



YETI – Search for young transiting planets



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YETI Observers, all over the world

Planet Formation and Evolution 2012

München

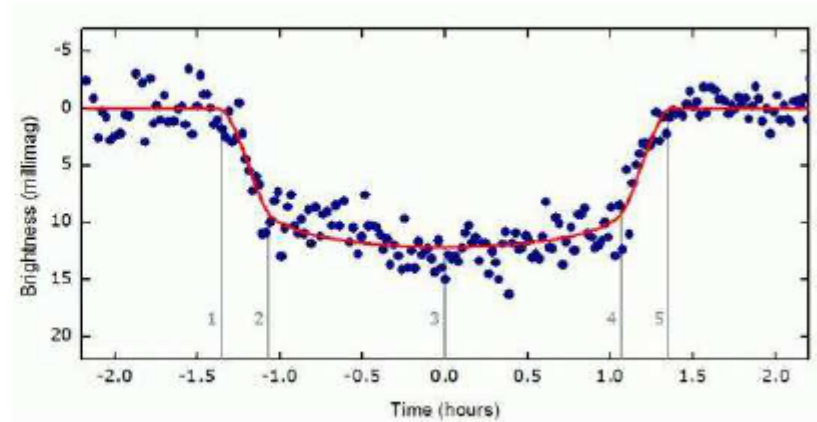
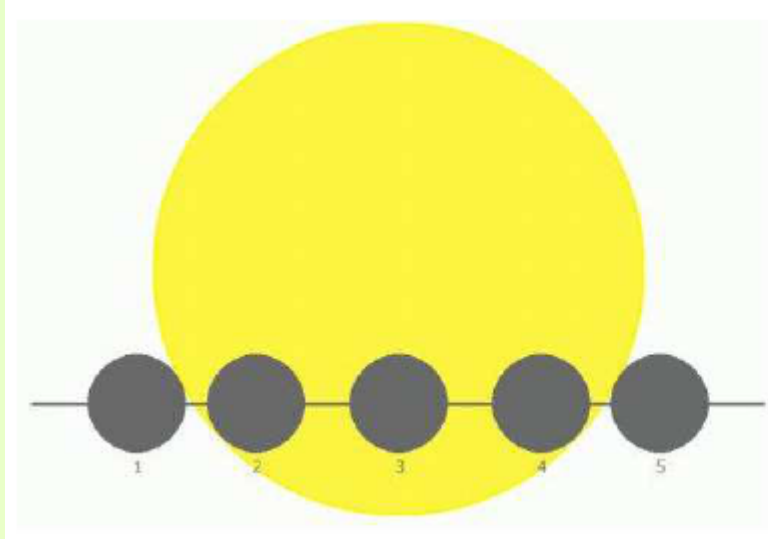
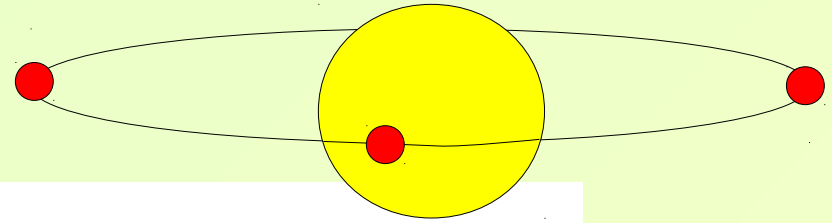
6. September 2012

Mercury transit
8. Nov. 06 (SOHO)



Venus transit 6. June 12

Transiting planets



Transit Wasp-3b:
Maciejewski et al.,
2011

Light curve → planetary radius, orbit inclination;
RV follow up → true planetary mass






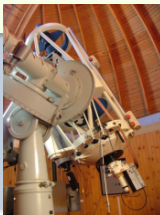
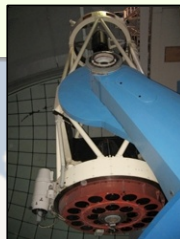

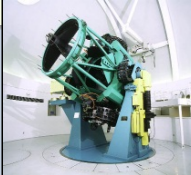
youngest transiting planets: Corot 2: 130 – 500 Myr from star spots
30 – 40 Myr from planet radius

Corot 20: 100 – 800 Myr from Li-abundance




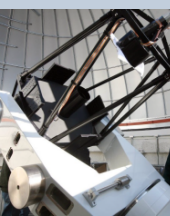
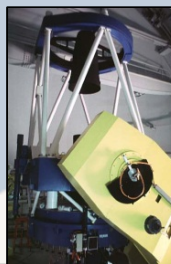

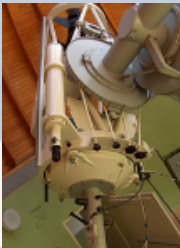
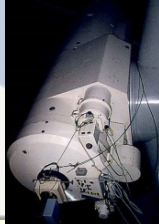

Wasp 10: 200 – 350 Myr from gyro-chronology

→ younger transiting planets needed, to test models, and planet formation scenarios

YETI-network (Y**o**ung **E**xoplanet **T**ransit **I**nitiative)

<p>Tenagra II 0.8-m telescope</p> 	<p>Llano del Hato Observatory 1-m Schmidt telescope</p> 	<p>Gettysburg Collage Observatory 0.4-m telescope</p> 	<p>Sierra Nevada 1.5-m telescope</p> 	<p>Jena Astrophysical Institute 0.9/0.6-m telescope</p> 	<p>Stara Lesna Astronomical Institute 0.6-m telescope</p> 	<p>Byurakan 1.0 and 2.6 telescopes</p> 	<p>Xinglong Observatory 90/60 cm</p> 	<p>Gunma Astronomical Observatory 1.5-m telescope</p> 
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<p>Mauna Kea Univ. of Hawaii 2.2m telescope</p> 	<p>Observatorio Cerro Armazones two 5.9" telescopes</p> 	<p>Stony Brook 14" telescope</p> 	<p>Swarthmore 0.6-m telescope</p> 	<p>Calar Alto 2.2-m telescope</p> 	<p>Torun 60 cm telescope</p> 	<p>Rozhen 0.6 and 2-m telescopes</p> 	<p>Nainital State Observatory 1-m telescope</p> 	<p>Lulin Lulin Observatory 1m Telescope</p> 
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YETI-network (Young Exoplanet Transit Initiative)

