OGLE-2015-BLG-1737: a giant planet beyond the snow line?

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Preliminary results

A. Cassan, Y. Tsapras, D. Bennett, I. Bond, OGLE/MOA/RoboNet collaborations, et al.

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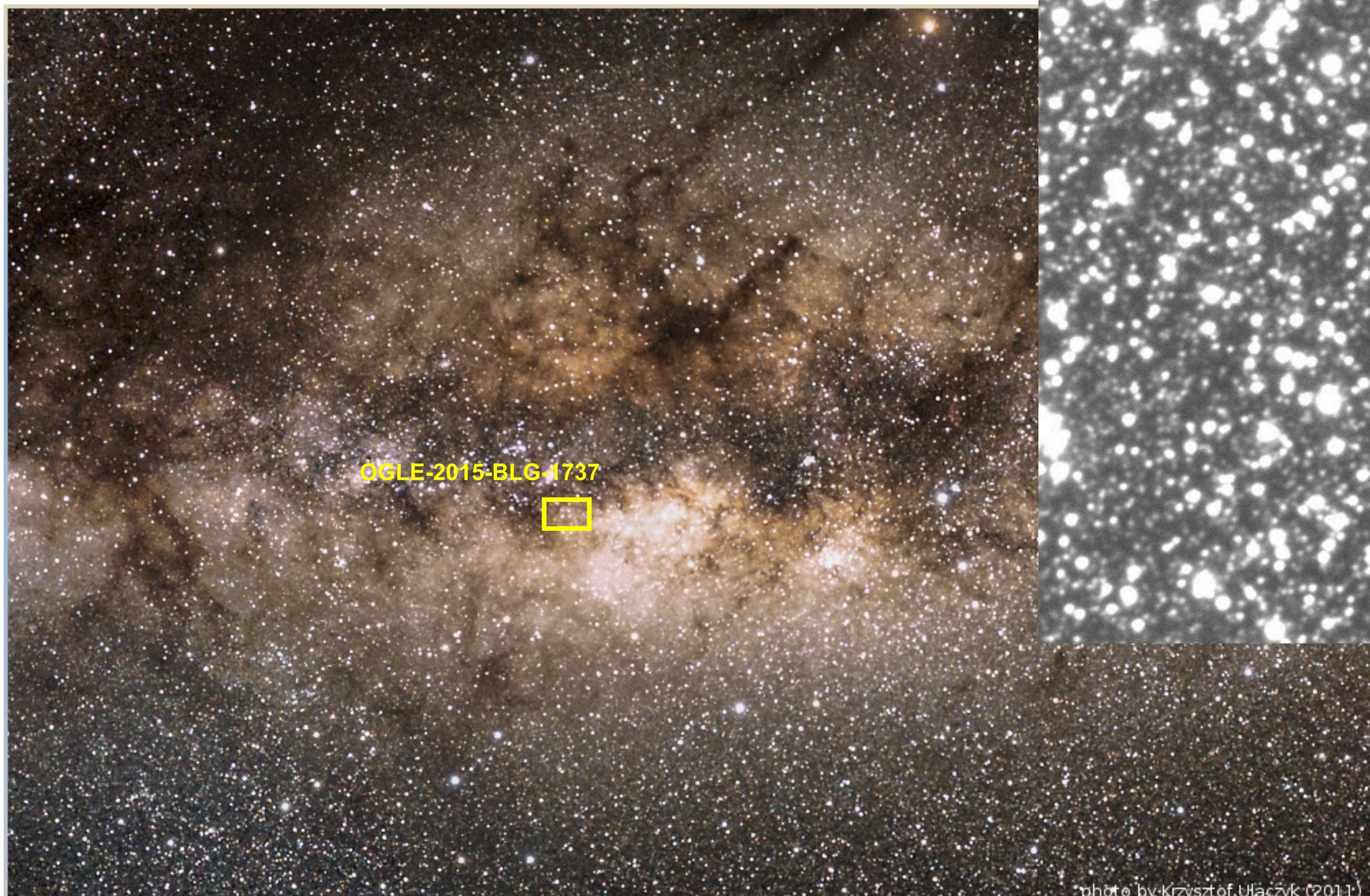
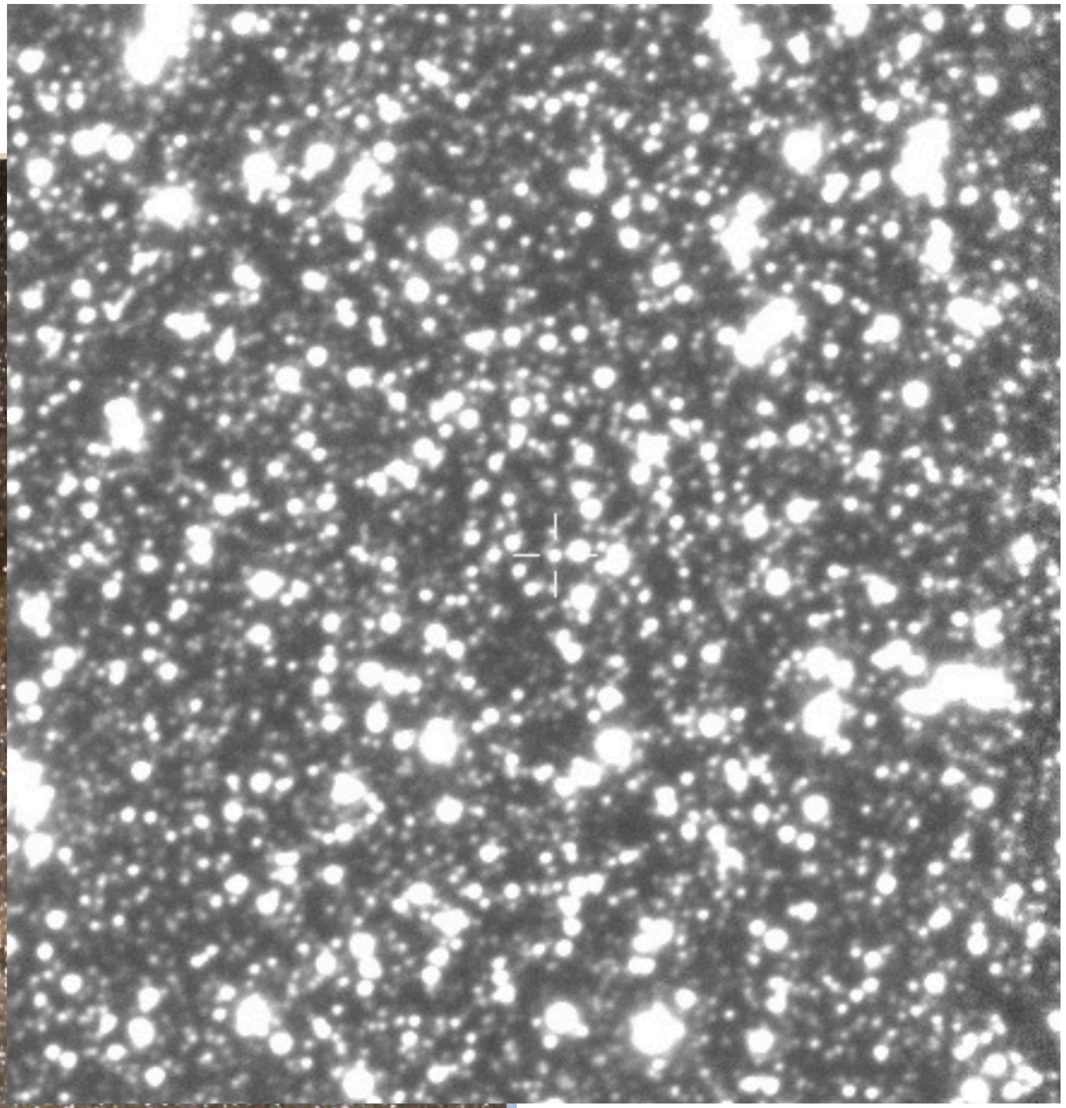
Detection and follow-up

OGLE-2015-BLG-1737 / MOA-2015-BLG-470



(photo by Krzysztof Ulaczyk, with permission from author. Plots by JS. See bigger version.)



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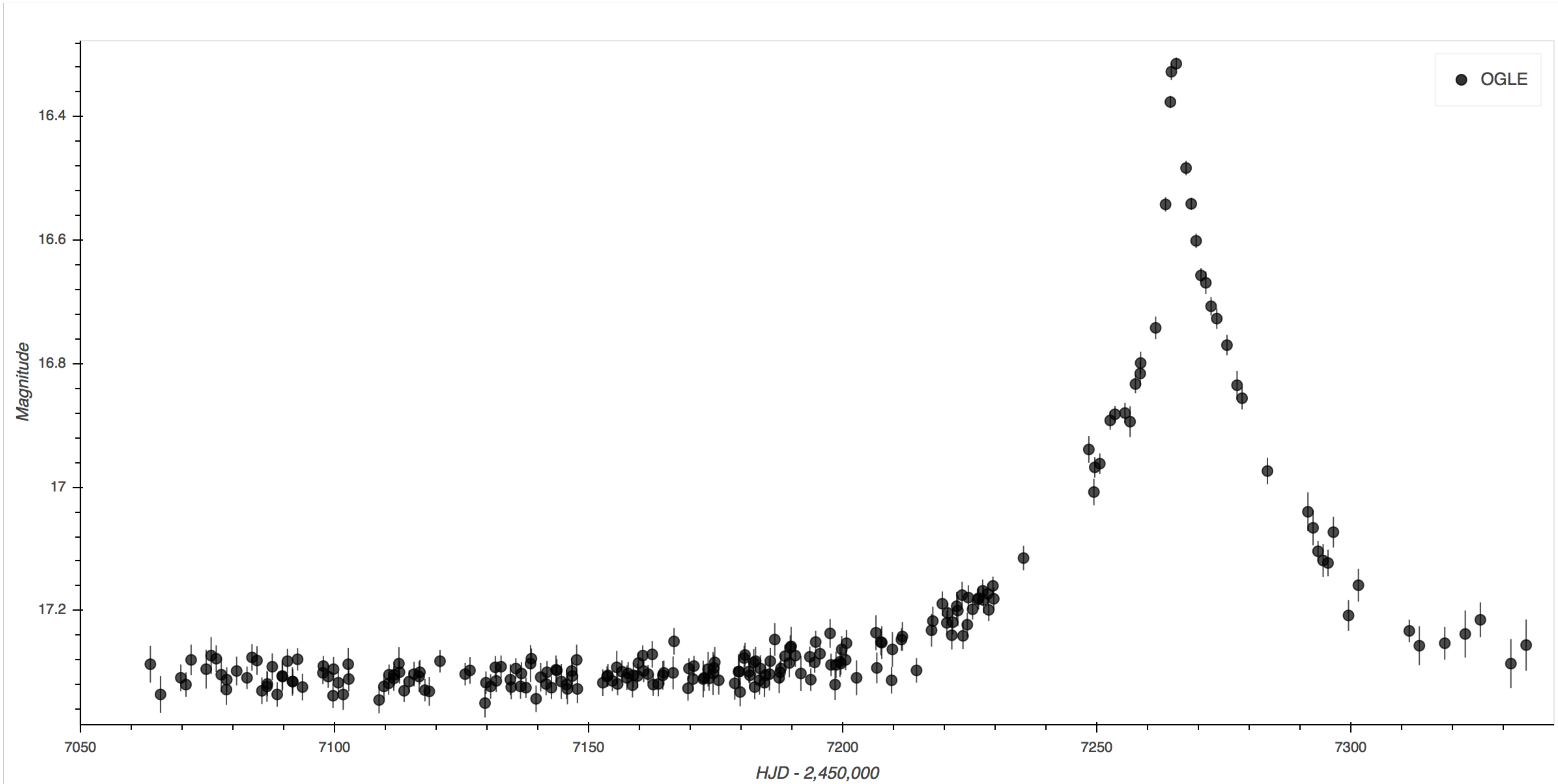

