

Distant Eclipsing Binary System Revealed with the Microlensing Telescope

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Contributors

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

Microlensing of variable stars

models

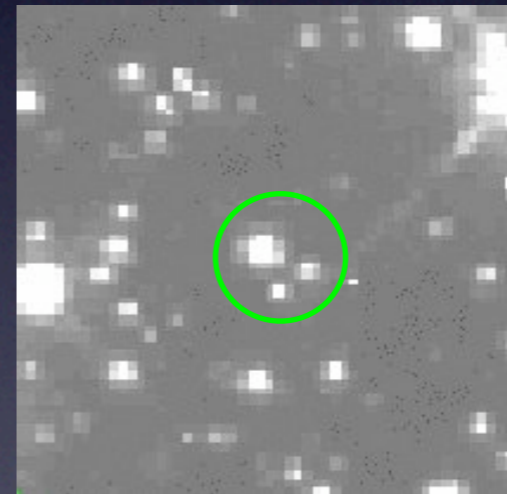
variable source

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

variable blend



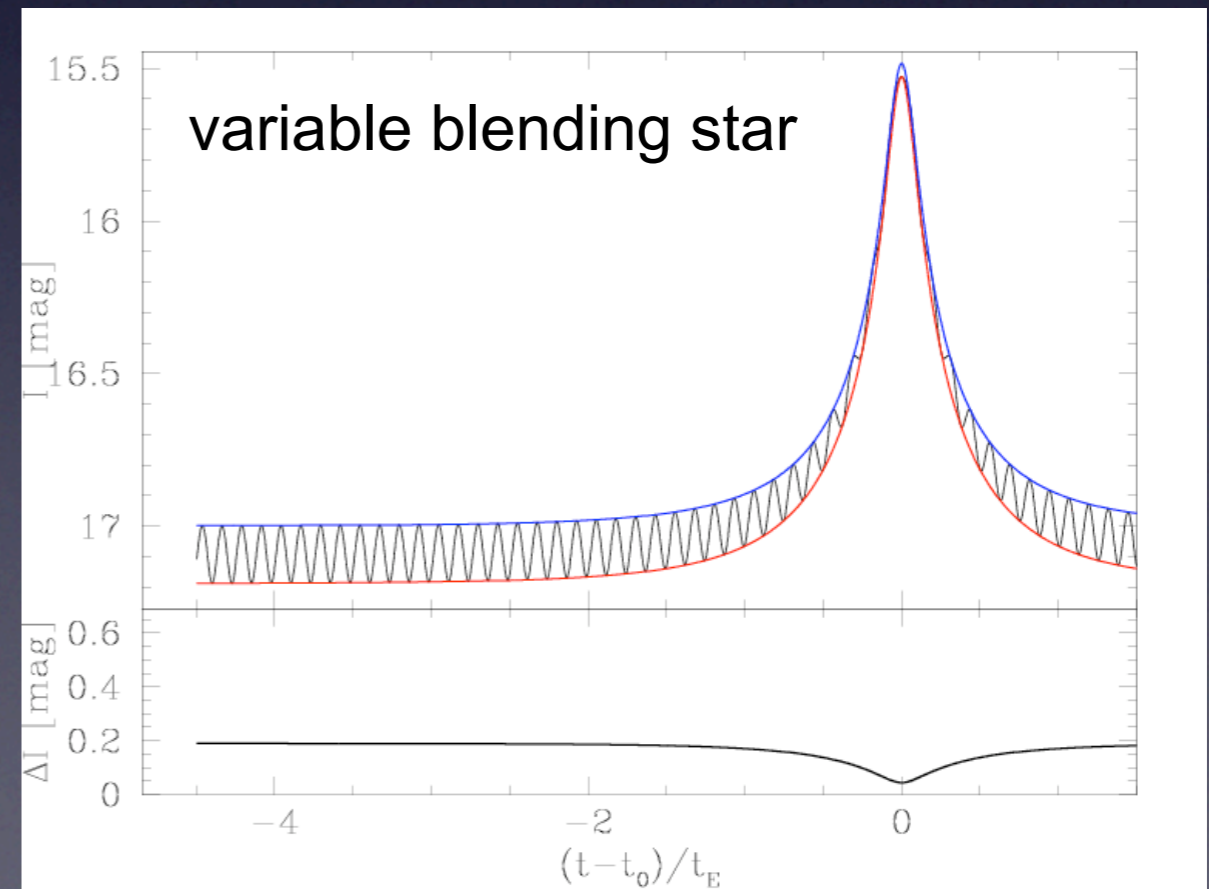
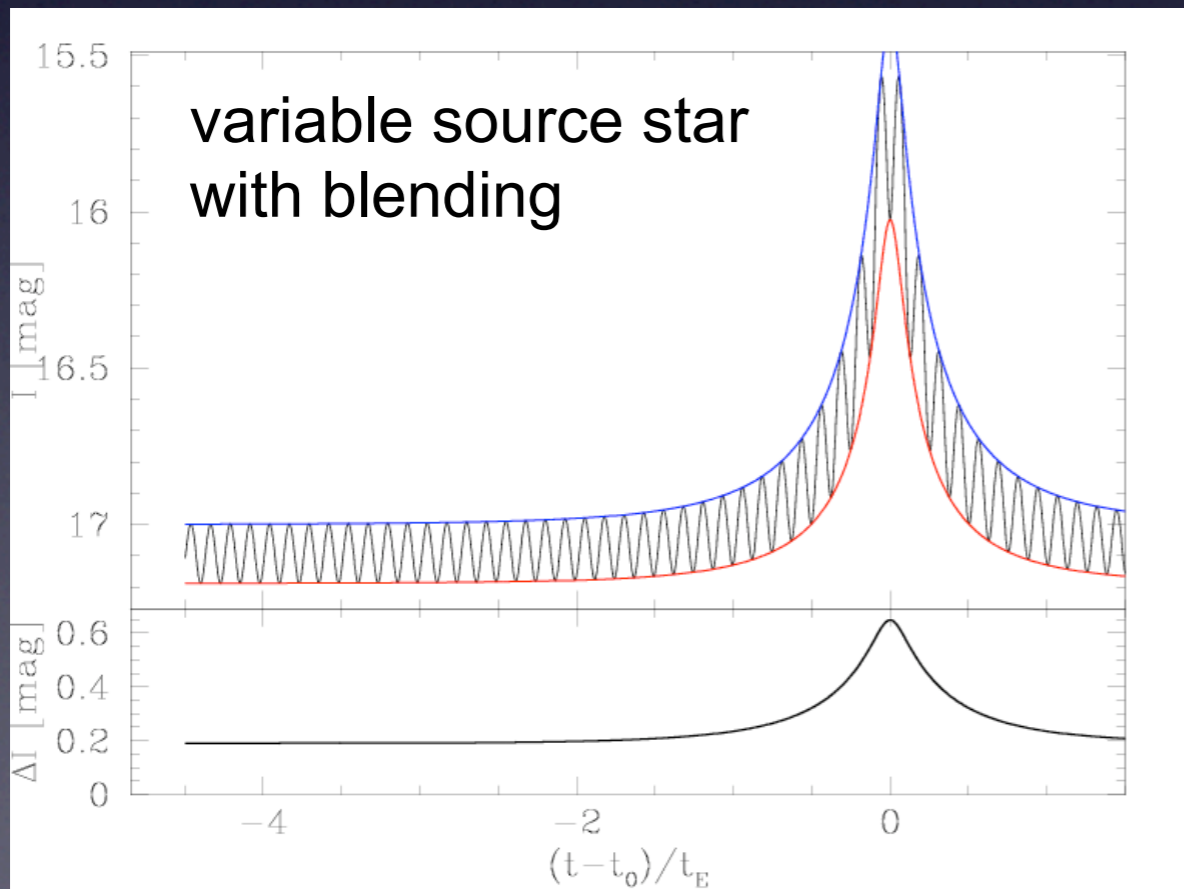
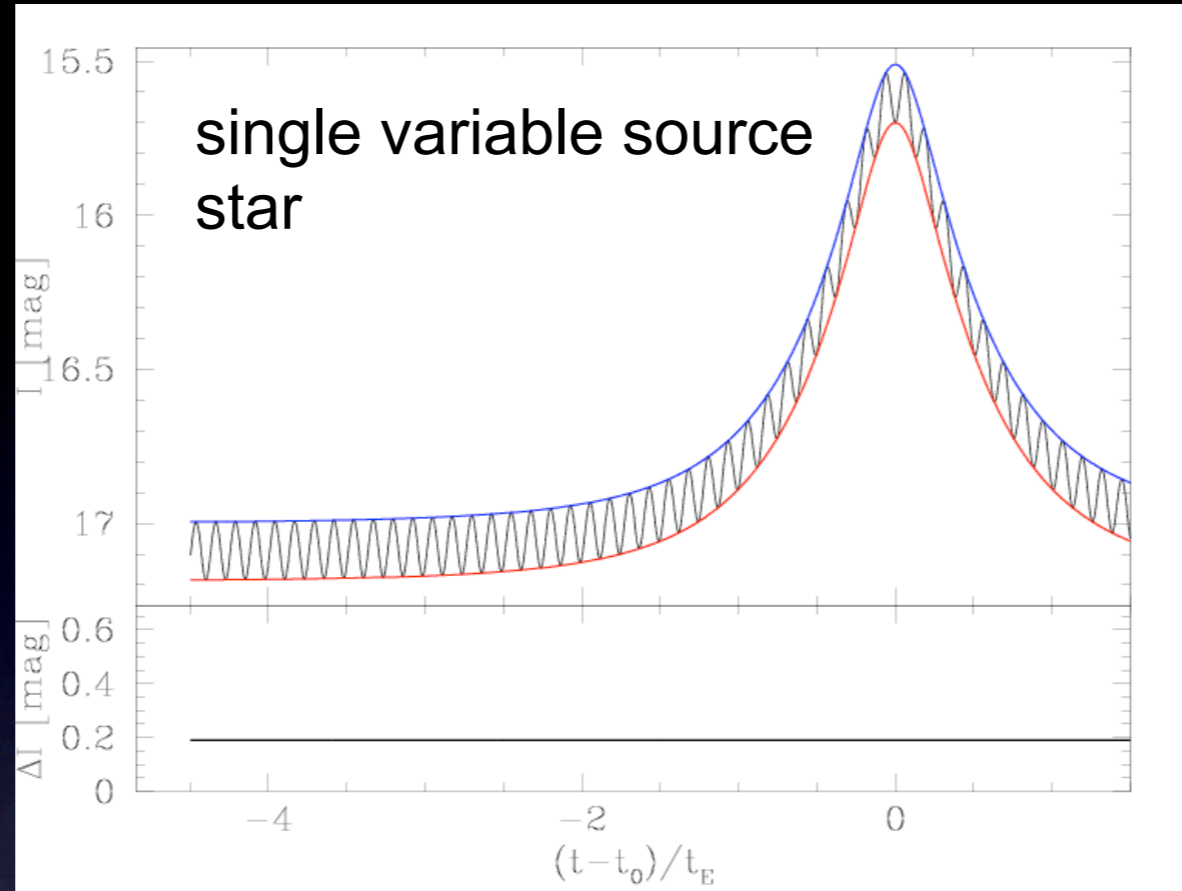
GROUND



