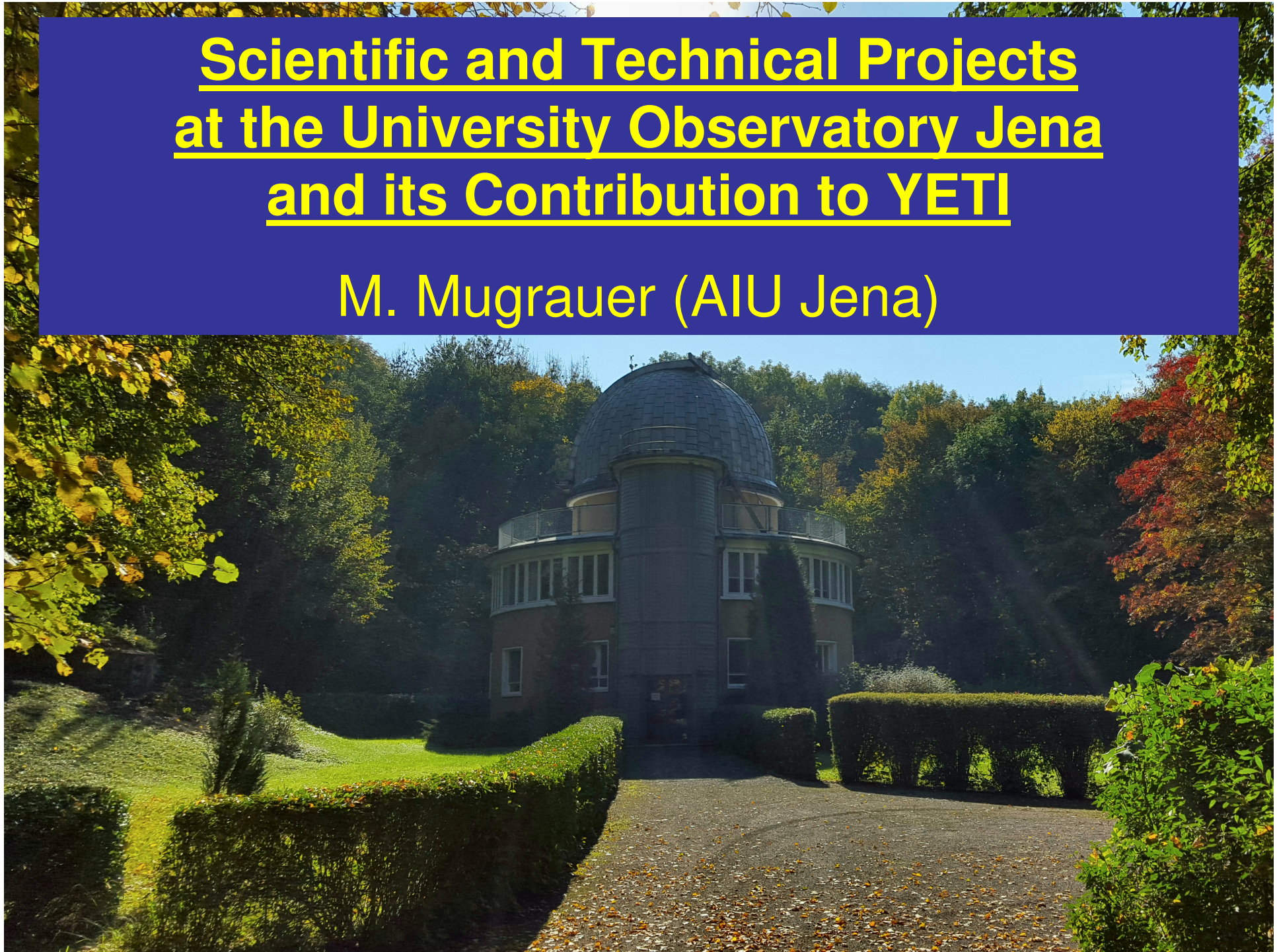
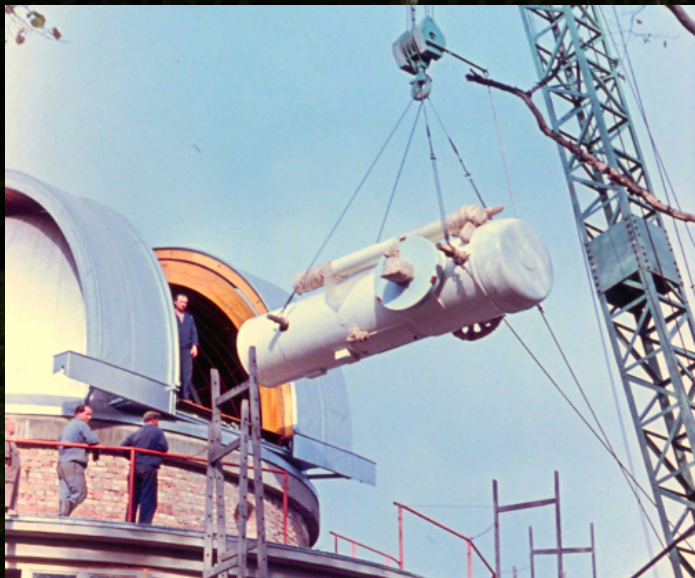
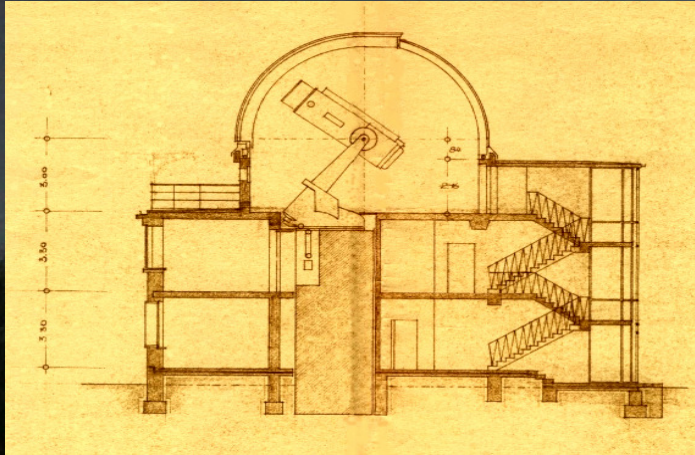