- OGLE, MOA, La Silla, CTIO, SAAO, SSO, Haleakala
- 1791 data used in the analysis
- **I-band** and **V-band** data from both OGLE and MOA

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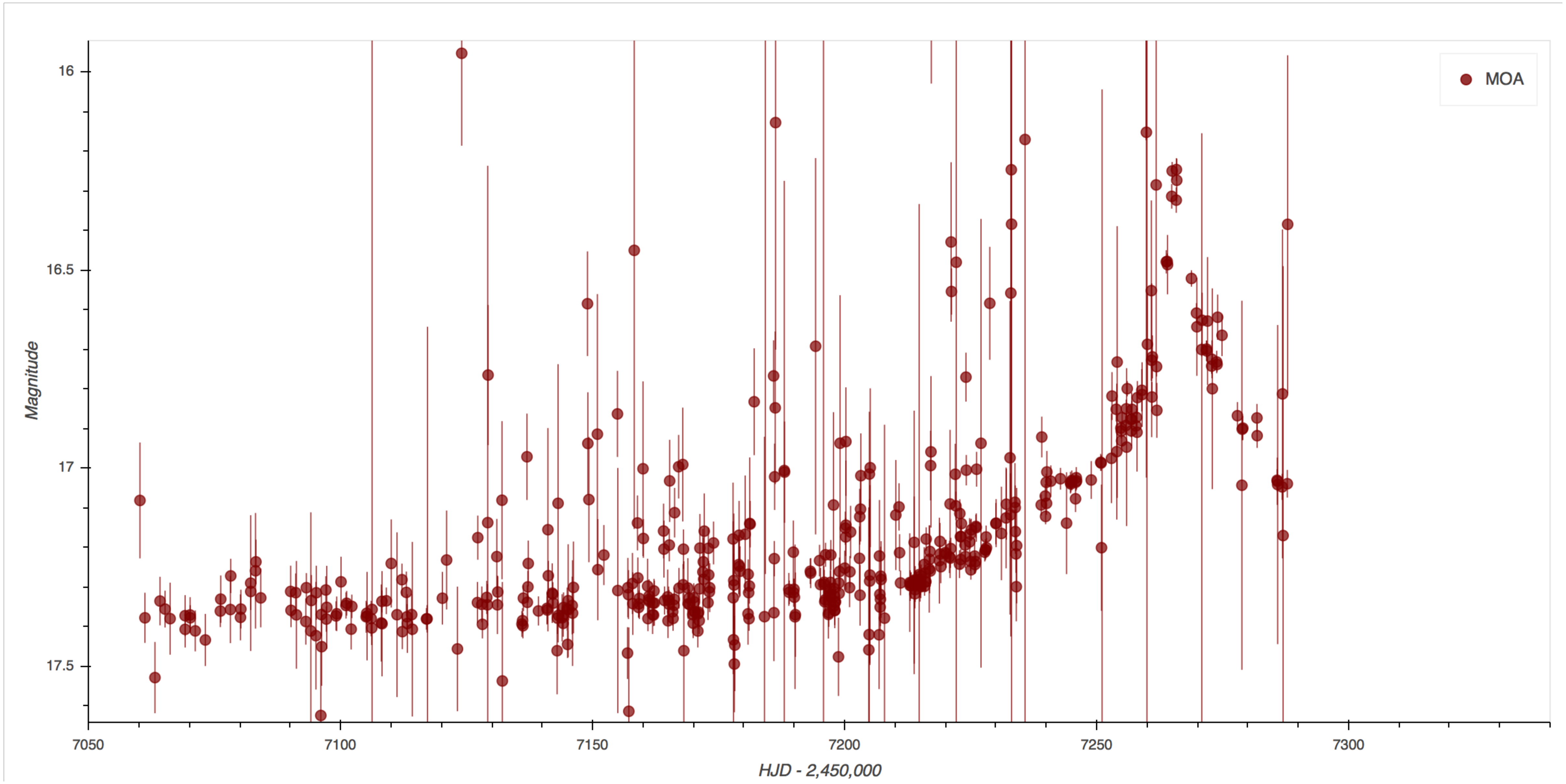

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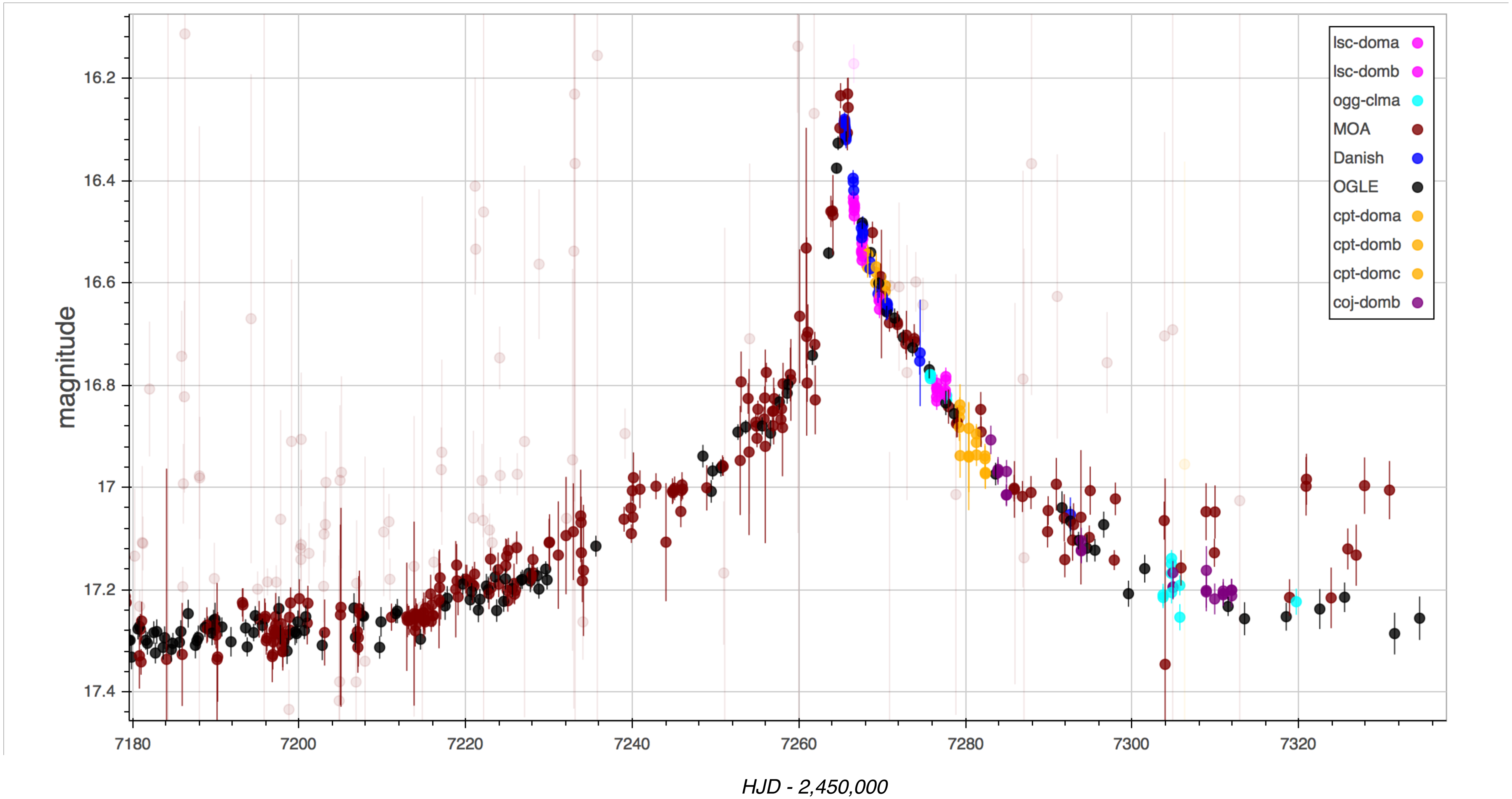

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- 1791 data used in the analysis
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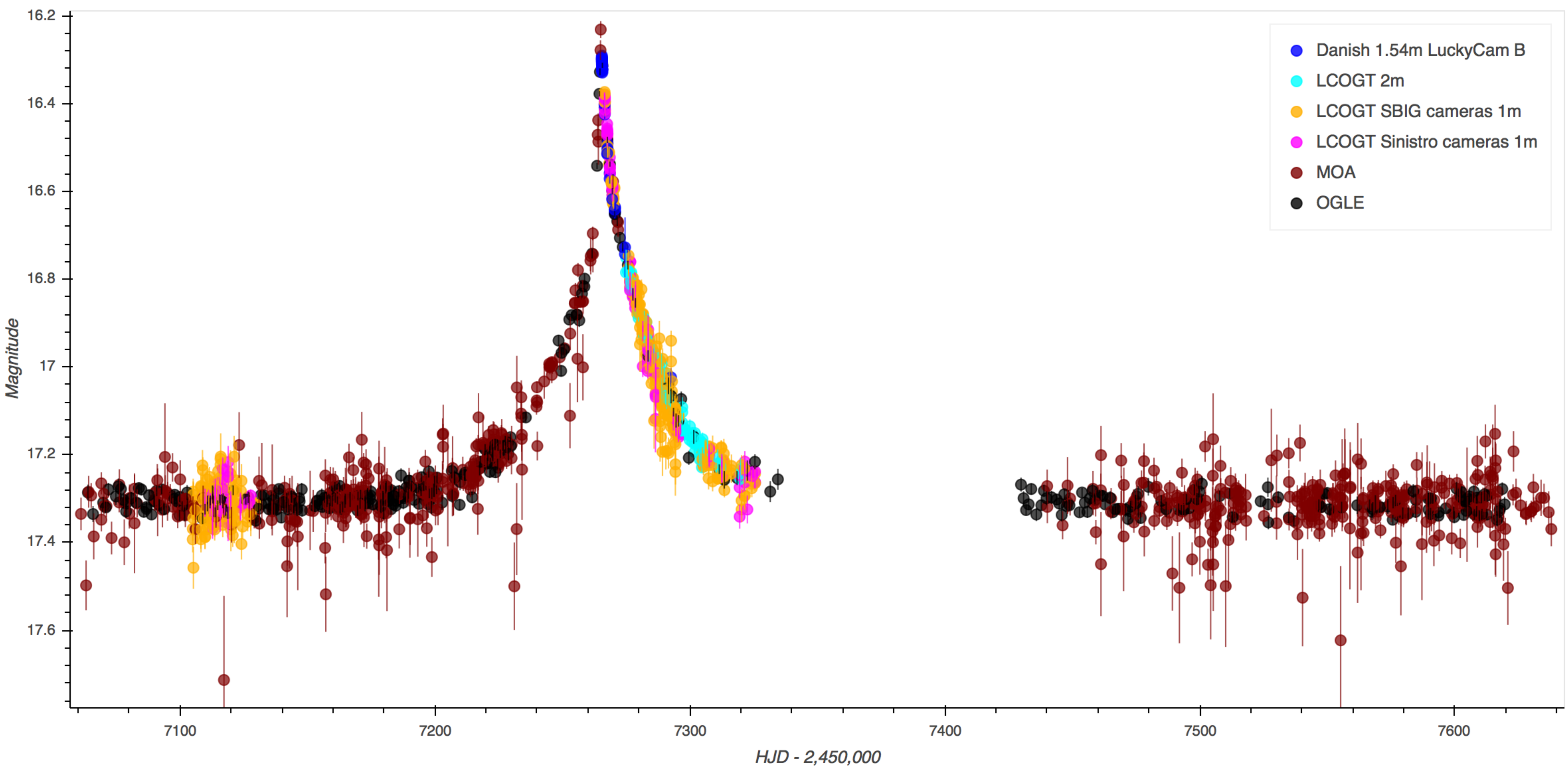
Data re-reduction