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The Young Exoplanet Transit Initiative (YETI)

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Trumpler 37

part of H-II region IC 1396

distance: 870 pc (*)

age: 4 to 10 Mio years (*)
→ formation of
planets finished

Diameter: 1.5°

Extinction:

$$A_V = 1.5 \text{ mag}$$

Cluster radial velocity

$$v = -15.0 \pm 3.6 \text{ km/s (*)}$$

18000 stars,
500 known members(*)



*Sicilia-Aguilar et al. (2004-2007),
Marschall and van Altena (1987)
Contreras et al. (2002)

central part of Trumpler 37 from 90/60cm Schmidt-Telescope Jena,
R-Band 60s, FOV: 53' x 53'

Observations

Jena (Großschwabhausen)

2009: 36 nights, 5515 data points
2010: 37 nights, 1800 data points
2011: 78 nights, 5100 data points
→ **12 500** data points in R filter in
each exposure time

B,V,I filter: 1300 data points

Photometric precision

for 10s exposure time:

163 stars: $\sigma < 5$ milli-mag

for 120s exposure time:

690 stars: $\sigma < 5$ mmag

5351 stars: $\sigma < 30$ mmag

Most cluster members have
brightness:

R = 11.0 to 17.0 mag

YETI campaign runs

2010:

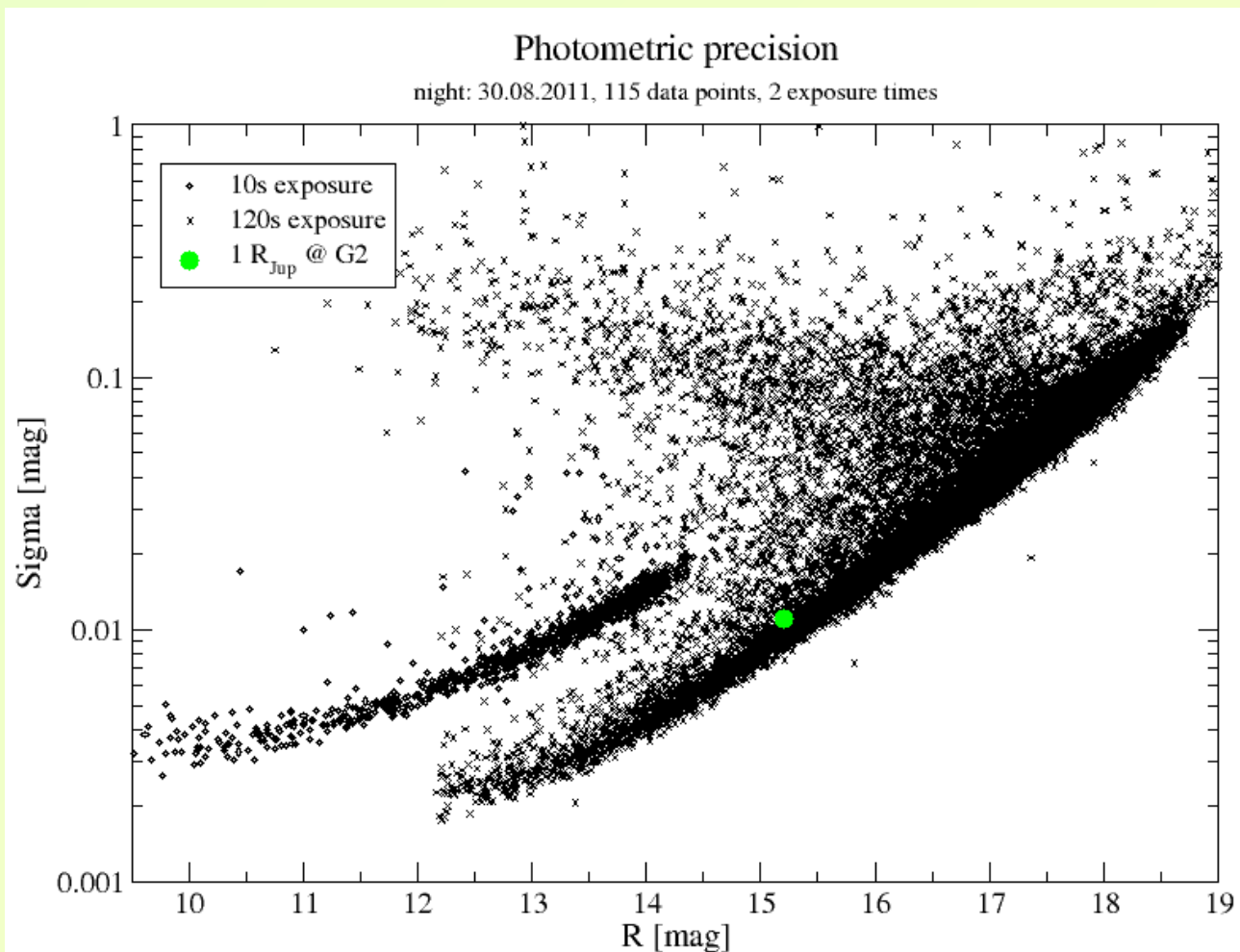
3. - 12. Aug.
26. - 12. Sept.
24. - 30. Sept.

→ **27500** images
from **11** telescopes

2011:

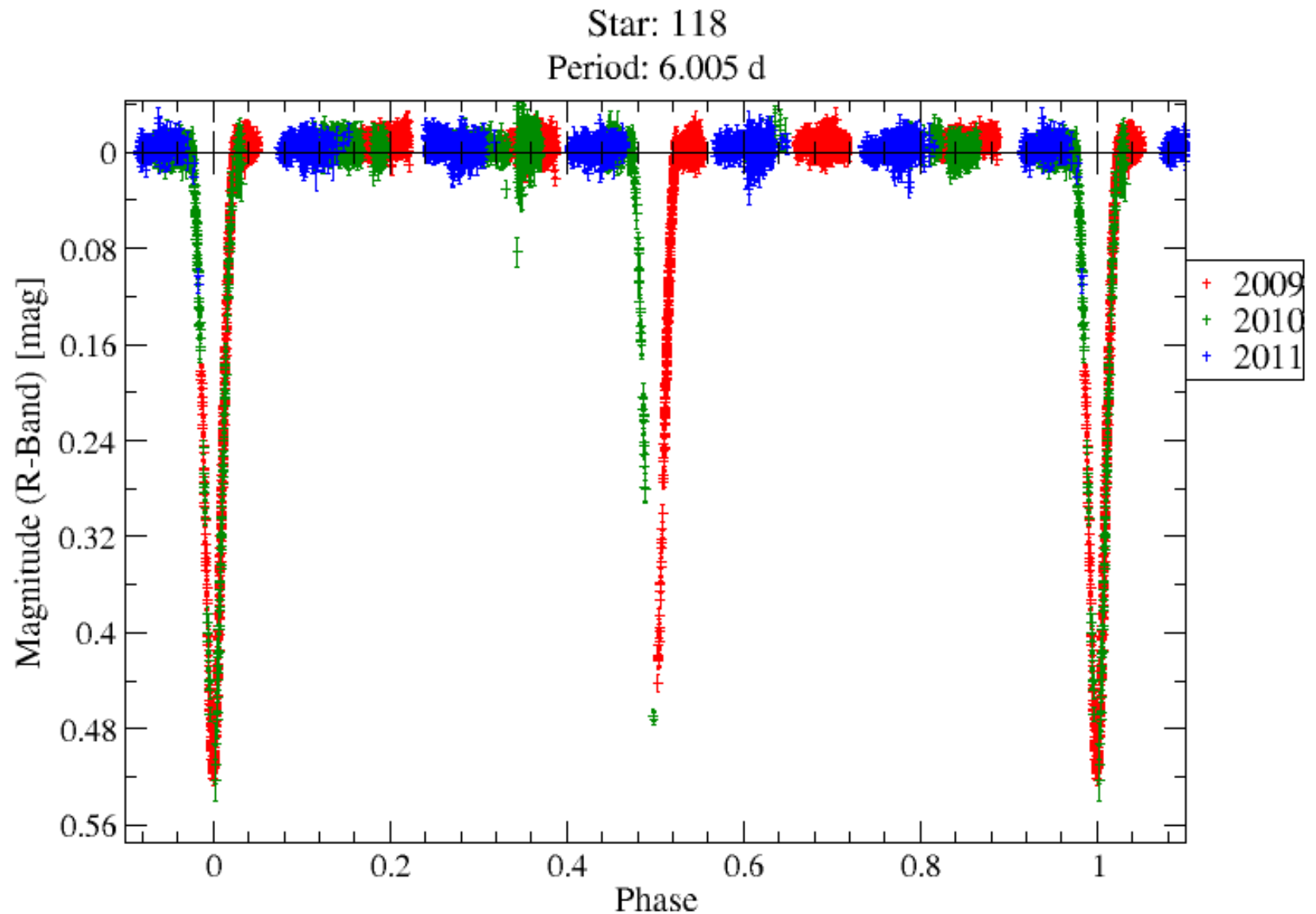
11. - 22. July
10. - 22. Aug.
9. - 20. Sept.