Scientific and Technical Projects at the University Observatory Jena and its Contribution to YETI

M. Mugrauer (AIU Jena)

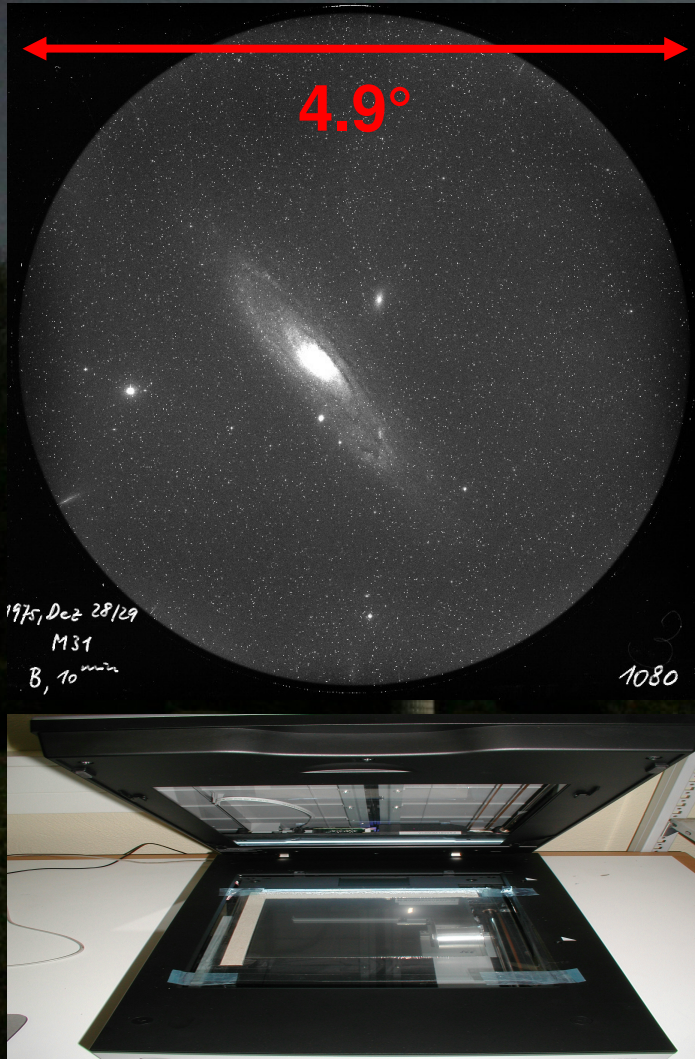


History of the University Observatory



- 1898: 1st proposal to construct an observatory outside of Jena by O. Knopf
- 1950: new proposal by H. Lambrecht accepted
- 1957: final design presented (H. Schlag)
- 1962: construction of the observatory
→ commissioning on 6 Dec 1962
- 1963 –
- 1982: more than 1200 plates taken,
all plates scanned & archived, see:
Poghosyan et al. 2014, AN 335, 440
- 2004 –
- 2006: modernization of telescope mount
and installation of a 1st CCD-imager
- 2007: start of continuous night time operation
- since: development of new instruments
CCD-imagers + spectrographs