HST

Wyrzykowski et al. 2006, AcA 56, 169

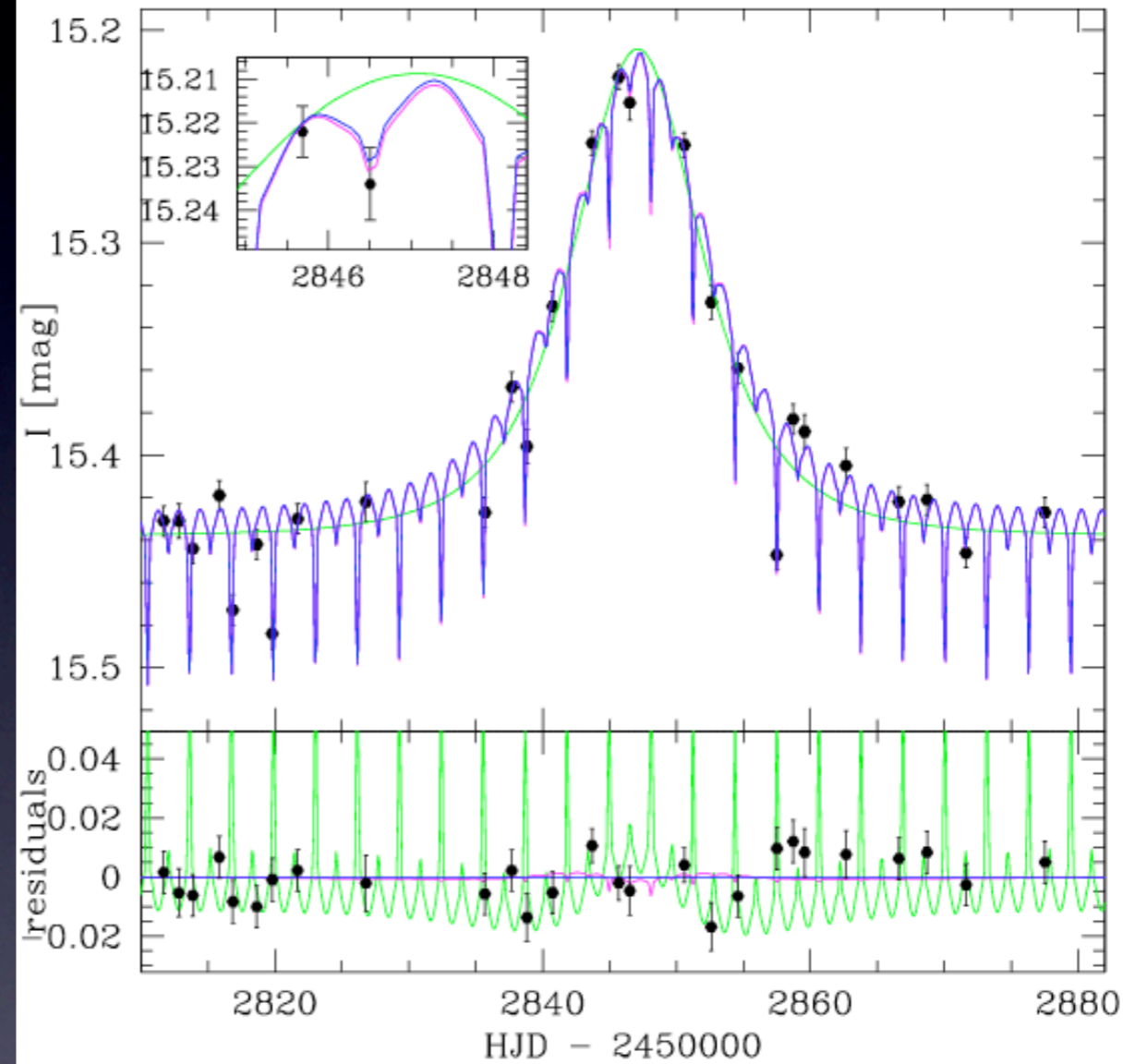
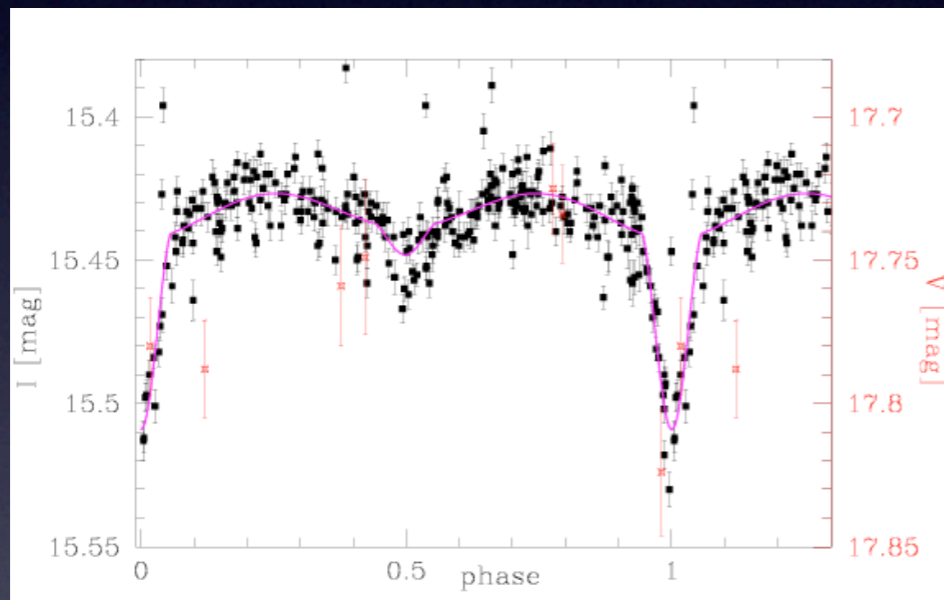
Amplitude of lensed variable



Eclipsing binary in the baseline

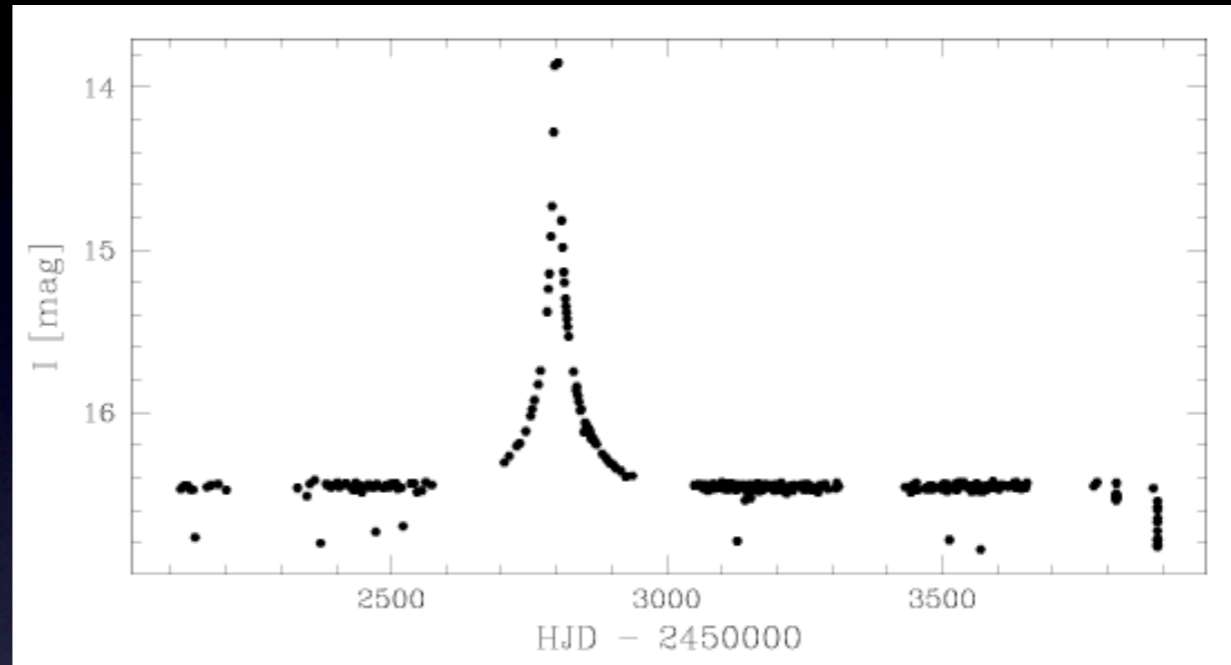
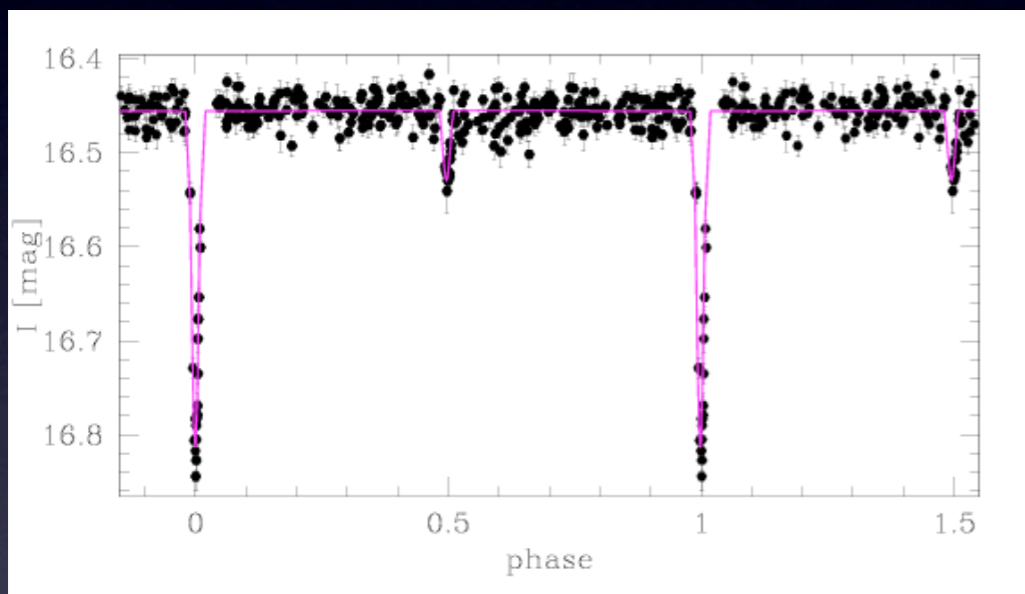
OGLE180047.11-285934.5

