Distant Eclipsing Binary System Revealed with the Microlensing Telescope

Łukasz Wyrzykowski

(woo-cash vi-zhi-kov-ski)

Institute of Astronomy, University of Cambridge, UK

Warsaw University Astronomical Observatory, Poland

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Contributors

- Jan Skowron
- Andy Gould
- Subo Dong
- MicroFUN, RoboNet, PLANET observers
- Alex Bergier (the title)

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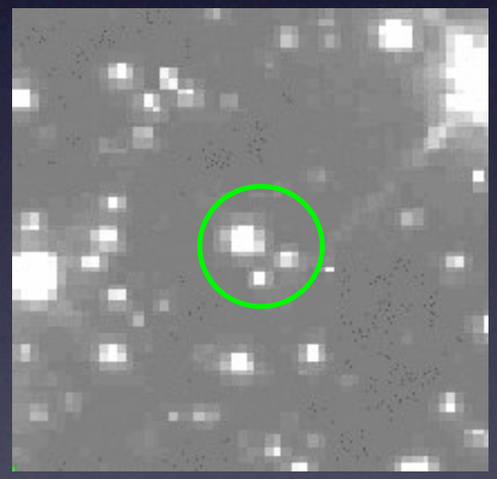
Microlensing of variable stars

models

variable source
- single (no blending)
- with additional constant flux (blended)

variable blend

GROUND



HST

Wyrzykowski et al. 2006, AcA 56,169

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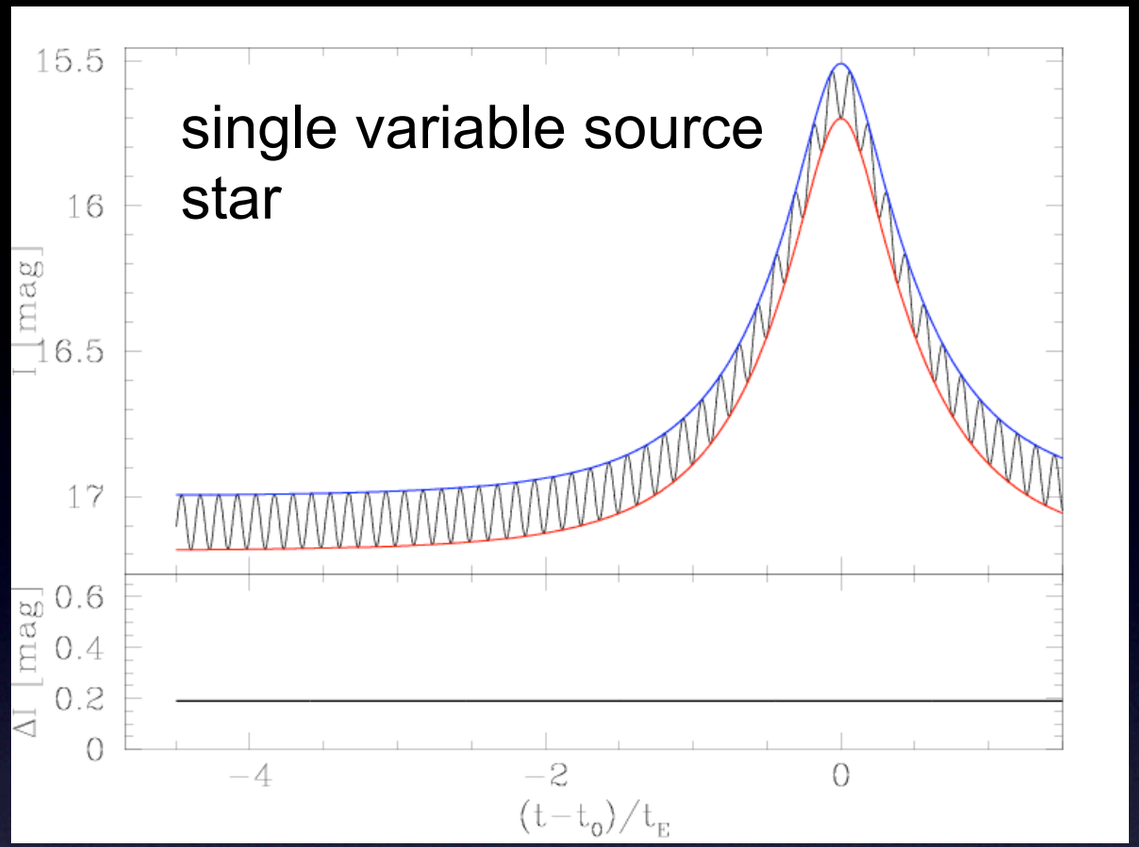
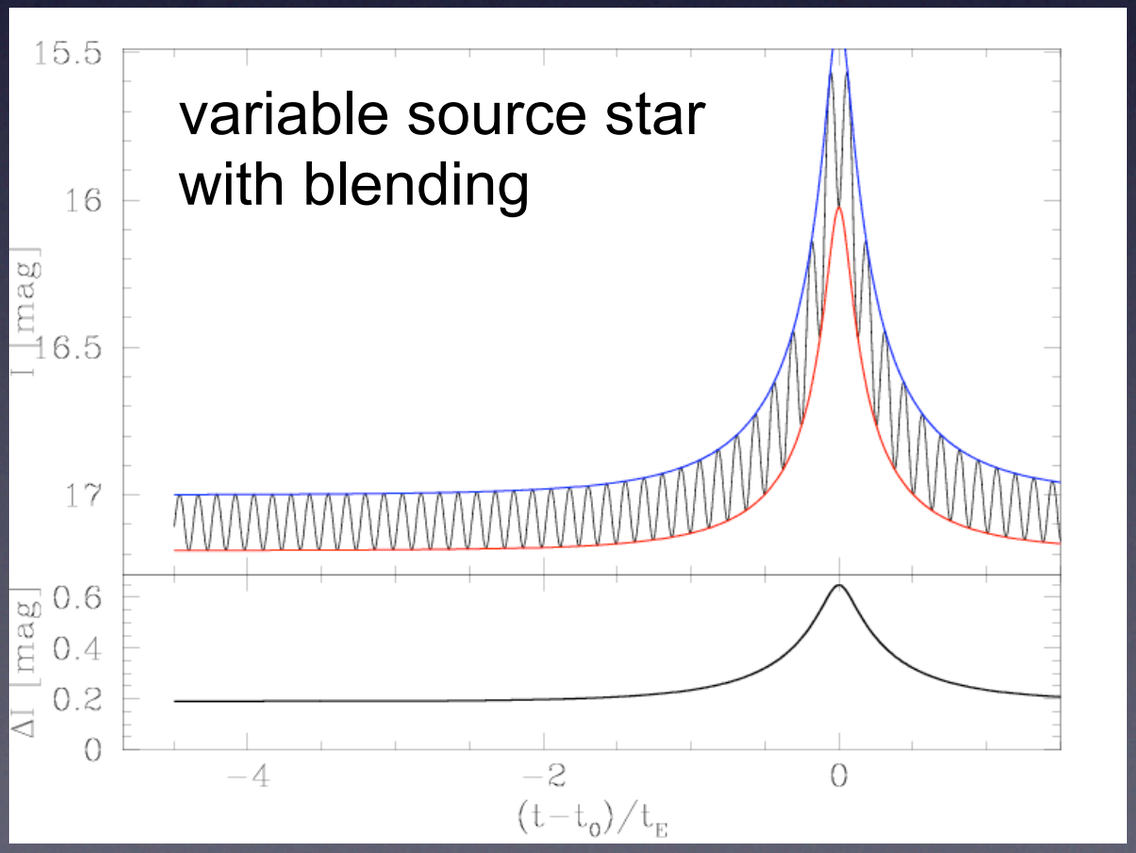
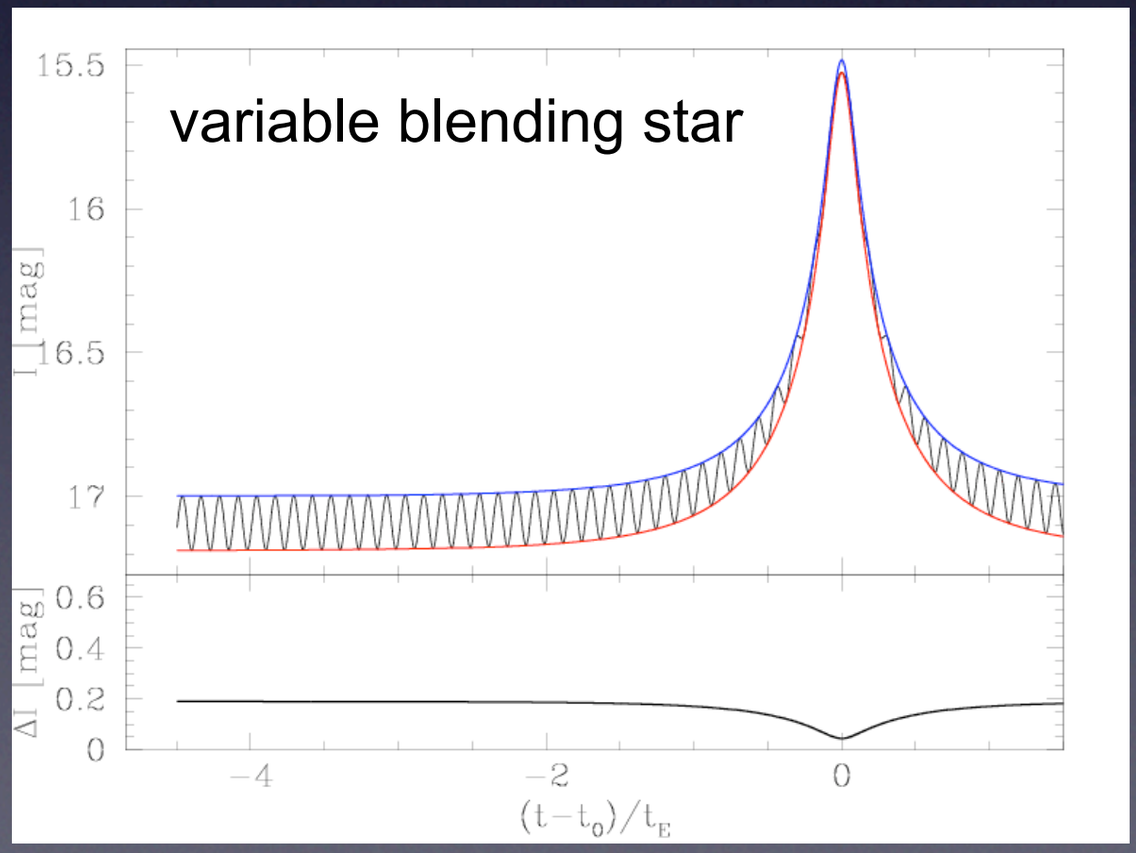
Amplitude of lensed variable







