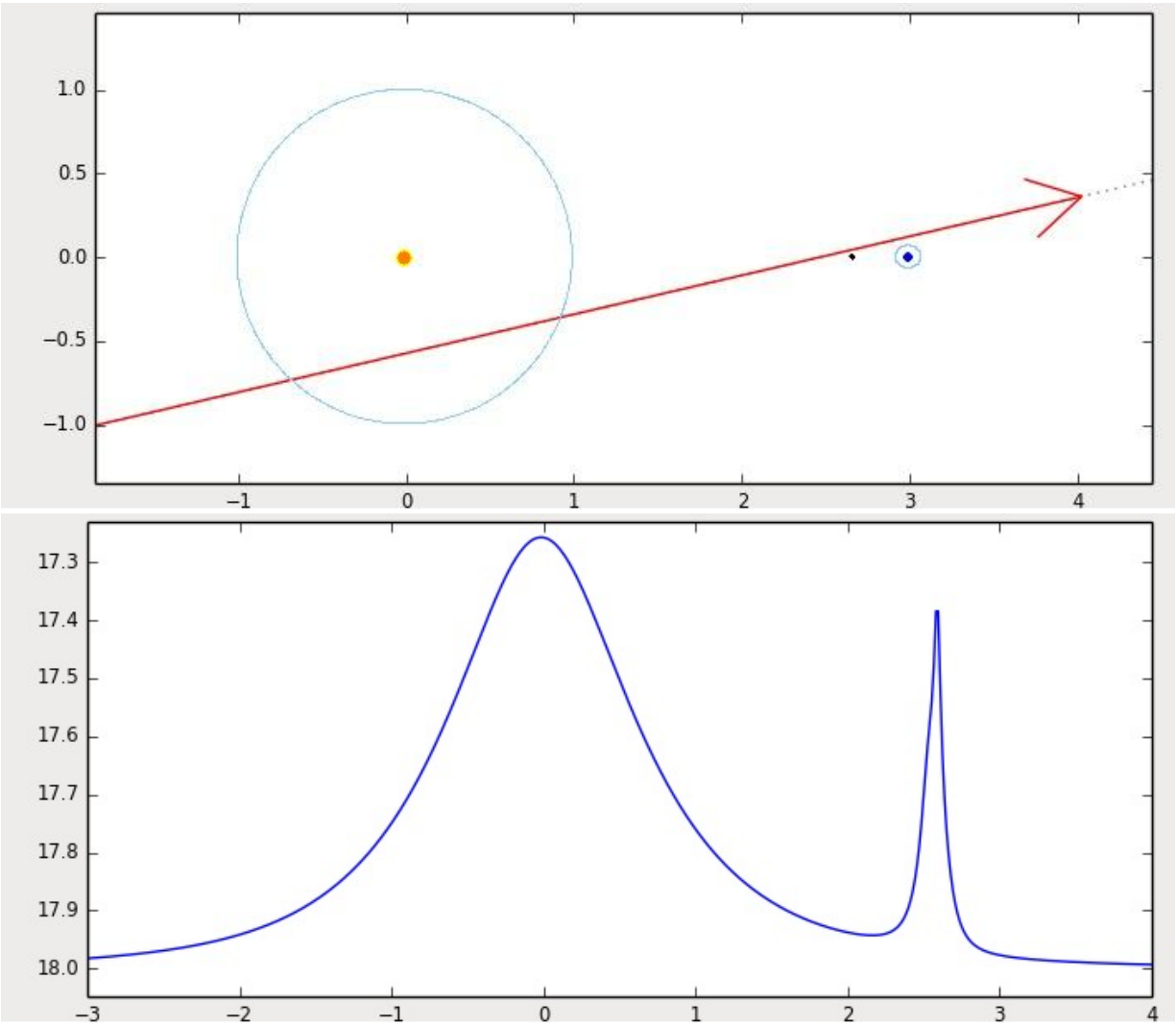


Microlensing by star with distant planet



Microlensing by star with distant planet

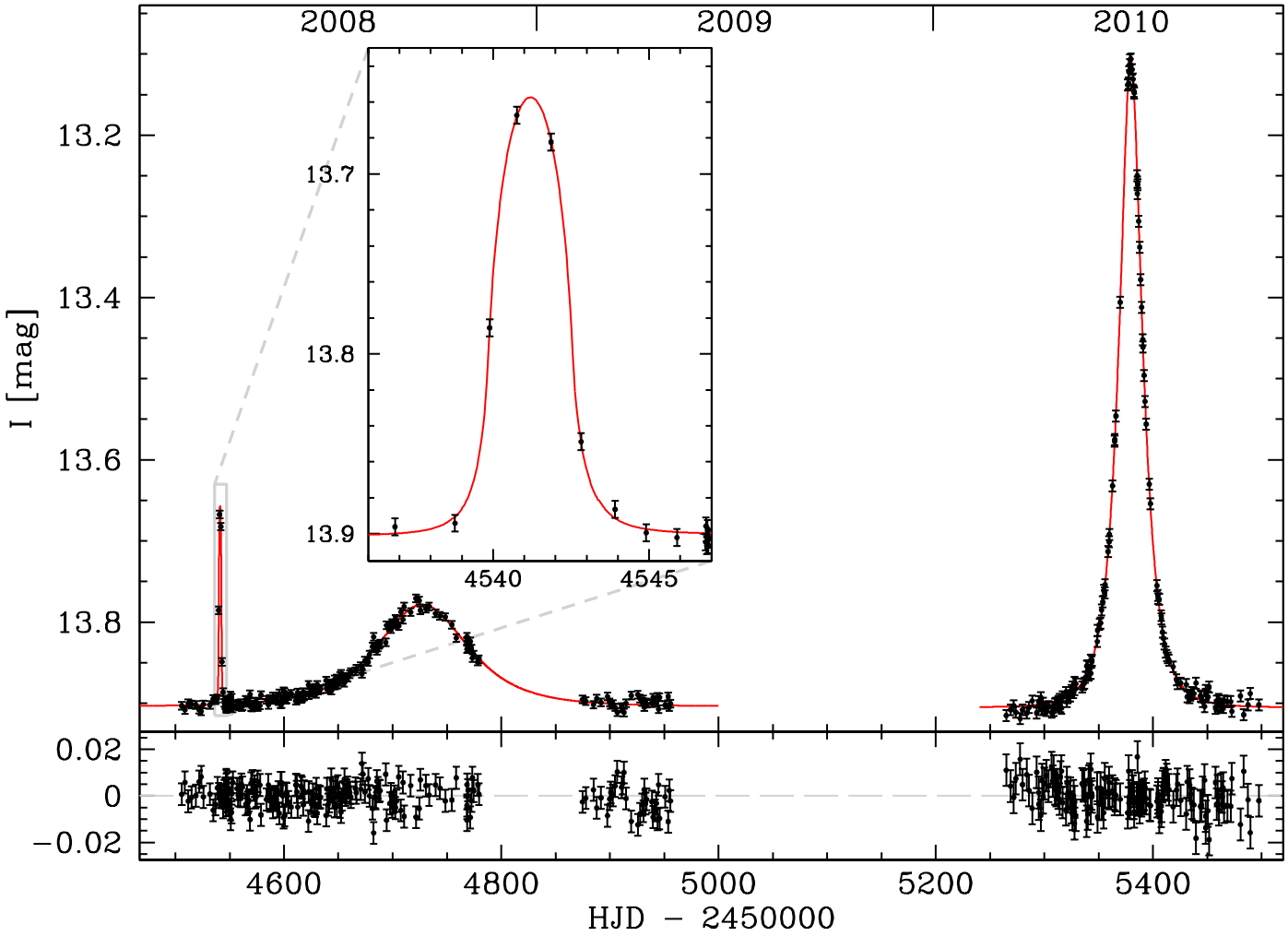


Planet in wide orbit may give signal similar to a free-floating planet.

OGLE-2008-BLG-092LAb – first known Uranus-like planet

$s = 5.26(11)$
$q = 2.41(45) \cdot 10^{-4}$

$M_\star = 0.71(22) \mathrm{M}_\odot$
$M_{\mathrm{pl}} = 3.9(14) \mathrm{M}_{\mathrm{Ur}}$
$a_\perp = 14.7(14) \mathrm{AU}$