$P = 3.1348$ d



Long time-scale eclipsing binary event

$$P = 7.1305 \text{ d}$$
$$t_E = 118 \text{ d}$$
$$A_{\text{max}} = 24$$

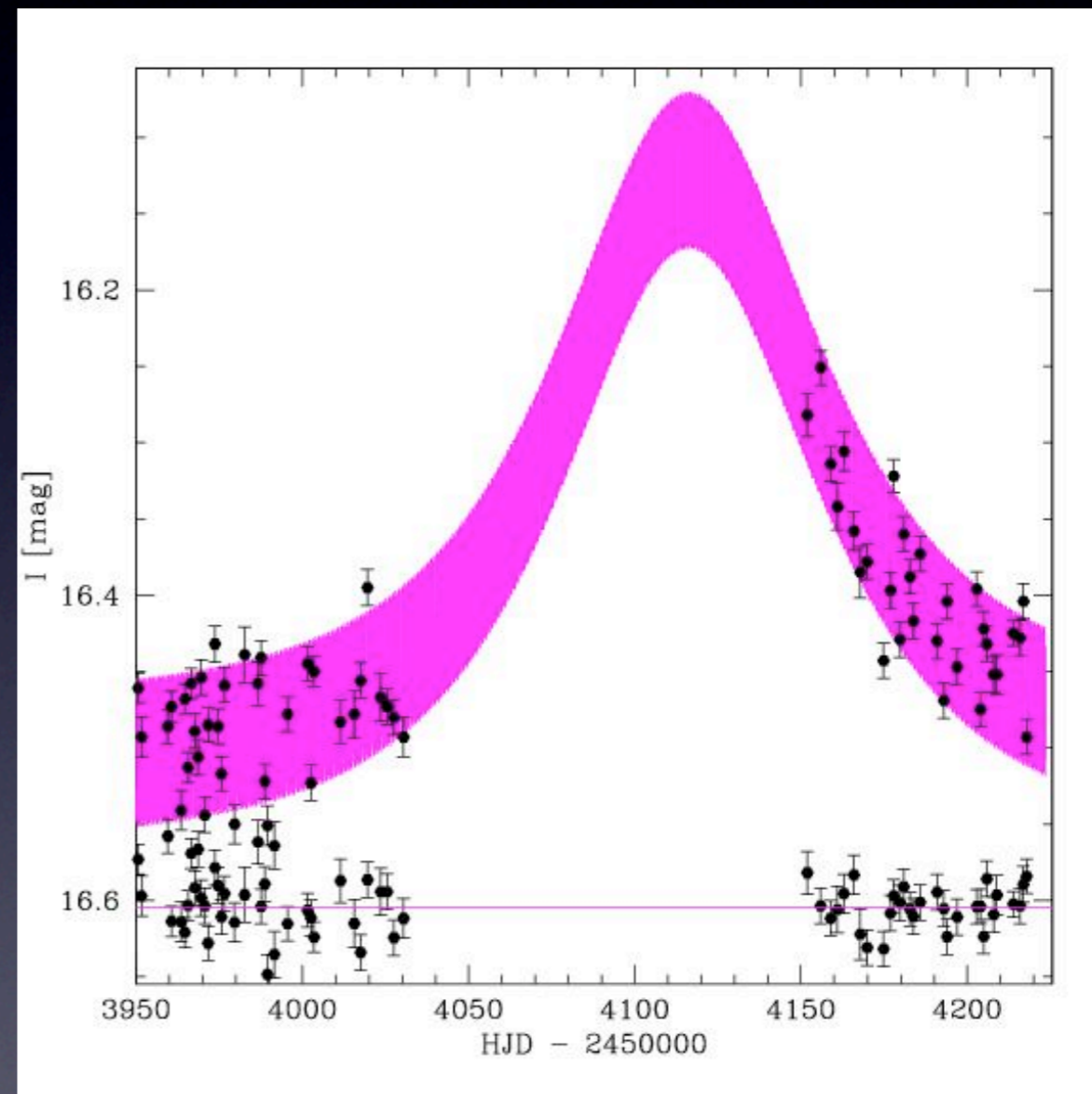
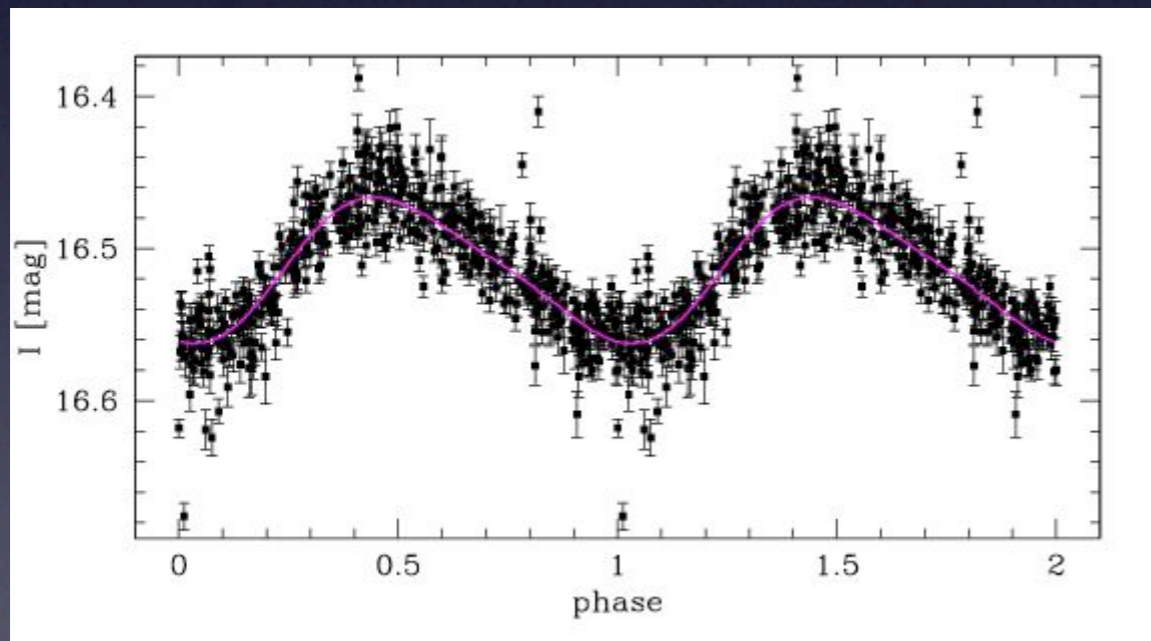


No eclipses observed during the event - three possible hypotheses

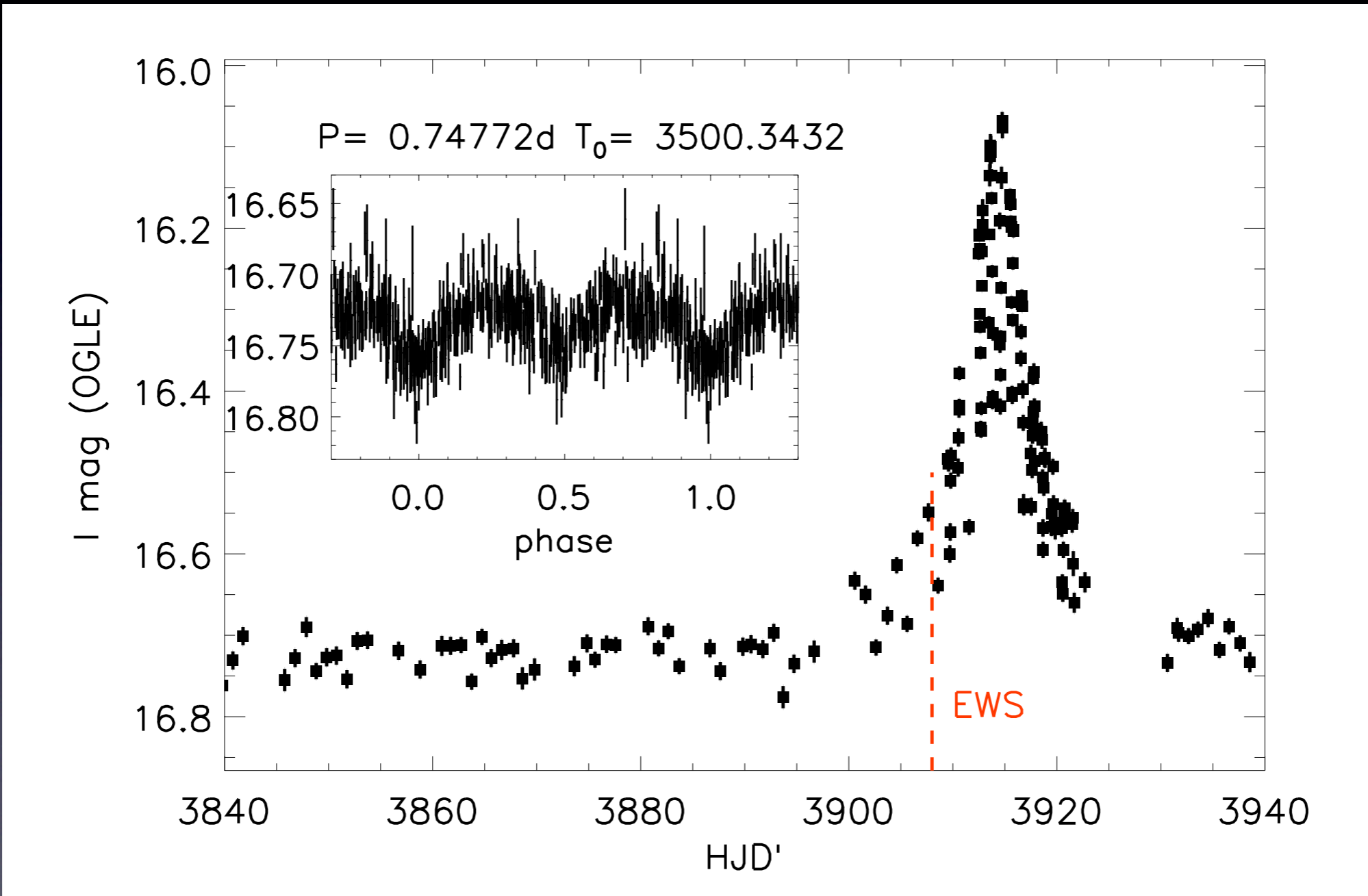
1. *Eclipsing binary being a source - **rejected***
2. *Eclipsing binary being a lens (binary) - no confirmation yet...*
3. *Eclipsing binary acting as a blend to a regular event*