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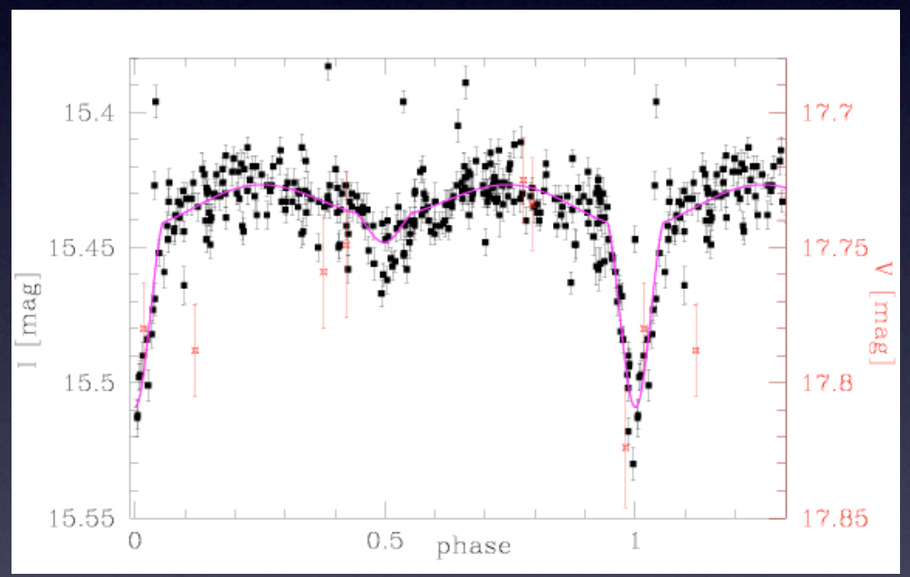
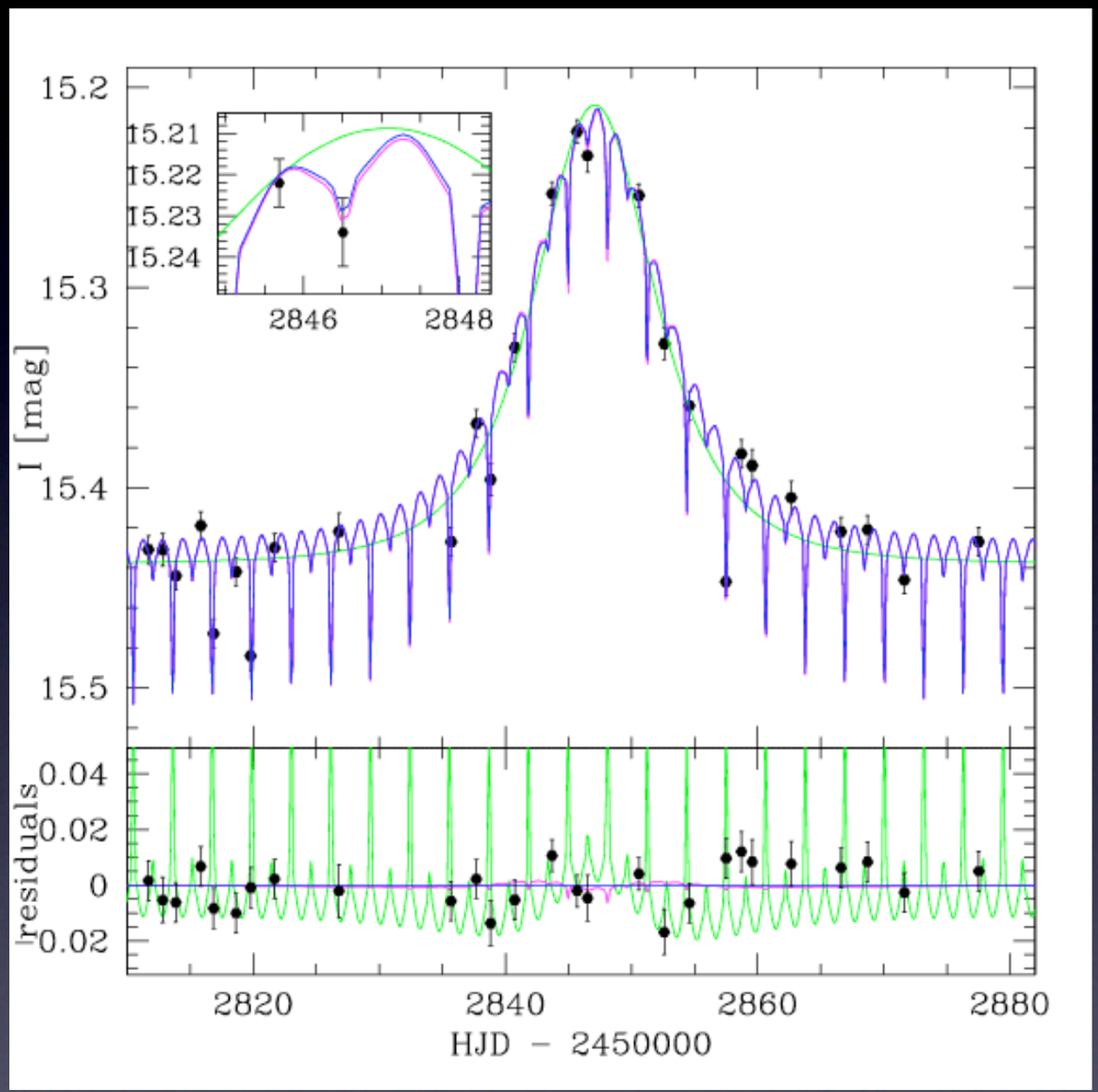
Eclipsing binary in the baseline

OGLE180047.11-285934.5

P= 3.1348 d





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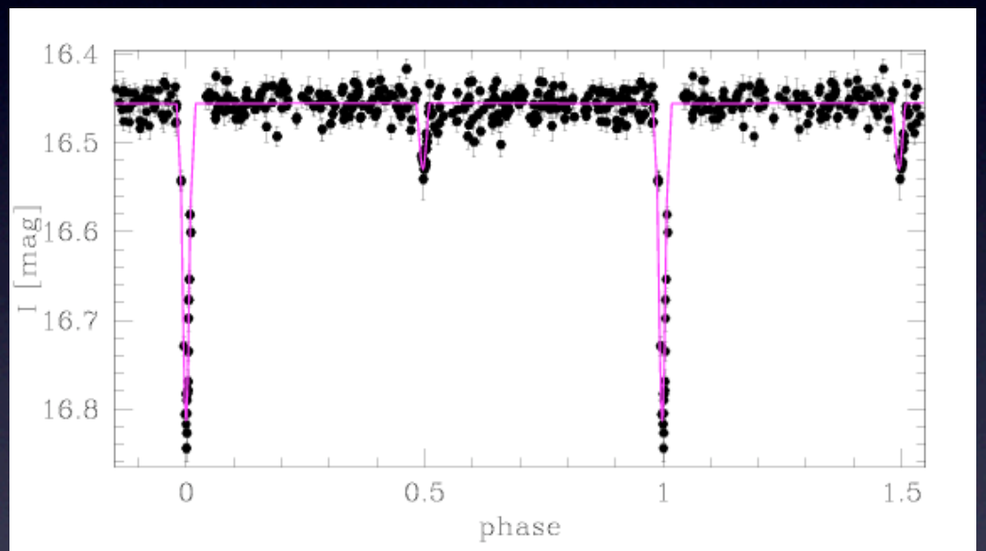
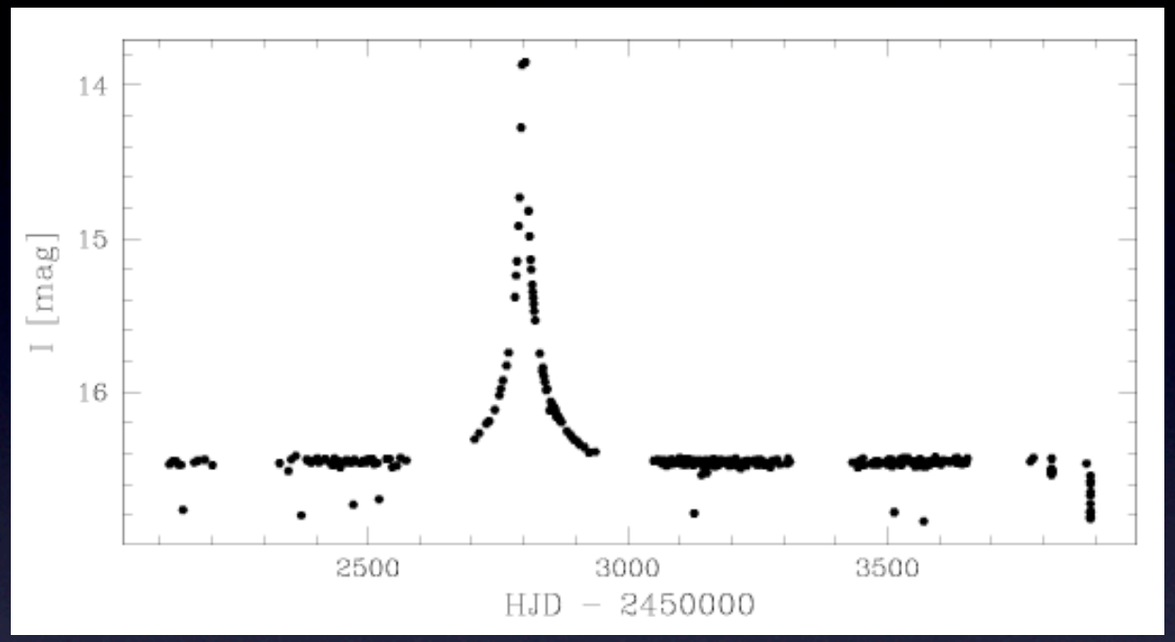
Long time-scale eclipsing binary event

P = 7.1305 d
t_E = 118 d
A_{max} = 24





No eclipses observed during the event - three posible hypotheses

1. *Eclipsing binary being a source - rejected*
2. *Eclipsing binary being a lens (binary) - no confirmation yet...*
3. *Eclipsing binary acting as a blend to a regular event*

