“Seeing” the Microlens with Hubble and VLT

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Why do we want to “see” it?

- Light curve -> Mass Ratio q & separation d

$$t_{\rm E} = \frac{\theta_{\rm E}}{\mu_{\rm rel}}, {\theta_{\rm E}}^2 = \kappa M \pi_{\rm rel}, \pi_{\rm rel} = 1/D_{\rm lens} - 1/D_{\rm Source}$$

- θ_E is *usually* known for planetary events, $D_{source} \sim$ 8kpc

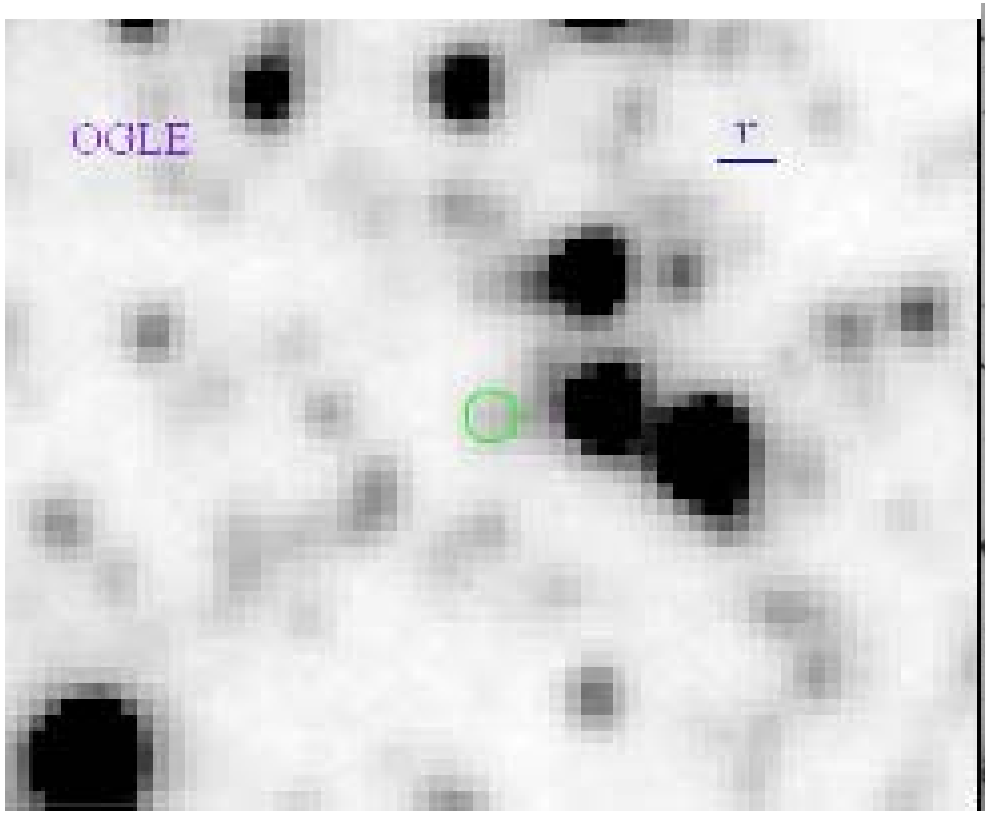
- We hope to know the M and D_{lens}

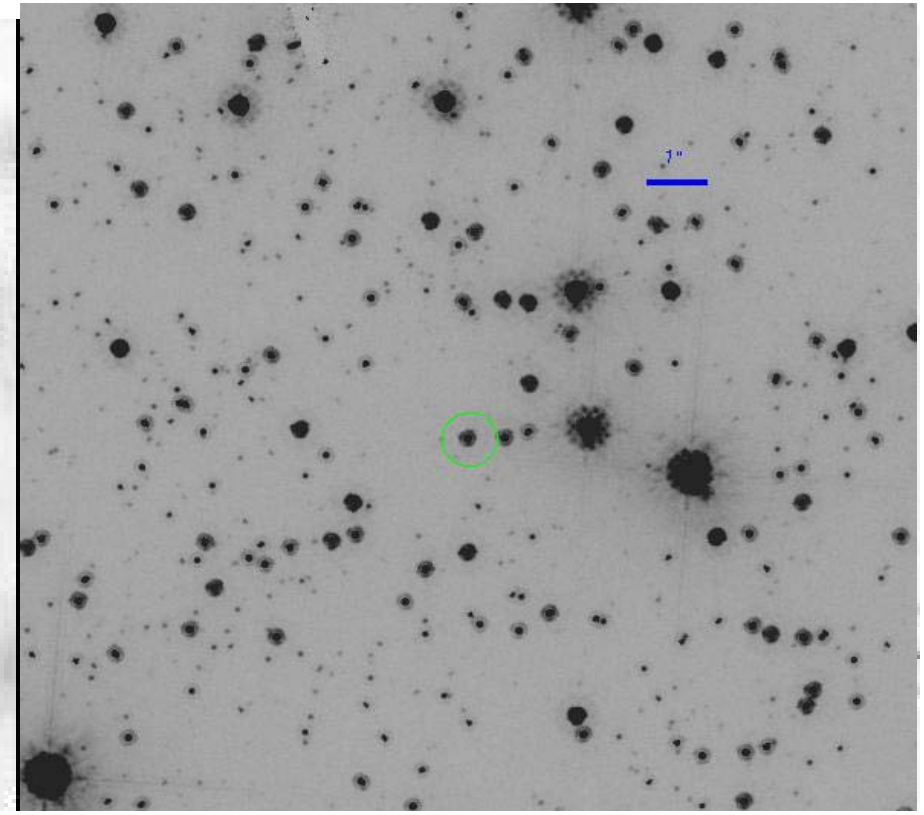
  => M_{planet}, d_{planet} (AU)