Microlensing of RR Lyrae variable OGLE 2007-BLG-044

$P = 0.29 \text{ d} \sim 7 \text{ h}$



OGLE 2006-BLG-357



OGLE 2006-BLG-357

Microlensing Model

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

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

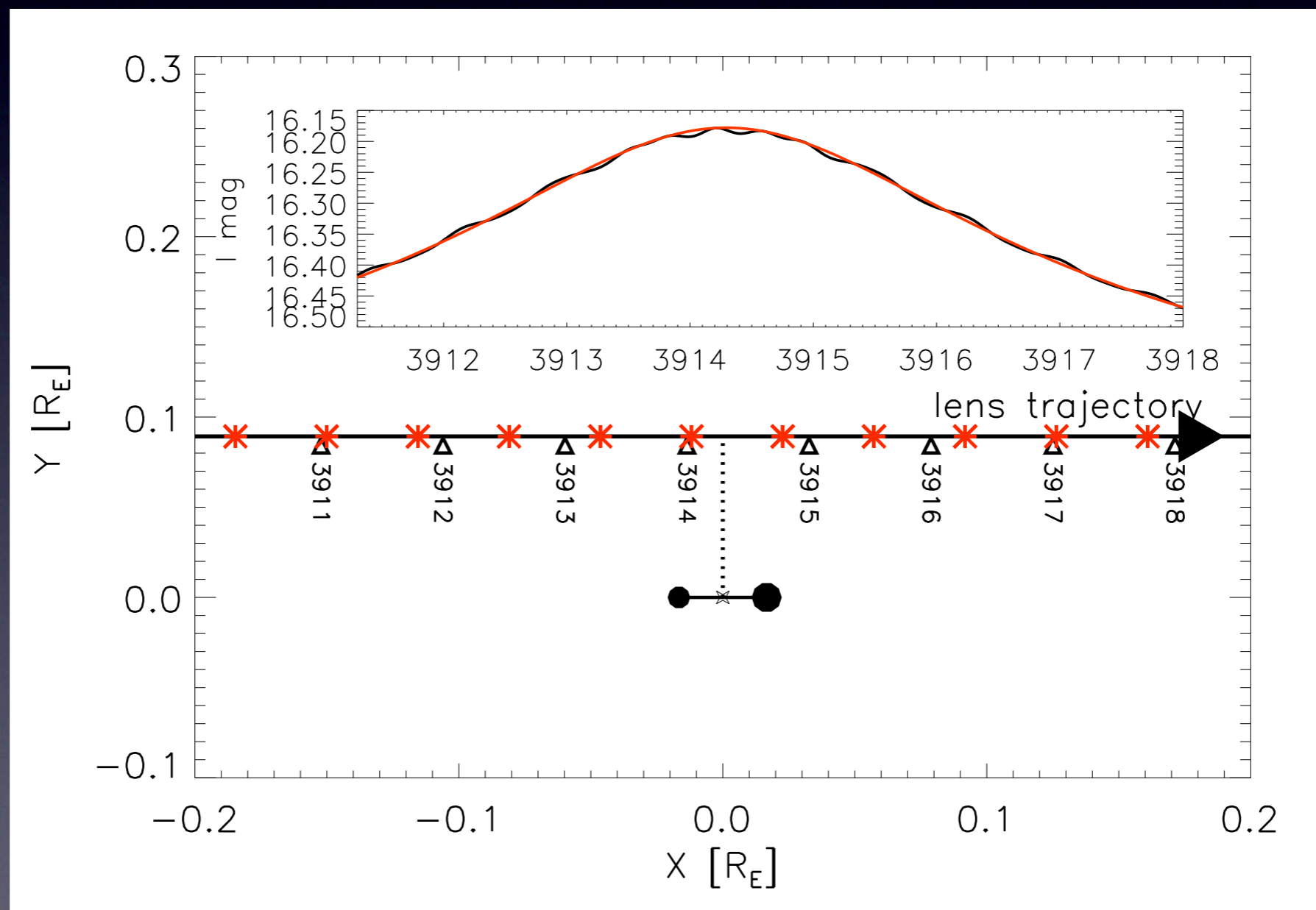
- f_{ecl} can be any arbitrary function
- we used 8-harmonics Fourier series (16 parameters)