→ **21000** images
from **9** telescopes



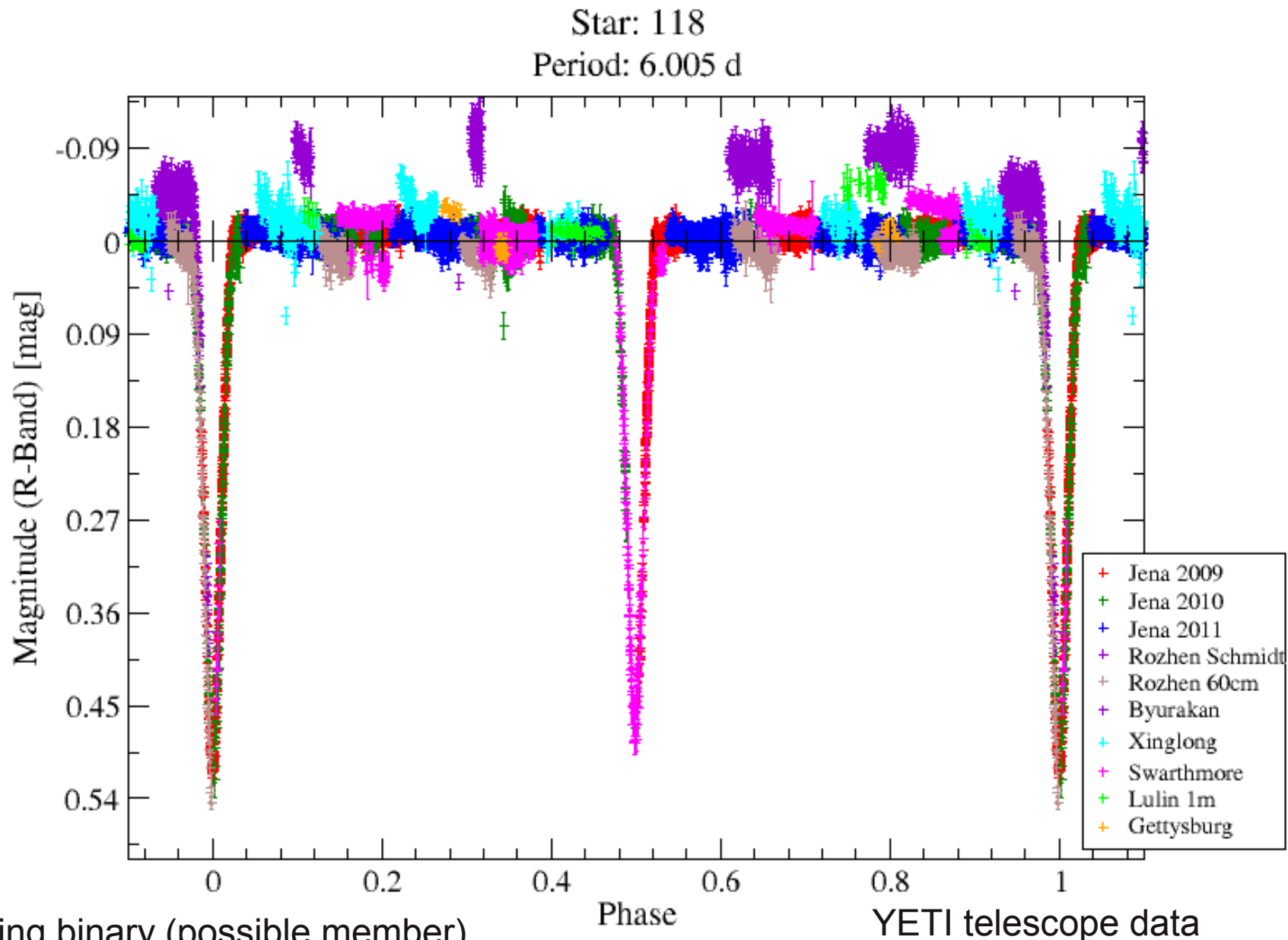
Multi-site campaign on Trumpler 37

10 000
data
points, but
still gaps in
the phase
folded light
curve



only Jena data

Multi-site campaign on Trumpler 37



no gaps

but need
for some
improvements
in combining
data from
different
telescopes

Star 118: eclipsing binary (possible member)

Transit-candidate

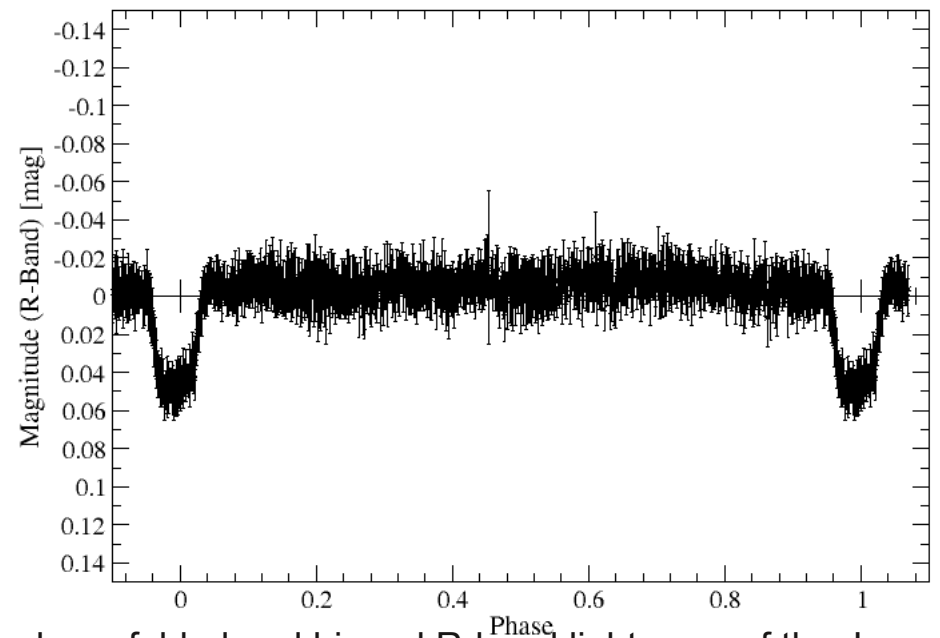
R = 15.1 mag

$\Delta R \approx 50$ milli-mag (Jena STK)

$\Delta I = 51.8$ milli-mag (Calar Alto 2.2m)

P = 1.3649 d

$t_{\text{trans}} = 0.1127$ d

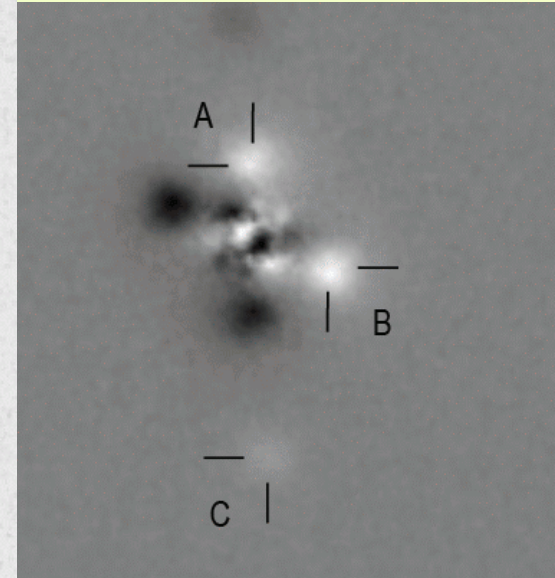
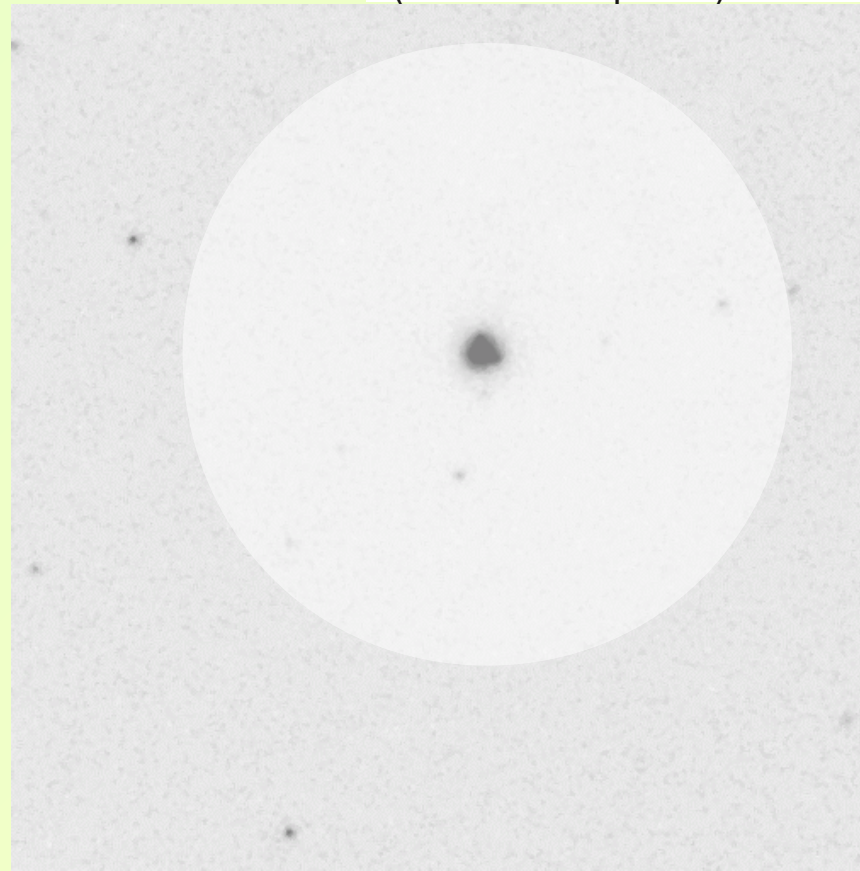


phase folded and binned R-band lightcurve of the Jena data (10 000 data points)