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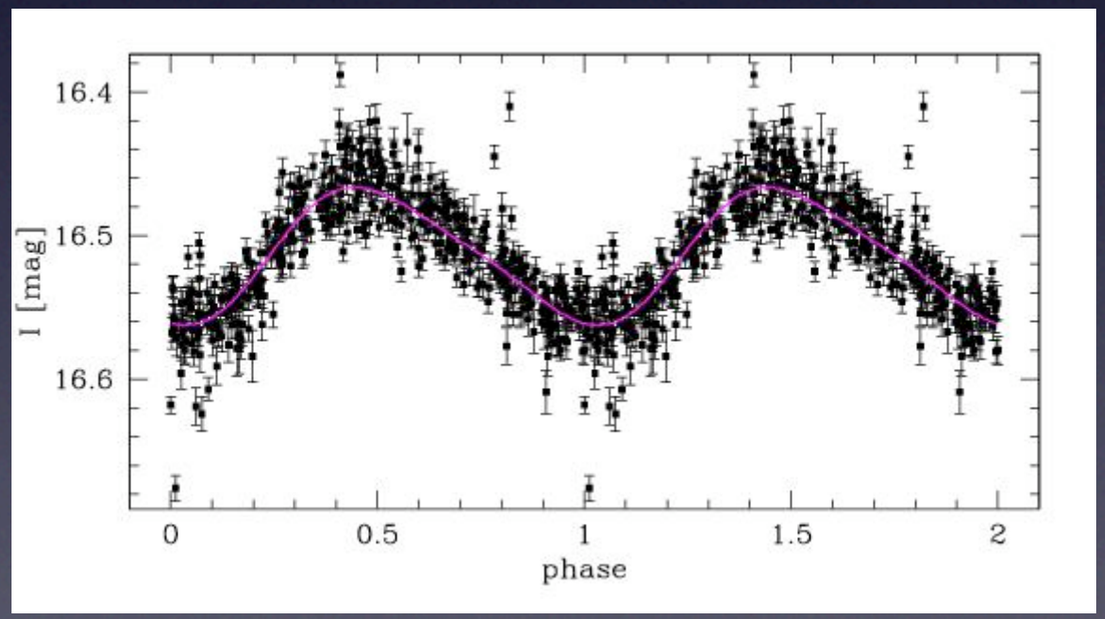
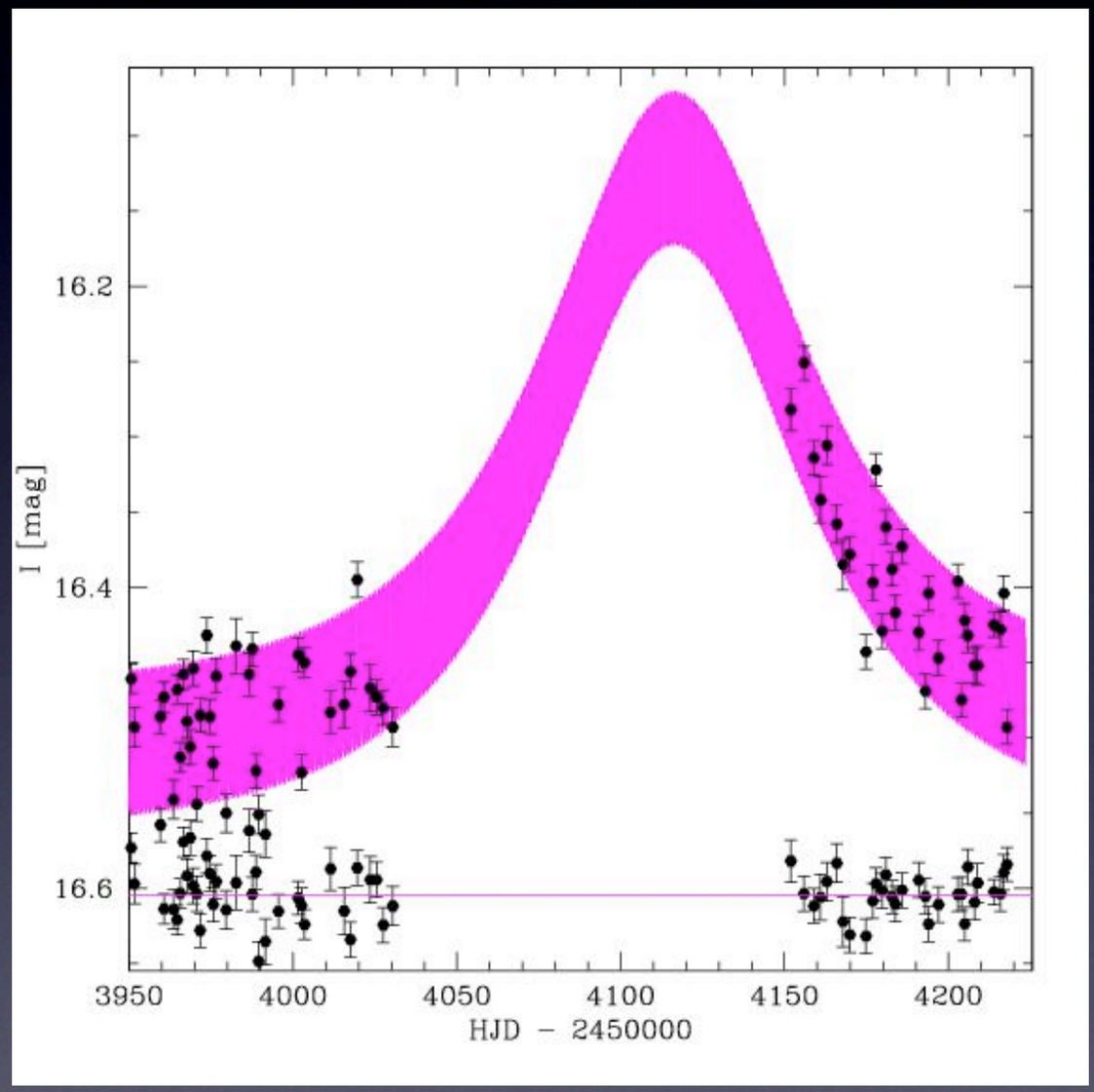
Microlensing of RR Lyrae variable
OGLE 2007-BLG-044

P= 0.29 d ~ 7 h





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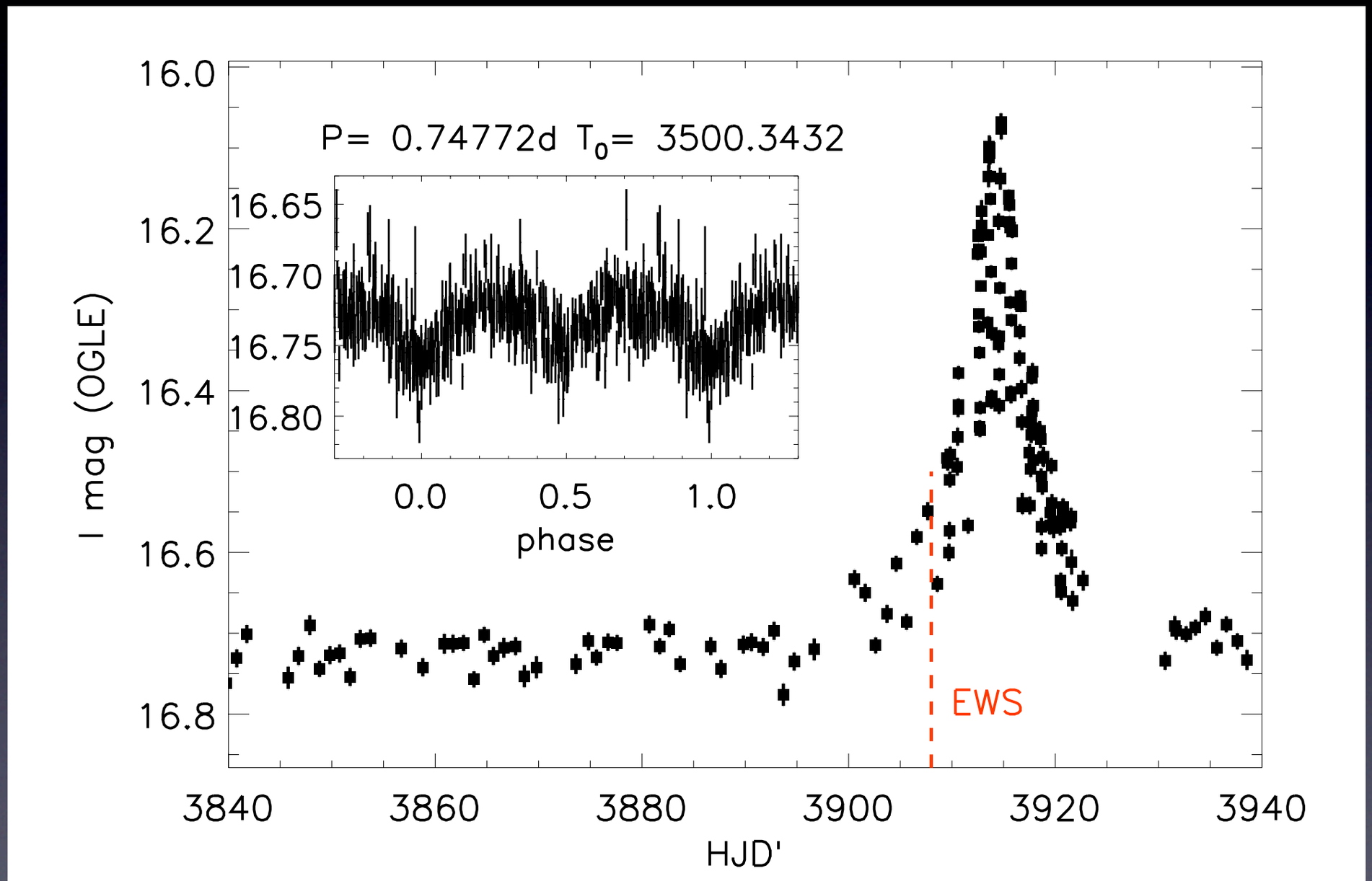
OGLE 2006-BLG-357



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OGLE 2006-BLG-357
Microlensing Model

- increase of the amplitude → variability of the source
- modelling with a 'shape' function f_{ecl} :

$$F^{ob}(t) = A(t)[F_S^{ob} \times f_{ecl}^{ob}(t)] + F_B^{ob}$$

- f_{ecl} can be any arbitrary function
- we used 8-harmonics Fourier series (16 parameters)