- Reduction with a common reference frame for each camera type / telescope aperture
- Photometry of two nearby events are used to get RoboNet baseline data prior the peak
- Bright nearby star : smaller PDF radius
- In practice ~1/3 of the rejected images can be used



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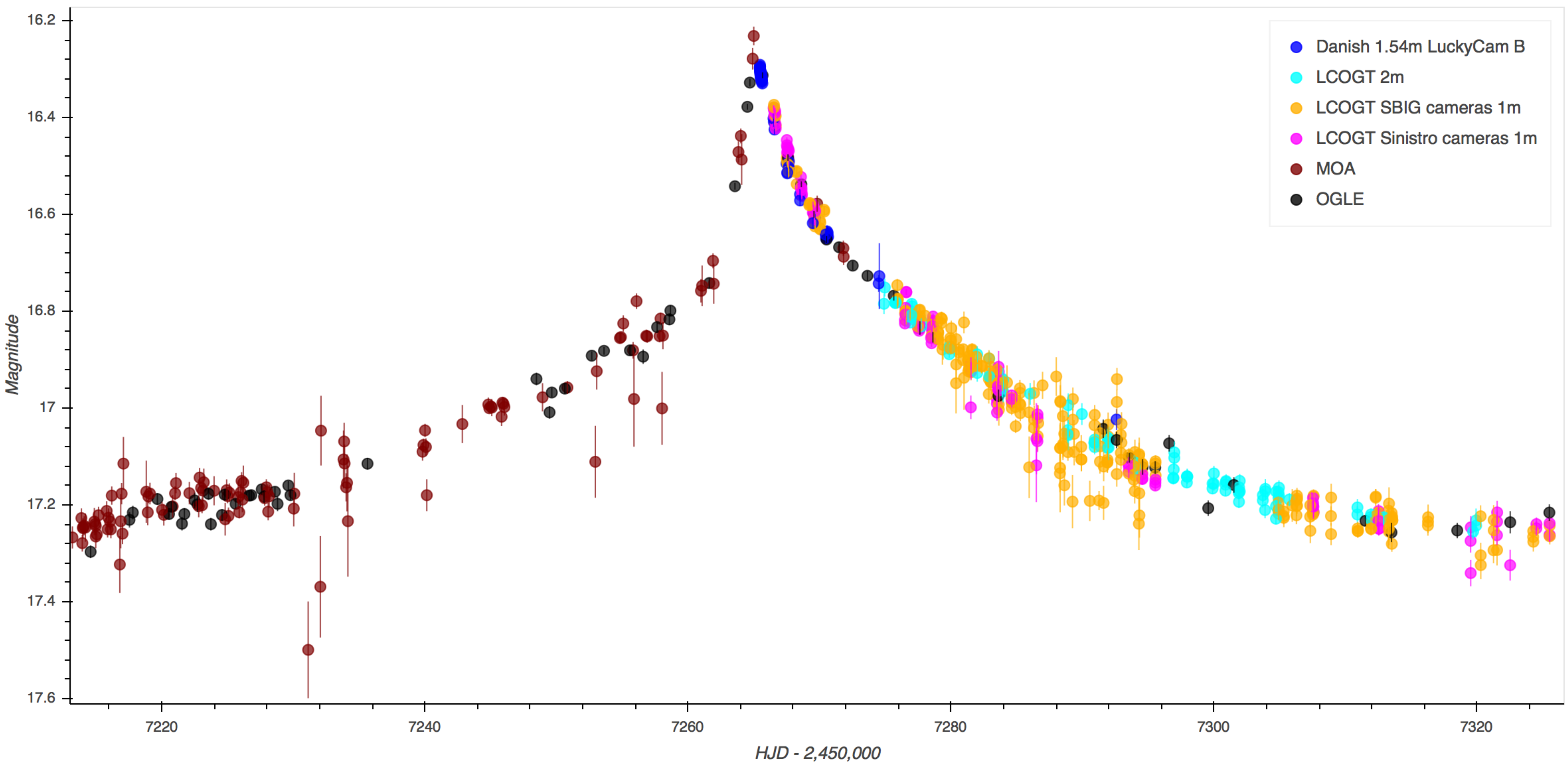

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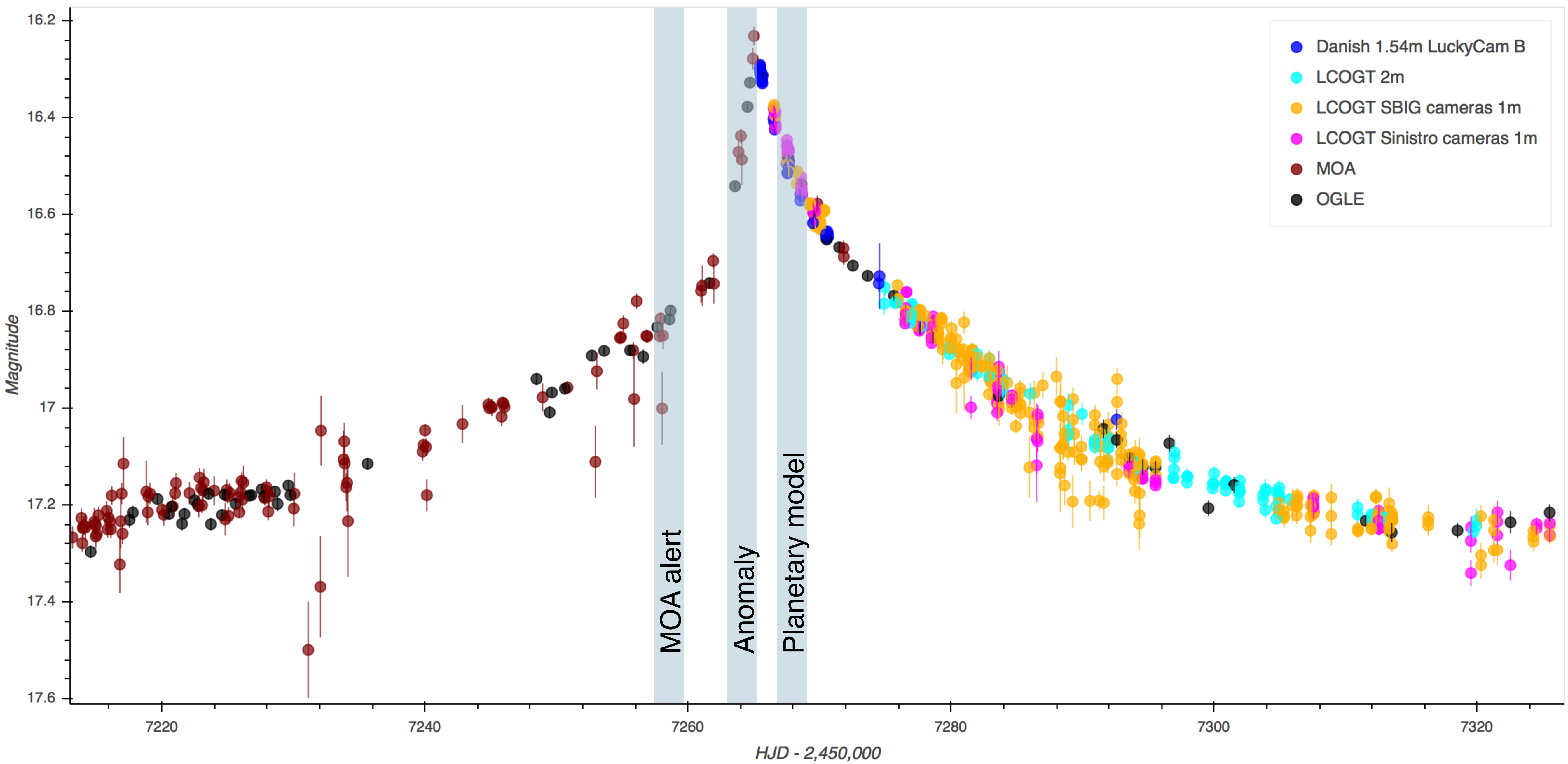
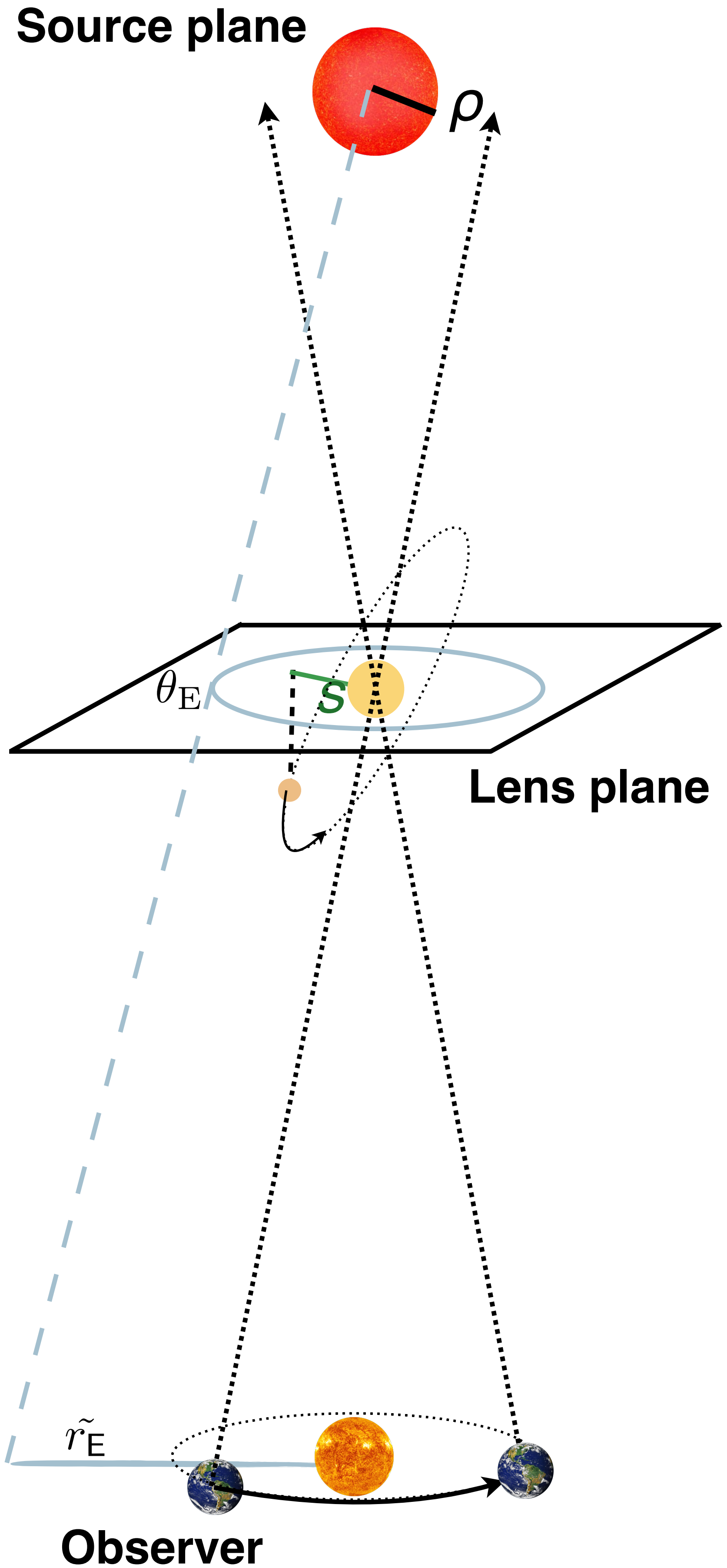