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University Observatory Jena



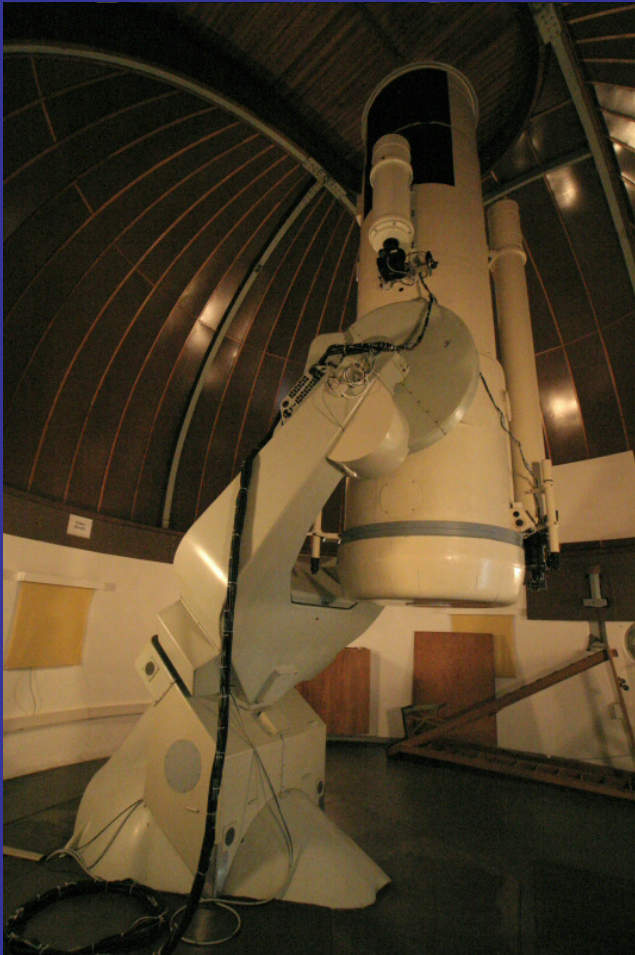
Grove near Großschwabhausen

University Observatory Jena



Building of the University Observatory Jena in the grove near Großschwabhausen

Telescopes operated at the University Observatory Jena



90/60/180cm Schmidt-Telescope

- Schmidt-Mode: $D = 60\text{cm}$, $f/D = 3$
- Nasmyth-Mode: $D = 90\text{cm}$, $f/D = 15$
- Tube-length = 4.72m , $m_{M1} = 315\text{kg}$,
 $m_{\text{total}} = 13\text{t}$ (6.4t movable)

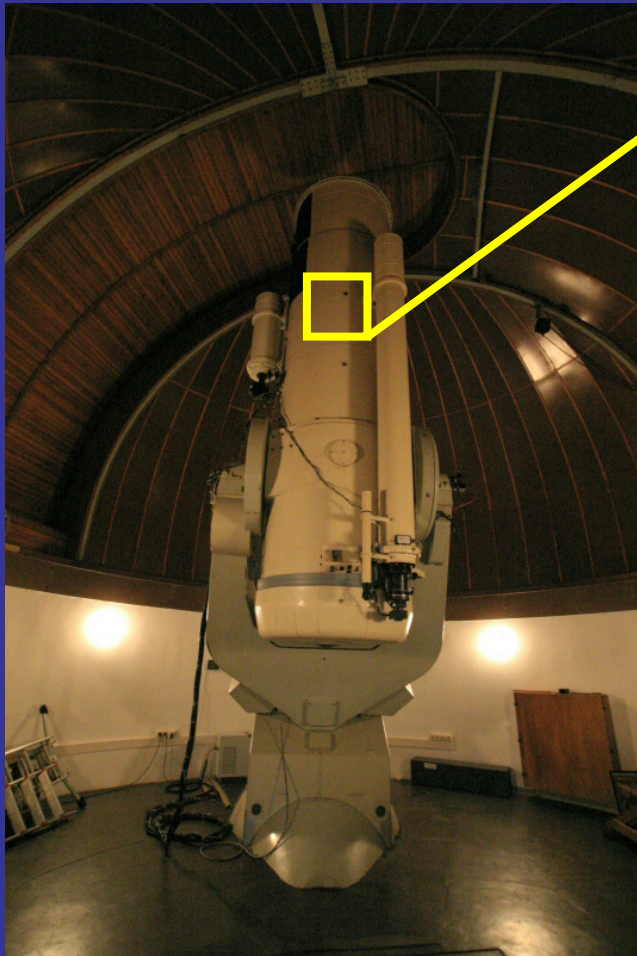
20cm - Refractor

$f/D = 15$, $m_{\text{total}} = 120\text{kg}$

25cm – Cassegrain

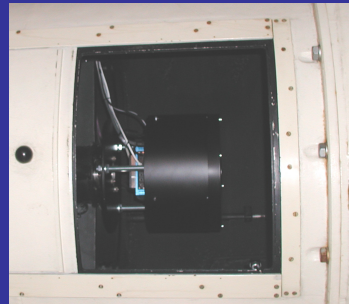
$f/D = 9$, $m_{\text{total}} = 45\text{kg}$

Instruments operated at the University Observatory Jena



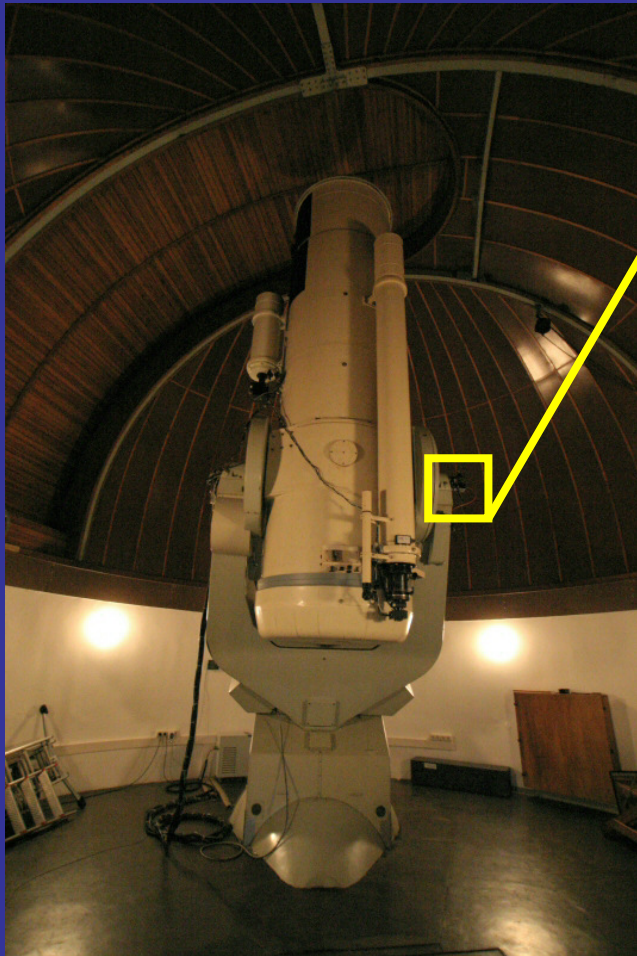
Schmidt-Teleskop-Kamera (STK)