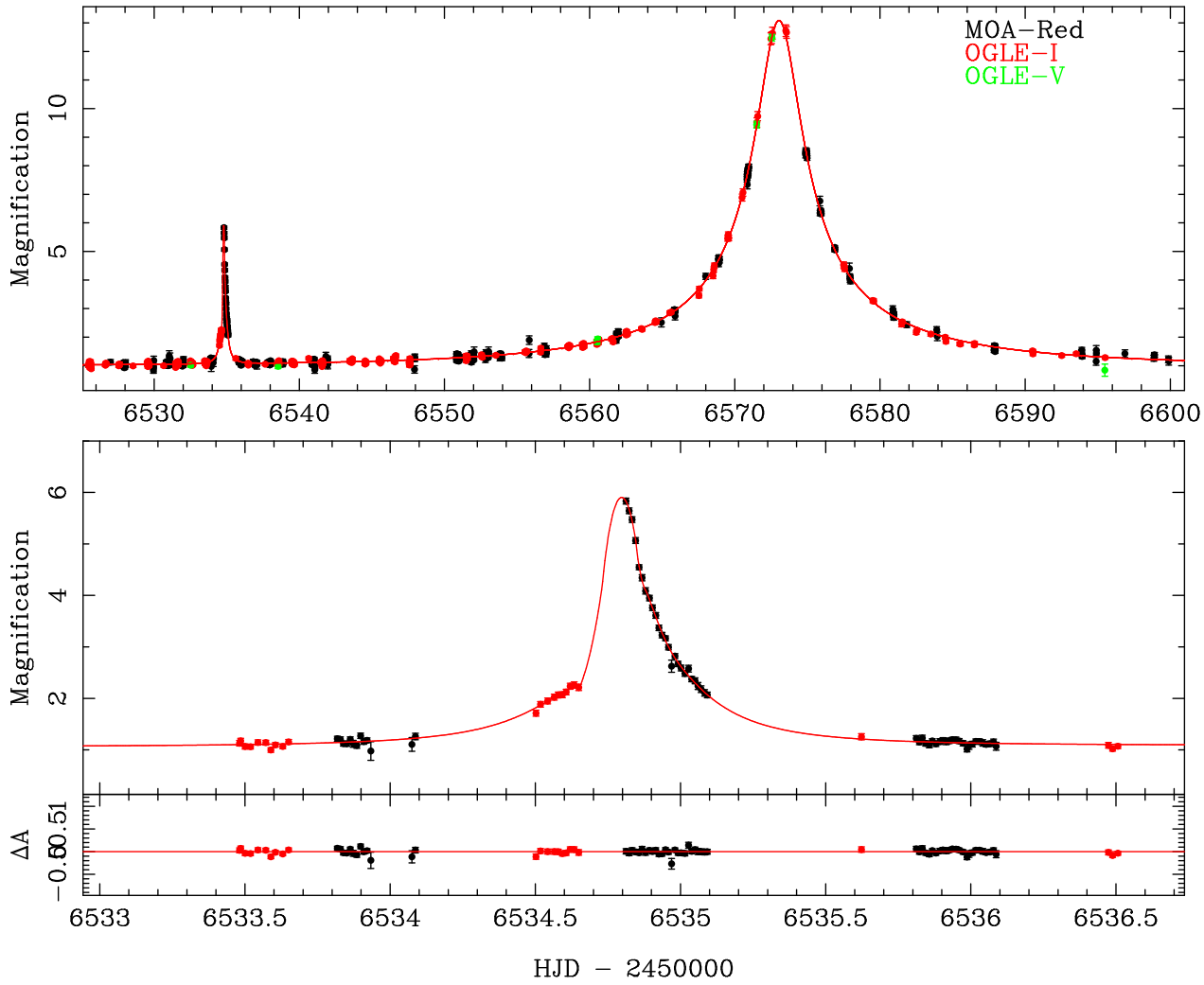


Poleski *et al.* 2014

MOA-2013-BLG-605 = OGLE-2013-BLG-1835

$s = 2.4$

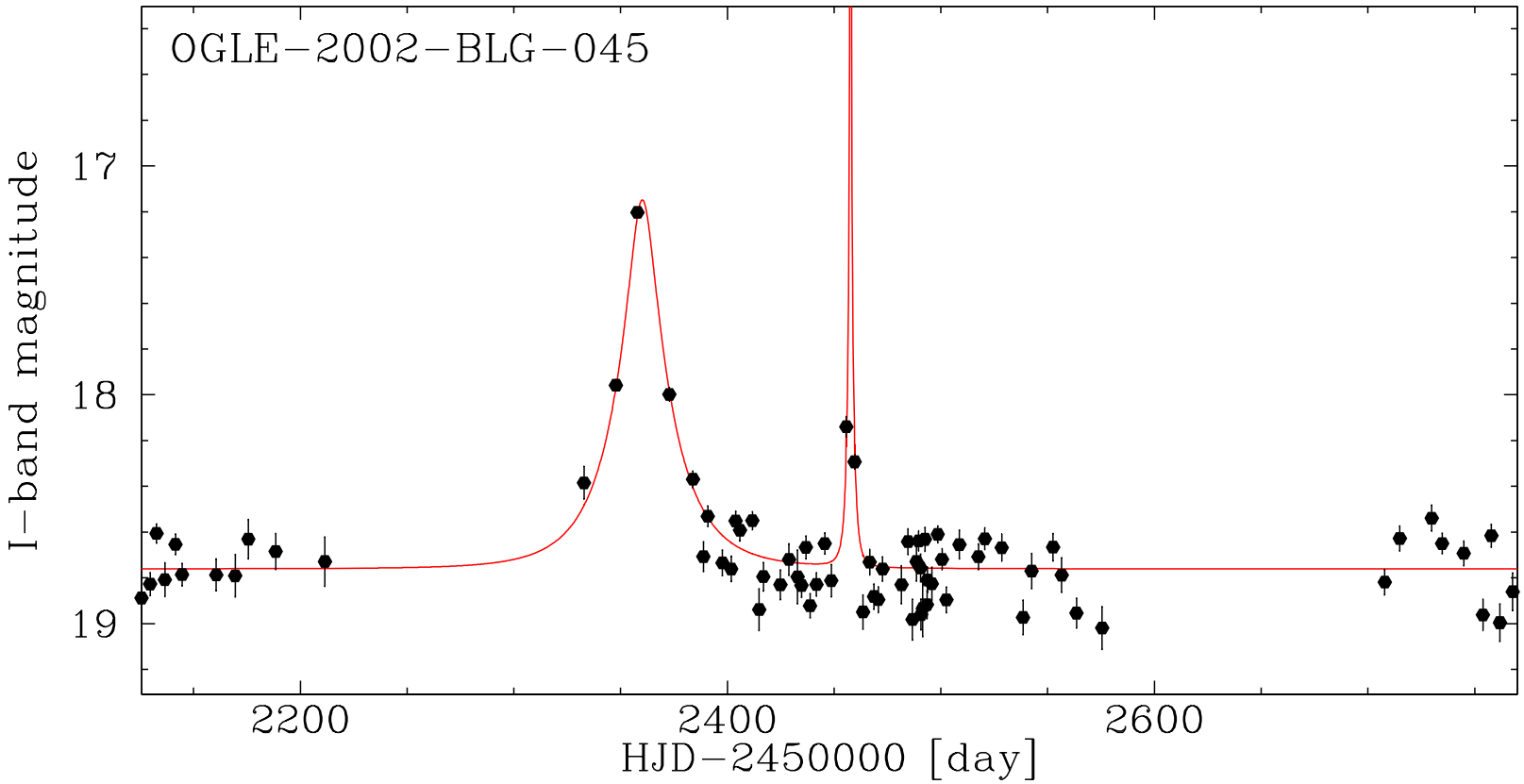
$q = 3.5 \cdot 10^{-4}$



See talk by Taka Sumi

OGLE-2002-BLG-045

$q = 0.008$
$s = 3.96$