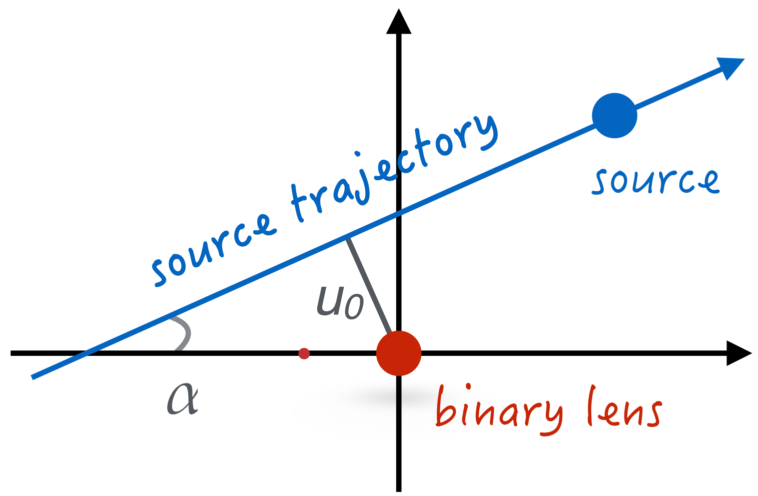
Modeling process



✦ Static binary lens model

- Finite source features may be detected
- There is not obvious caustic crossing
- Rectilinear source trajectory

mass ratio q
projected separation s
time origin t_0
Einstein timescale t_E



- Broad exploration on a grid in s and q

$$s = \frac{a_\perp}{\mathrm{R_E}} \qquad q = \frac{M_2}{M_1}$$

- Long timescale event

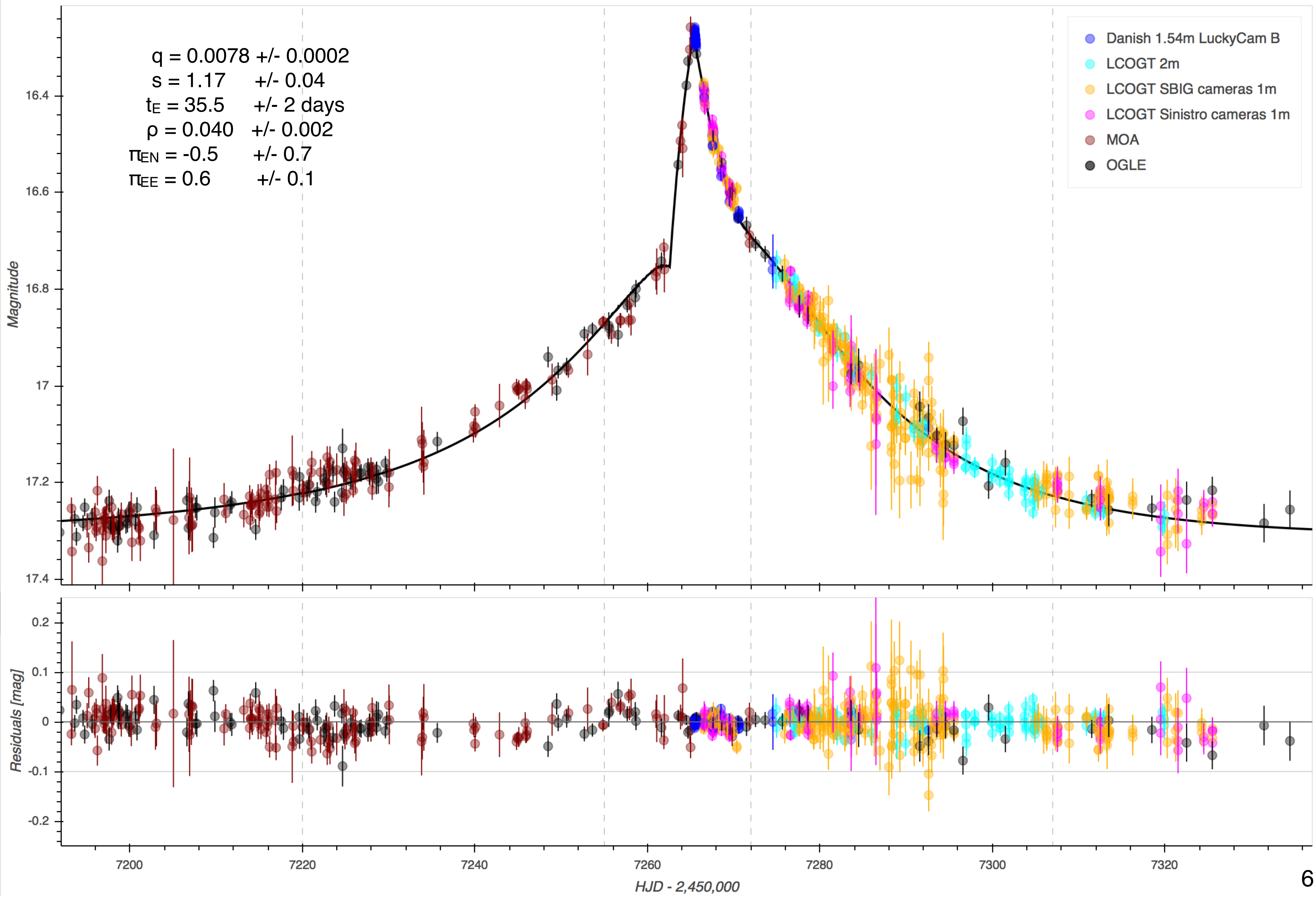
✦ Annual parallax

- Two components of $\boldsymbol{\pi_E} = \frac{\pi_{\rm rel}}{\theta_{\rm E}} \frac{\boldsymbol{\mu_{rel}}}{\mu_{\rm rel}} = \frac{\mathrm{AU}}{\tilde{r}_{\rm E}}$

✦ Lens orbital motion

- Two addtional parameters $\gamma_\parallel = \dot{s}/s \qquad \gamma_\perp = \dot{\alpha}$

Planetary model



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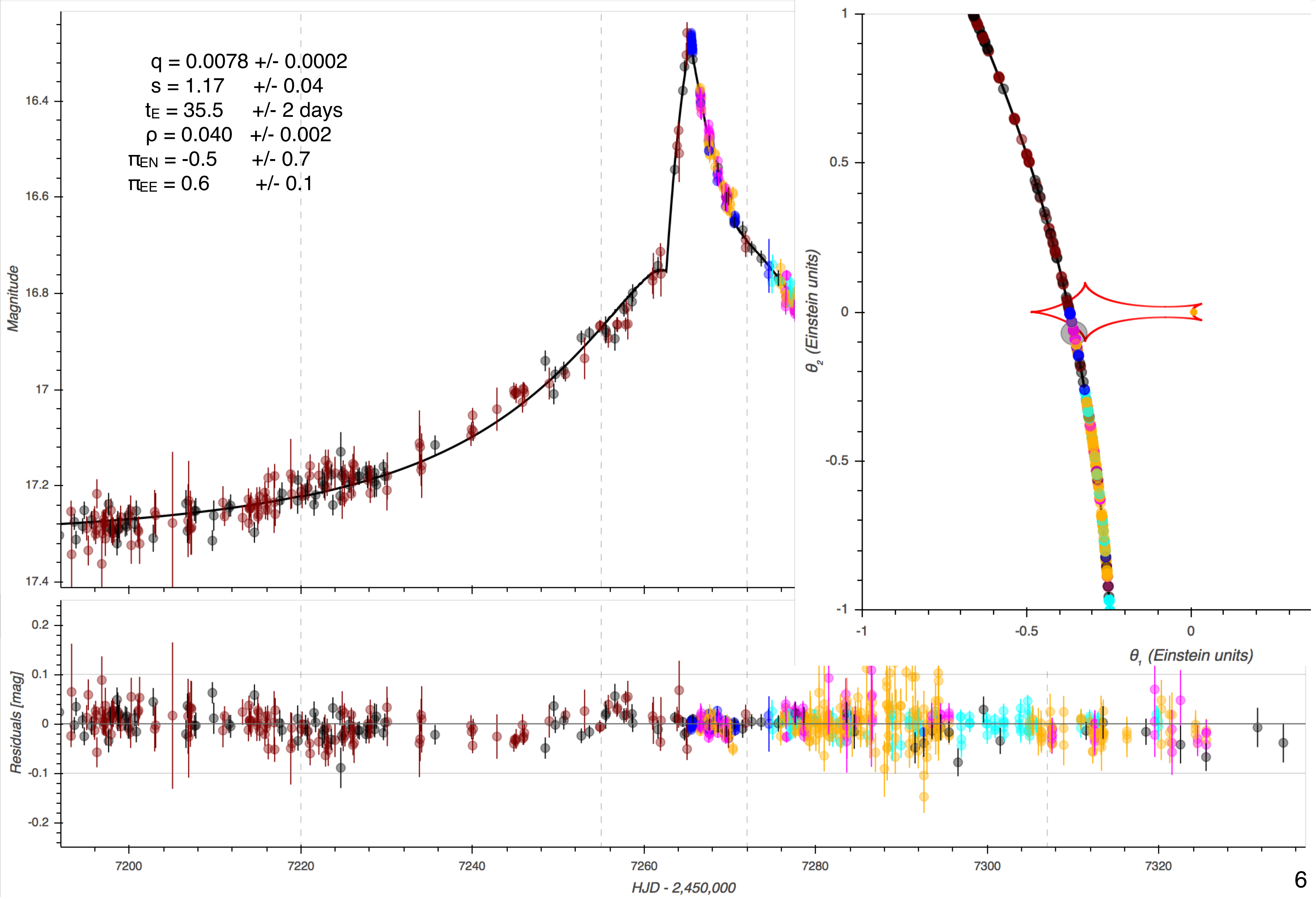