- after fit: extracting the real 'shape' function:

$$f_{ecl}^{ob}(t) = \frac{F_{data}^{ob} - F_B^{ob}}{AF_S^{ob}}$$

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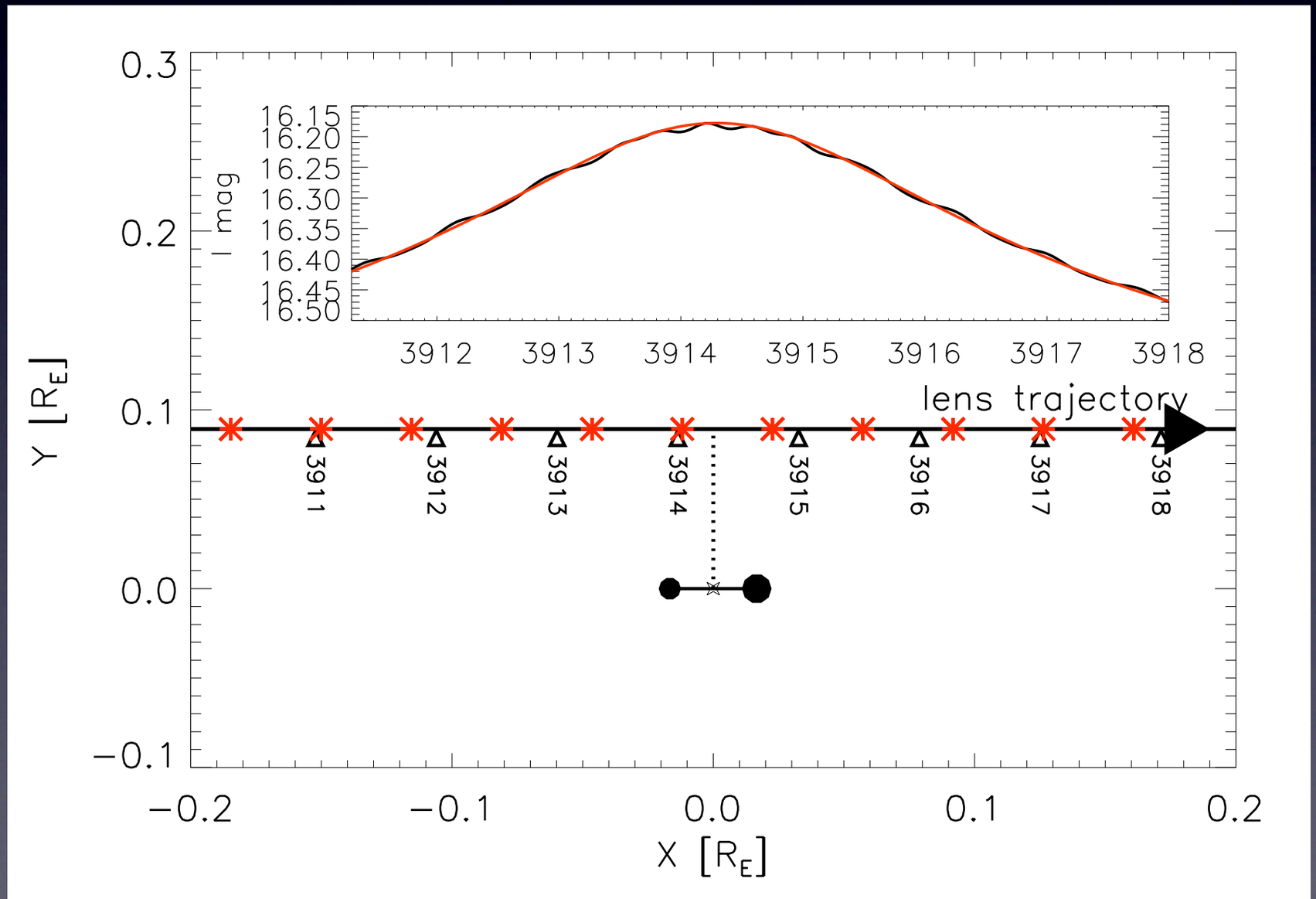
OGLE 2006-BLG-357
Microlensing Model

- the source is apparently in orbital motion
- 'xallarap' effect may be present at 0.01 mag level



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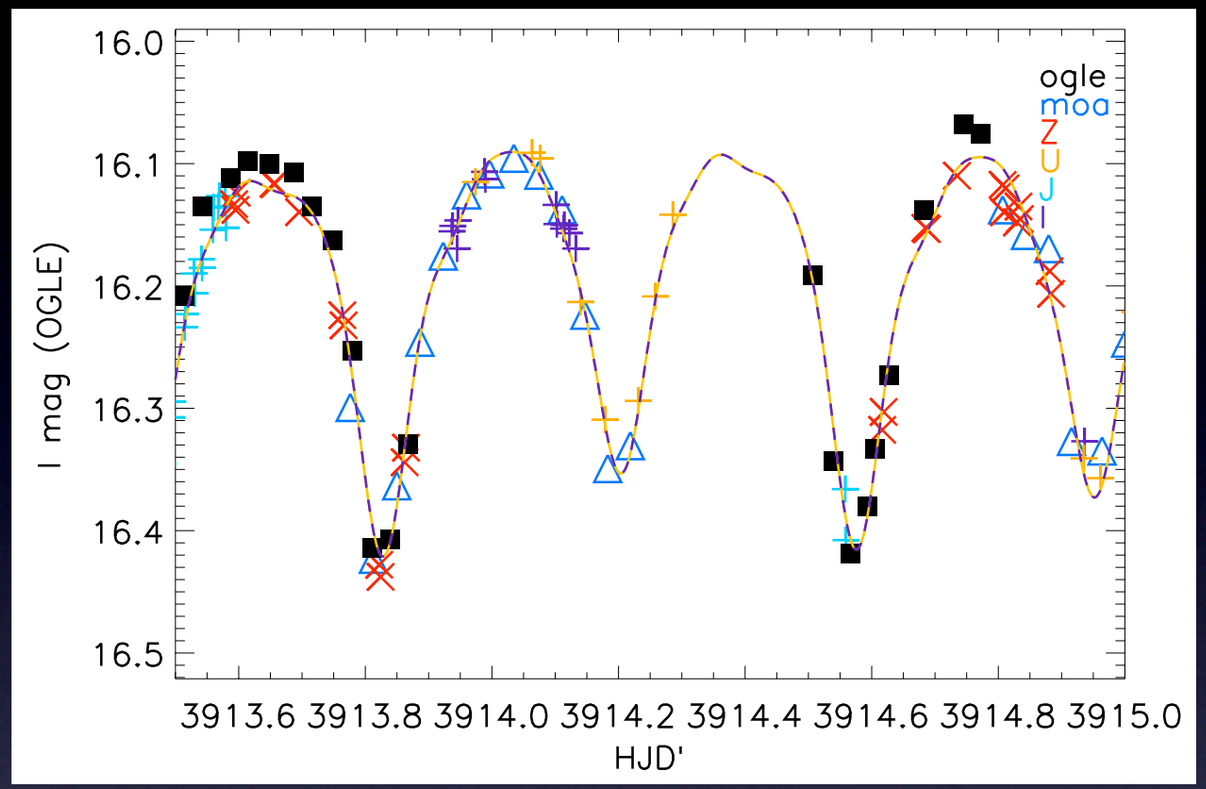
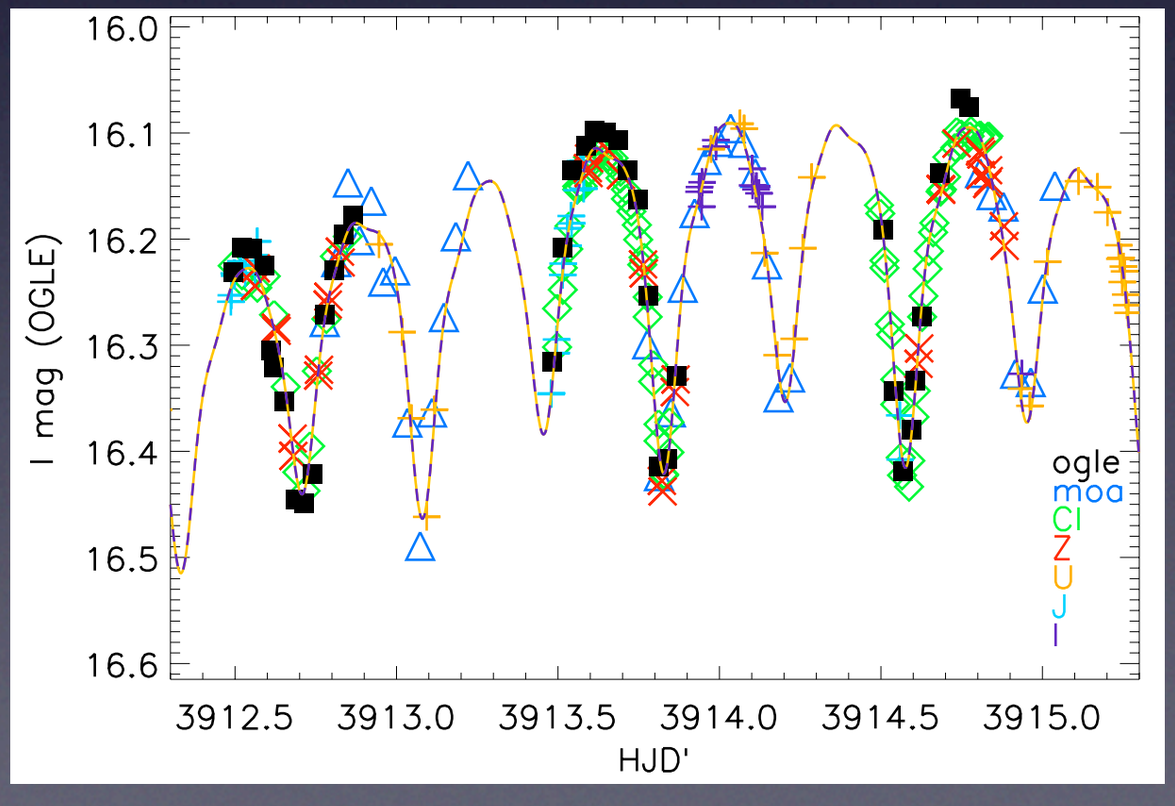
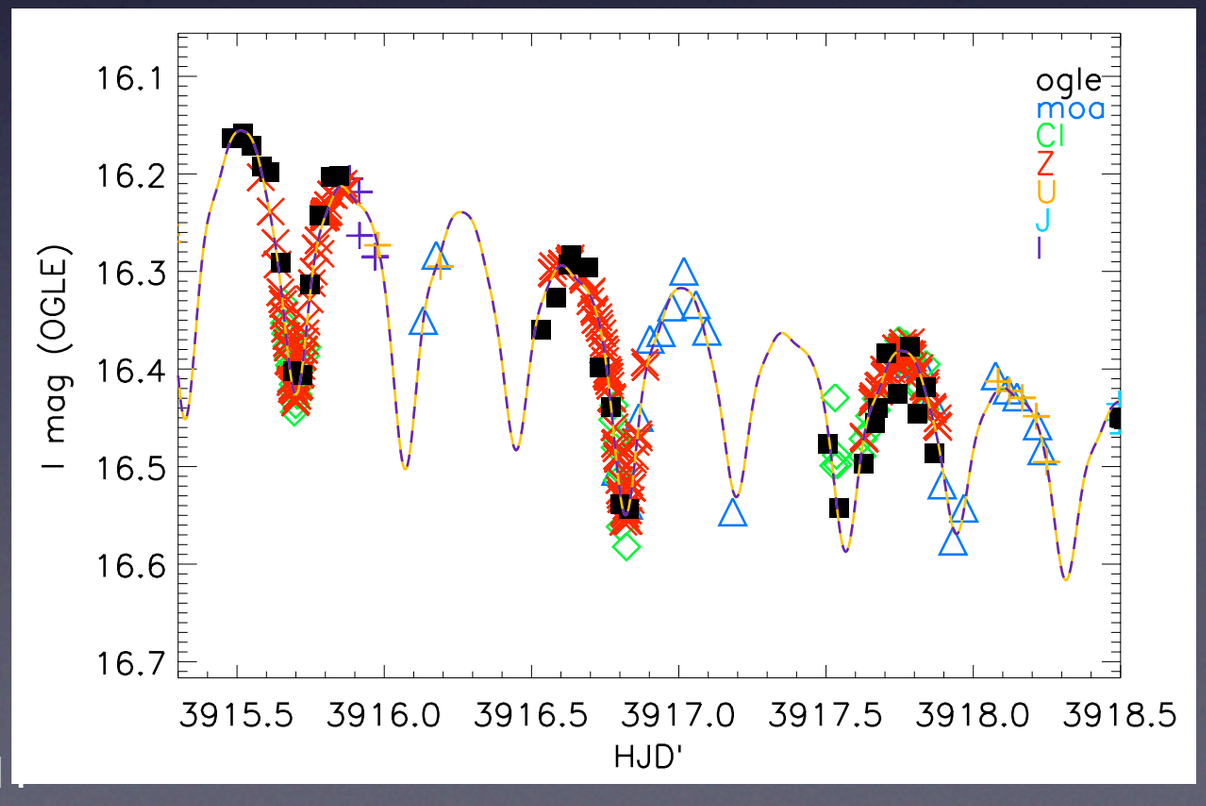
OGLE 2006-BLG-357
Microlensing Model