Skowron *et al.* 2009

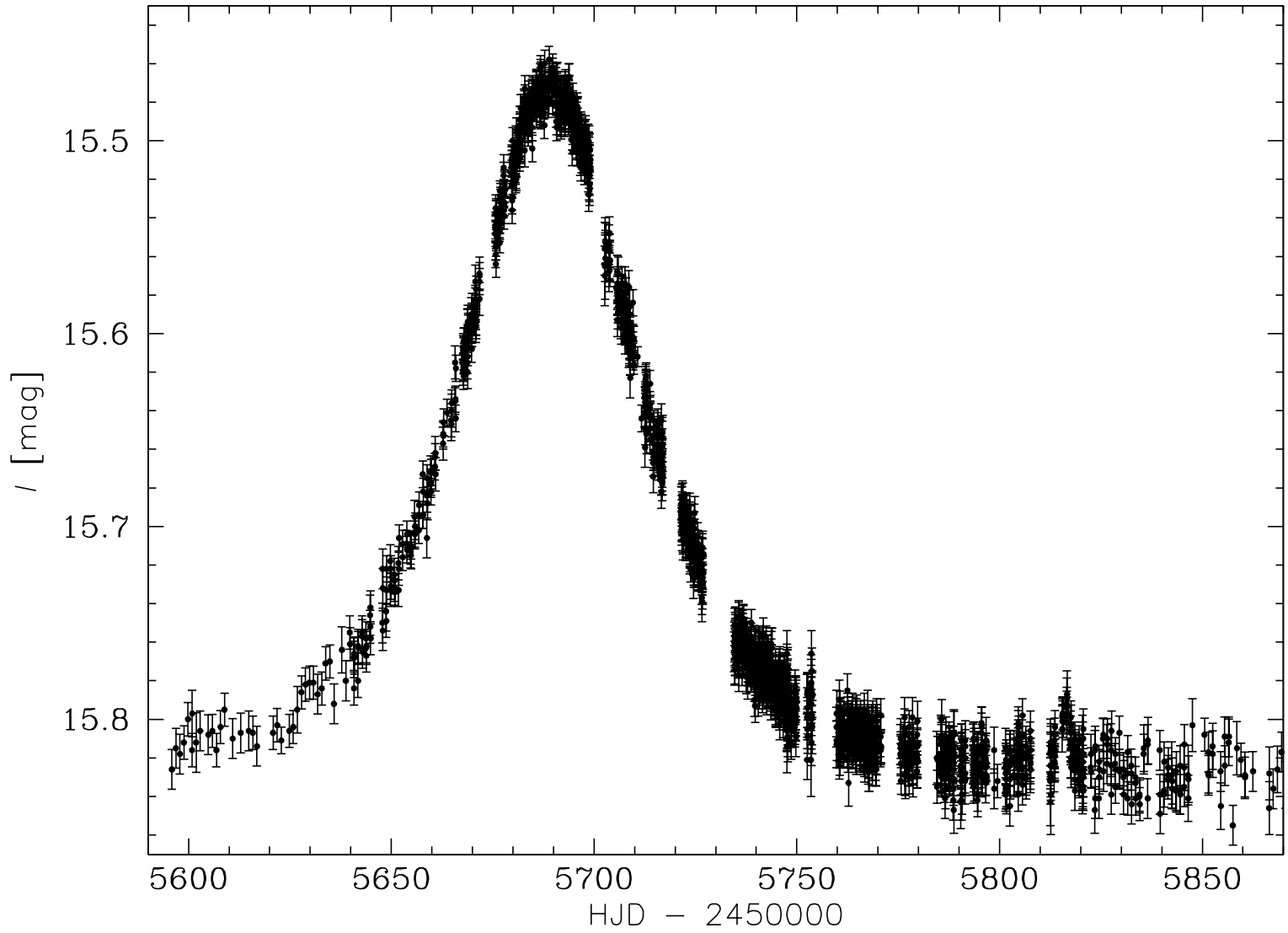
More data needed: MOA-I, EROS...

Other similar events

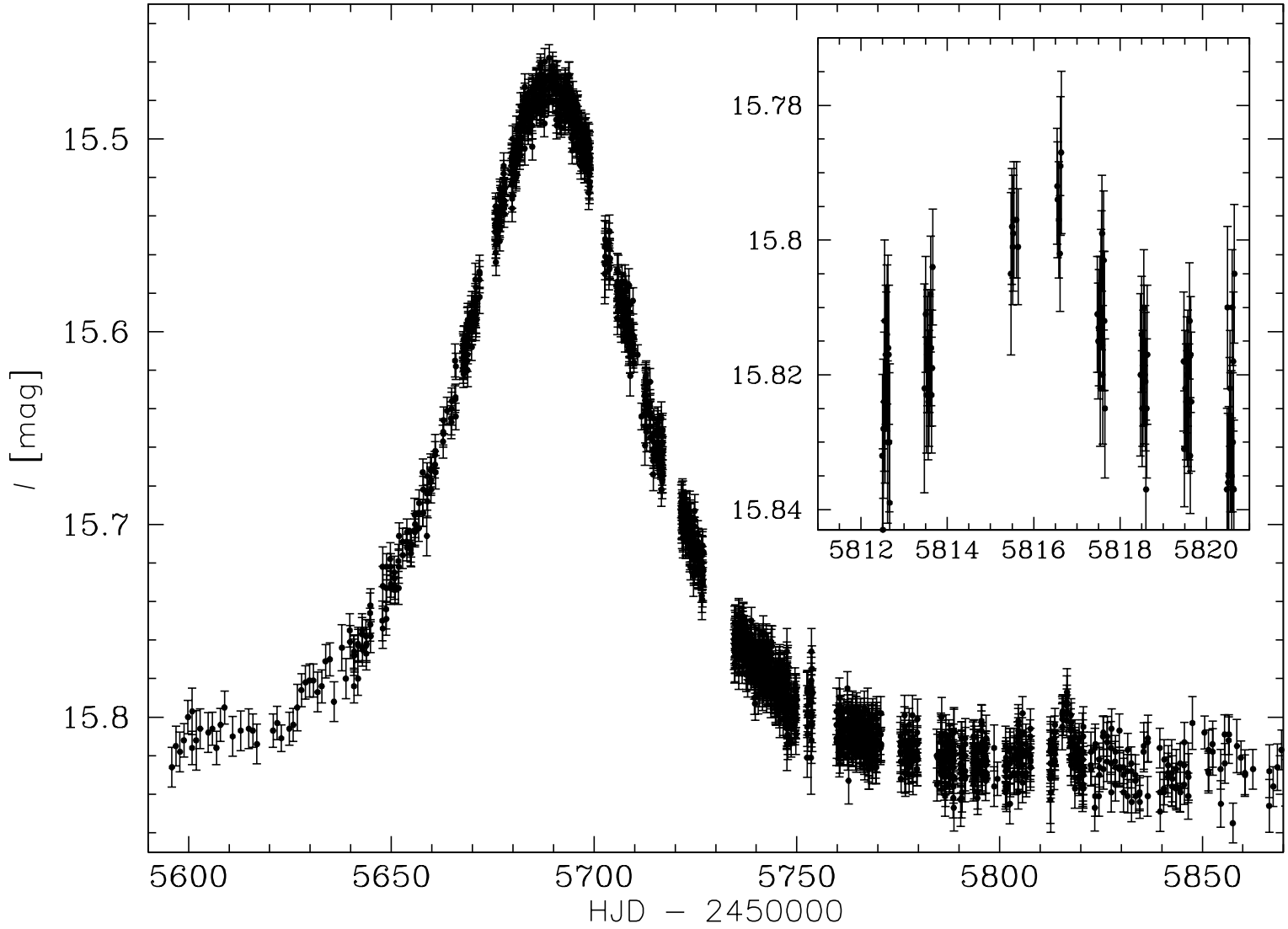
- ⋆ Very short caustic crossing:
  - MOA-BIN-1 (Bennett *et al.* 2012),
  - OGLE-2011-BLG-0302,
  - OGLE-2011-BLG-1114,
- ⋆ Free floating planets (including candidates):
  - OGLE-2003-BLG-084 (Poindexter *et al.* 2005),
  - 10 events from Sumi et al. 2011,
  - MOA-2011-BLG-274 (Choi *et al.* 2012, Freeman *et al.* 2014).