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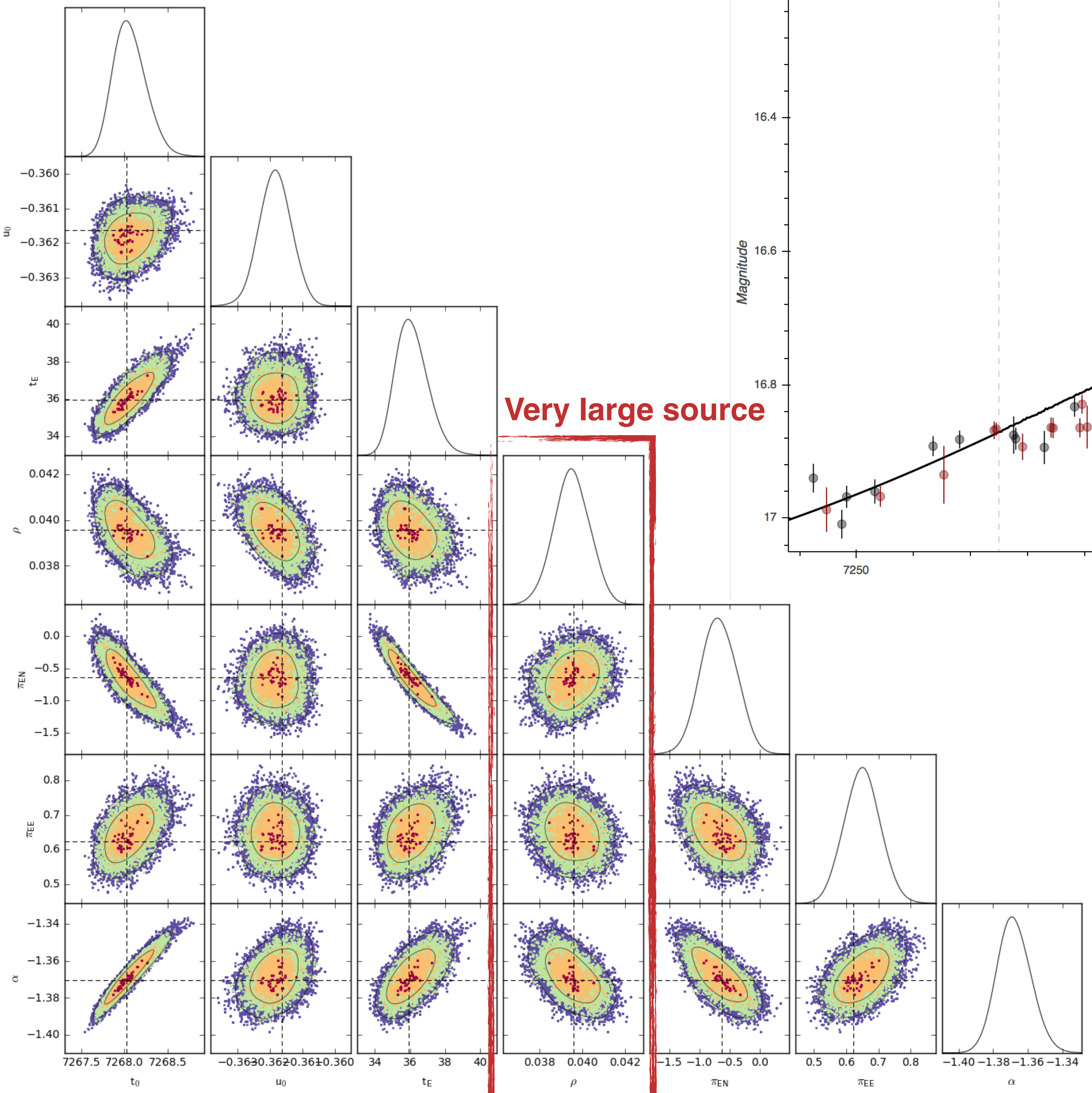
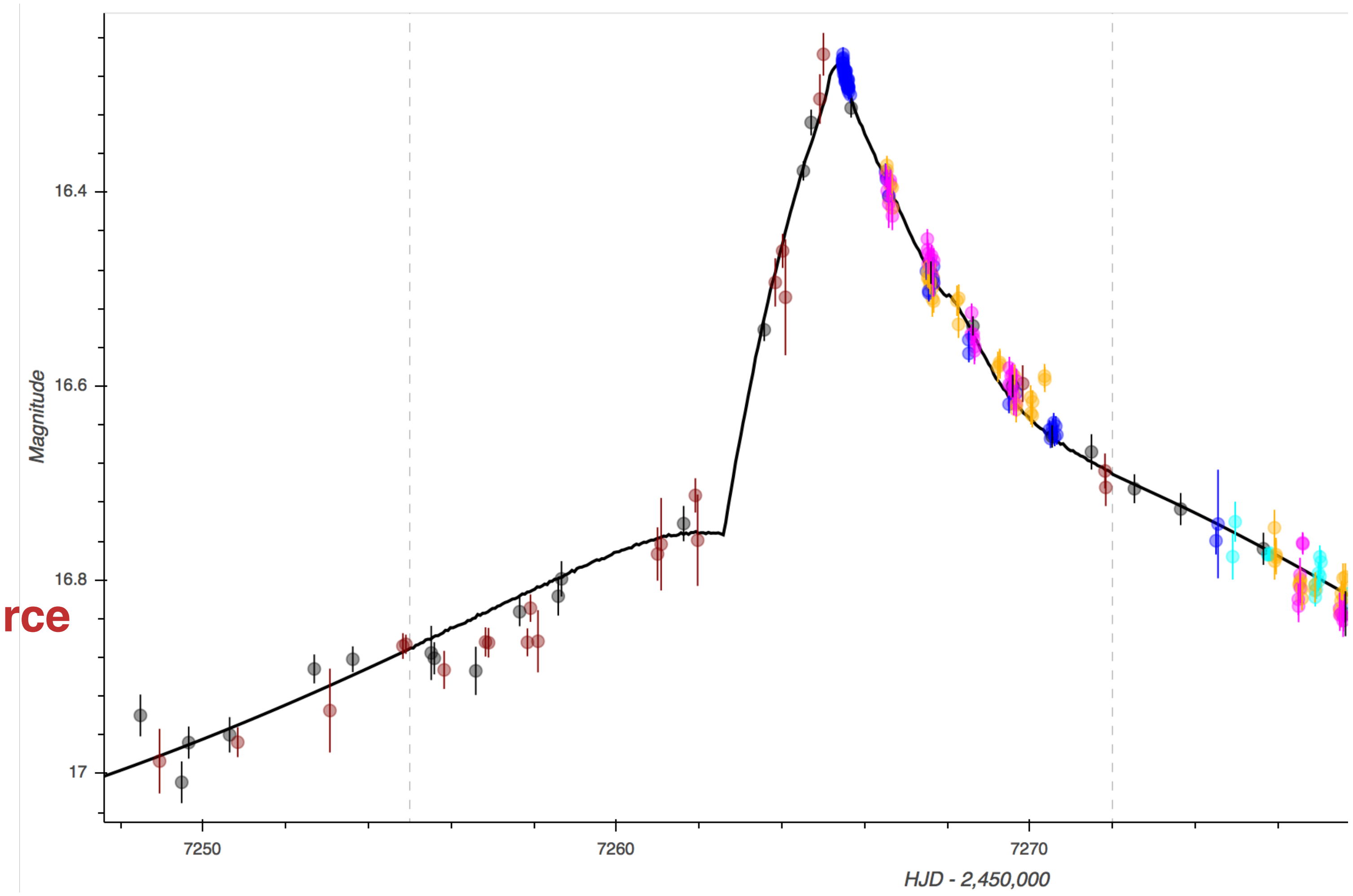




- Mass ratio q ~ 0.008

Planetary mass ratio

- Separation s ~ 1.17

Source characterization

✦ **Measuring the source angular radius yields θ_E:** $\rho = \frac{\theta_S}{\theta_E}$

✦ **From the light curve modeling**

- Light curve fitting gives source flux in I-band $I_S = 18.15$
- Best light curve model yields source flux in V-band $V_S = 20.50$
- Source color $(V\text{-}I)_S = 2.35$

✦ **From the OGLE CMD**

- Correction of reddening with RCG method (Nataf et al.2013)