- Optics: $D = 60\text{cm}$ ($f/D = 3$)
- CCD: E2V CCD42-40
- Chip: 2048x2048 Pixel ($13.5\ \mu\text{m}$)
- PS: 1.55" / Pixel
- FoV: 52.8' x 52.8'
- Filter: B, V, R, I, z
- Limit: $V = 19.2\ \text{mag}$ @ 1min



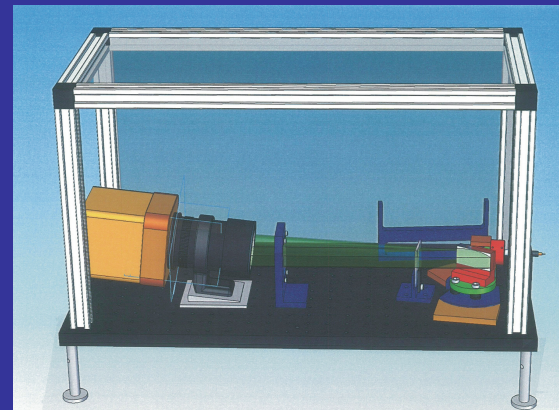
Mugrauer & Berthold 2010, AN 331, 449

Instruments operated at the University Observatory Jena



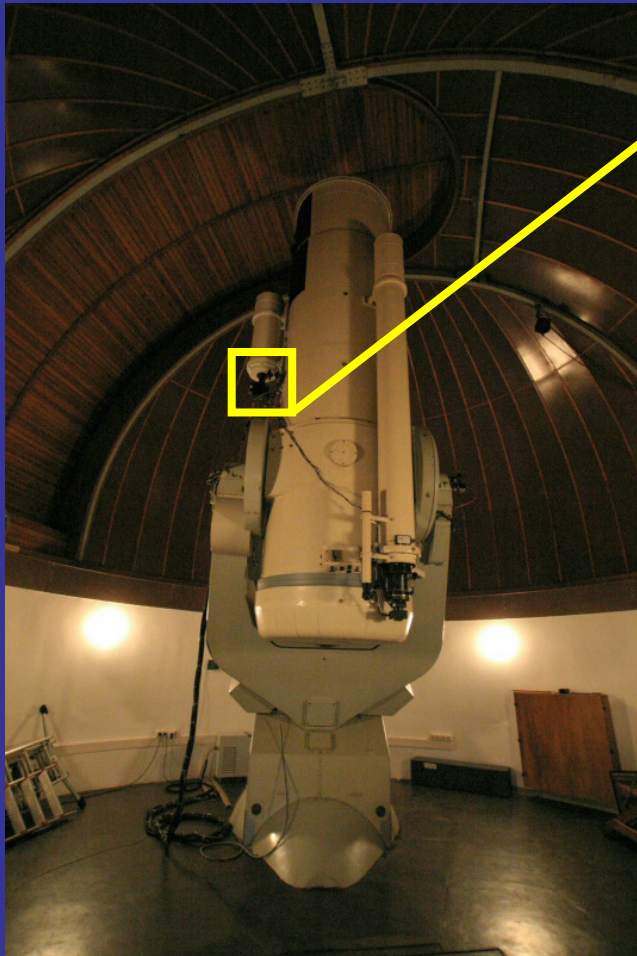
Spectrograph (FLECHAS)

- Optics: $D = 90\text{cm}$ ($f/D = 15$)
- Spectralrange: $3900 - 8100 \text{ \AA}$
- $\langle \Delta\lambda/\text{Pixel} \rangle = 0.24 \text{ \AA}$
- $R = \lambda/\Delta\lambda = 9300$
- Limit: $V = 12 \text{ mag @ } 10\text{min}$



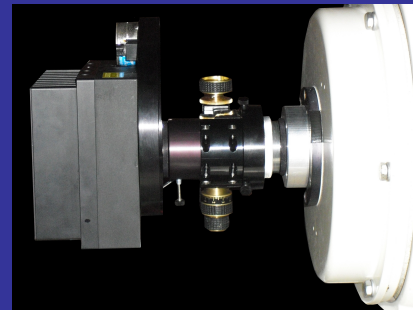
Mugrauer, Avila & Guirao 2014, AN 335, 417