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

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

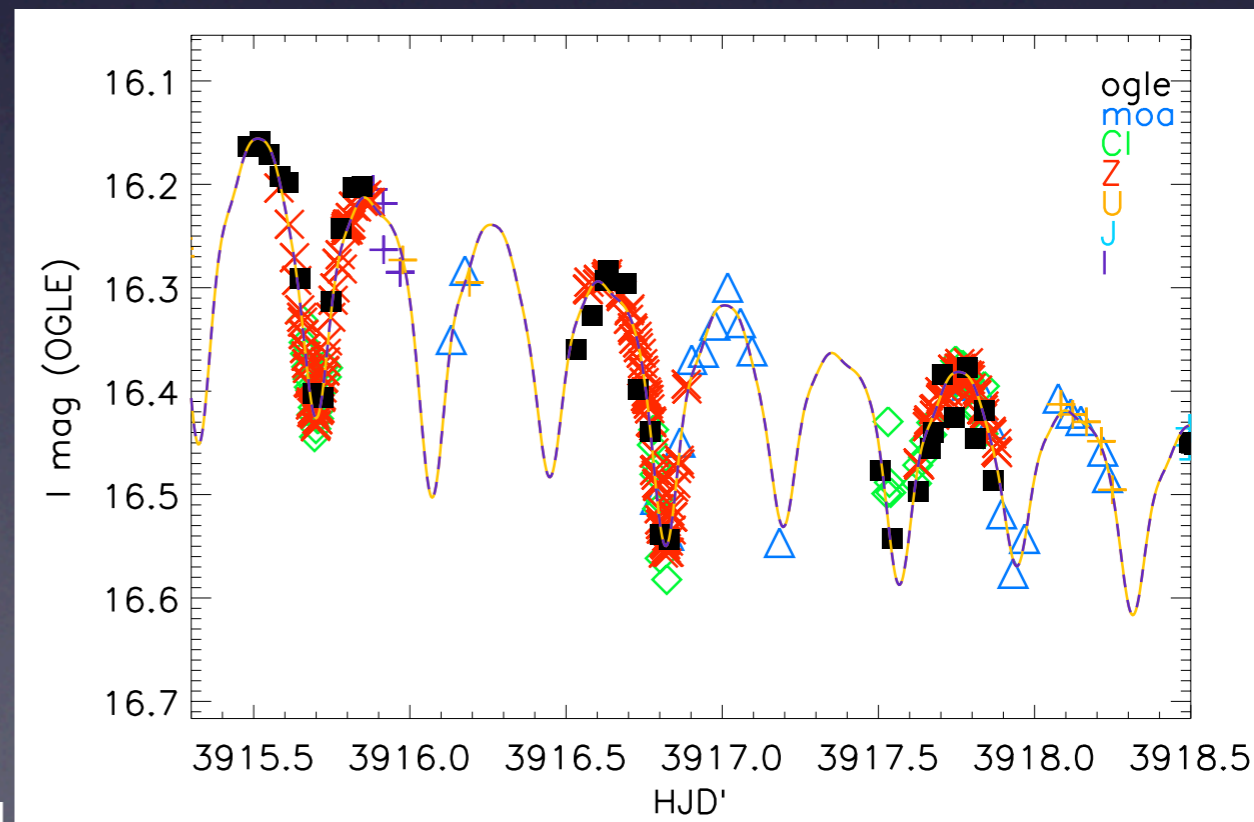
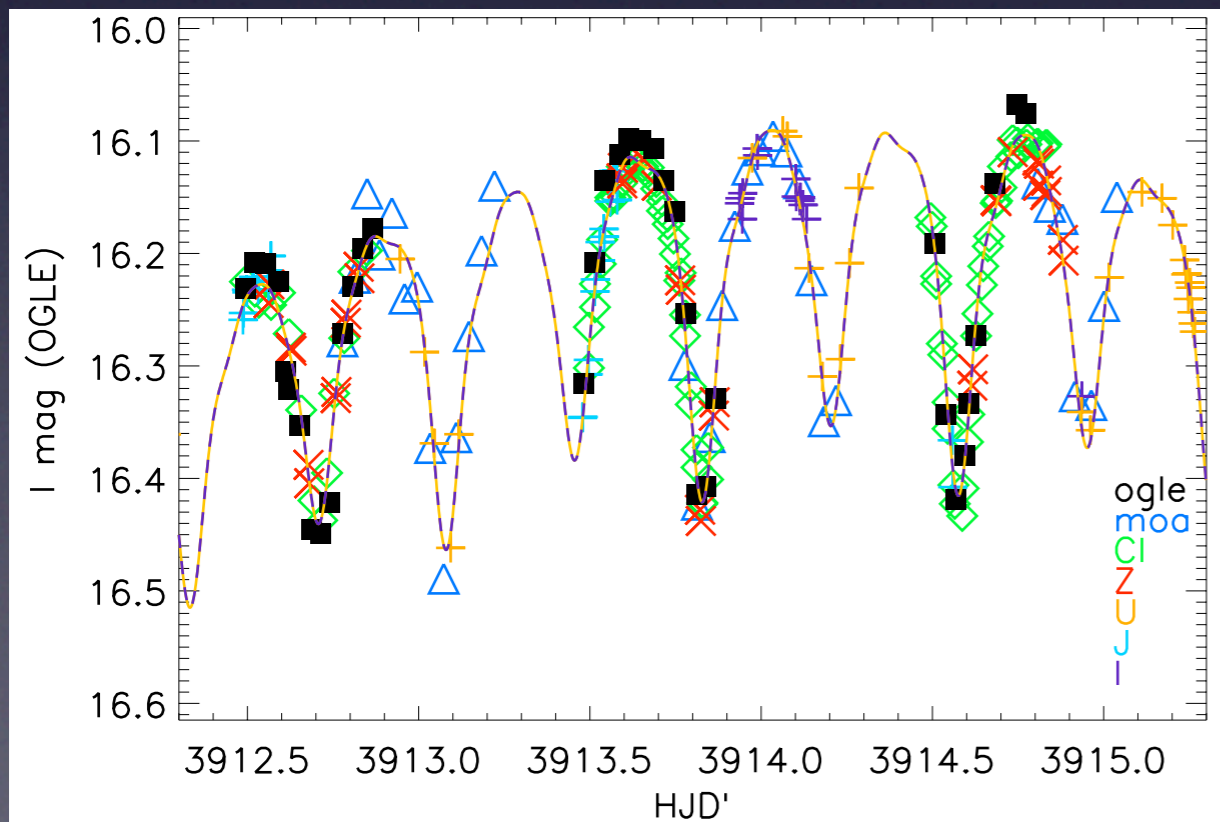
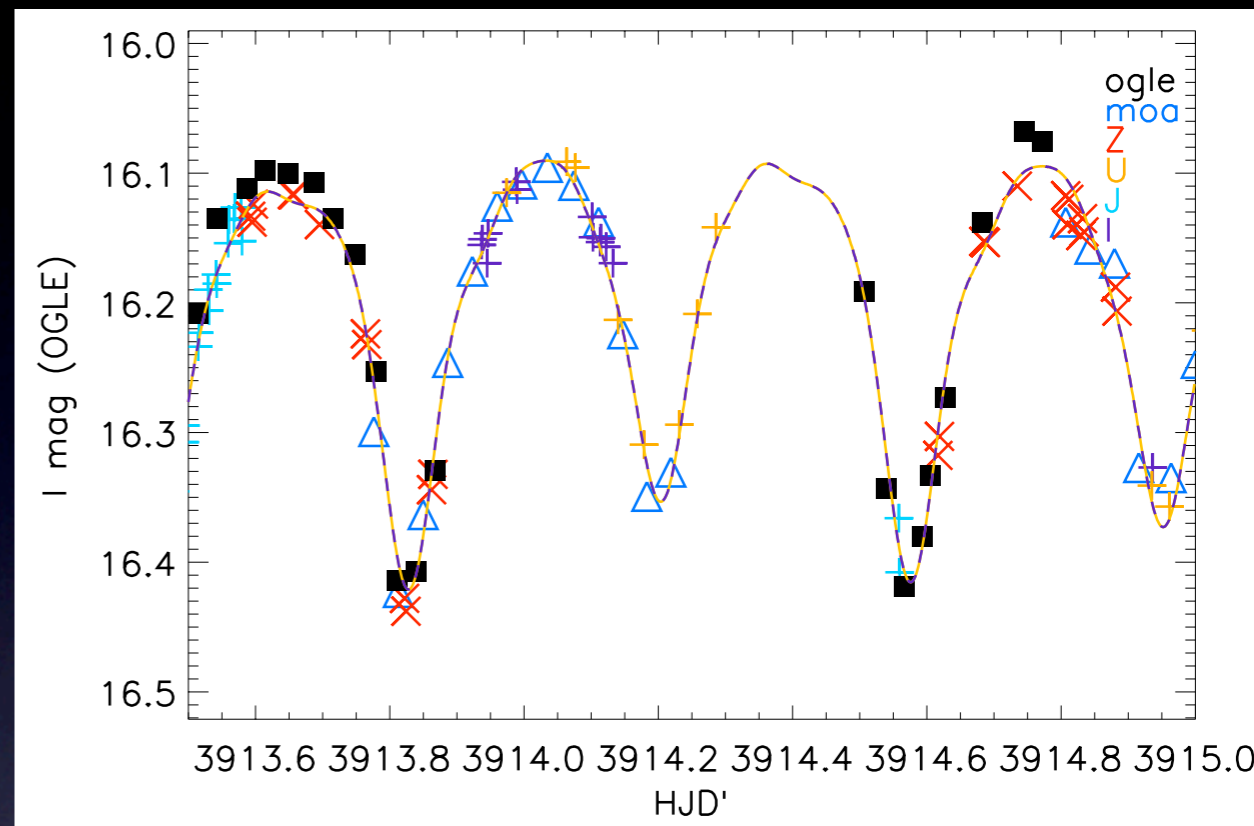
OGLE 2006-BLG-357 Microlensing Model

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



OGLE 2006-BLG-357 Microlensing Model

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



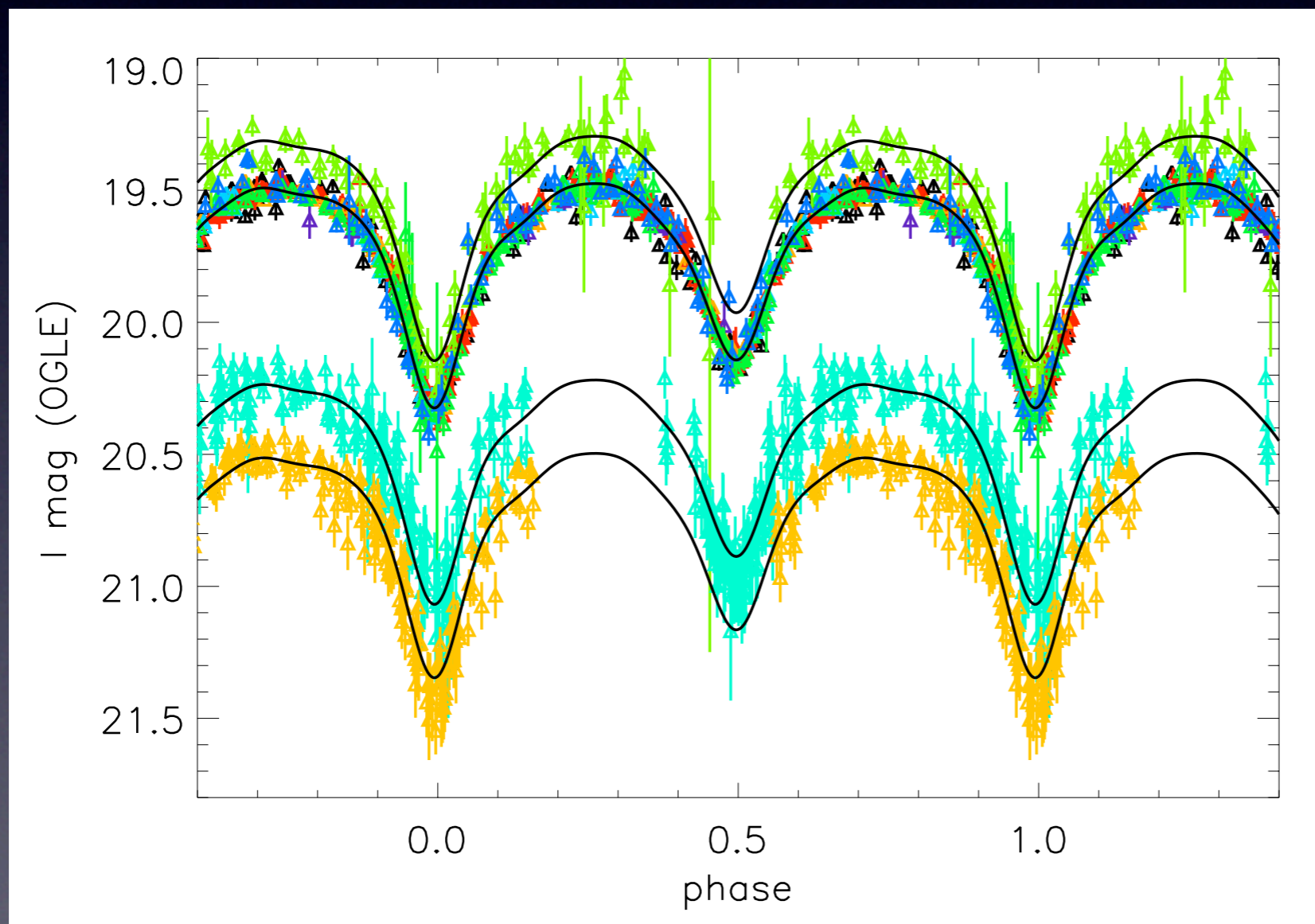
OGLE 2006-BLG-357 Microlensing Model

parameter	standard		xallarap	
t_0	3914.289650	± 0.001701	3914.293278	± 0.001701
t_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