We can also check the archival light curves.

OGLE-2011-BLG-0173



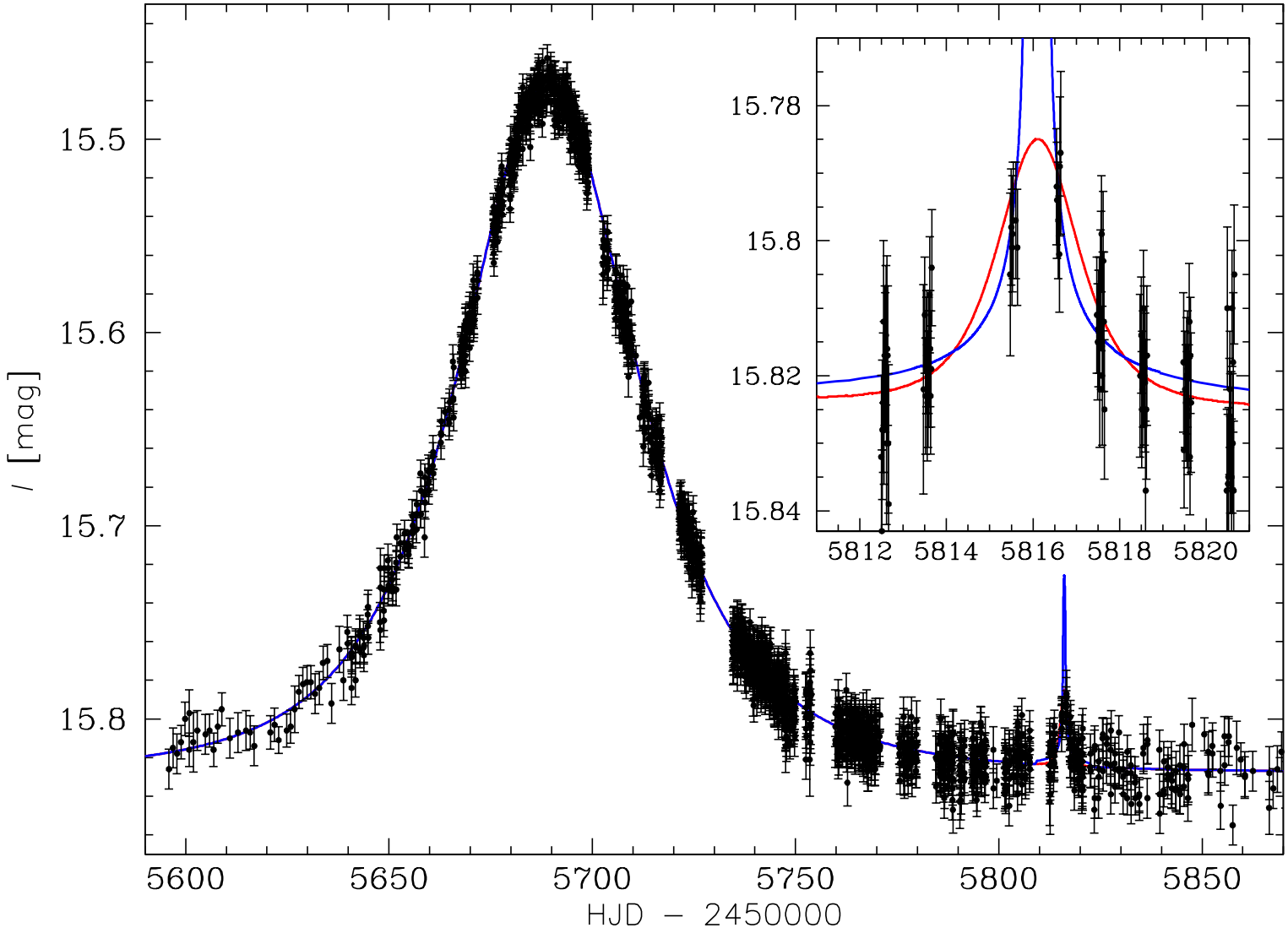
OGLE-2011-BLG-0173



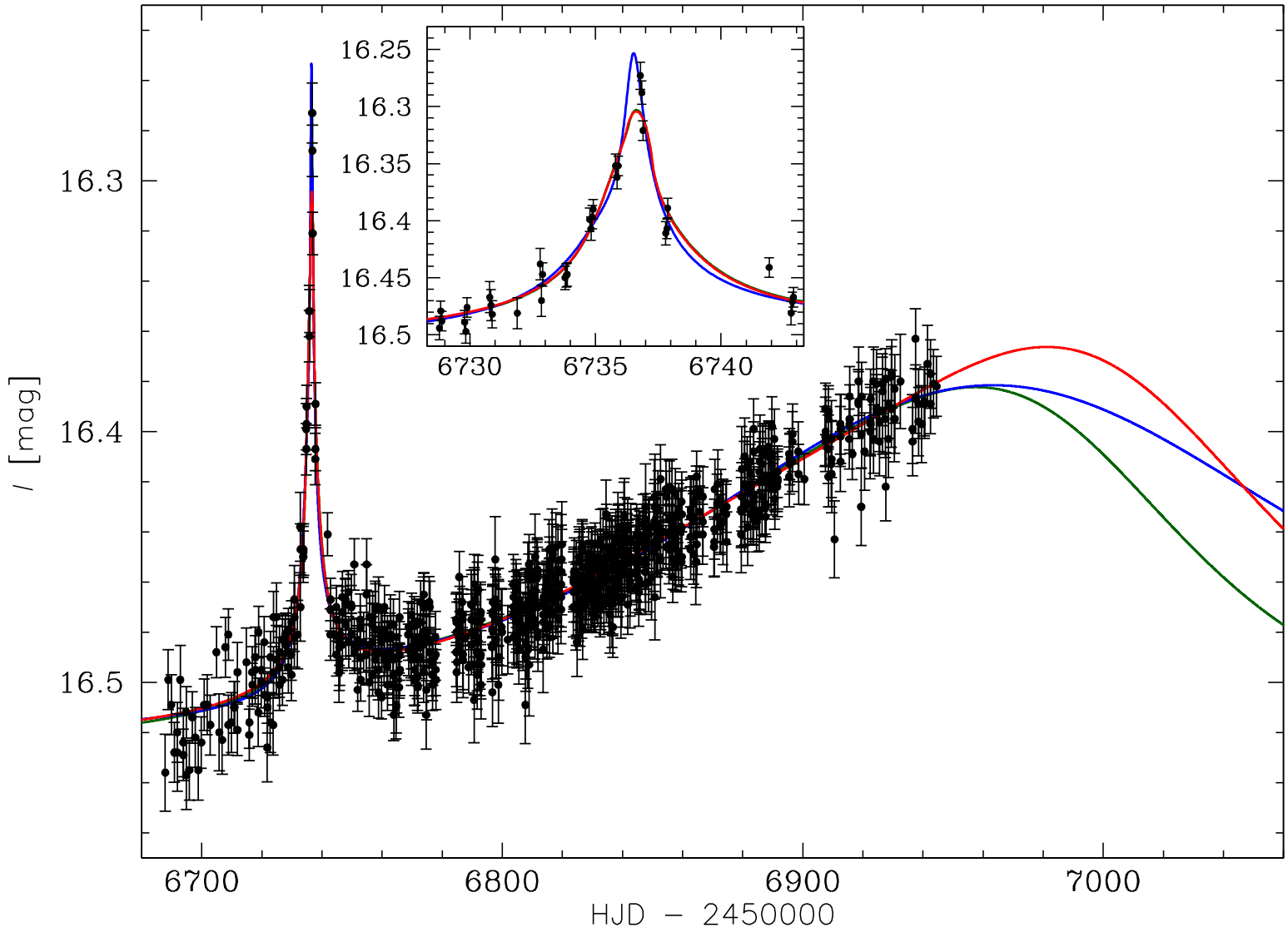