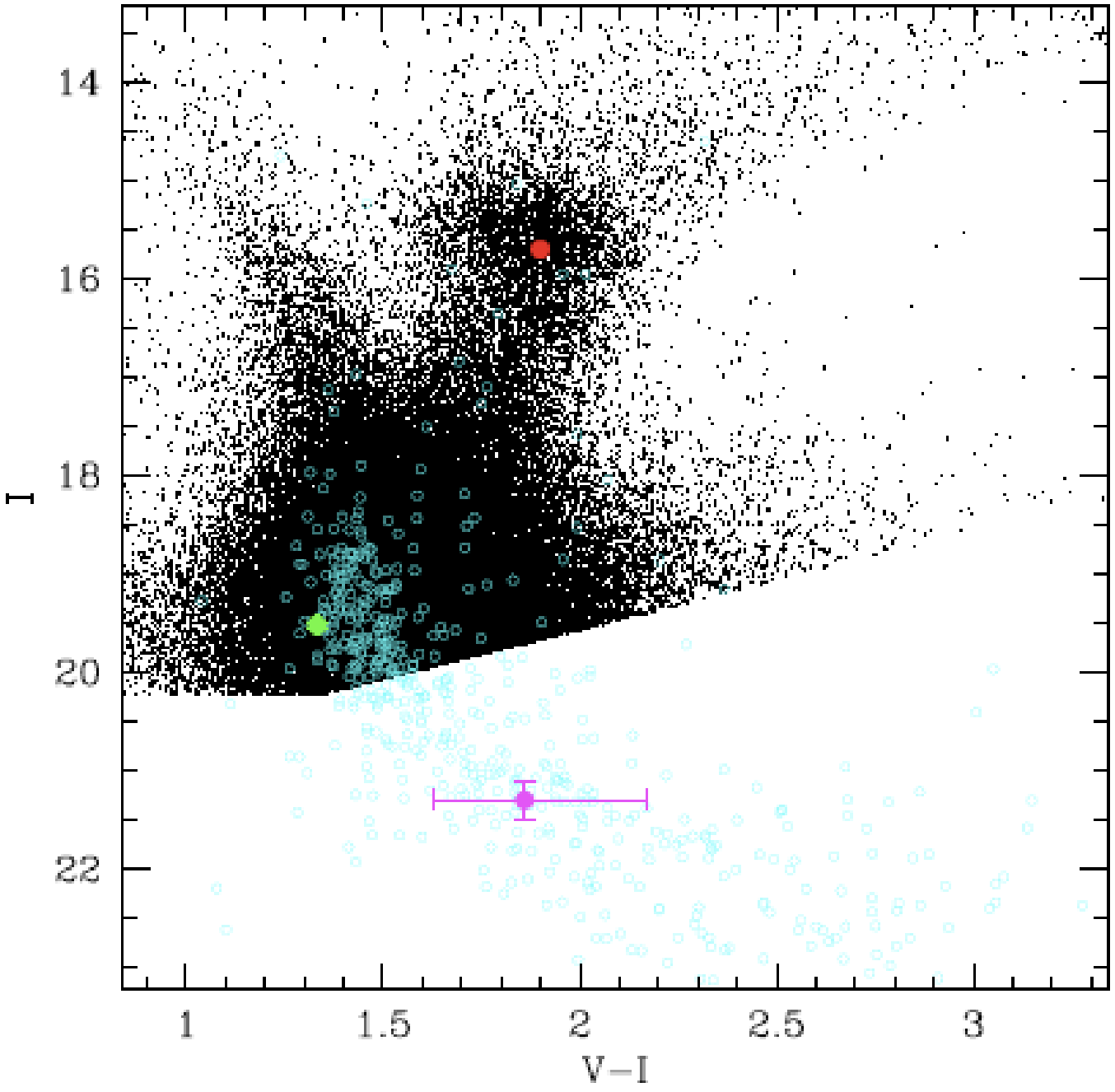
Excess Flux

- Flux = F_{source} x A + F_{blend}
  - F_{blend}: Lens; Unrelated nearby star <-> Bulge Field is very crowded!
  - High-res imaging is needed
    - Hubble Space Telescope
    - Adaptive Optics in IR from the ground (VLT NACO)
- Measure brightness (and color) of the lens