  $I_{S0} = 16.43$

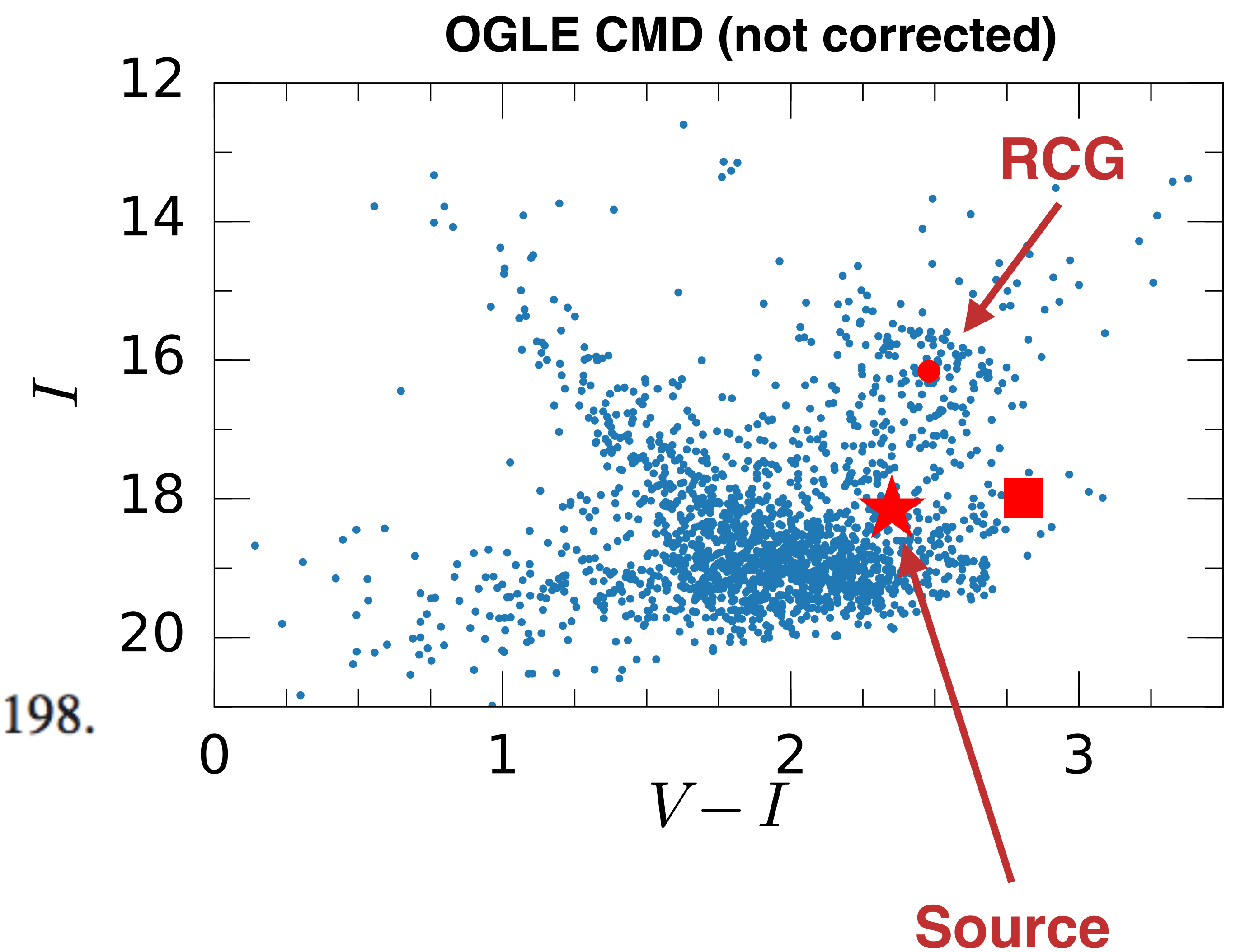
  $(V\text{-}I)_{S0} = 0.932$

- First estimation of the angular source radius (Kervella & Fouqué 2008)

$$\log \theta_* = -0.2 I_\circ + 0.4895 (V-I)_\circ - 0.0657 (V-I)_\circ^2 + 3.198.$$

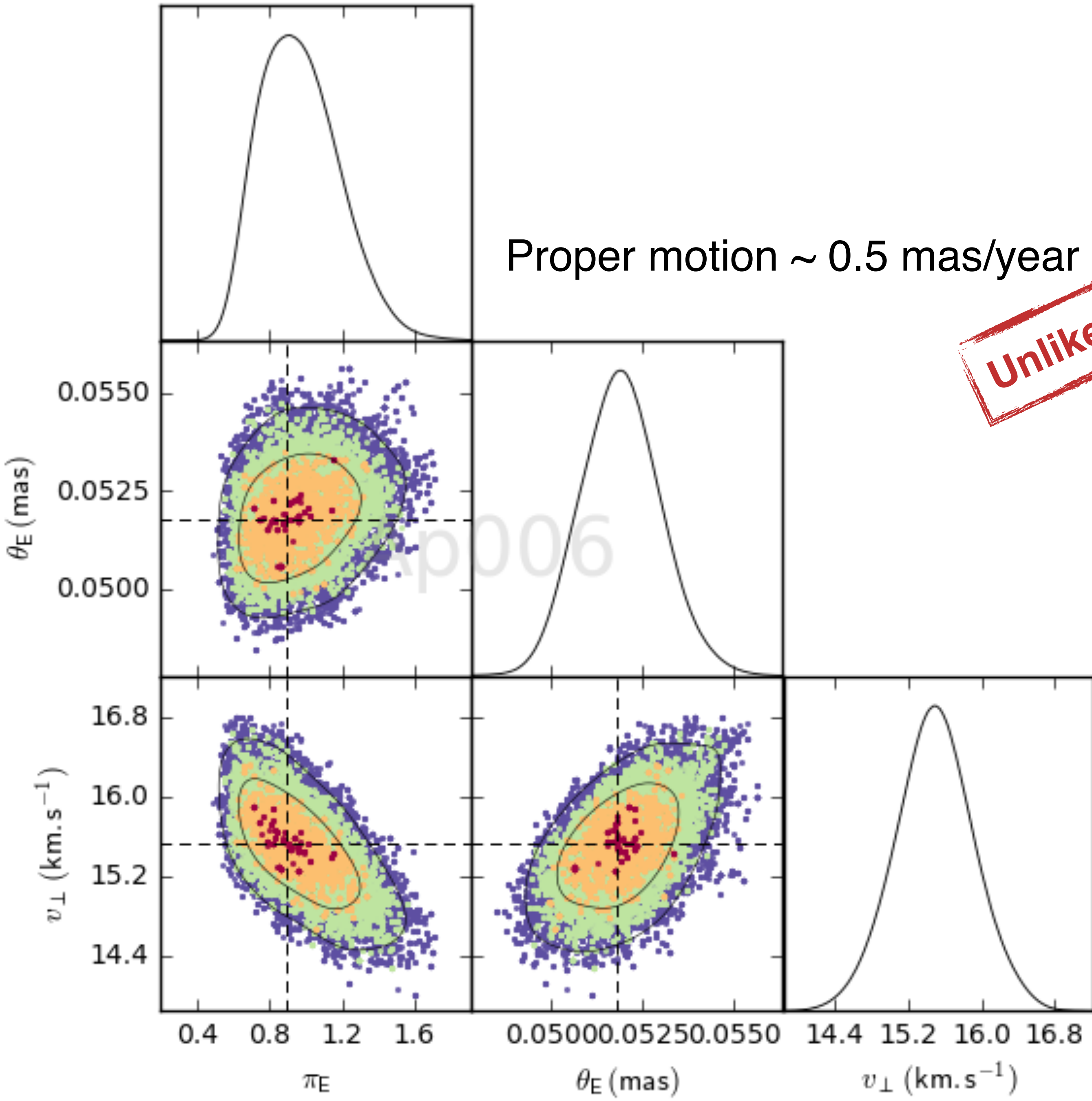
$\theta_* = 2.1\ \mu\text{as}$

→ **Subgiant source**



Discussion on the lens properties

✦ Lens properties



Proper motion ~ 0.5 mas/year

Unlikely

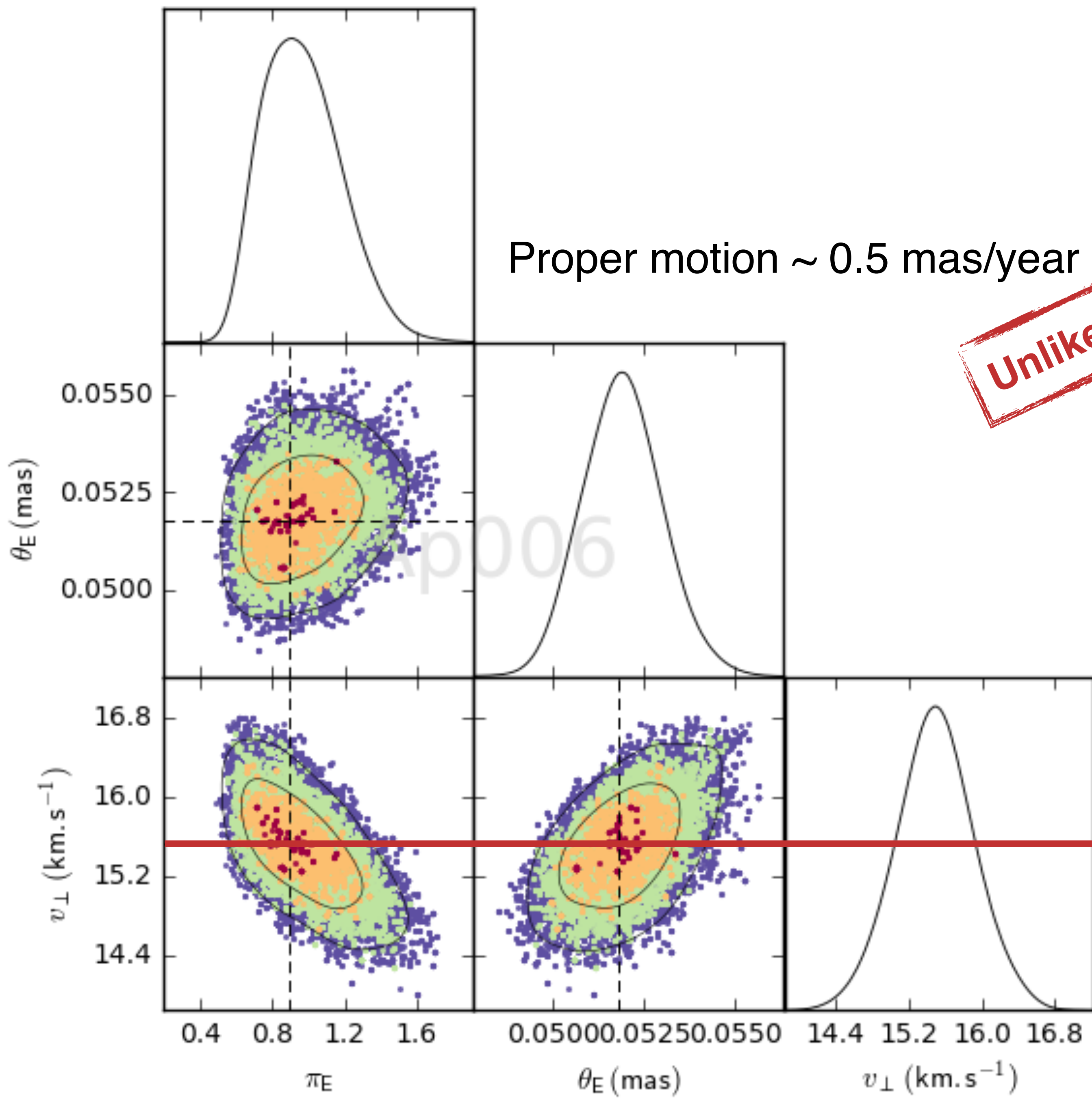
Measuring parallax effects

$$\frac{M}{\mathrm{M}_\odot} = \frac{1}{\kappa\,\pi_\mathrm{E}^2}\left(\frac{1\,\mathrm{kpc}}{D_\mathrm{L}} - \frac{1\,\mathrm{kpc}}{D_\mathrm{S}}\right)$$