OGLE-2011-BLG-0173 = MOA-2011-BLG-133

double lens:
$q = 5 \cdot 10^{-4}$
$s = 4.7$

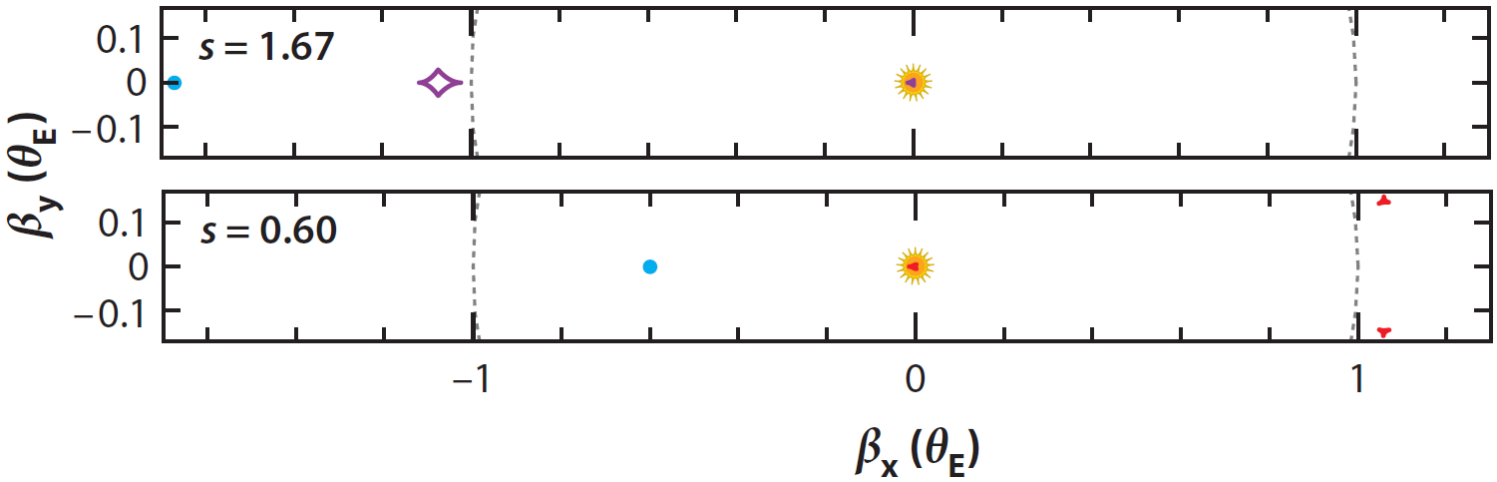
double source:
$F_2/F_1 =$
$6 \cdot 10^{-4}$