Ground v.s. Space






14
16
18
20
22
I
1
1.5
2
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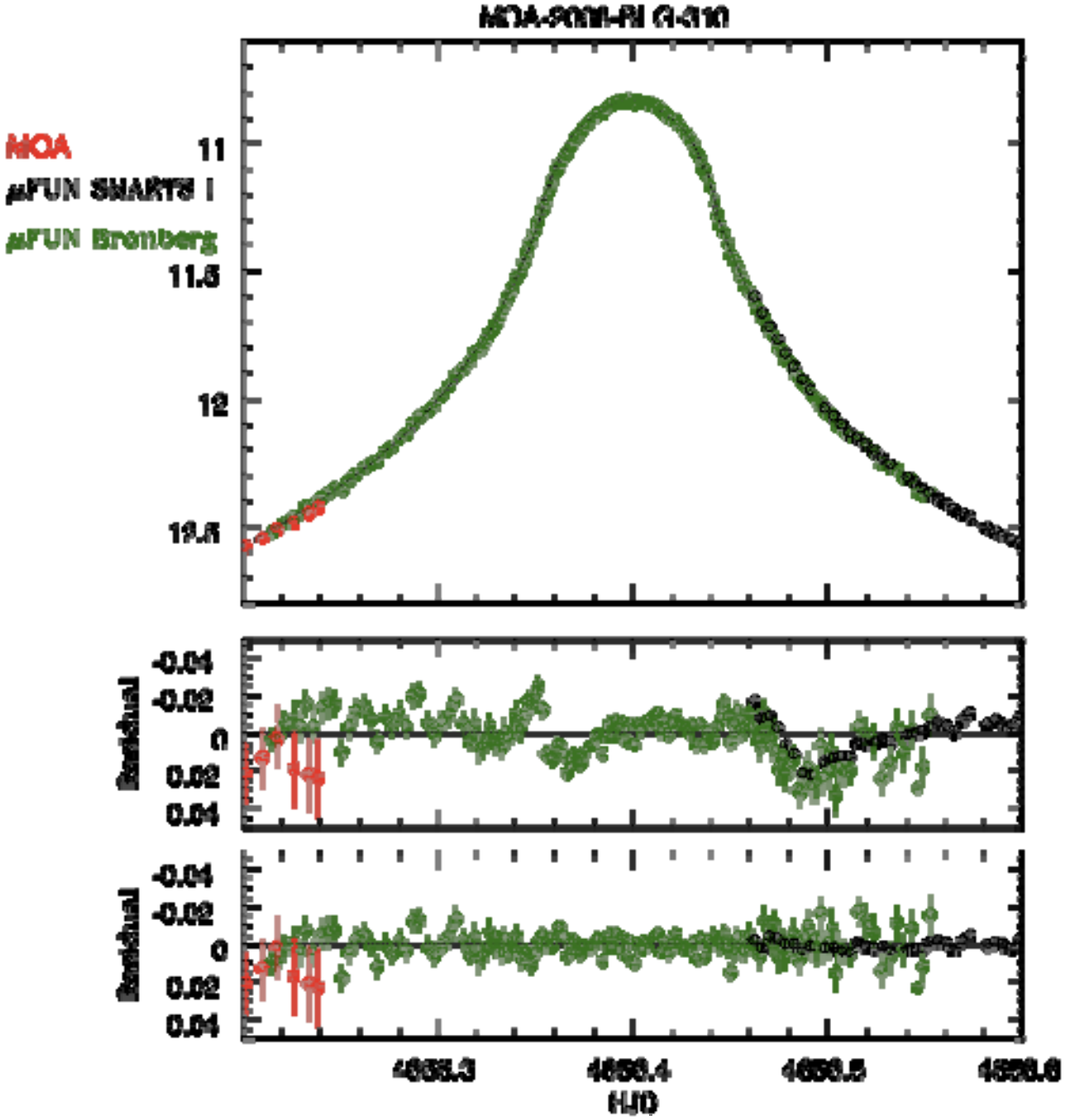
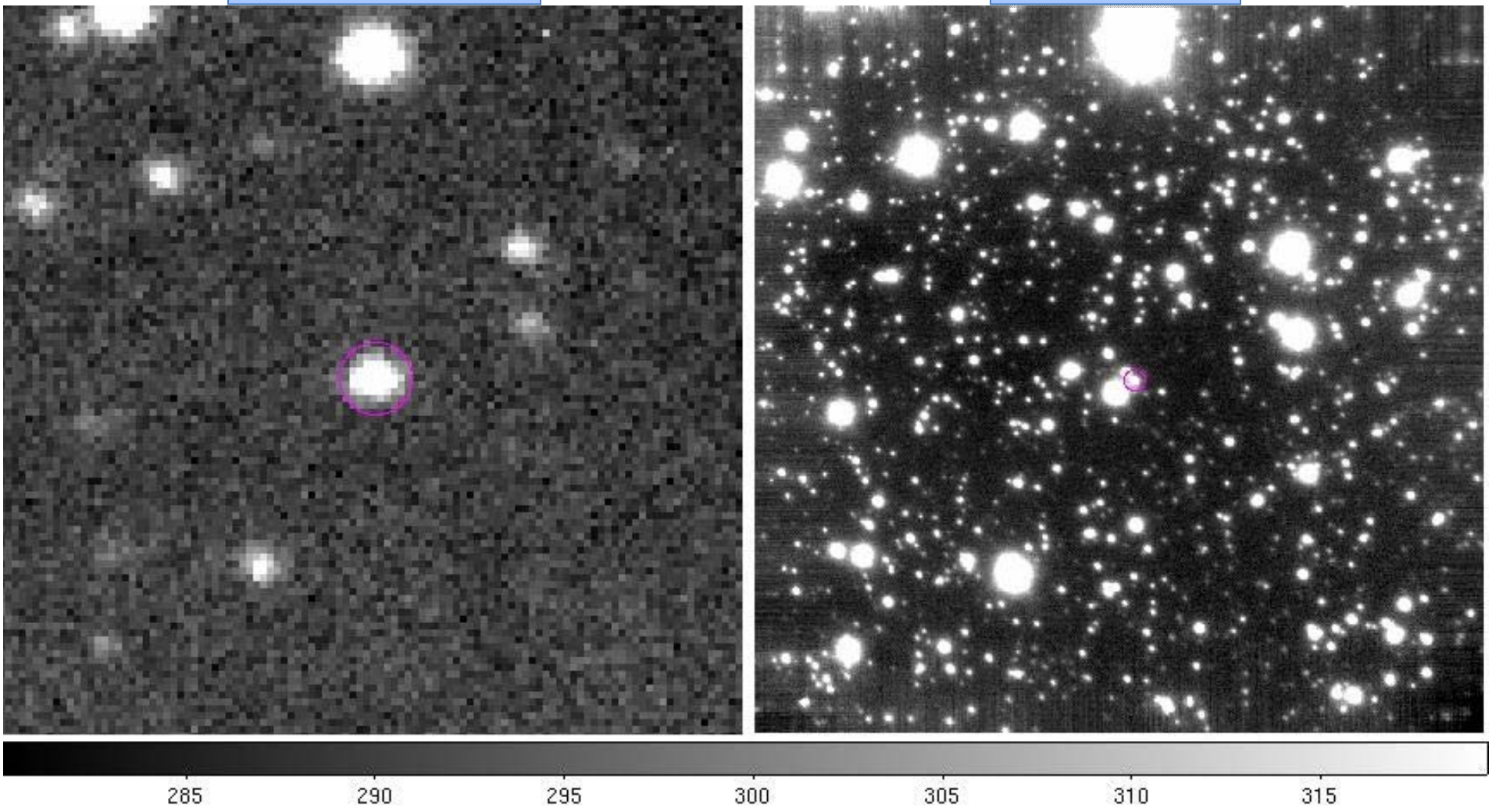
3
V−I