✦ Very unlikely situation for a timescale of 35 days

Discussion on the lens properties

✦ **Lens properties**



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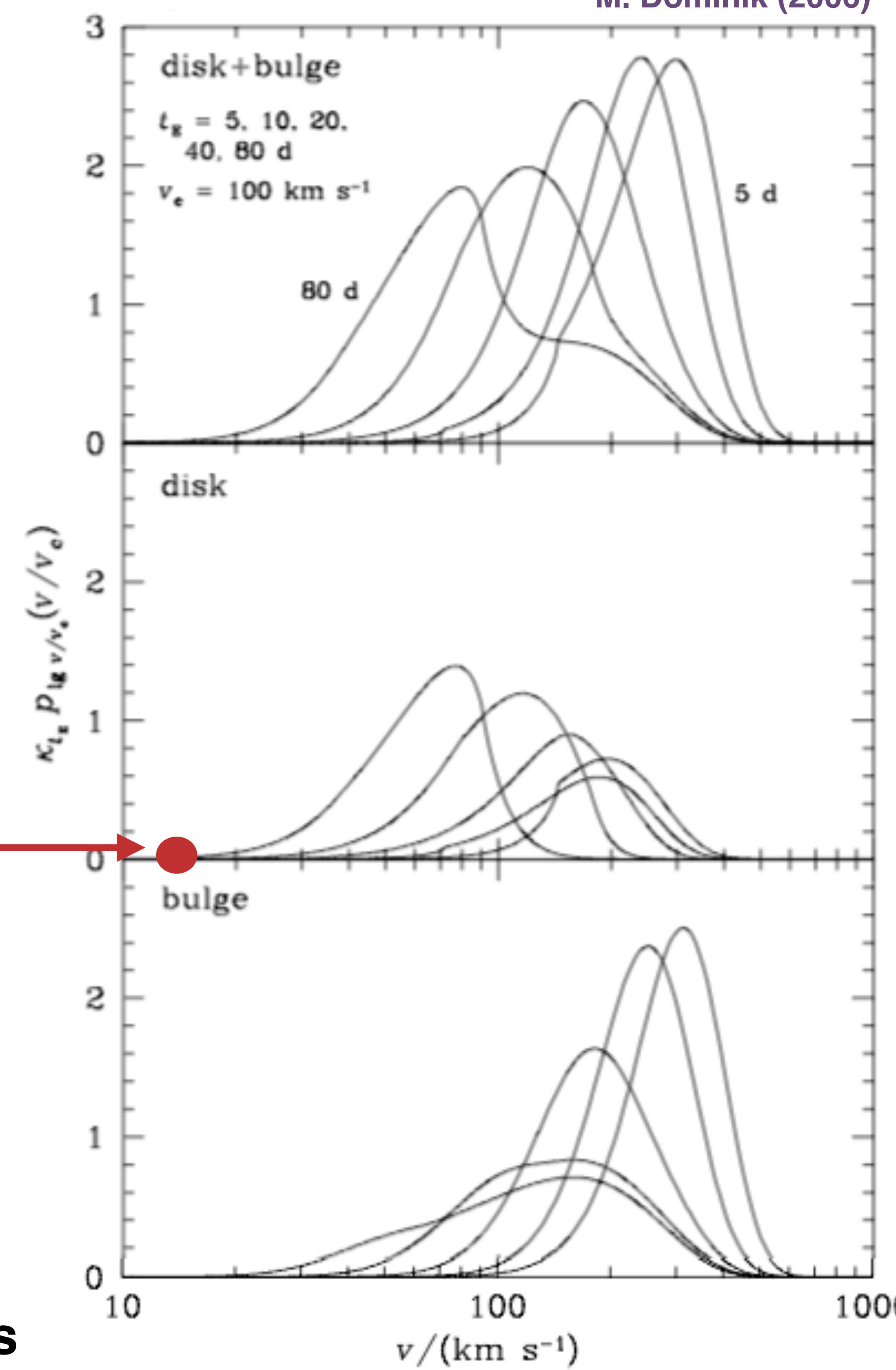
Unlikely

✦ **Galactic model prediction**

M. Dominik (2006)



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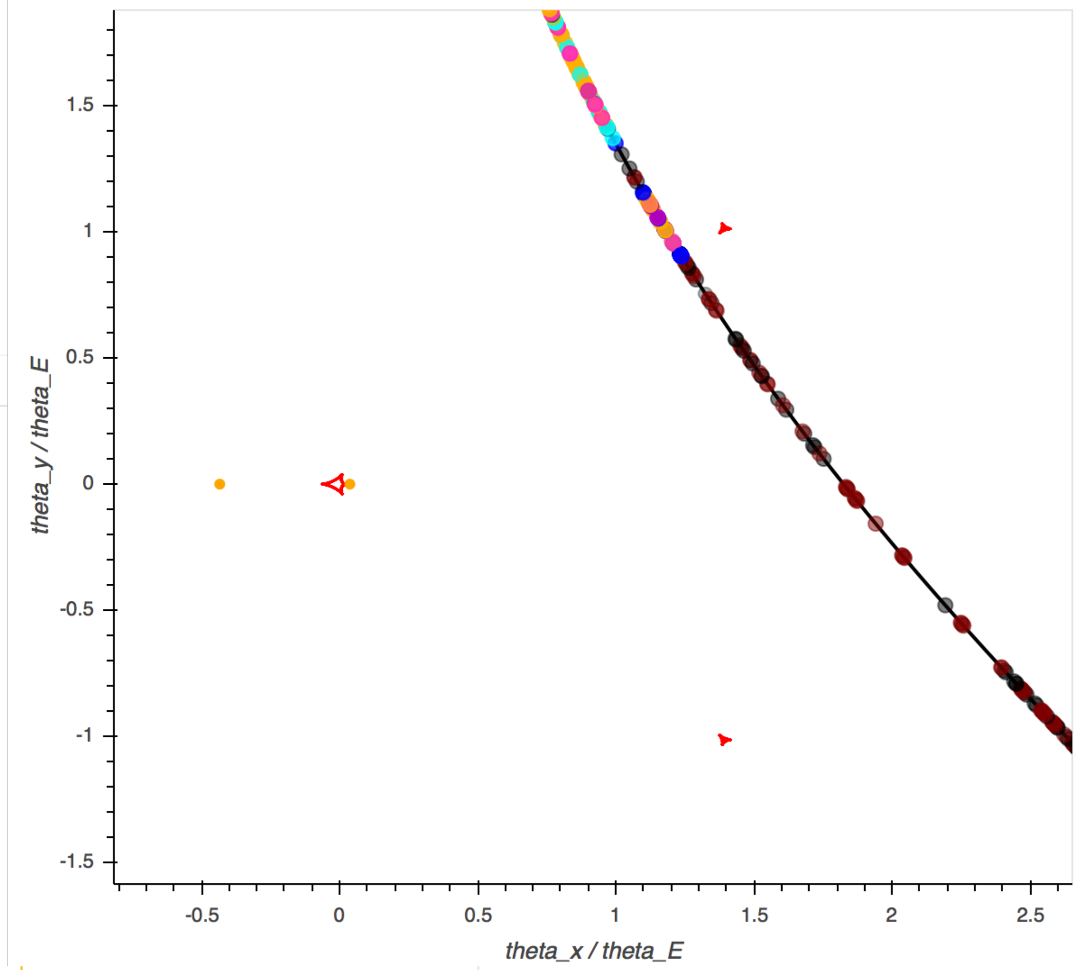
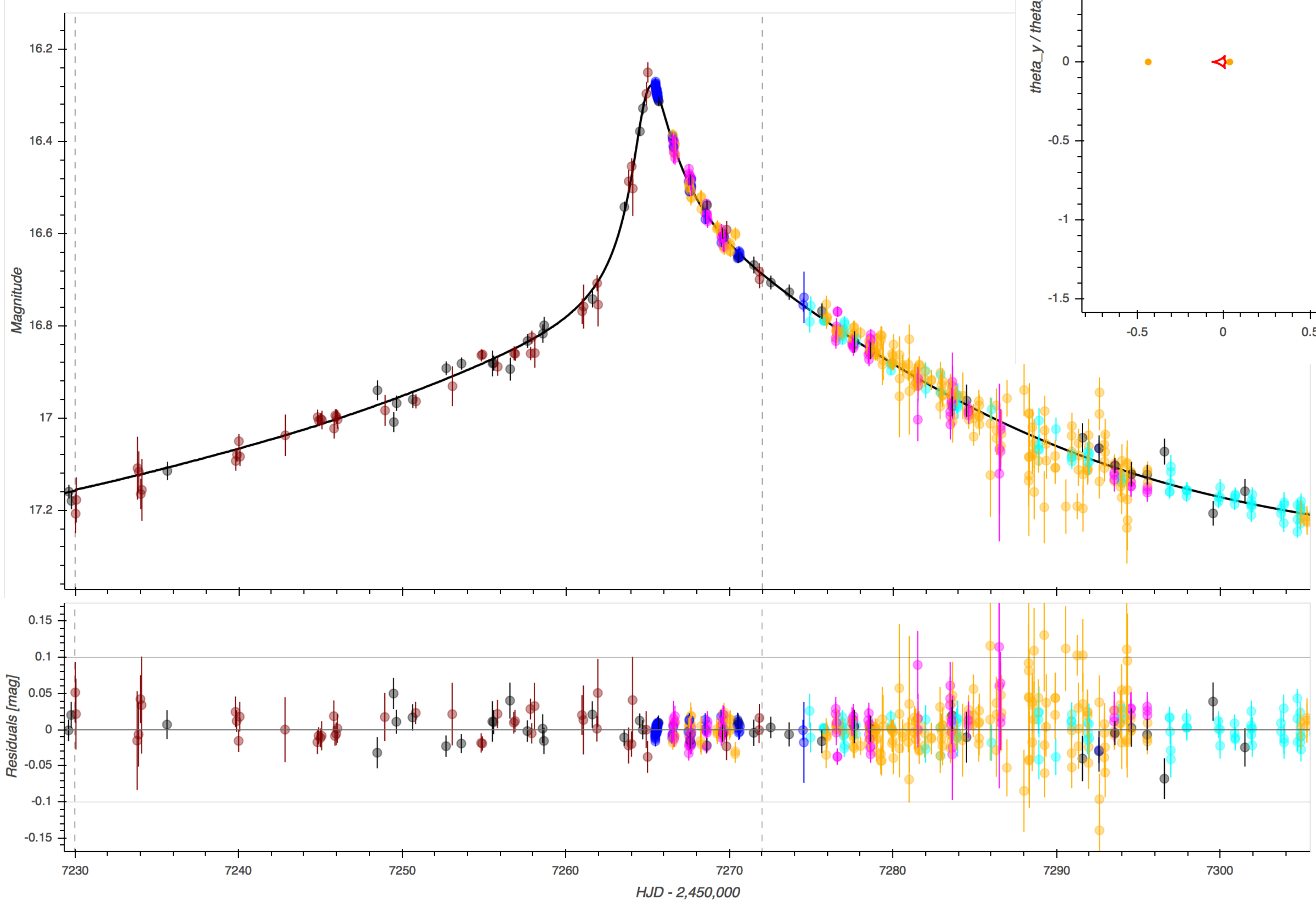
✦ **Very unlikely situation for a timescale of 35 days**

Impact of the photometry quality

- Data re-reduction leads to **new competive models**
- Models degenarated (geometry)
- **Blending ratio for OGLE: -0.8**