- OGLE
- MOA
- μFUN I,V,H,J
- Danish 1.54m
- Canopus 1.0m
- Faulkes South 2.0m
- Liverpool 2.0m







OGLE 2006-BLG-357
Microlensing Model

parameter	standard		xallarap	
t_0	3914.289650	±0.001701	3914.293278	±0.001701
$t_{\rm E}$	21.508	±0.217	21.636	±0.217
u_0	0.091122	±0.001080	0.089259	±0.001080
Period	0.747720	±0.000000	0.747720	±0.000000
T_0	3500.343160	±0.000000	3500.343160	±0.000000
a_1	-0.0329	±0.0005	-0.0335	±0.0005
ϕ_1	-0.0236	±0.0165	-0.0246	±0.0165
a_2	-0.2655	±0.0009	-0.2668	±0.0009
ϕ_2	0.0484	±0.0017	0.0426	±0.0017
a_3	-0.0123	±0.0005	-0.0115	±0.0005
ϕ_3	-0.7972	±0.0458	-0.9810	±0.0458
a_4	-0.0797	±0.0005	-0.0788	±0.0005
ϕ_4	0.1554	±0.0063	0.1678	±0.0063
a_5	-0.0134	±0.0005	-0.0146	±0.0005
ϕ_5	0.8174	±0.0329	0.8554	±0.0329
a_6	-0.0310	±0.0005	-0.0317	±0.0005
ϕ_6	0.2925	±0.0164	0.2926	±0.0164
a_7	0.0019	±0.0005	-0.0024	±0.0005
ϕ_7	-33.0721	±0.2014	1.3917	±0.2014
a_8	-0.0138	±0.0005	-0.0127	±0.0005
ϕ_8	0.0034	±0.0374	-0.0822	±0.0374
$f_{S_{OGLE}}$	0.0665	±0.0007	0.0655	±0.0008
f_{S_Z}	0.0760	±0.0008	0.0748	±0.0009
f_{S_U}	0.0754	±0.0009	0.0764	±0.0010
f_{S_J}	0.1060	±0.0011	0.1040	±0.0012
f_{S_I}	0.1175	±0.0033	0.1167	±0.0034
$f_{S_{CI}}$	0.0683	±0.0009	0.0672	±0.0009
$f_{S_{CV}}$	0.0725	±0.0010	0.0718	±0.0011
$f_{S_{MOA}}$	0.1576	±0.0016	0.1546	±0.0017
$f_{S_{CH}}$	0.0510	±0.0008	0.0500	±0.0008
$f_{S_{CJ}}$	0.0523	±0.0008	0.0520	±0.0008
light ratio	-	-	0.42311	±0.00570
a	-	-	0.016624	±0.001126
χ^2, N_{dof}	4368.1833	2969-29	4370.1440	2969-31

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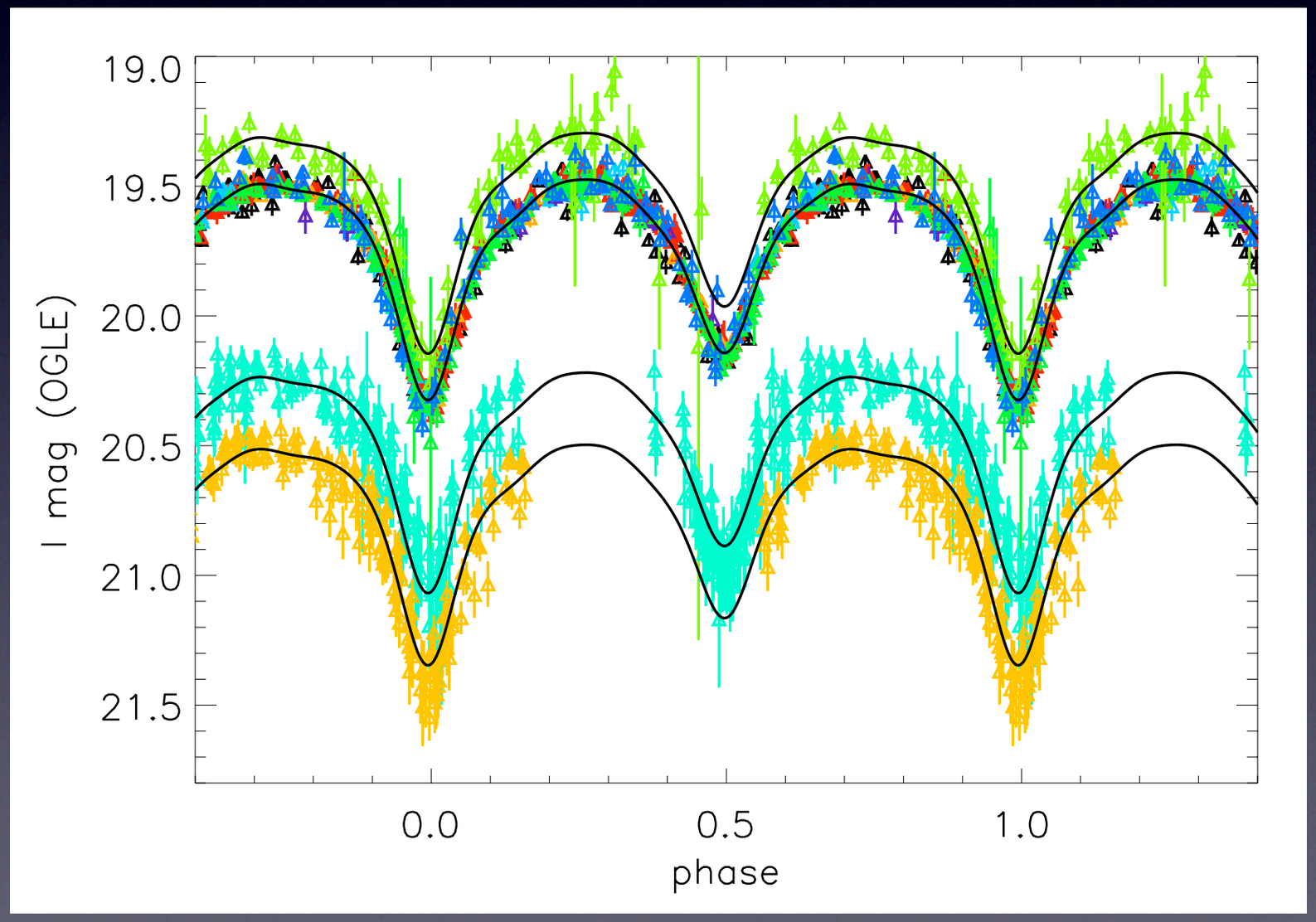
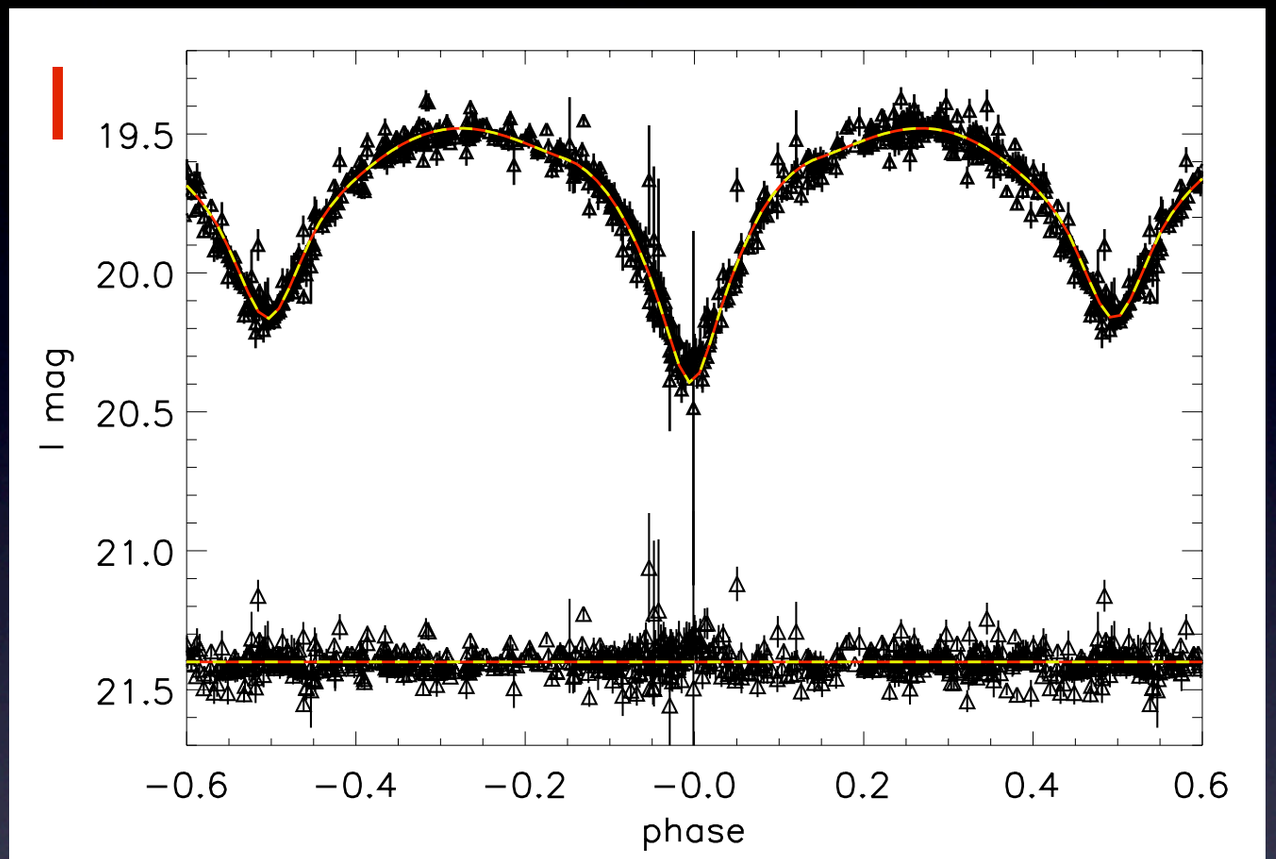
OGLE 2006-BLG-357
Microlensing Model