$q \sim 3 \times 10^{-4}$

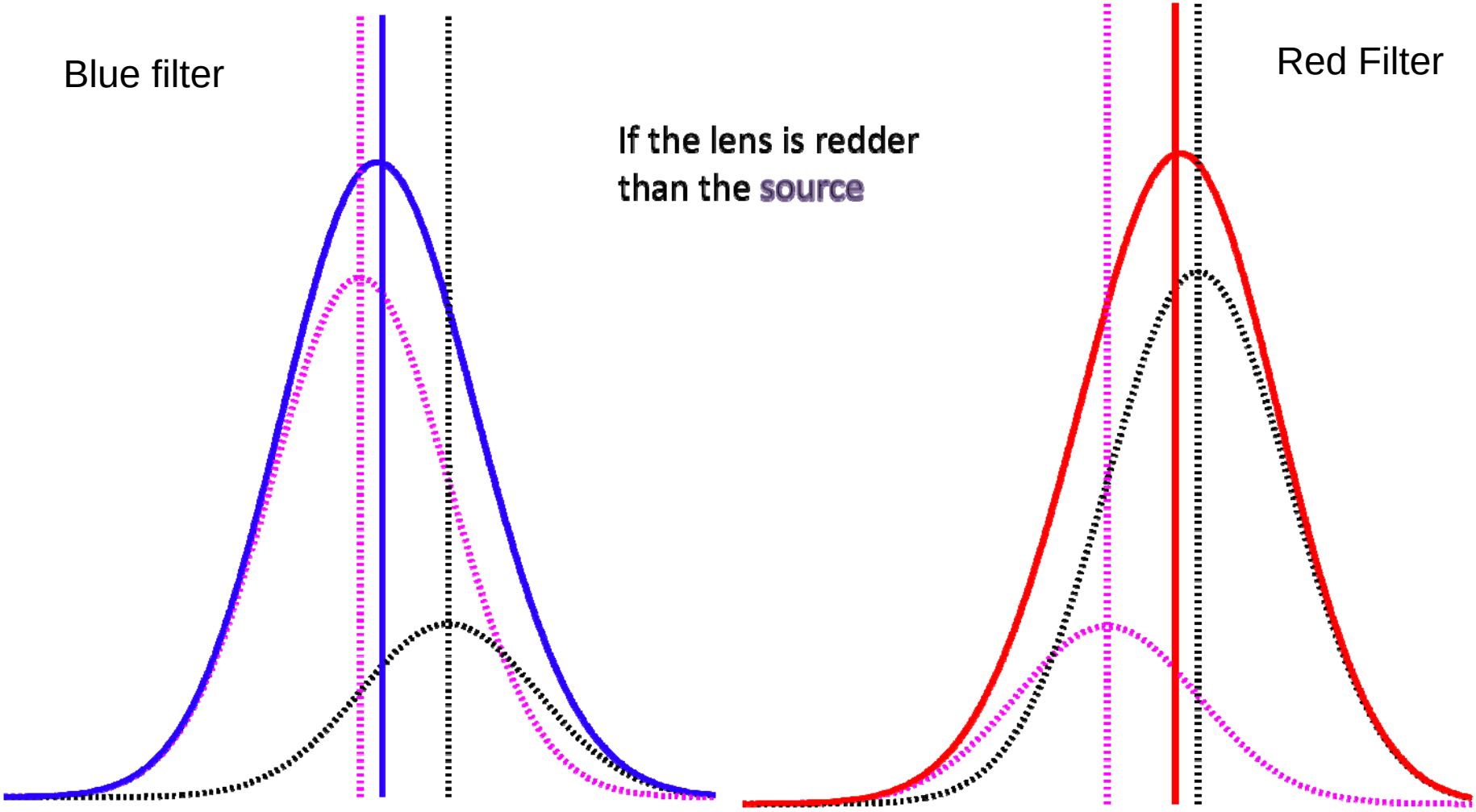
Ground H-band

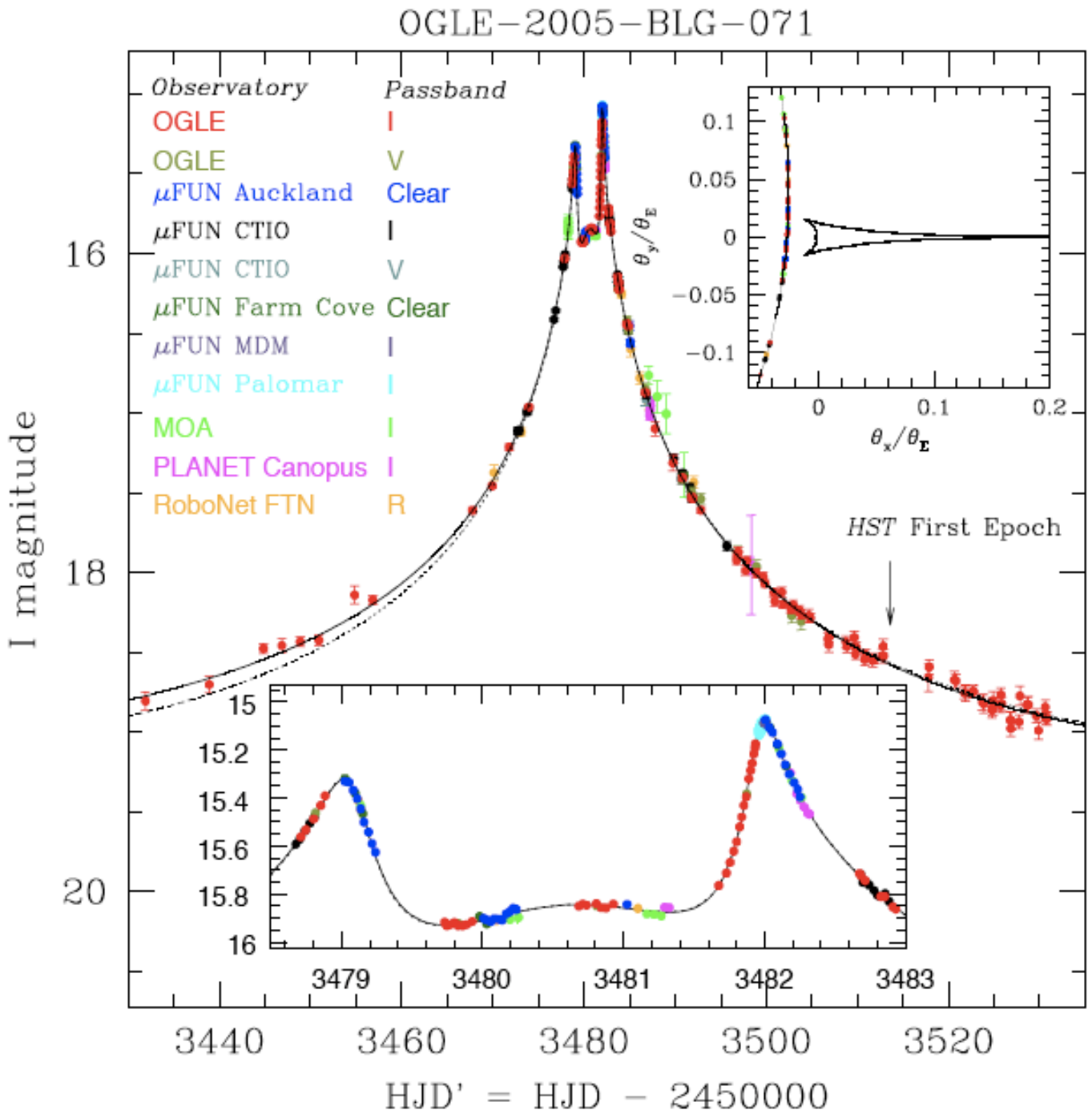
VLT NACO