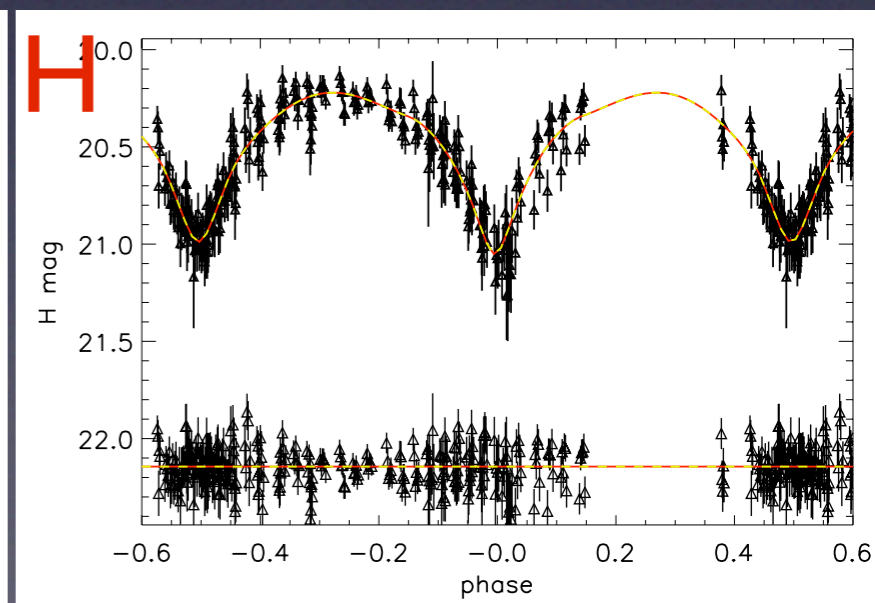
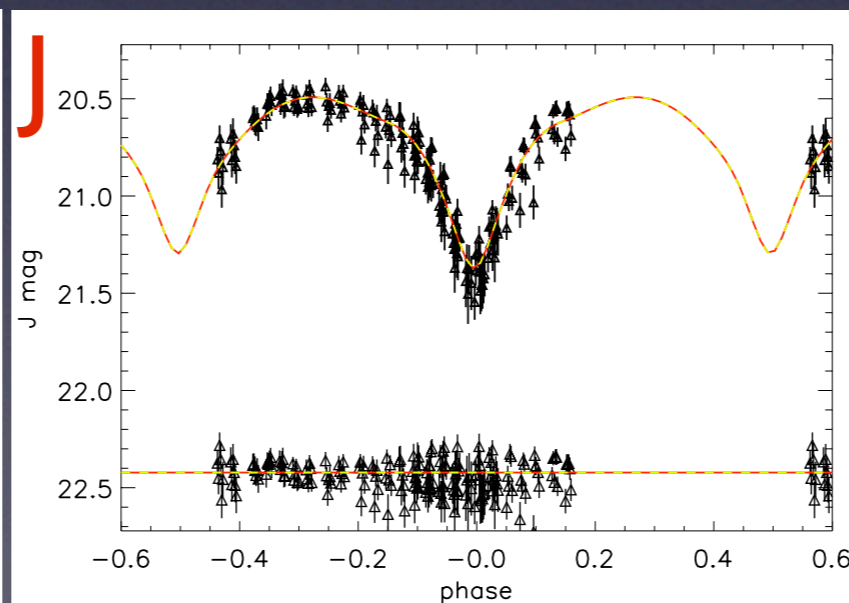
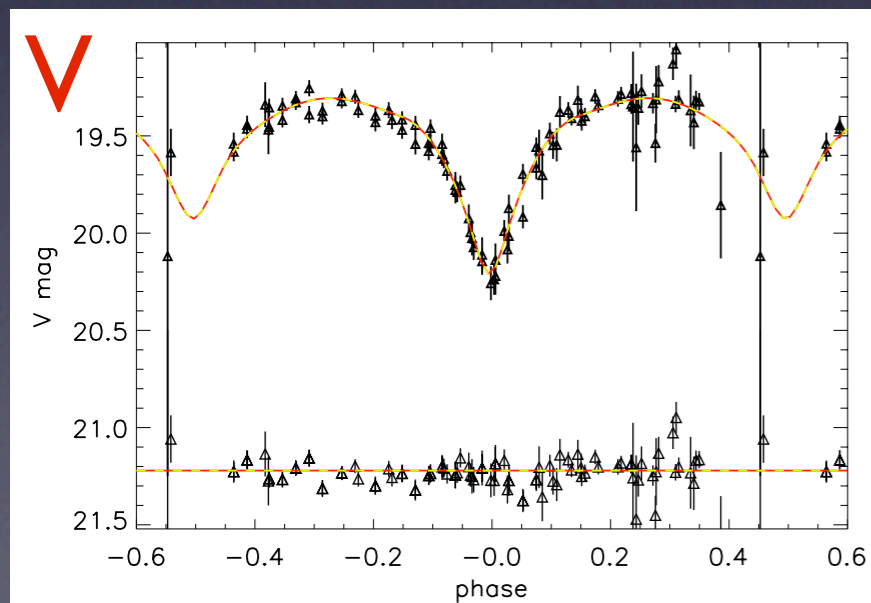
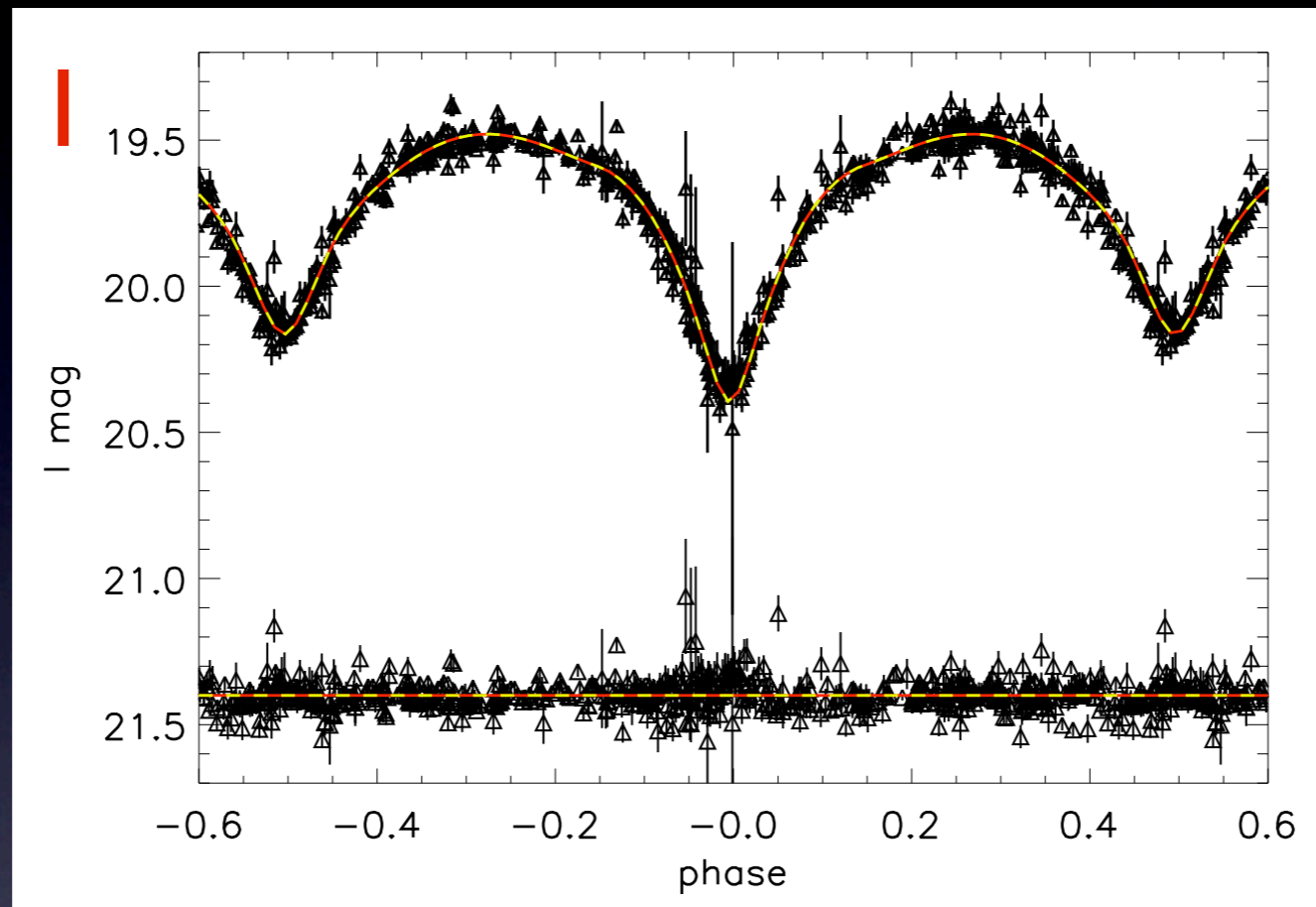
OGLE 2006-BLG-357 Microlensing Model