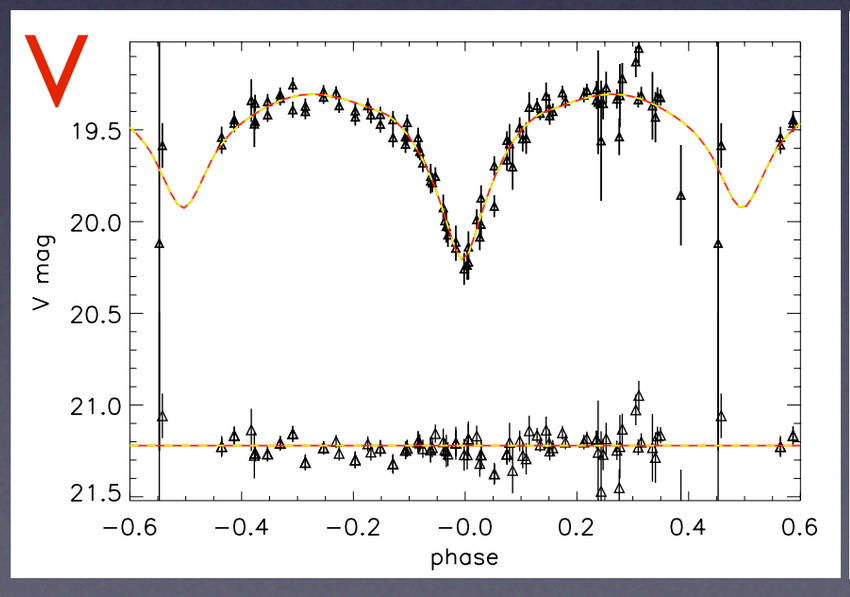
- Shape of the source variability was extracted
- Source brightness was derived using blending parameters
- No colour fluctuations detected

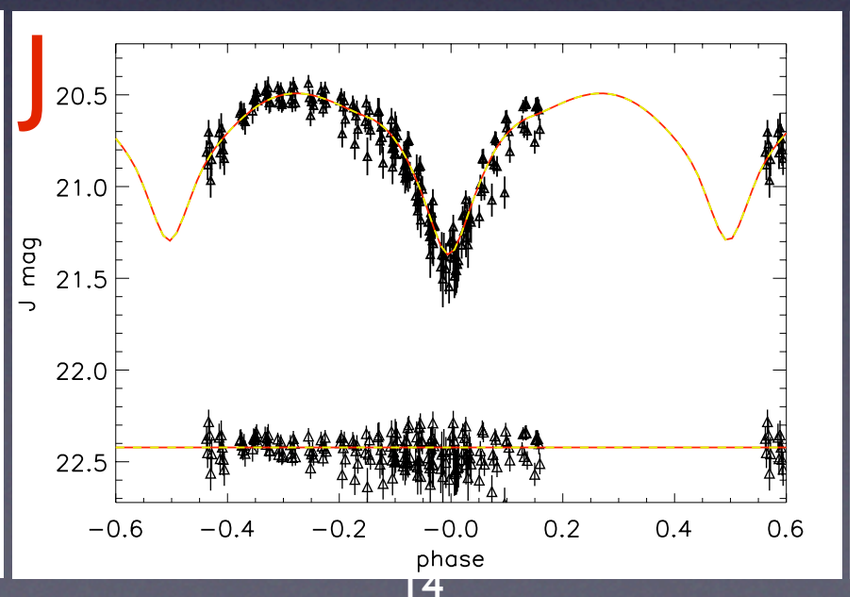


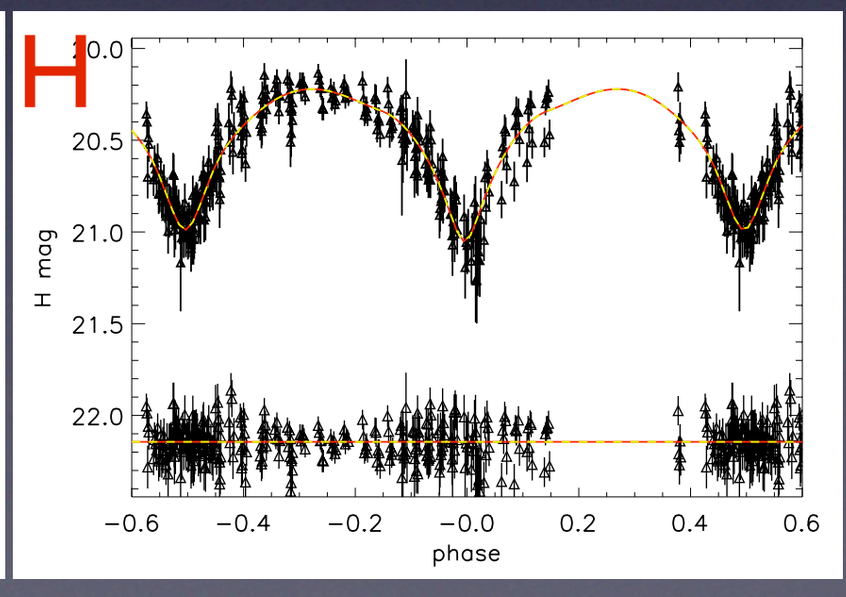
Precision of 5m telescope! FOR FREE!