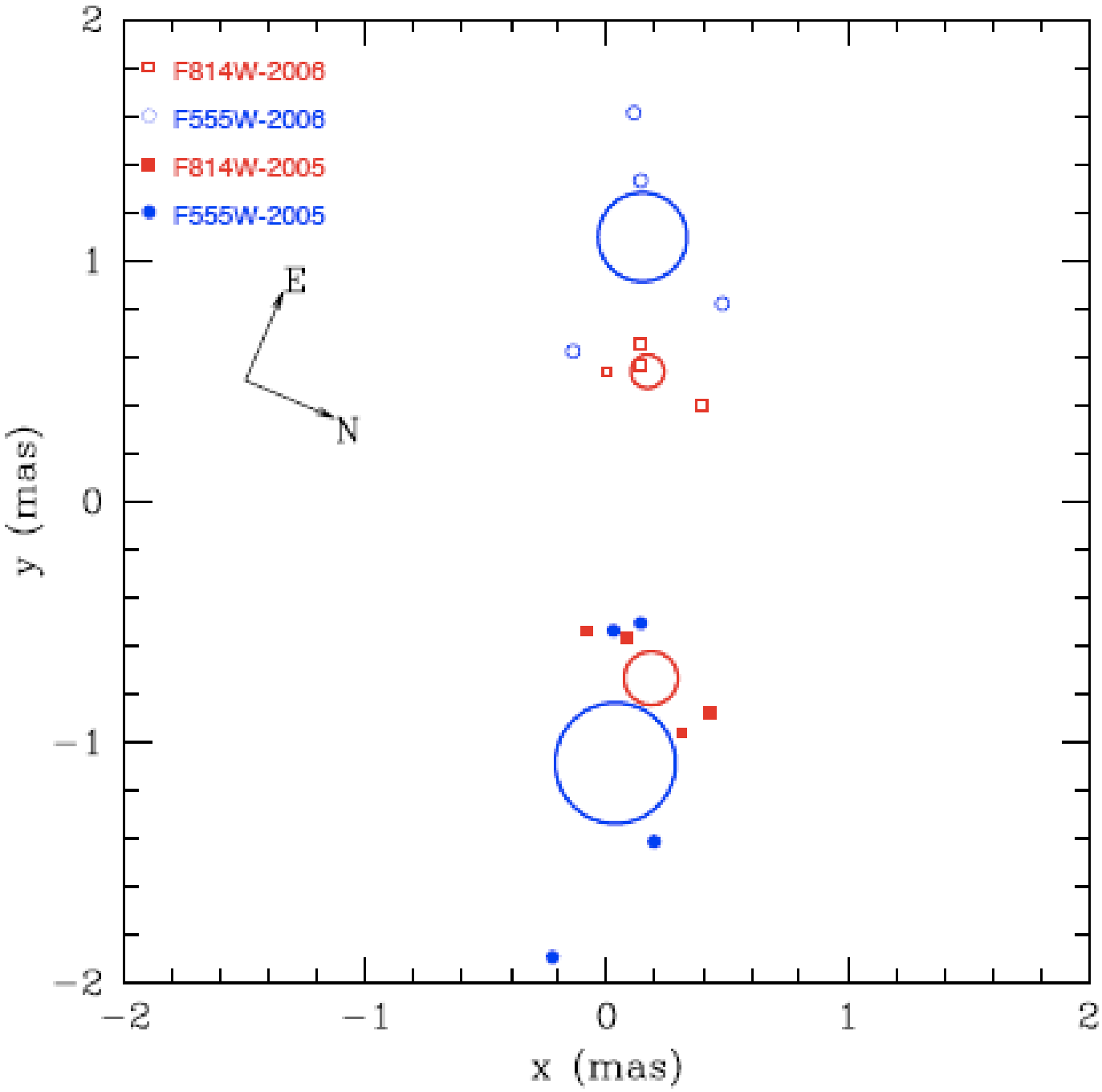
- θ_E =0.14 mas, $\pi_{rel} = 1/D_{Lens} - 1/D_{Source}$ = 2.4 uas $(M/M_{Sun})^{-1}$
- A planet in the bulge?