High resolution infrared imaging to check, whether there are other (eclipsing?) stars nearby (in the optical PSF)

→ 8m Subaru AO imaging

=> all too faint



Follow-up - Keck

Radial velocity orbit for transit candidate:
HIRES spectrograph at 10m-Keck-I telescope

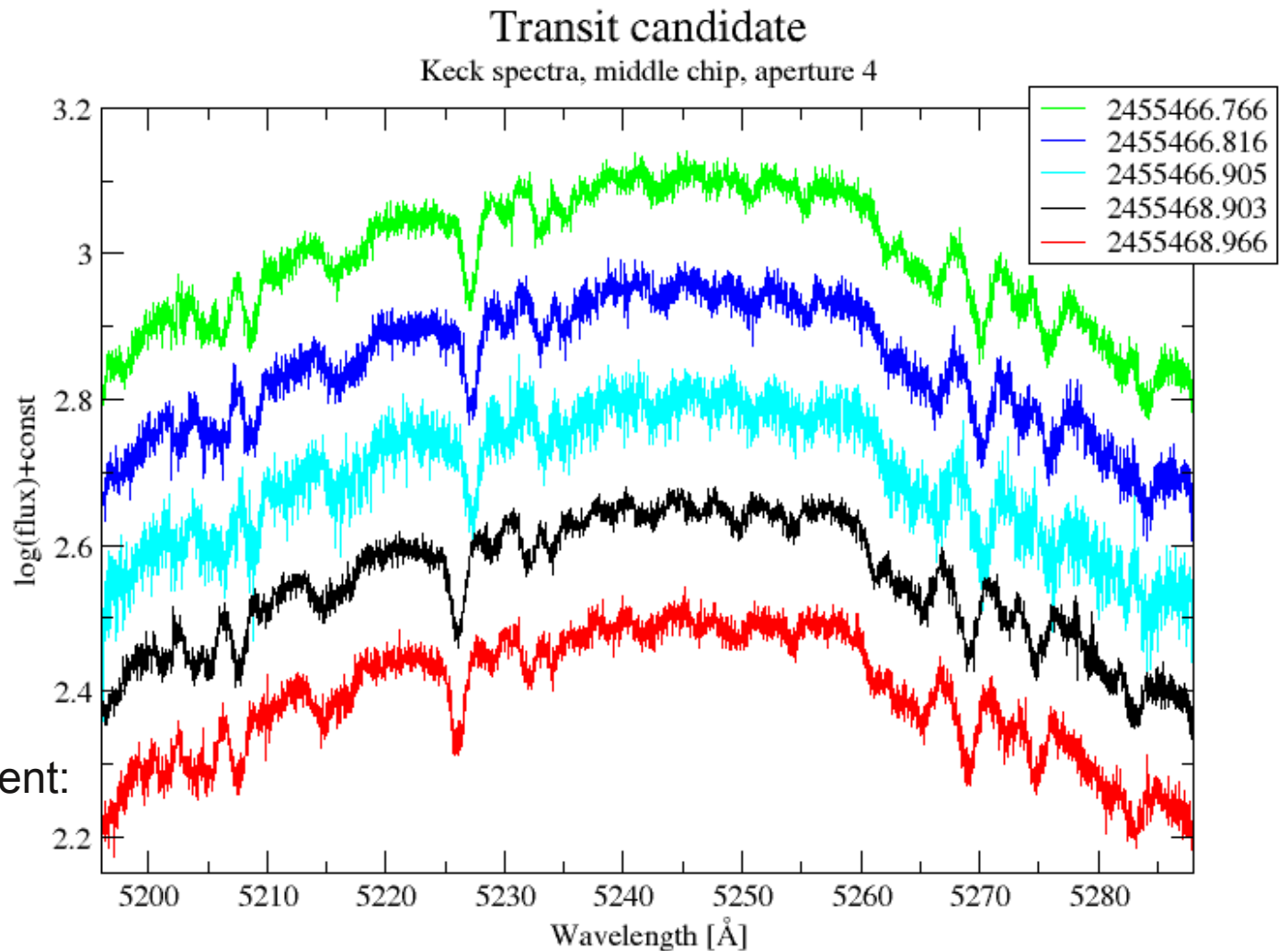
Cross correlation with
artificial spectra:

HJD-2455000	RV [km/s]
466.74372	9.071
466.79397	10.548
466.88945	11.482
468.88121	-47.398
468.94959	-48.682
521.68193	-3.242

Mass of the small component:

$$M_B = 0.16 \pm 0.02 M_{\text{sun}}$$

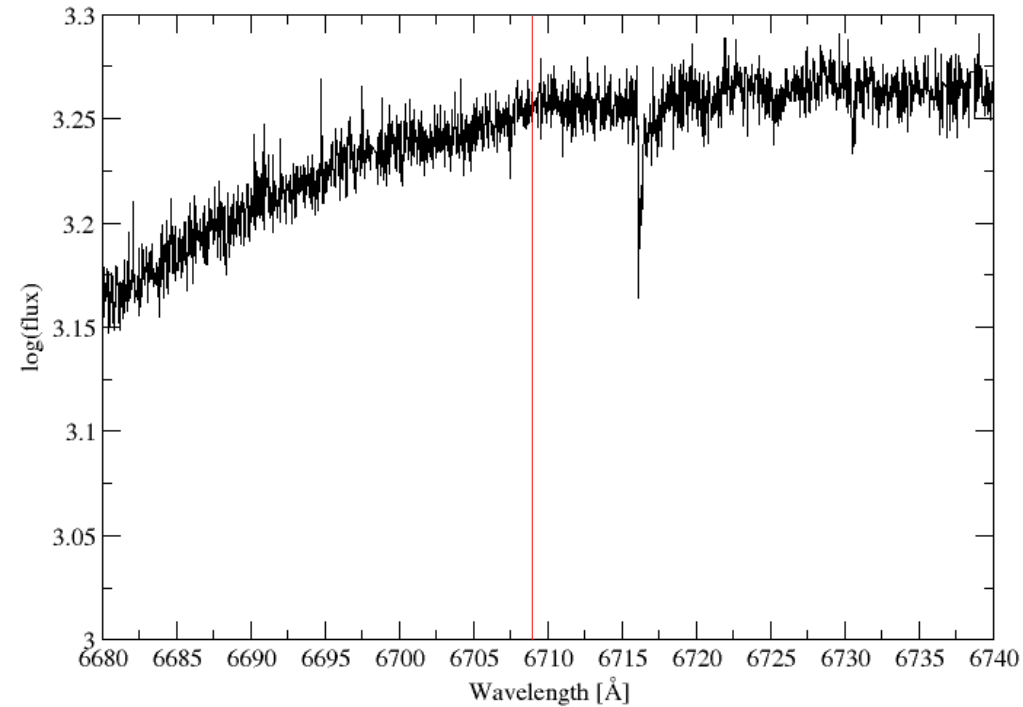
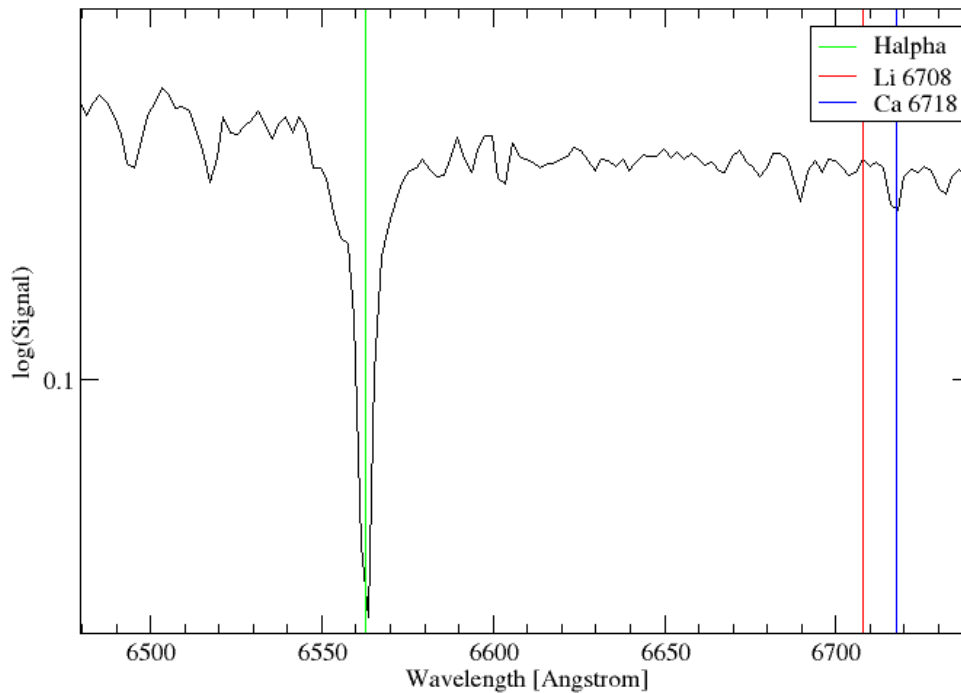
(M6 V)



Follow-up - Lithium

Star: 3218

Calar Alto 2.2m - CAFOS



low res spectra:
weak Lithium line, $EW = 0.1 \text{ \AA}$
→ dubious, weather young