OGLE 2006-BLG-357
Source Model









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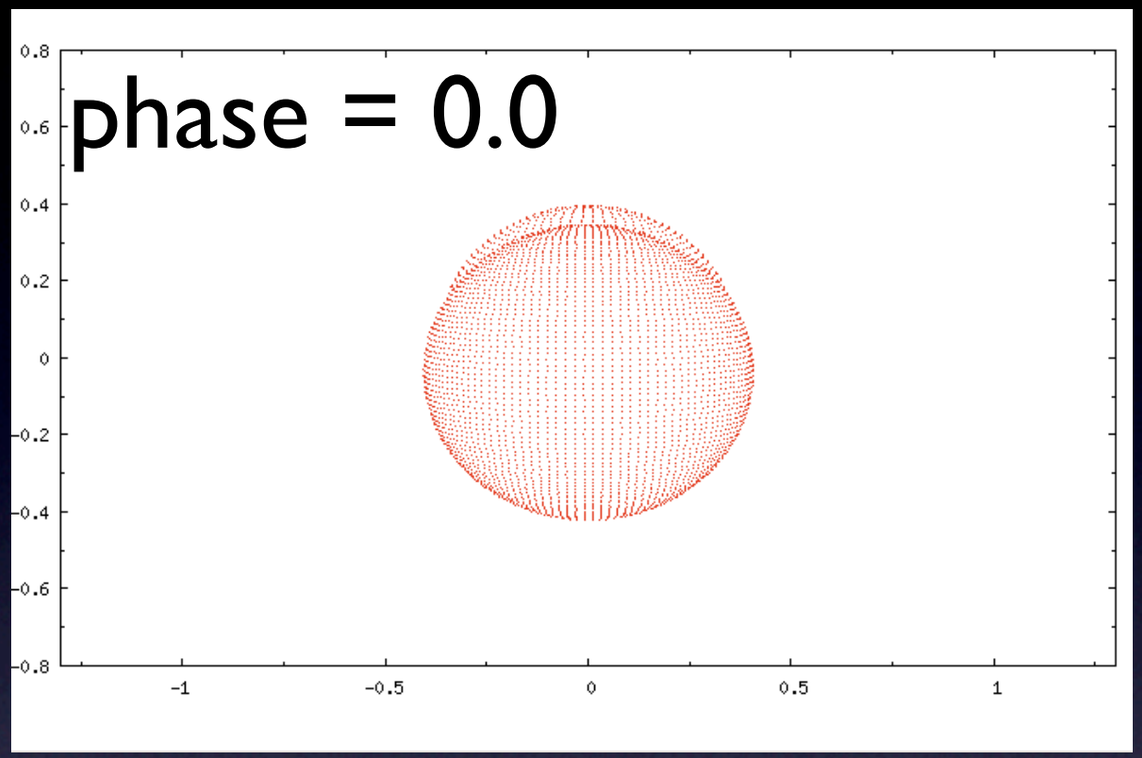
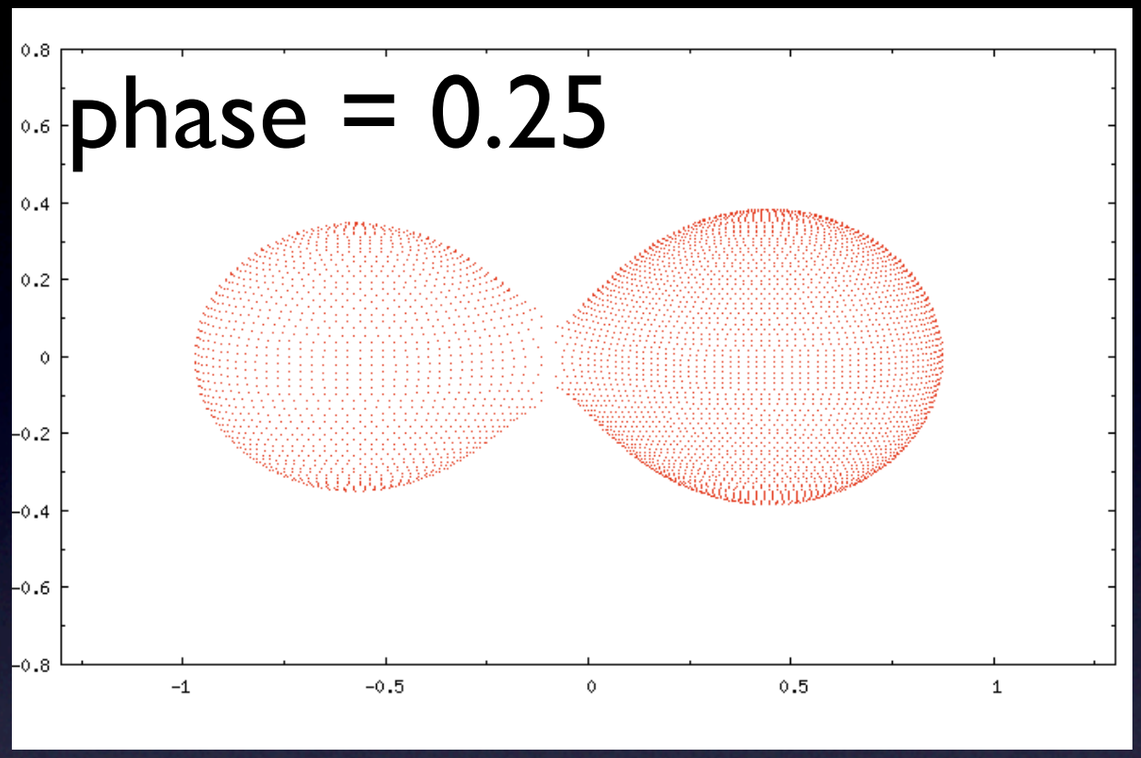
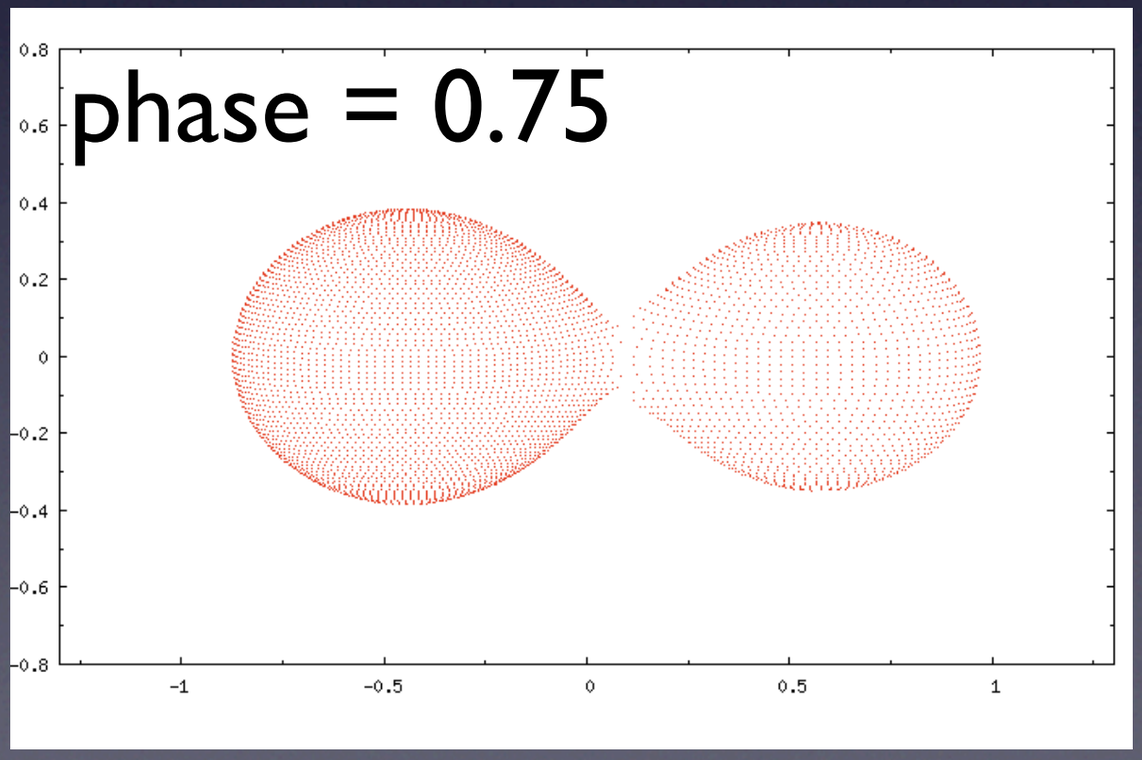
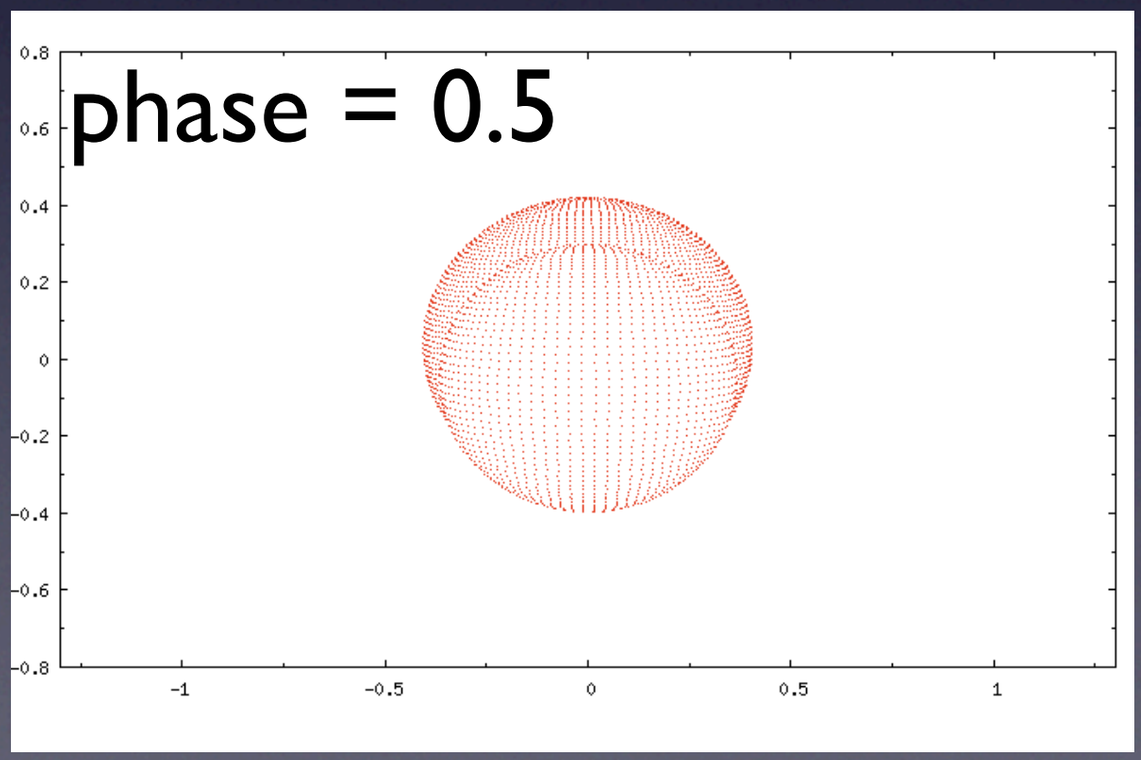
OGLE 2006-BLG-357
Source Model









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OGLE 2006-BLG-357
Source Model

Parameter	Primary	Secondary
Period	0.747720	
Inclination	85.2±0.2	
Mass ratio ($\frac{M_2}{M_1}$)	1.296±0.004	
Radii ratio ($\frac{R_2}{R_1}$)	1.093±0.003	
Radius (R/a)	0.376313	0.411212
$T_{eff}(K)$	10000	10000
Ω	4.0978	4.1631
Lum. ratio ($\frac{L_{I2}}{L_{I1}}$)	0.938	
Albedo	0.50	0.50
Grav.brightening	0.32	0.32
L_3	0	

filter	chi^2/N_{dof}	N_{data}
I	1.7454	2013
V	3.7480	285
H	3.7481	855
J	0.7962	555

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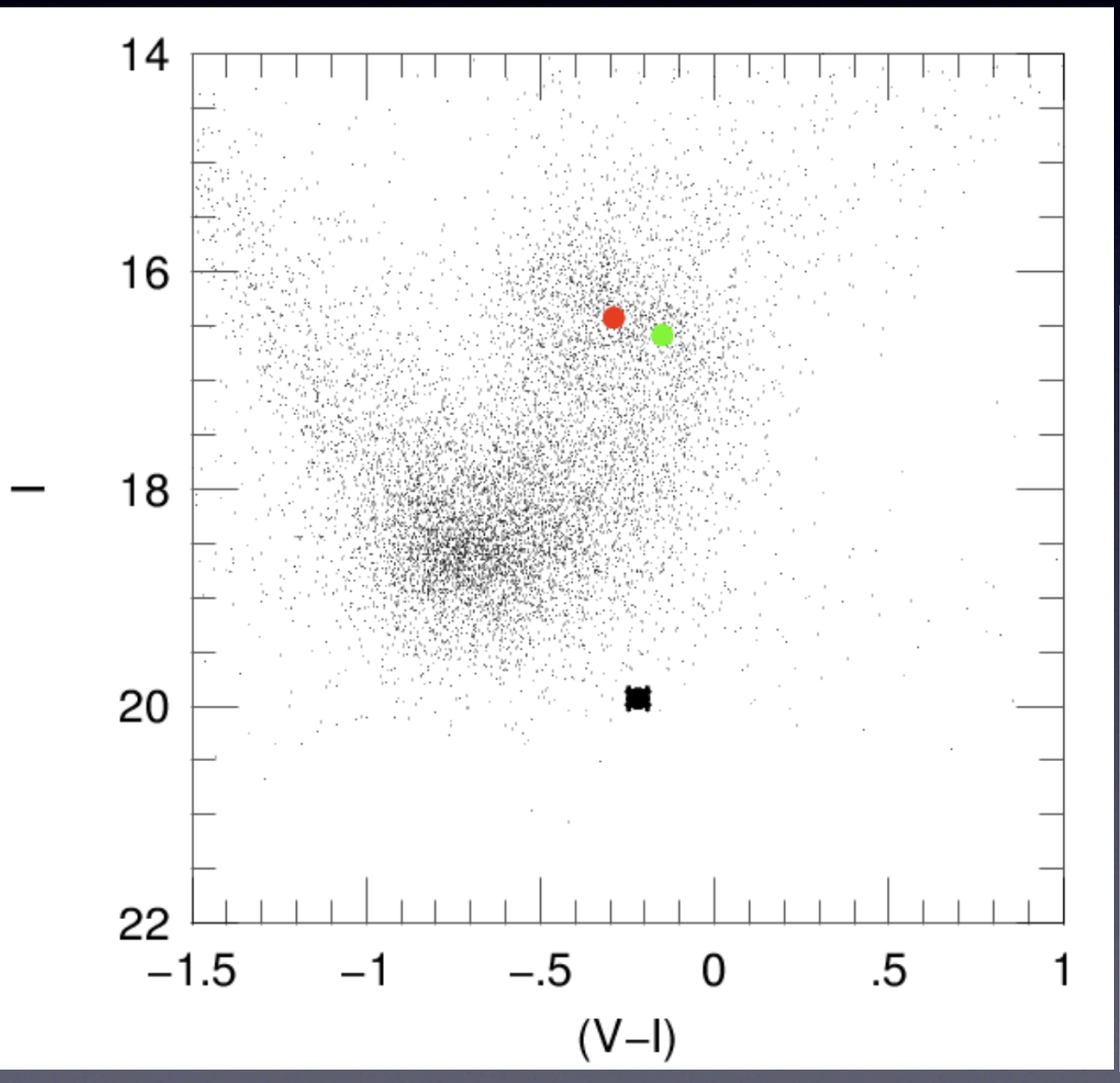
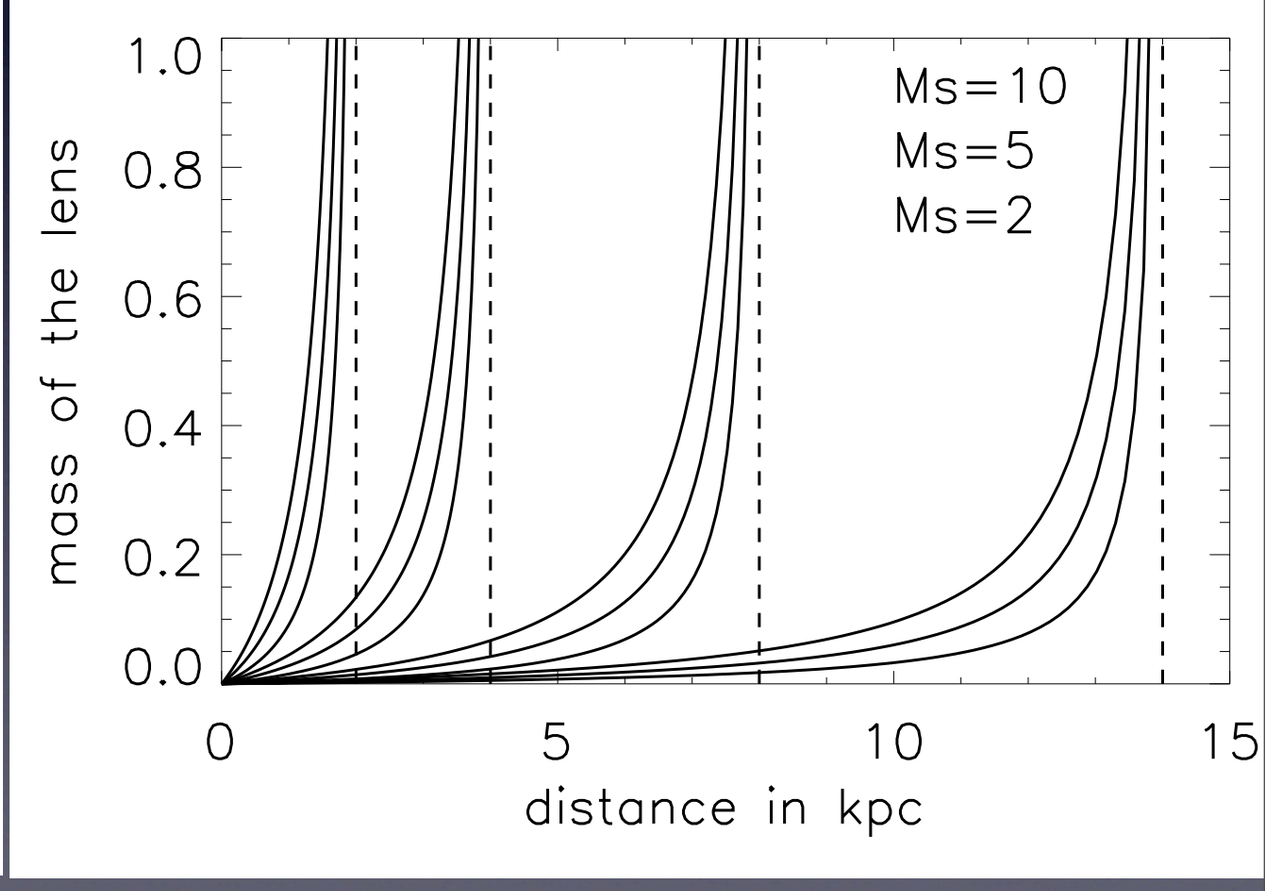
Lens