Color-dependent centroid shift





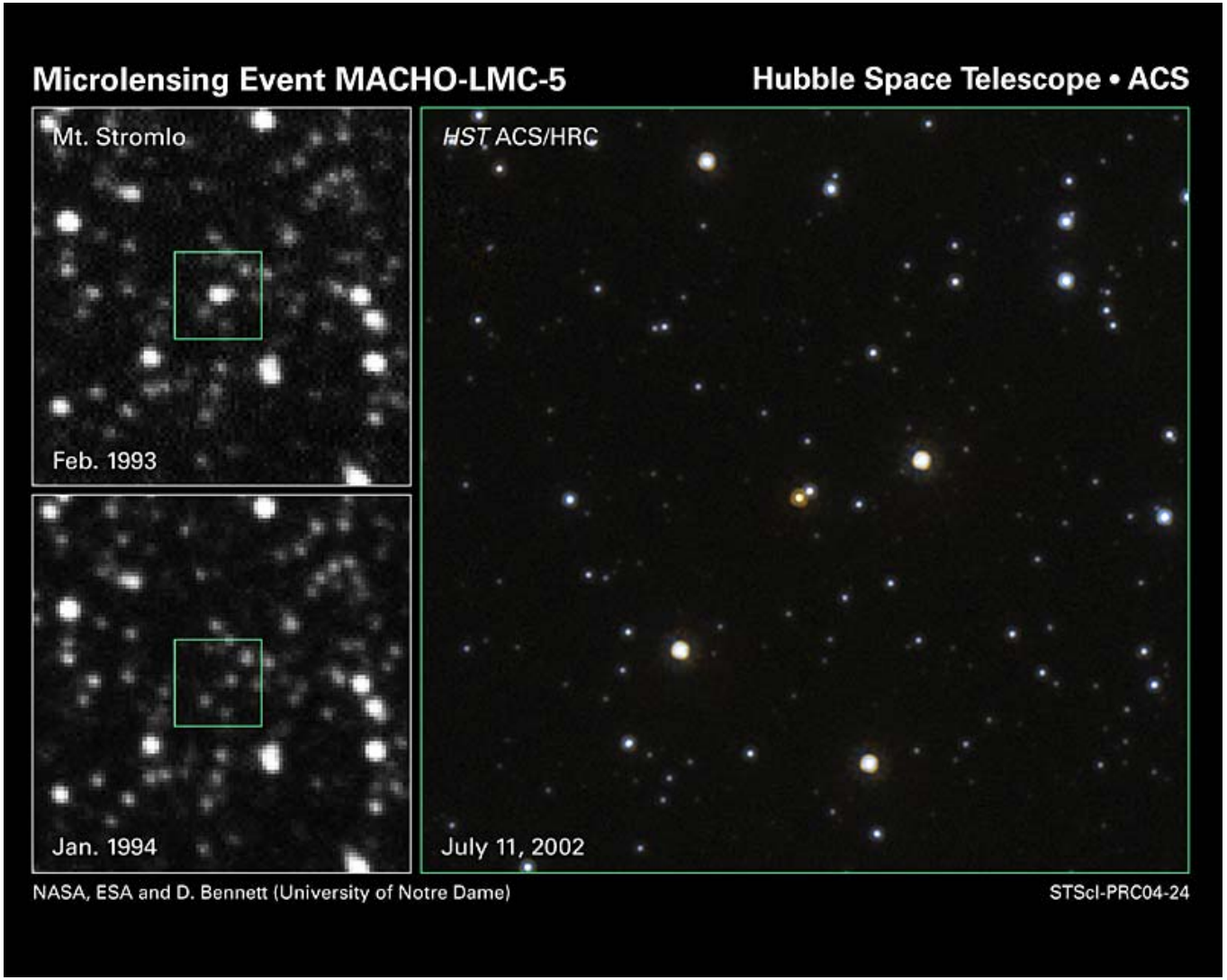
May 2005
Feb 2006

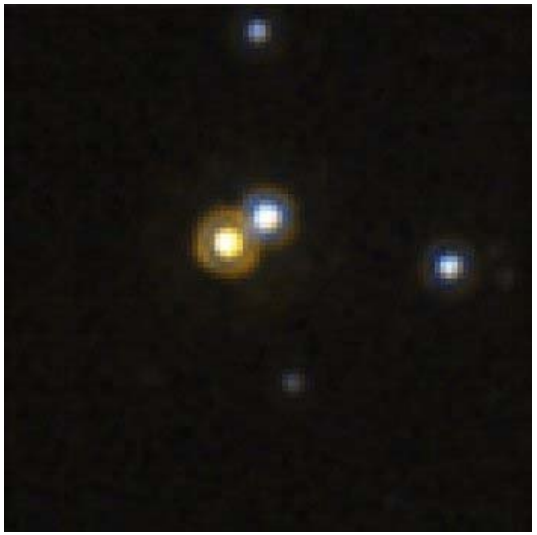


$$\theta_{\rm E} = t_{\rm E} \times \mu_{\rm E}$$

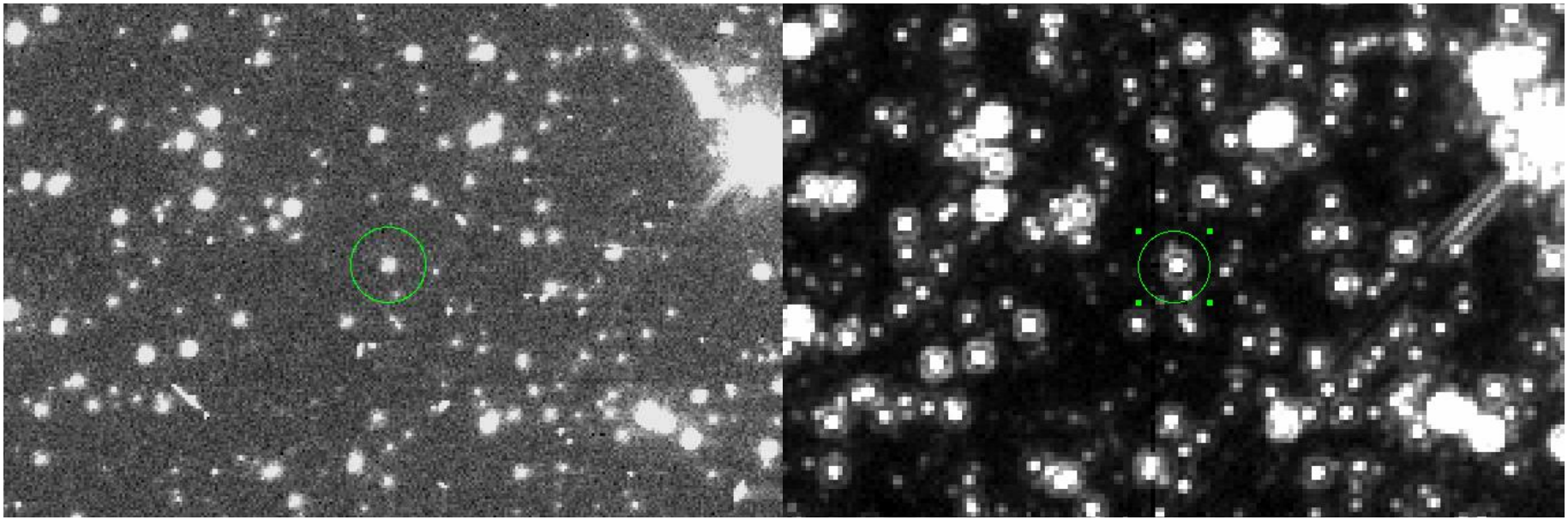
Name	M_* ($M_\odot$)	Metallicity	Dist. (pc)	M_p ($M_{\rm Jup}$)	P (days)	a (AU)	Ref.
GJ 876c	0.32 ±0.03	−0.12 ±0.12	4.660 ±0.004	0.6– 0.8	30.340 ±0.013	0.13030	1,2,3
GJ 876b	–	–	–	1.9– 2.5	60.940 ±0.013	0.20783	–
GJ 849b	0.49 ±0.05	0.16 ±0.2	8.8 ±0.2	$0.82/\sin i$	1890 ±130	2.35	4
GJ 317b	0.24 ±0.04	−0.23 0.2	9.2 ±1.7	$1.2/\sin i$	692.9 ±4	0.95	5
OB06109Lb	0.50 ±0.05	? ?	1490 ±130	0.71 ±0.08	1830 ±370	2.3 ±0.2	6
OB06109Lc	–	–	–	0.27 ±0.03	5100 ±730	4.6 ±0.5	–
OGLE-2005 -BLG-071Lb	0.46 ±0.04	Subsolar?[a]	3300 ±400	3.5[b] ±0.3	–	3.6[b,c] ±0.2	This Paper