Spectral type: G2

high res spectra:
no Lithium line visible

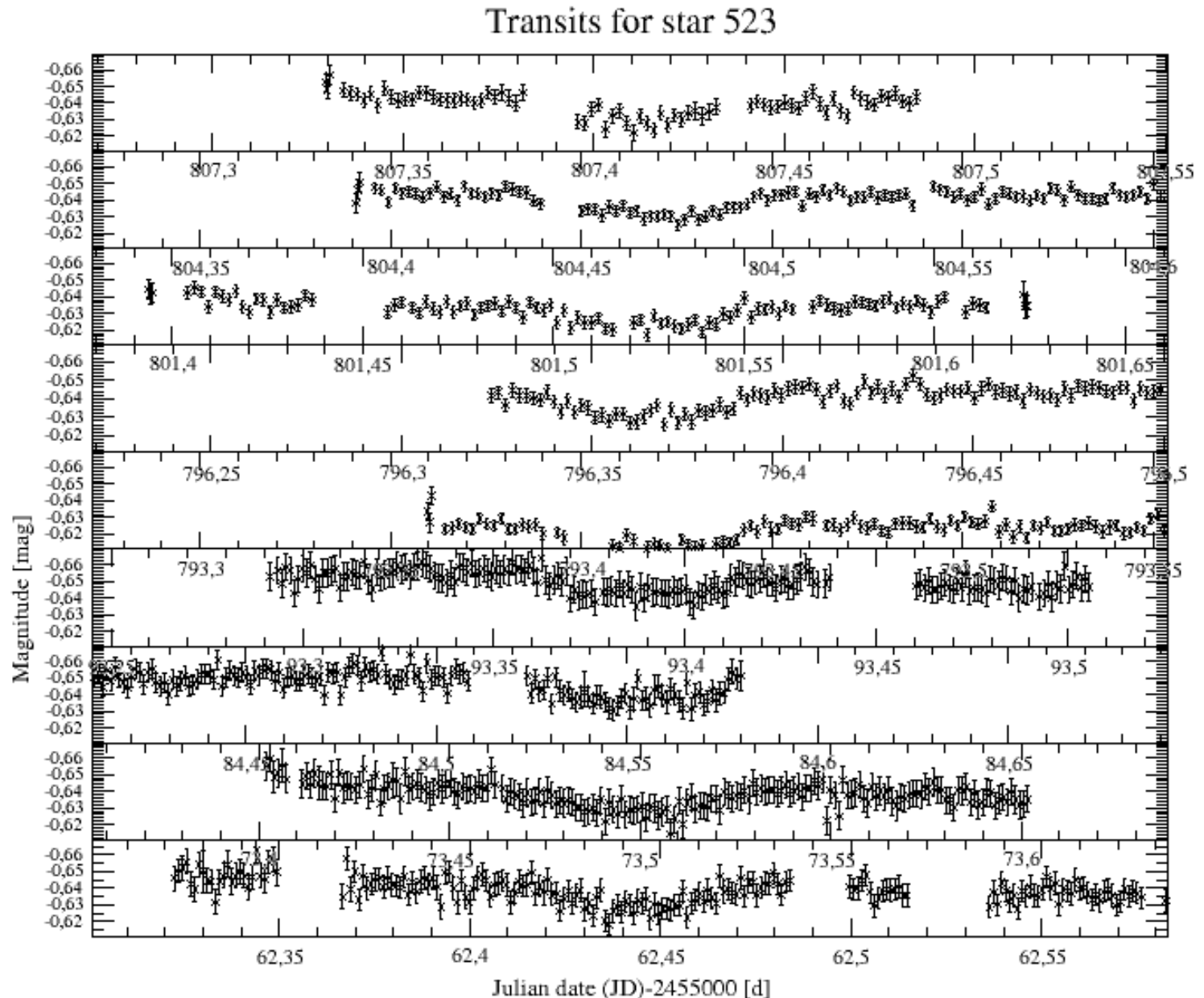
New transiting candidate

R = 13.4 mag
V = 14.1 mag
B-V = 0.8 mag
≈ G4

proper motion and
color magnitude
diagram → probable
member

star is active over
several days with
 $\Delta m \approx 15$ milli-mag

$P_{\text{transit}} \approx 0.7367$ d



New transiting candidate

R = 13.4 mag
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≈ G4

proper motion and color
magnitude diagram →
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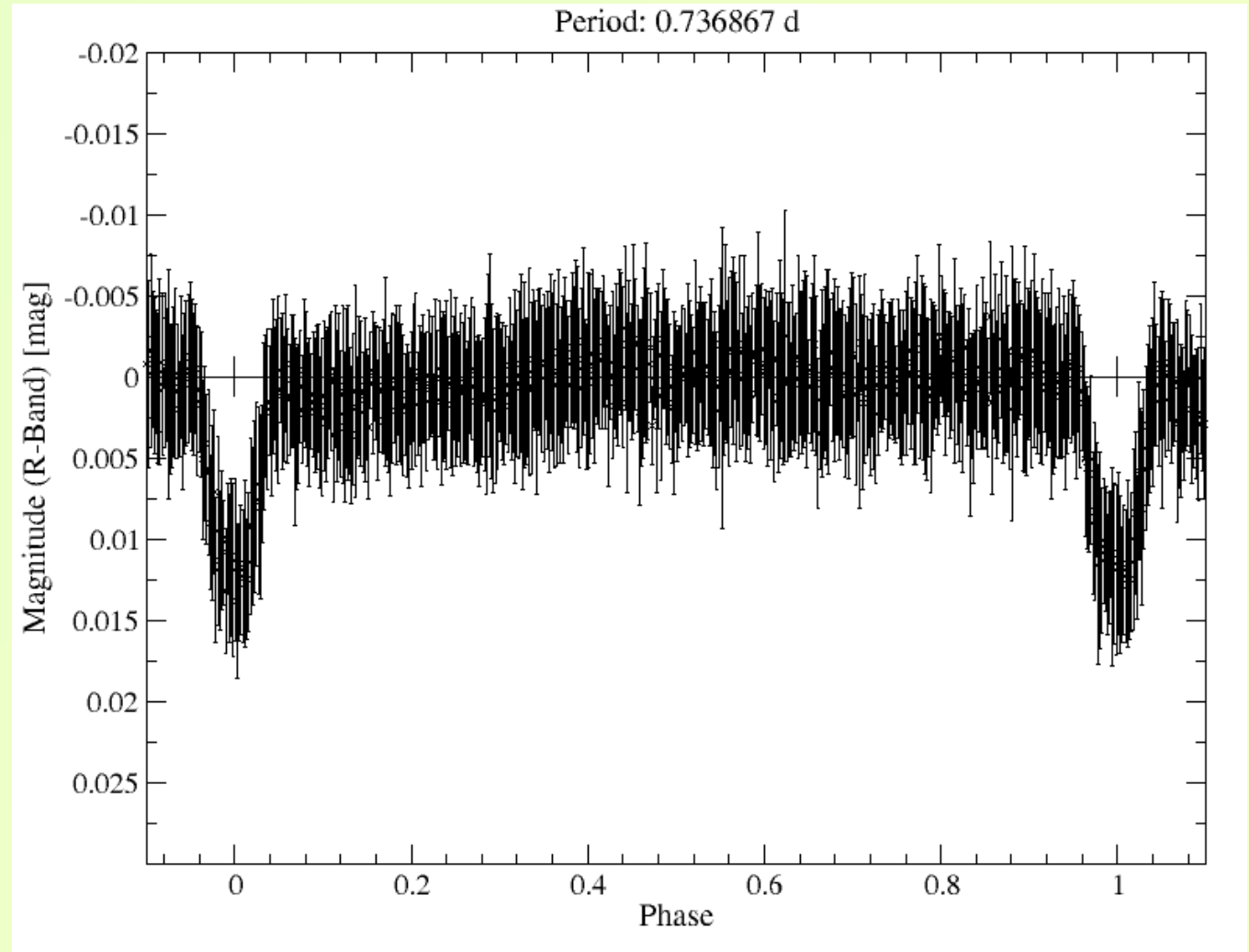
$\Delta m_{\text{transit}} \approx 13$ mmag

$P_{\text{transit}} \approx 0.736867$ d

Fit with IDL-tap:

$i = 71.2^\circ$

$R_p/R_* = 0.1084$



New transiting candidate

R = 13.4 mag

V = 14.1 mag

B-V = 0.8 mag

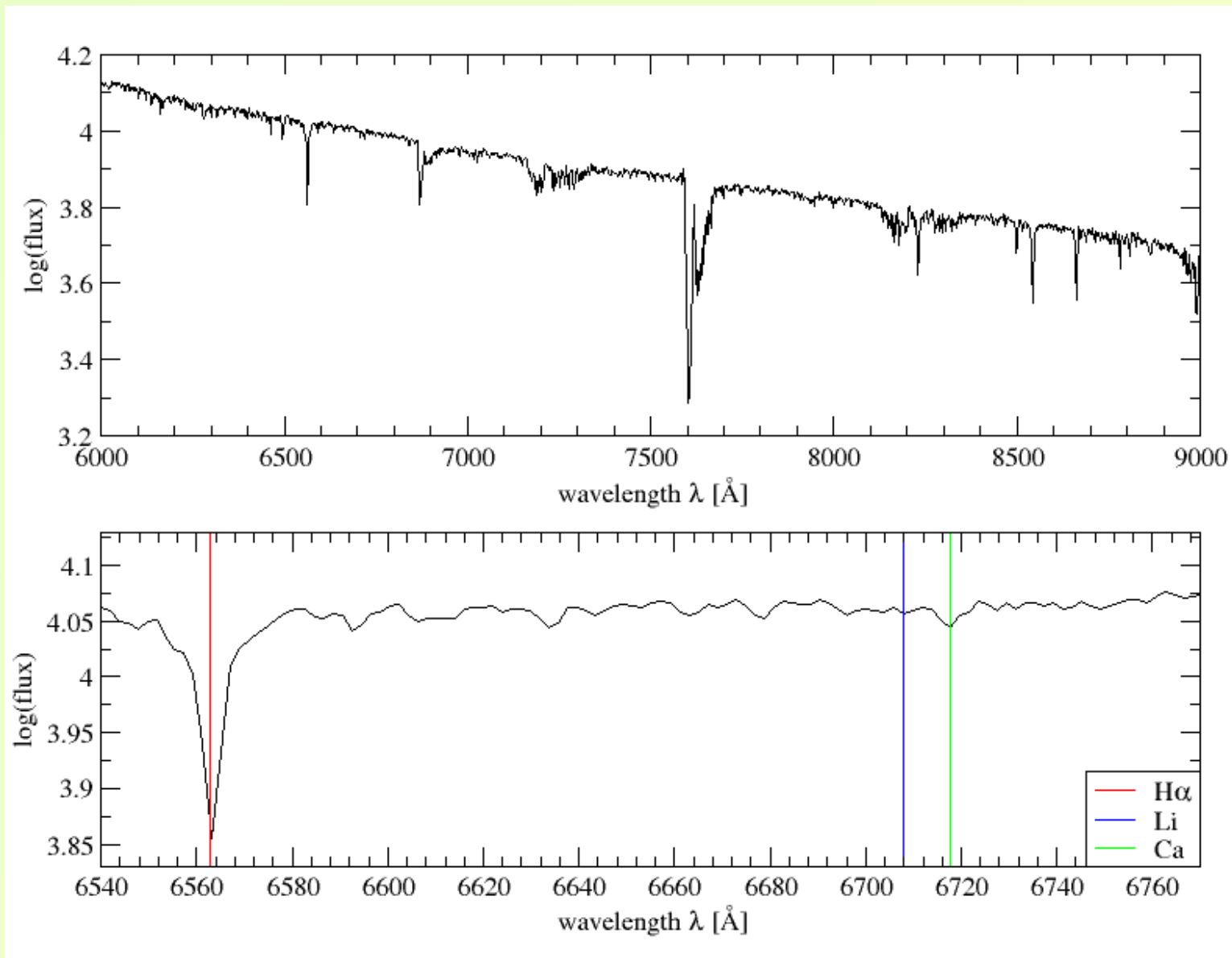
≈ G4

$P_{\text{transit}} \approx 0.7367$ d

$\Delta m \approx 15$ milli-mag

duration ≈ 1.5 h

no Lithium in Calar
Alto 2.2.m spectra



Conclusions and further investigations

We are able to find transit signals of Jupiter sized planets and do follow up

YETI-network closes observational gaps

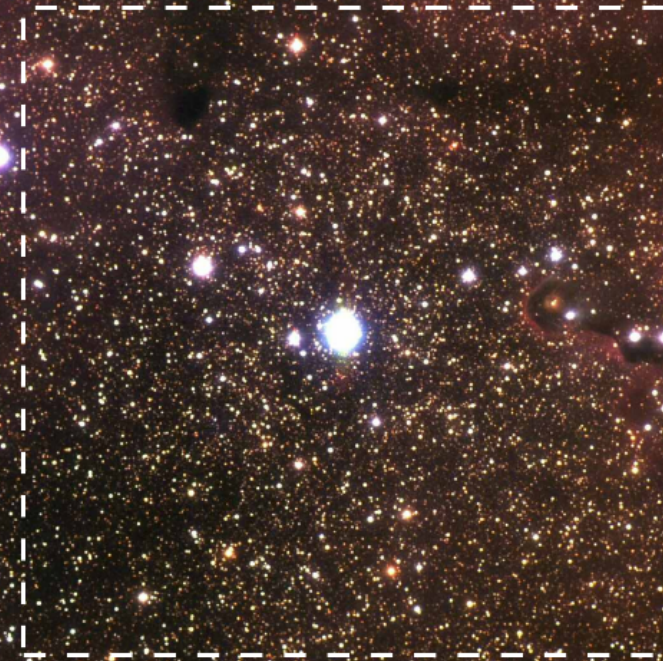
Similar monitoring for more young clusters: 25 Ori (8 Myr, 6 YETI-campaigns already done), monitoring on IC 348 (2 Myr) started

Improved transit search (**see Poster 58 by M. Kitze**), adding up images
→ more transit candidates expected (especially at late type stars)
→ Additional follow-up observations (membership, orbits, masses, ...)

Investigation of ~3 eclipsing binary members → test of theoretical evolutionary models

Goal: young planets to constrain formation models, to study planetary interior, and to compare with solar system planets

Thanks for your attention



Color

image of Trumpler 37 and STK FoV (Jena telescope data, stitched by Mugrauer)