- if all blended light comes from the lens
- I ~ 16.7, V-I ~ -0.2 - Red Clump (bulge) object?



lens mass estimate using xallarap



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What we learned:

- Source - an over-contact eclipsing binary located probably on the other side of the Bulge
- Lens could be in the Bulge
- Interesting cases, like OGLE 2006-BLG-357, occur from time to time
- Community response was great - a lot of measurements
- Unfortunately in this case the scientific output was not very exciting
- But LETS NOT GET DISCOURAGED!

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What can we learn:

- studies of distant variable stars

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What can we learn:

- studies of distant variable stars
- brave idea:
  - ★detect planetary transits on microlensed sources

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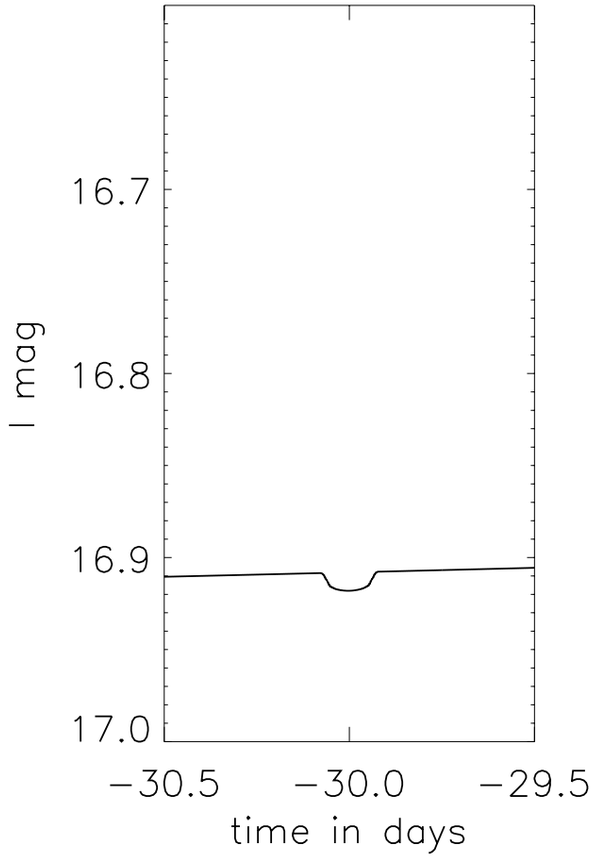
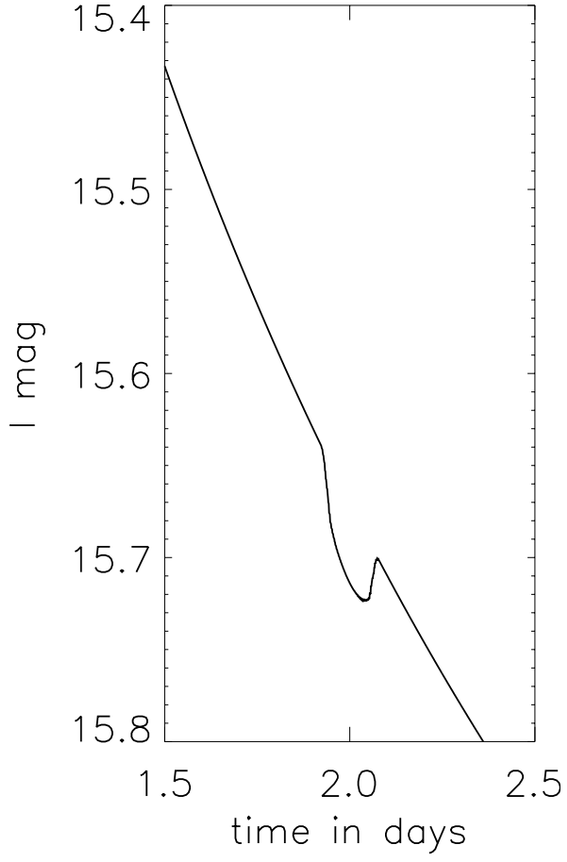
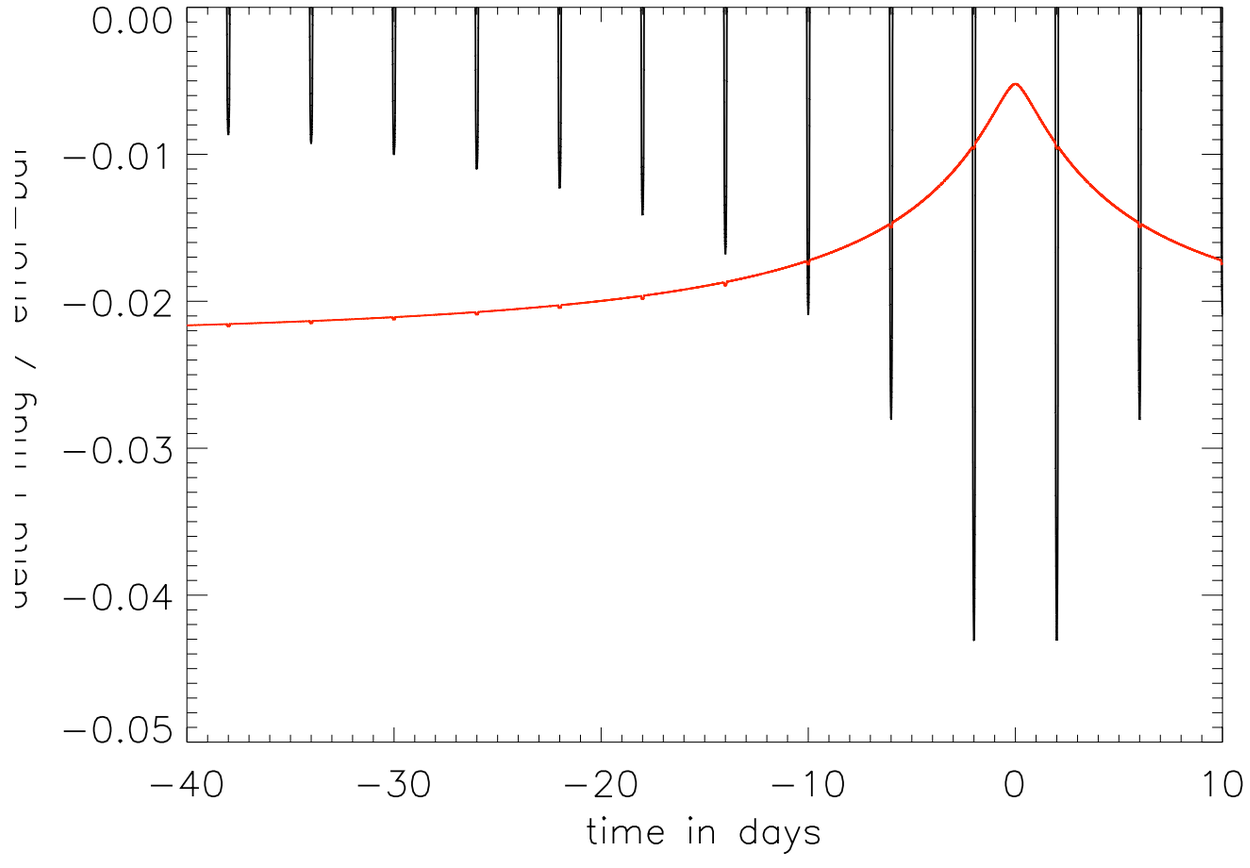
What can we learn:

- studies of distant variable stars
- brave idea:
  - ★detect planetary transits on microlensed sources

R_*=0.5 R_{Sun} M_*=0.5 M_{Sun} R_P=1 R_{Jup} M_P= 1 M_{Jup} Period=4d, f_S=0.1







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Thank you!