→ **not physically acceptable**

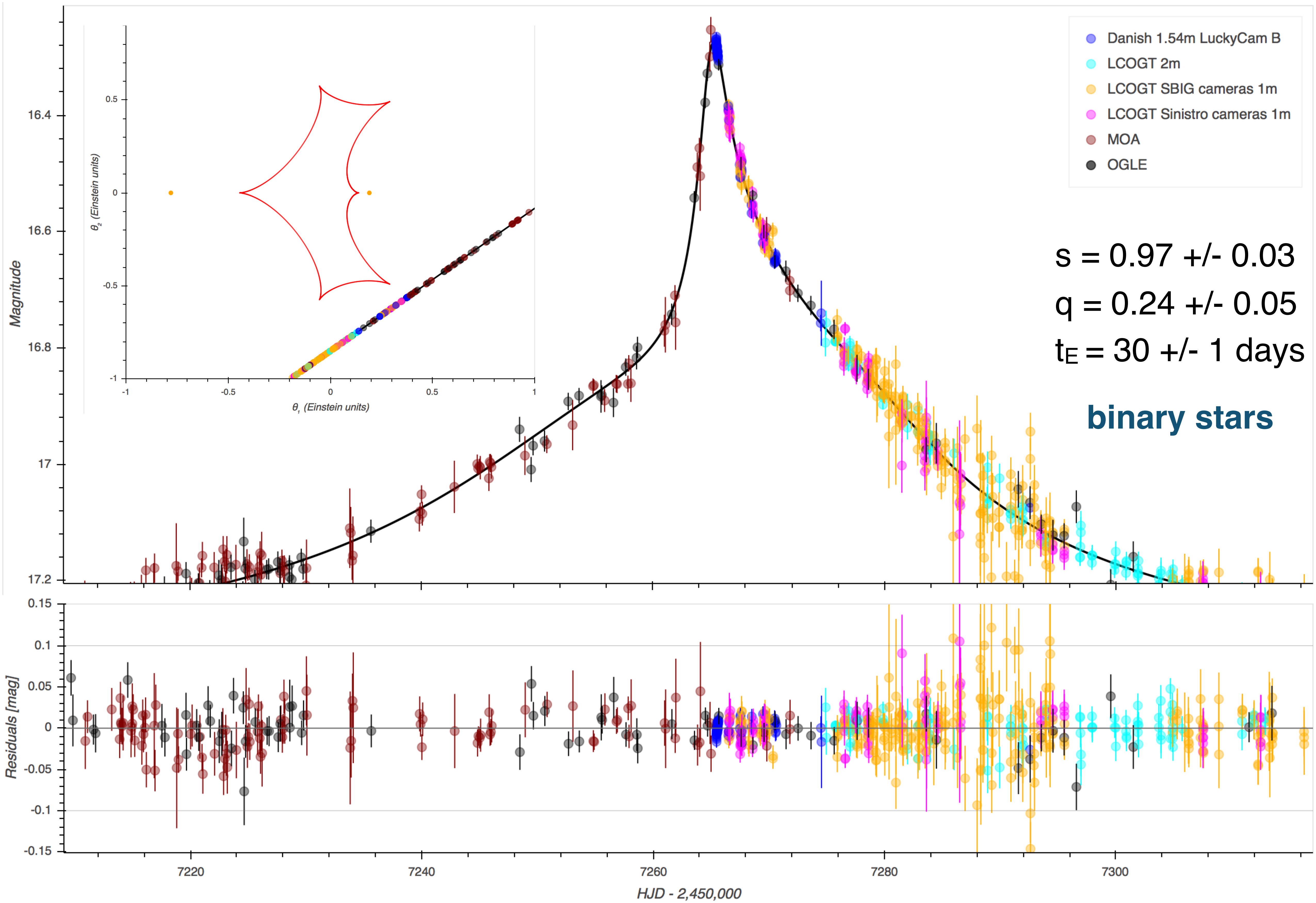




- q ~ 0.09
- s ~ 0.47

Best-fitting static model

- Very recent new broad exploration give finally a lens consisting in a binary stars mass ratio



s = 0.97 +/- 0.03

q = 0.24 +/- 0.05

t_E = 30 +/- 1 days

binary stars

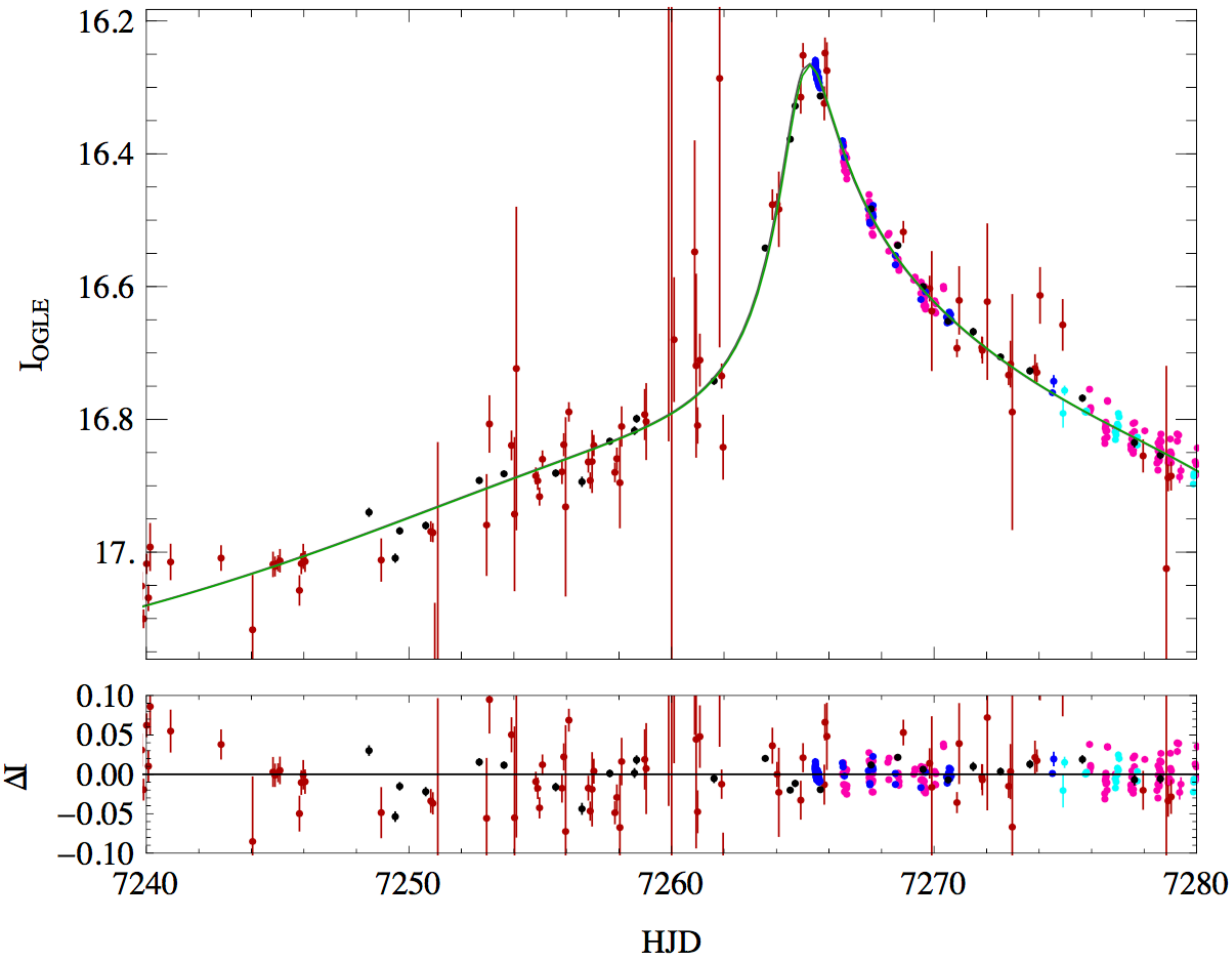
Best-fitting model

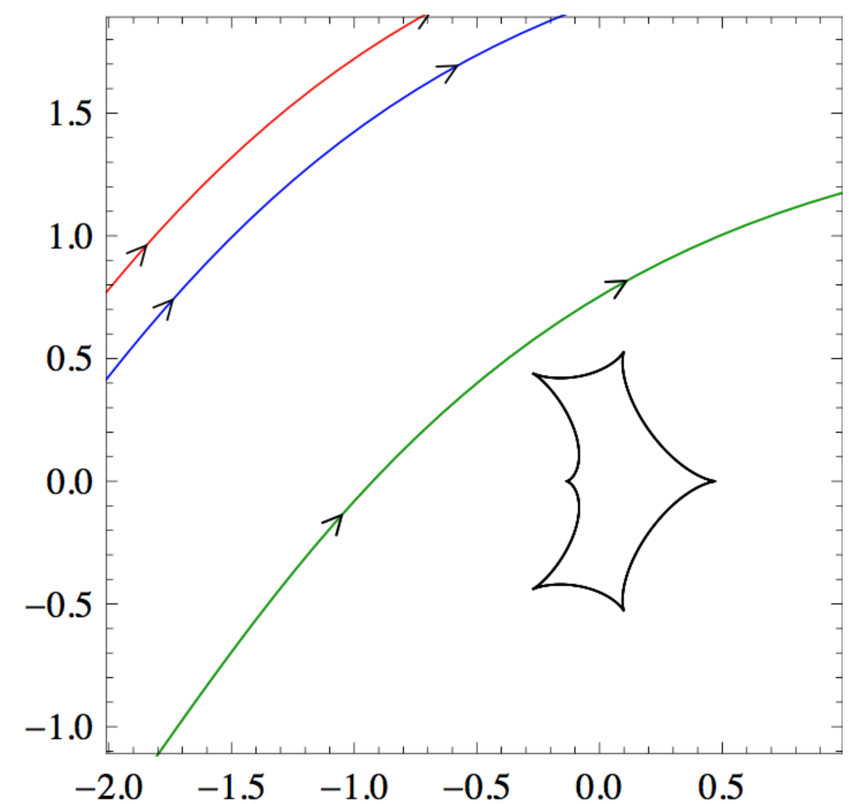
- Model with parallax from **RTModel (Valerio Bozza)**

s=1.00795±0.168779　q=0.225038±0.244761　u0=0.624049±0.331157

θ=3.79636±0.270016　$\rho*$=0.0000101301±0.381436　tE=28.3391±7.20004

t0=7264.7±3.70615　π1=1.16157±5.93325　π2=−0.00288068±0.986043





Conclusion

- OGLE-2015-BLG-1737 is now better explain by a lens consisting in a binary

- Re-reduction here plays a crucial role in the final result

- Models with parallax and/or orbital motion that fit very well the light curve were not consistant with galactic models

- Models consistant with galactic models had negative blending.

- Models with parallax and orbital motion are still under investigation but these effects seems to be clearly detected in the light curve.

Mass and distance to the lens should be constrained.