Many years after the event





OGLE-2007-BLG-349 HST + VLT

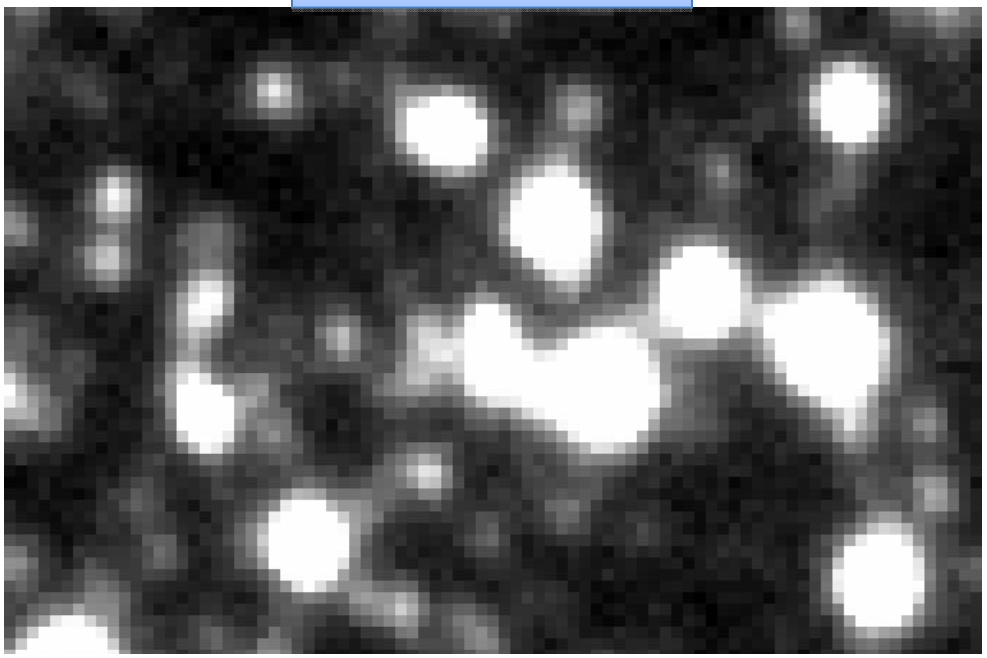


WFPC2 PC camera

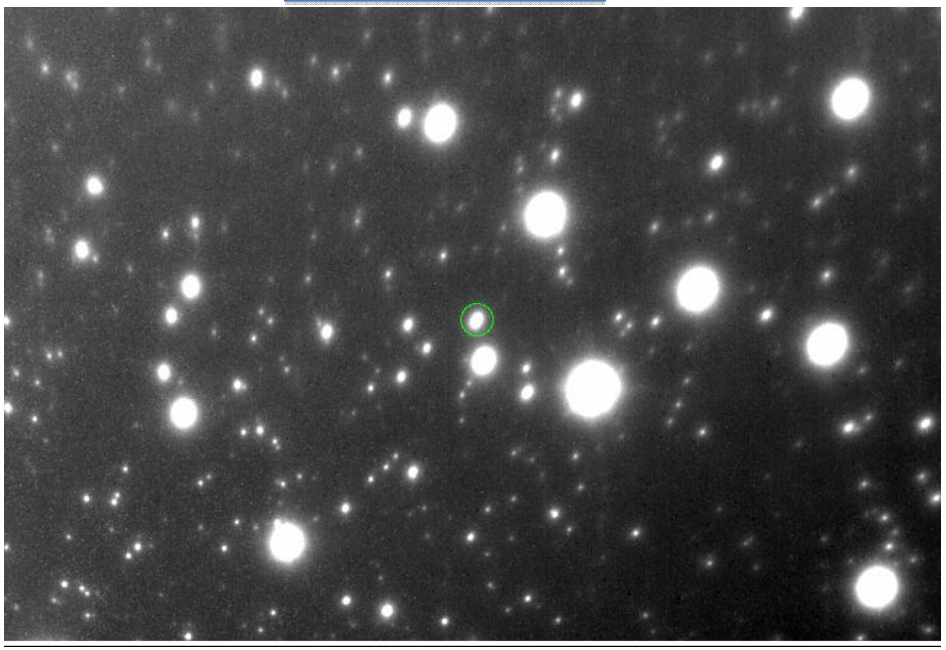
NICMOS

OGLE-2008-BLG-270 VLT NACO

OGLE



VLT NACO



In the future…

- VLT ToO proposal
  - For 2009 season
- HST proposal
  - Observe all planetary microlensing events without a good mass measurement at present
  - Galactic distribution of extrasolar Planets