OGLE-2014-BLG-0298 = MOA-2014-BLG-535

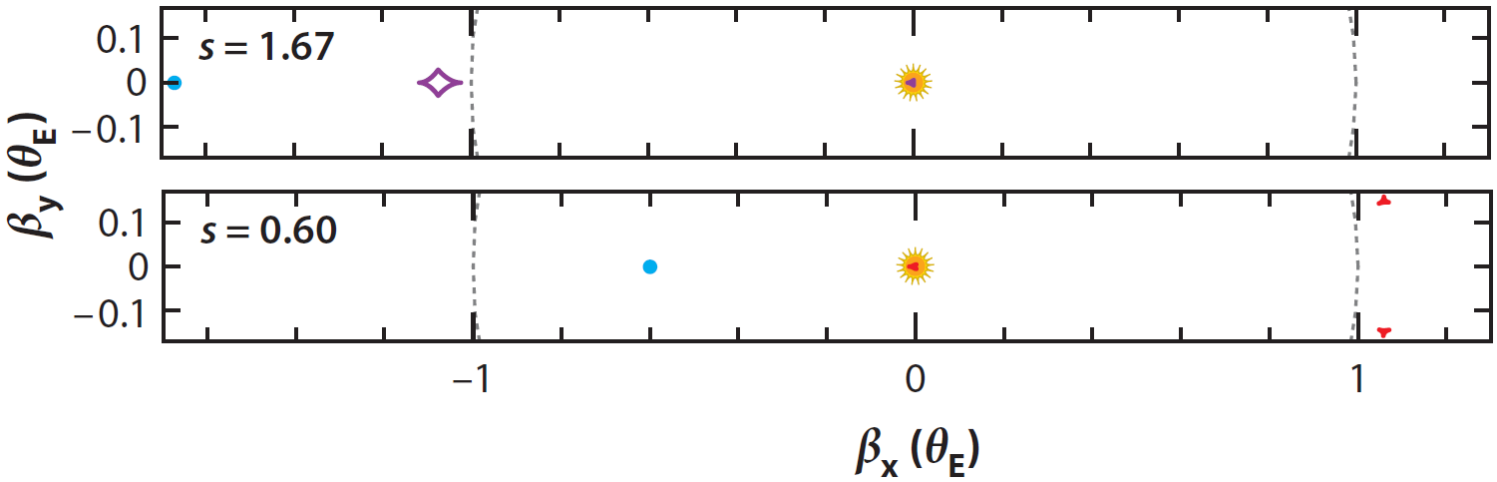


Degeneracy of caustics



Gaudi 2012

Degeneracy of caustics



Gaudi 2012

In the case of OGLE-2014-BLG-0298 we find $q \approx 0.01$ and $s \approx 0.3$.

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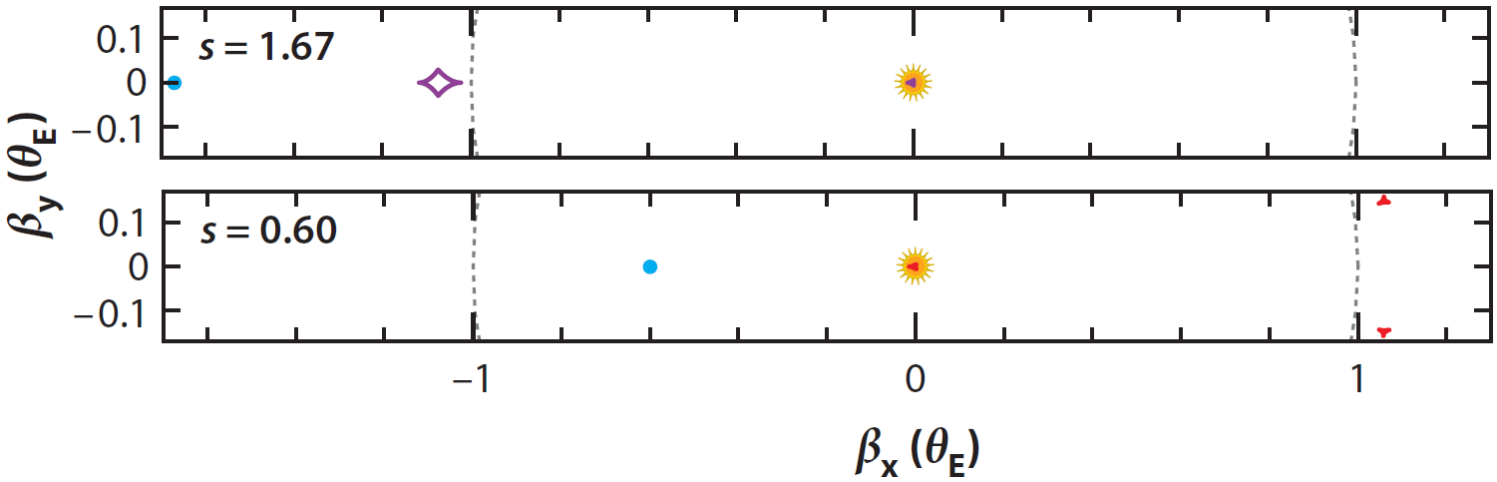

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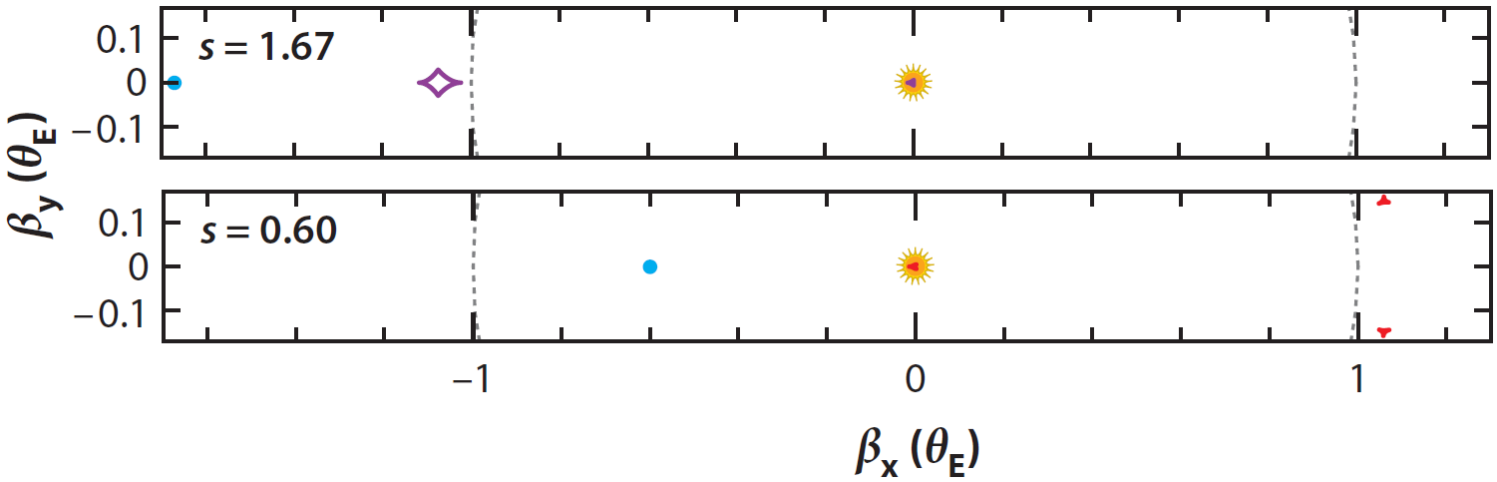