Instruments operated at the University Observatory Jena



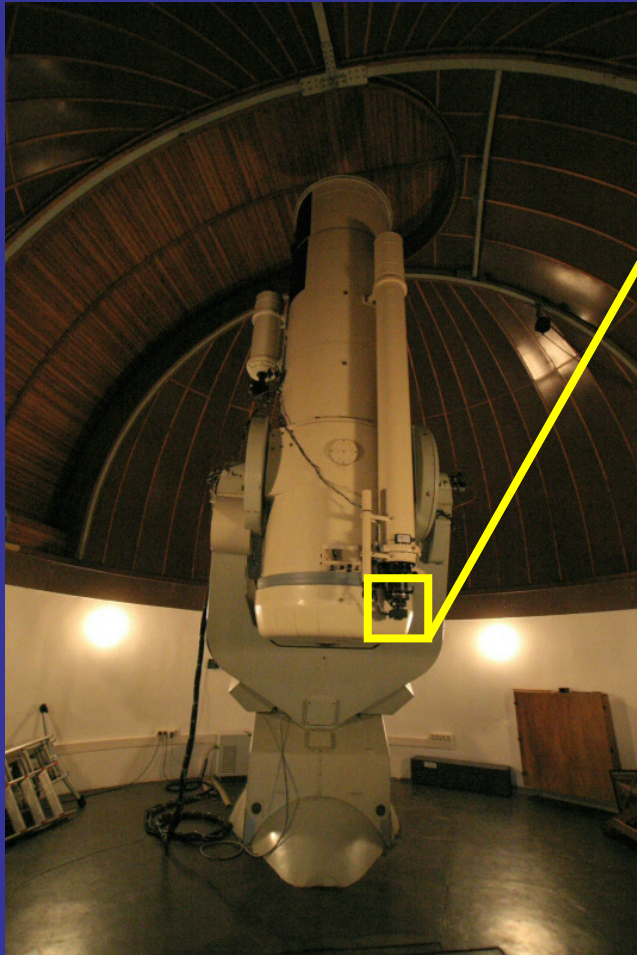
Cassegrain-Teleskop-Kamera (CTK-II)

- Optics: $D = 25\text{cm}$ ($f/D = 9$)
- CCD: E2V PI47-10
- Chip: 1056×1027 ($13 \mu\text{m}$)
- PS: $1.20''$ / Pixel
- FoV: $21.0' \times 20.4'$
- Filter: B, V, R, I, z
- Limit: $V = 18.2 \text{ mag @ } 1\text{min}$



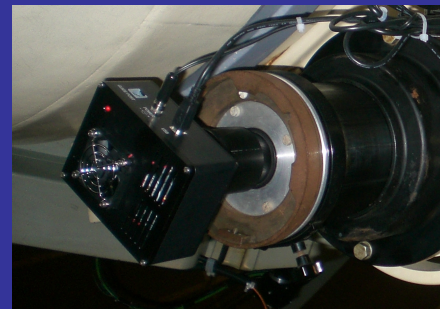
Mugrauer 2009, AN 330, 419 & 2016, AN 337, 226

Instruments operated at the University Observatory Jena



Refraktor-Teleskop-Kamera (RTK)

- Optics: $D = 20\text{cm}$ ($f/D = 15$)
- CCD: KAF 402ME
- Chip: 765x510 Pixel ($9\ \mu\text{m}$)
- PS: $0.62''$ / Pixel
- FoV: $7.9' \times 5.3'$
- Filter: B, V, I, clear
- Limit: $V = 16.4\ \text{mag}$ @ 1min



Mugrauer 2016, AN 337, 226



Control Room of the Observatory

Telescope Control

Autoguiding

North East
 South West

Pixel offset
 X: 739 Y: -243

Clacks
 UTC **23:24:59** LMST **13:15:39** TLO **12:17:59**

Current equatorial		Current horizontal	
Right ascension	13h 15m 39.7s	Azimuth	359° 59' 29.6"
Declination	+50° 59' 59.8"	Elevation	+89° 55' 44.2"
Hour angle	00h 00m 00.0s	Air mass	1.000

```

bgthread: pending CAN status 0x0 read
Info Dec: seeking commutation, please wait...
Info RA: seeking commutation, please wait...
Info: old position found, Azimuth = 360.0°, Elevation = 5.3°.
Info: connected to dome sensor
...commutation found.
          
```

Dome control

Slit	Dome rotate	Sensor
<input type="button" value="Open"/>	<input type="button" value="CCW"/> <input type="button" value="CW"/>	<input type="button" value="Reconnect"/>
<input type="button" value="Stop"/>	<input type="button" value="Park position"/>	<input type="button" value="Follow telescope"/>
<input type="button" value="Close"/>	<input type="button" value="Flat position"/>	Position: 103.5°
<input checked="" type="checkbox"/> active	<input checked="" type="checkbox"/> active	Target: 61.0°

Manual control

Use the numeric keypad to move the telescope

Actions

Current delta: 0.0005 °/s (FLECHAS)
 Speed right ascension: 0.0042 °/s
 Speed declination: 0.0000 °/s