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

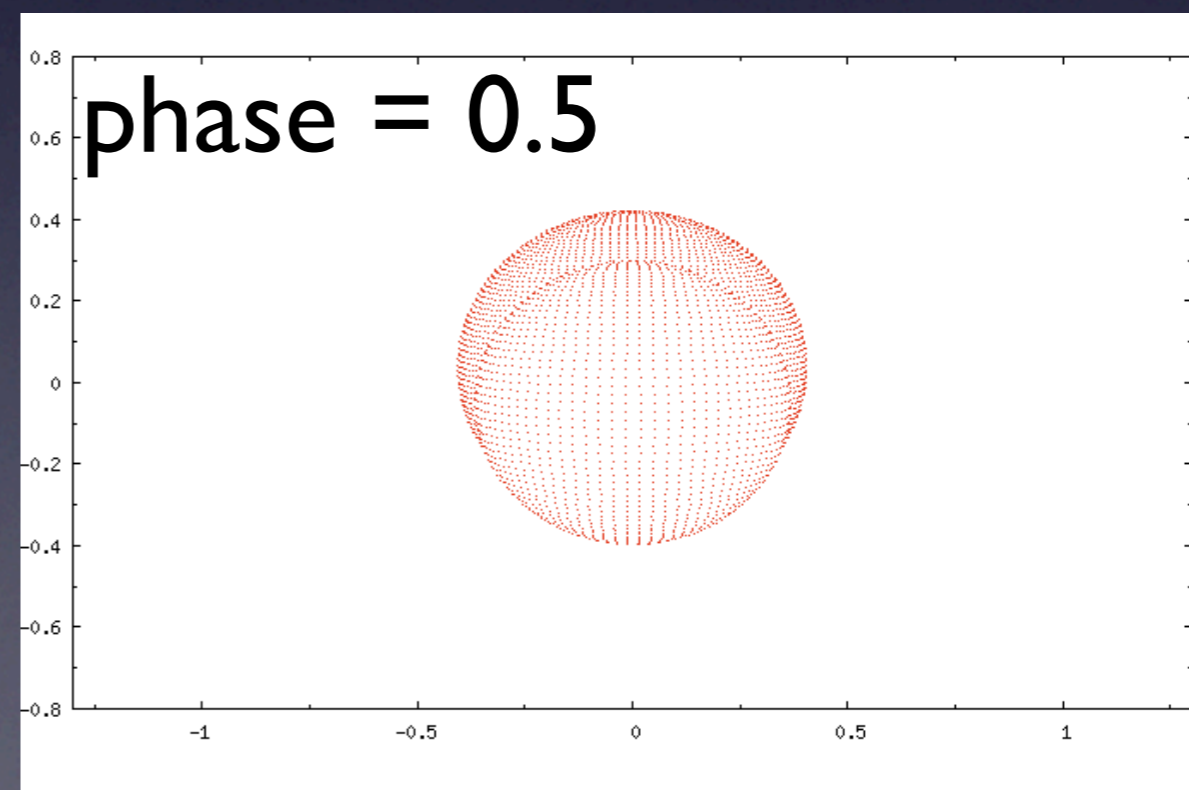
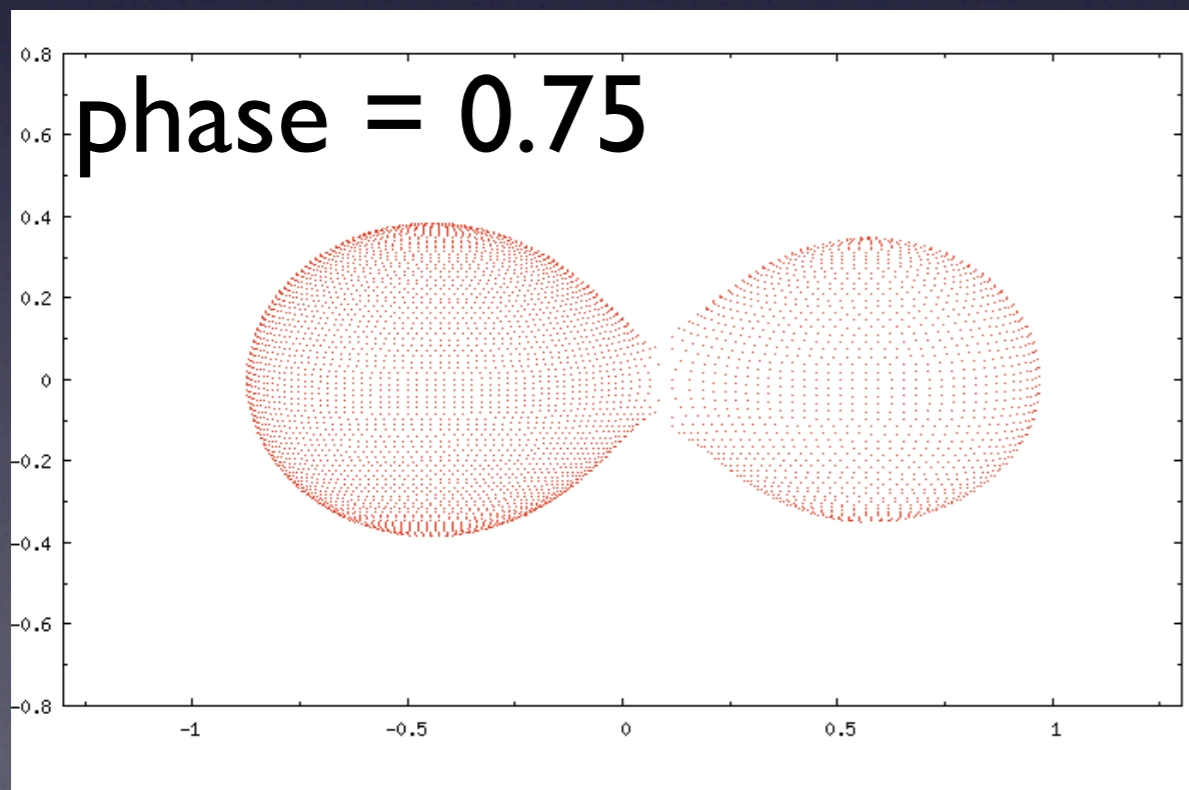
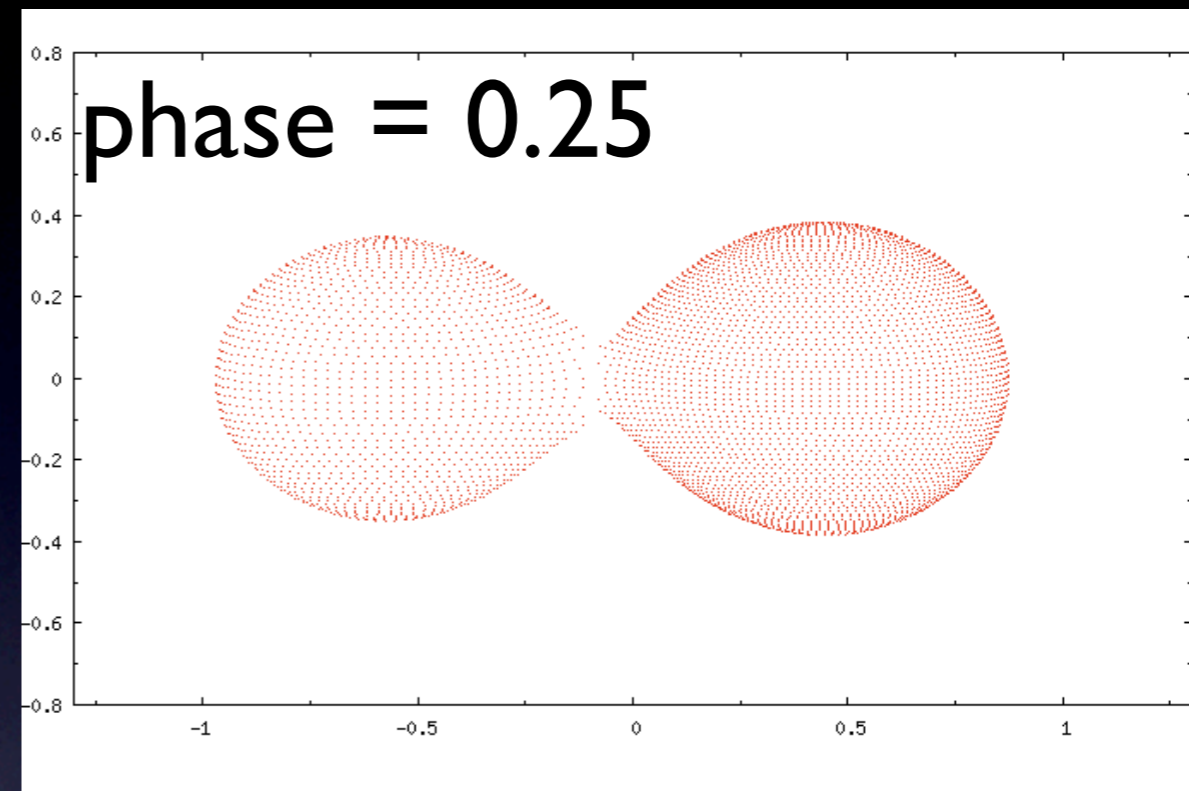
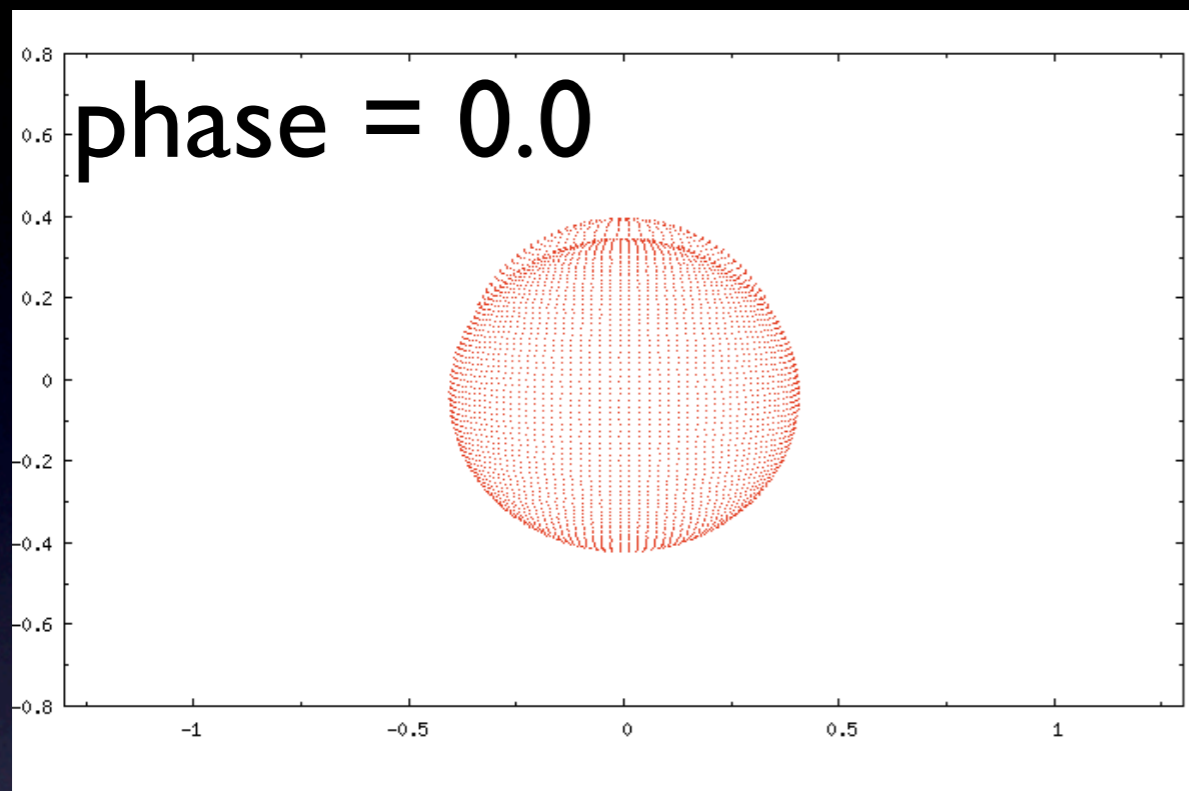


Precision of
5m telescope!
FOR FREE!