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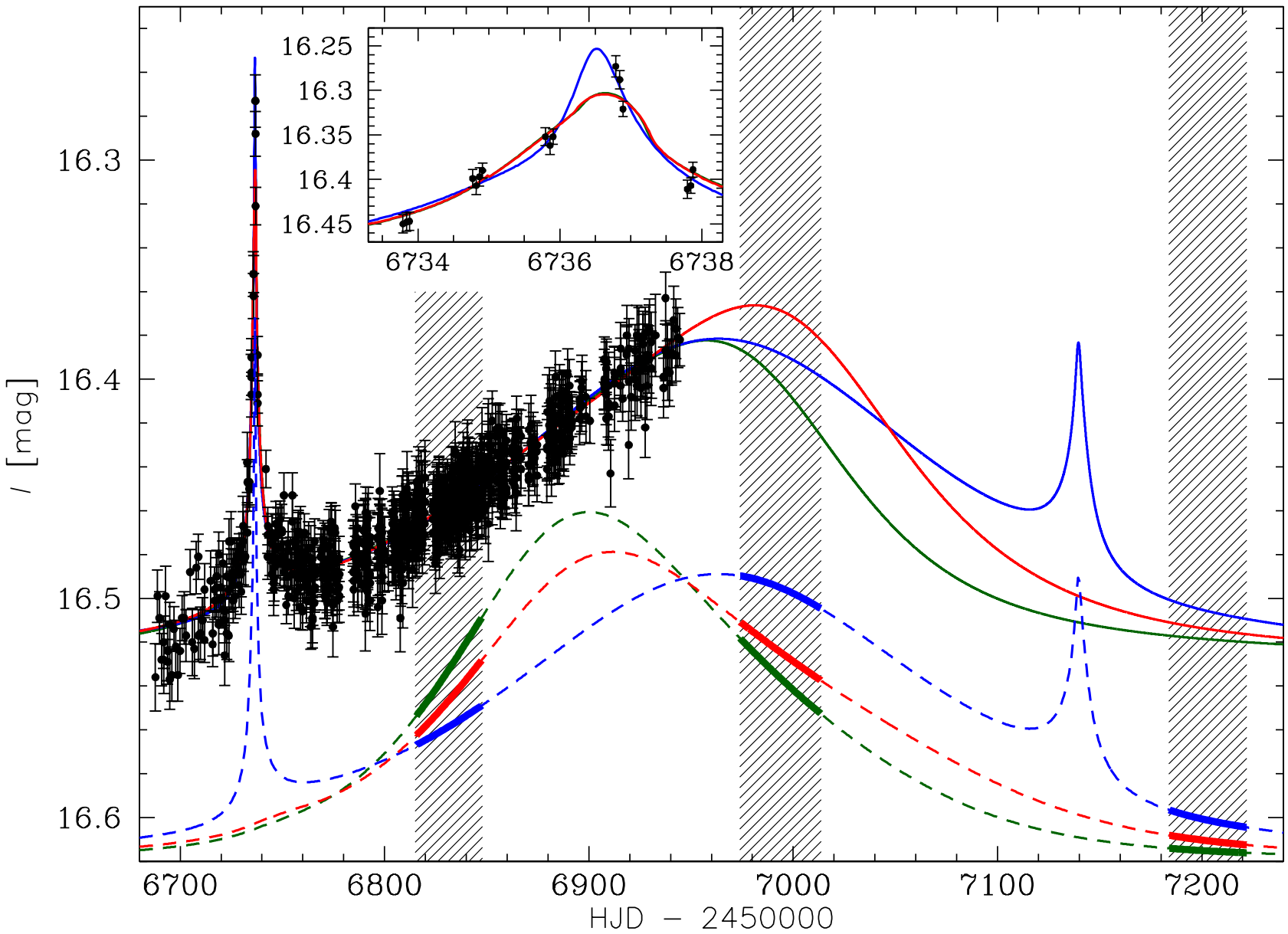
In the case of OGLE-2014-BLG-0298 we find $q \approx 0.01$ and $s \approx 0.3$.
This suggests a high mass planet or a low mass brown dwarf ≈ 1 AU from the host.
Both microlensing parallax and binary rotation are important.

OGLE-2014-BLG-0298 – Spitzer observations



Summary

- Only microlensing allows us to study analogs of Uranus and Neptune.
- Different contaminants: binary sources and $s < 1$ binaries.
- All presented planetary anomalies in survey-only data.
- The OGLE-2002-BLG-045 and OGLE-2011-BLG-0173 events could be analyzed more deeply if more data exists.
- OGLE-2014-BLG-0298 turns out to be unique – the first case to gain expertise in measuring $\pi_{\rm E}$ for events with large $t_{\rm E}$ and satellite data.

END

Image credit: Ewa Zegler-Poleska