GSH Skycam and Weather Station

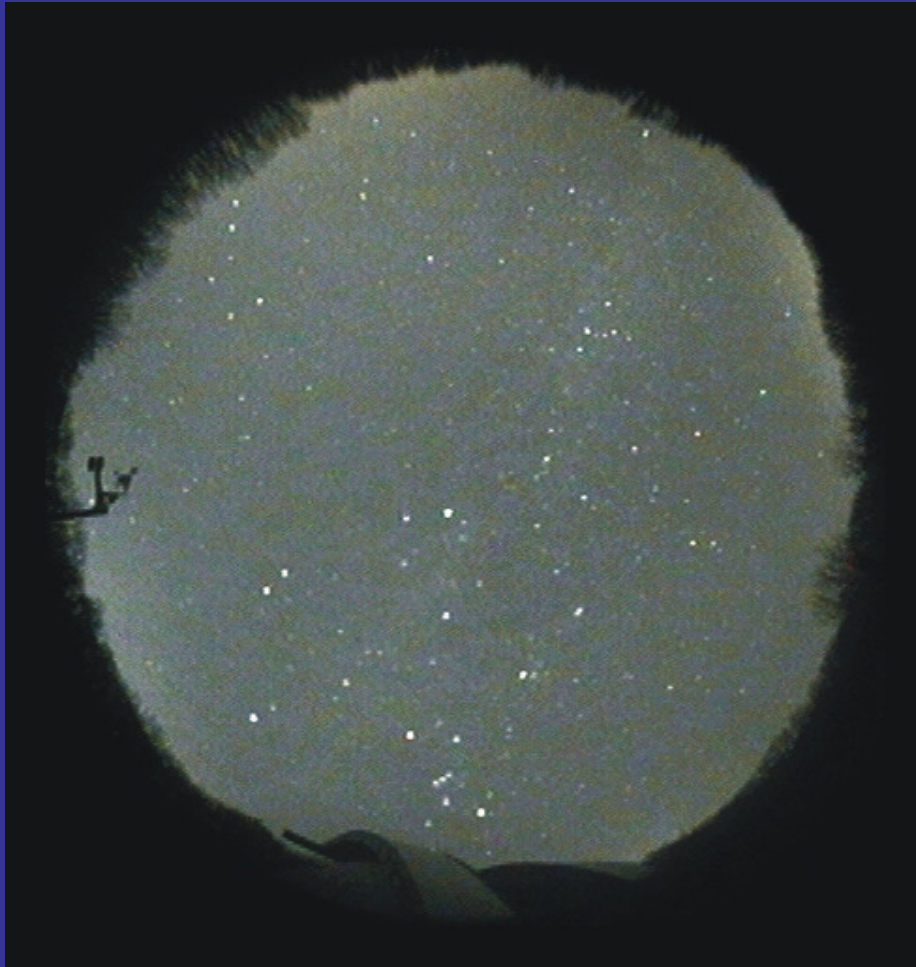
Skycam



Weather Station



GSH Skycam and Weather Station



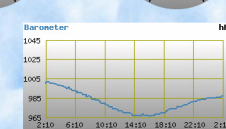
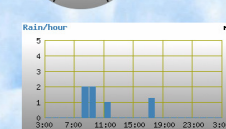
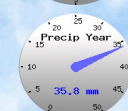
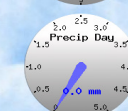
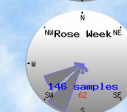
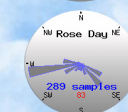
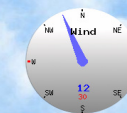
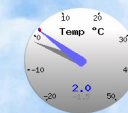
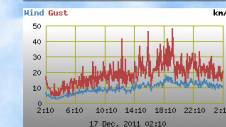
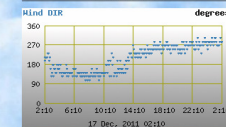
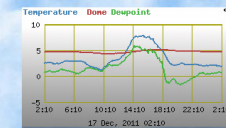
Temperature outside:	2.0 °C
Temperature dome:	4.9 °C
Apparent Temp:	-2.4 °C
Dewpoint:	0.8 °C
Humidity:	92 %
Humidity dome:	79 %
Air pressure:	987.0 mb +
Barometer:	987.3 mb
Wind:	NNW at 12.9 km/h
High Wind:	31 km/h at 00:36
Recent Avg Wind:	10 km/h
Recent Beaufort Scale:	Light Breeze (2)
Today's Rain:	0.00 mm
Rain Rate:	0.00 mm/h
High Rain Rate:	0.00 mm/h at ----
Storm Total:	4.32 mm
Monthly Rain:	35.81 mm
Yearly Rain (JAN):	35.81 mm
Est. Cumulus Base:	145 m
High Temperature:	2.3 °C at 00:47
Low Temperature:	2.0 °C at 01:54
High Humidity:	92 % at 01:38
Low Humidity:	88 % at 00:00
High Dewpoint:	0.9 °C at 01:38
Low Dewpoint:	0.4 °C at 00:00
High Barometer:	987.3 mb at 01:55
Low Barometer:	985.2 mb at 00:47