OGLE 2006-BLG-357 Source Model



OGLE 2006-BLG-357 Source Model



OGLE 2006-BLG-357

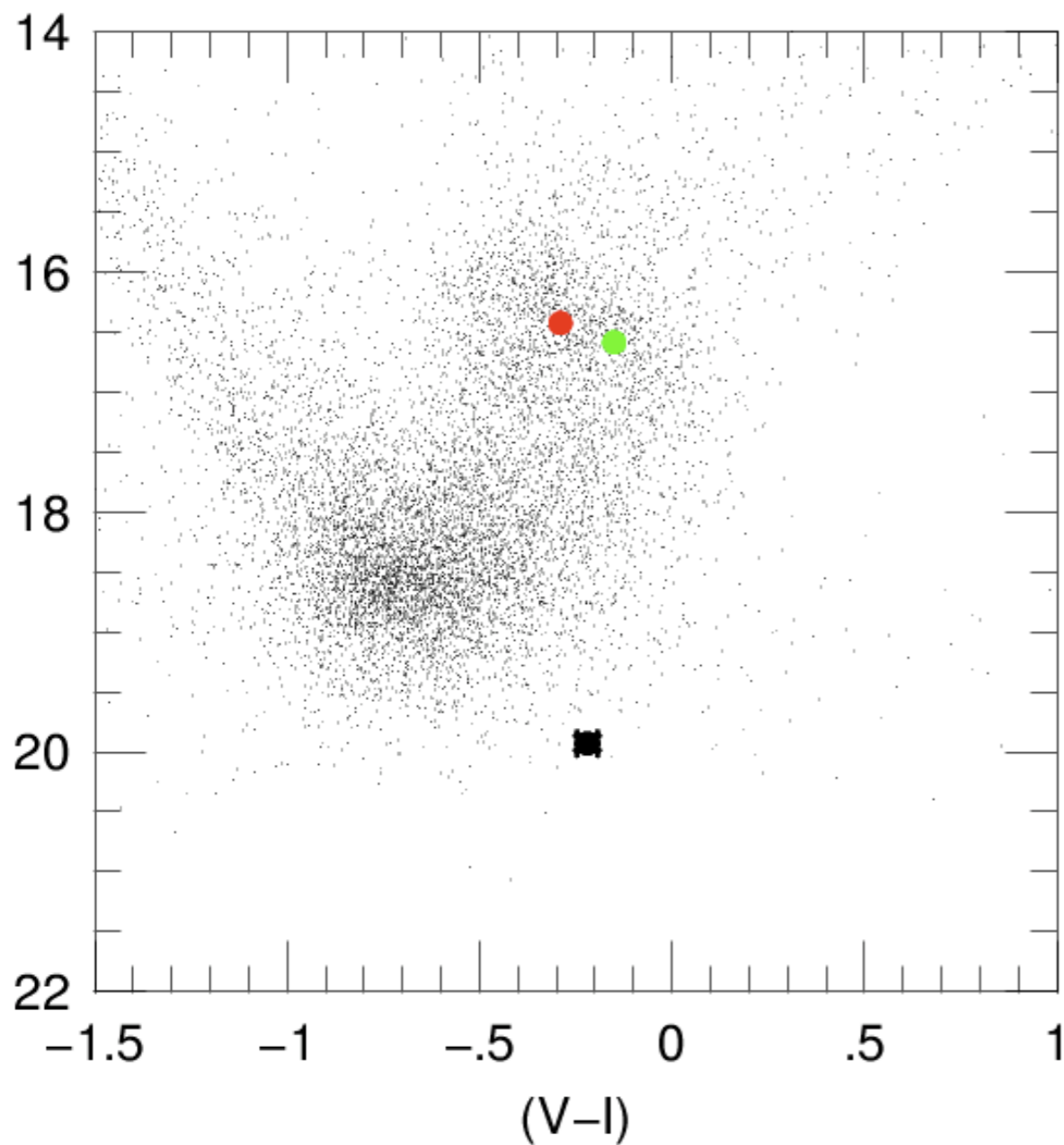
Source Model

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	

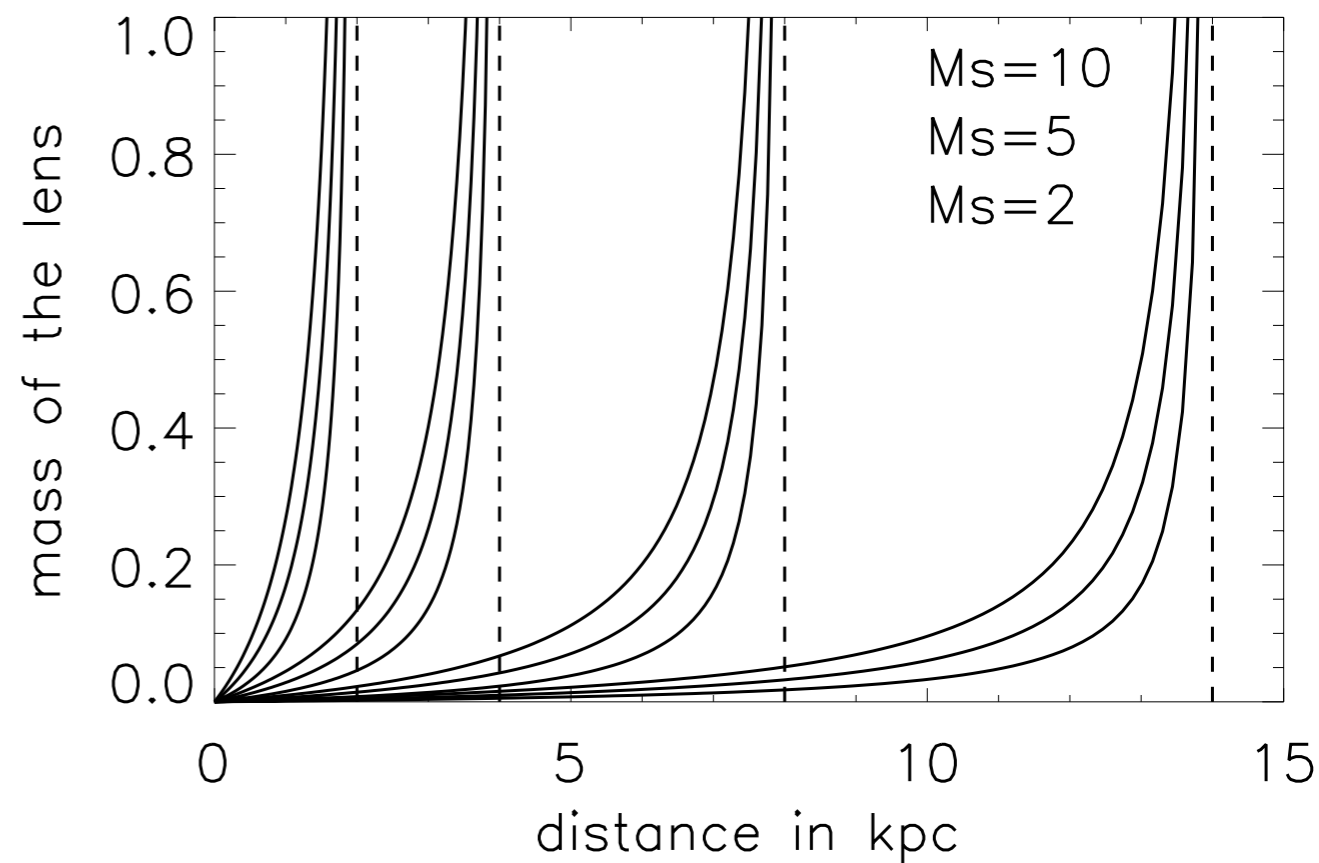
filter	chi^2/N_{dof}	N_{data}
I	1.7454	2013
V	3.7480	285
H	3.7481	855
J	0.7962	555

Lens

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



lens mass estimate using xallarap



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!

What can we learn:

- studies of distant variable stars

What can we learn:

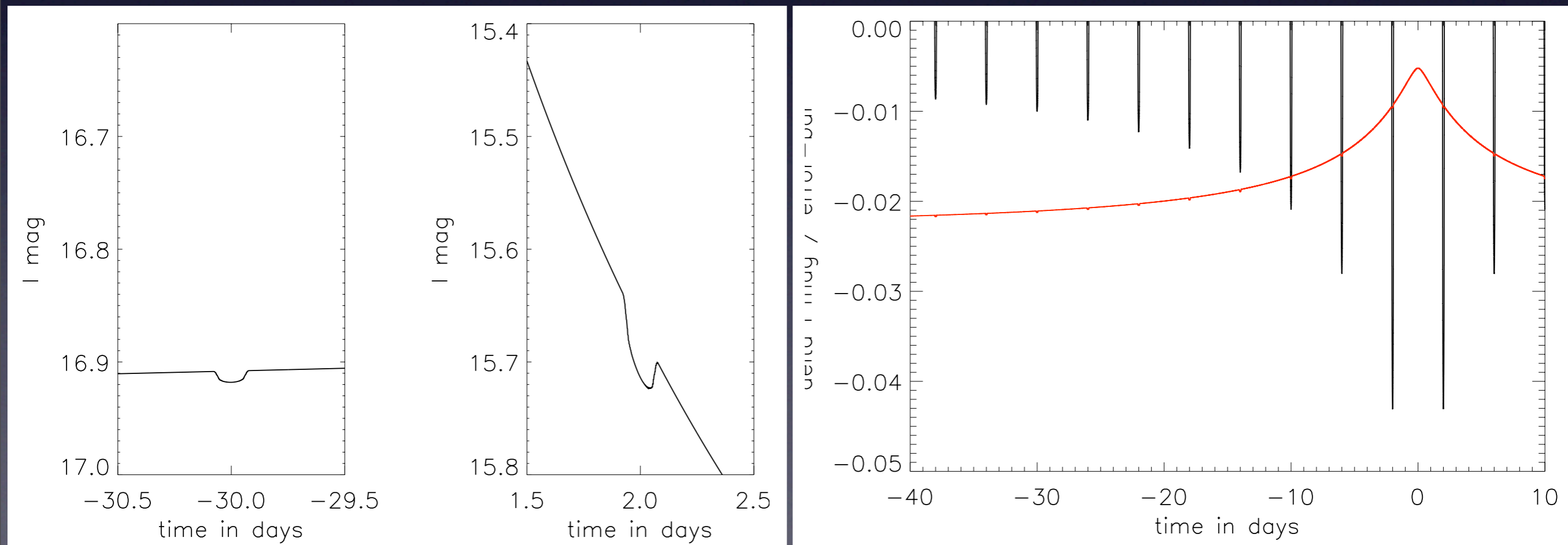
- studies of distant variable stars
- brave idea:
 - ★ detect planetary transits on microlensed sources

What can we learn:

- studies of distant variable stars
- brave idea:

★ detect planetary transits on microlensed sources

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



Thank you!