University Observatory Jena Großschwabhausen - Weather

50° 55' 44" N - 11° 29' 03" E - 370 m
17 Dec, 2011; 02:10:10

Sunrise 08:12 - Sunset 16:09 - Moon: Waning 61% Full

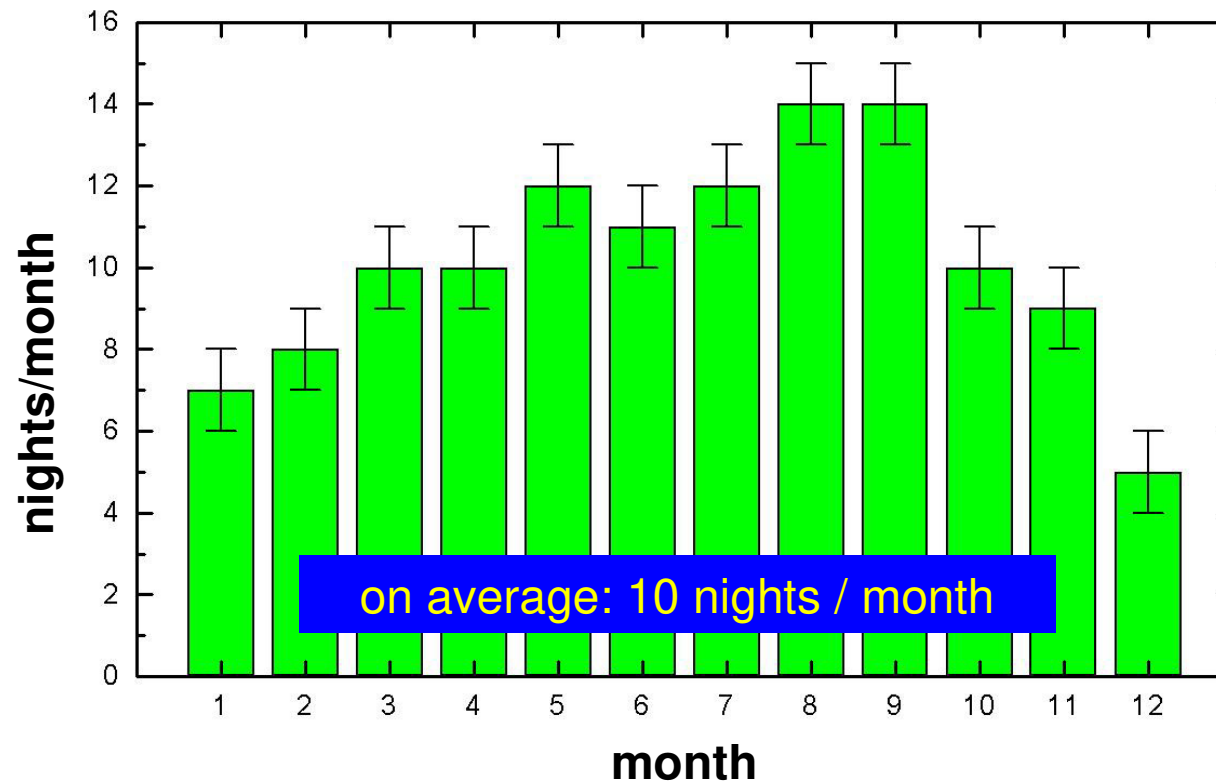


Almanac Last24 Hours Last7 Days Last28 Days Last365 Days Nightlog format

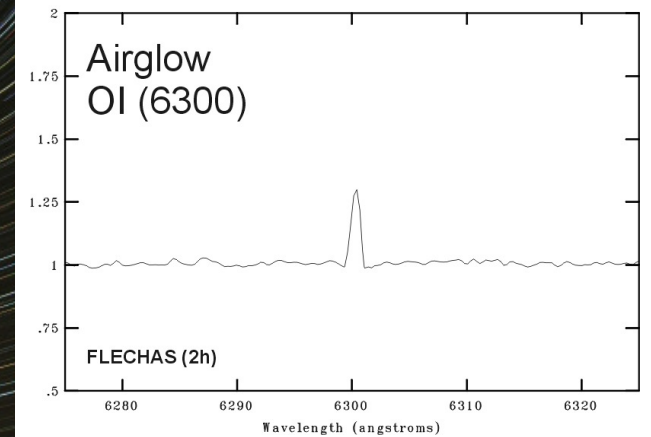
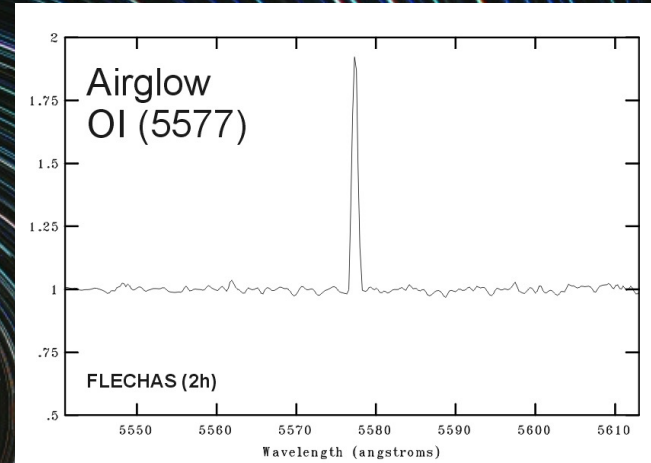
Climatological Summaries: Jan 2012 Monthly Report Yearly Report

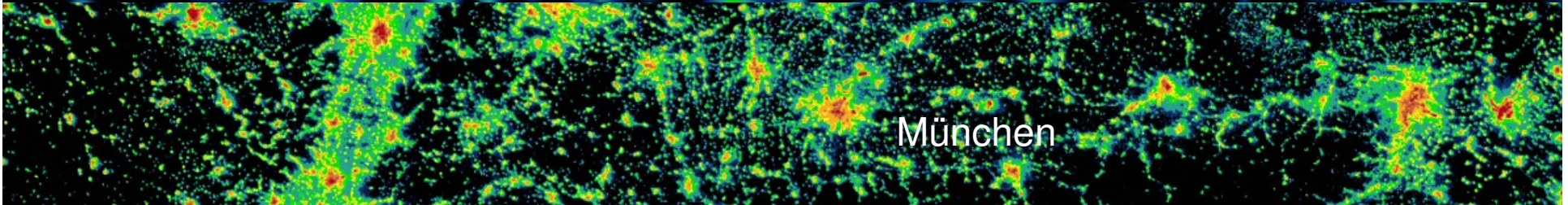
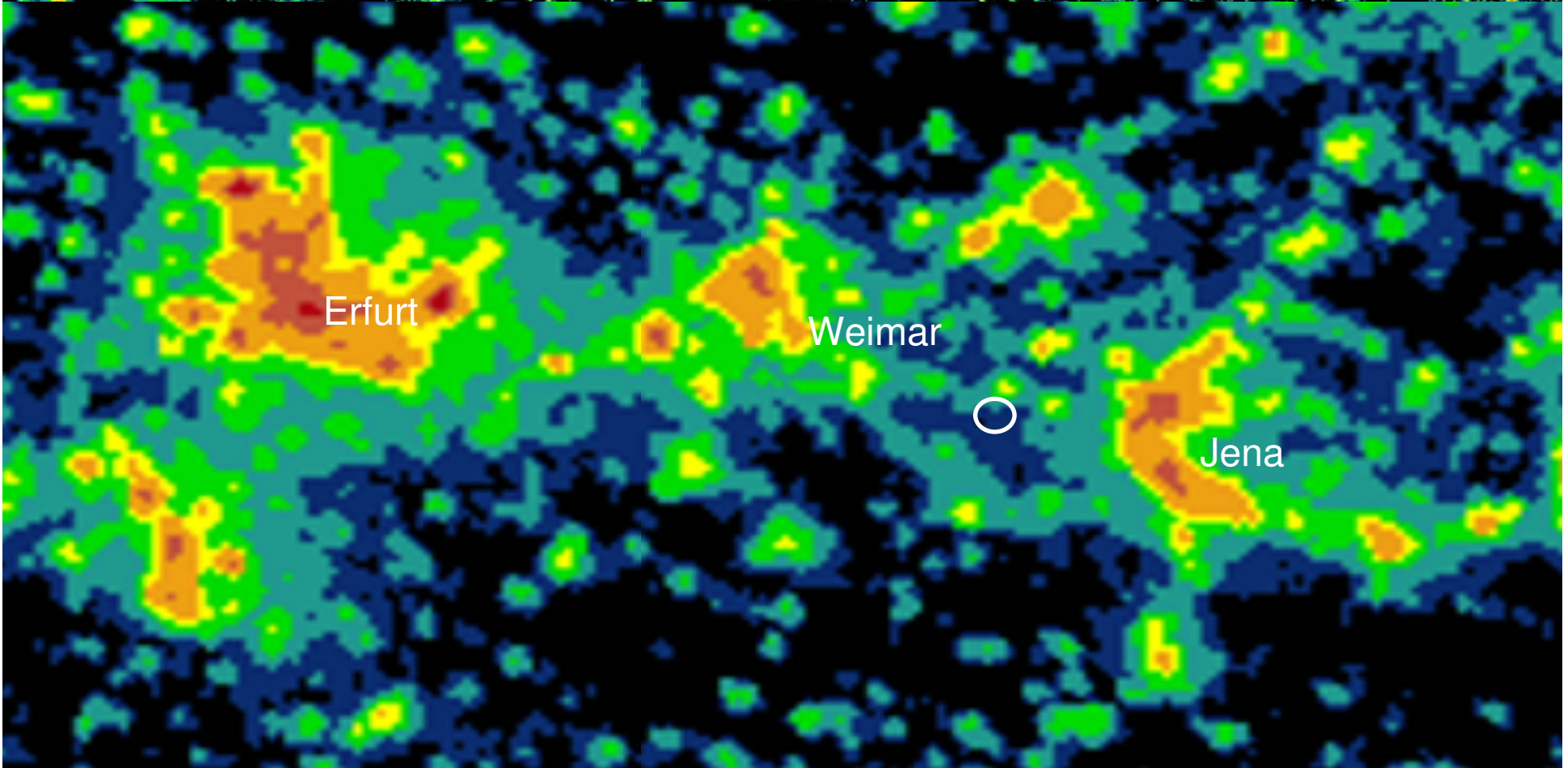
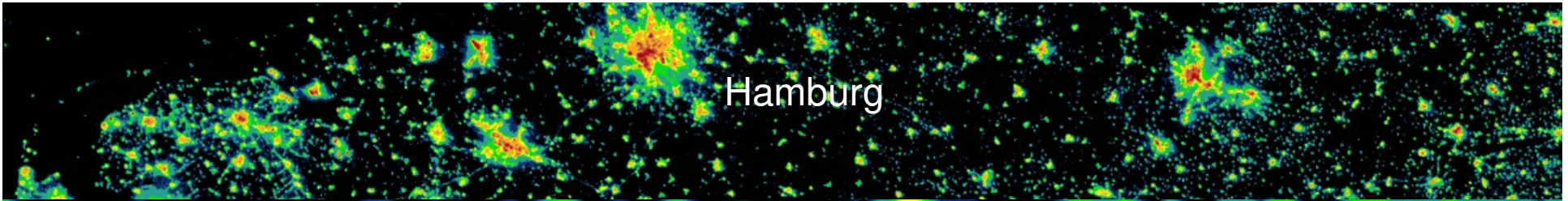
Browse Archive Records: 10 Jan 2012 Browse Day Records

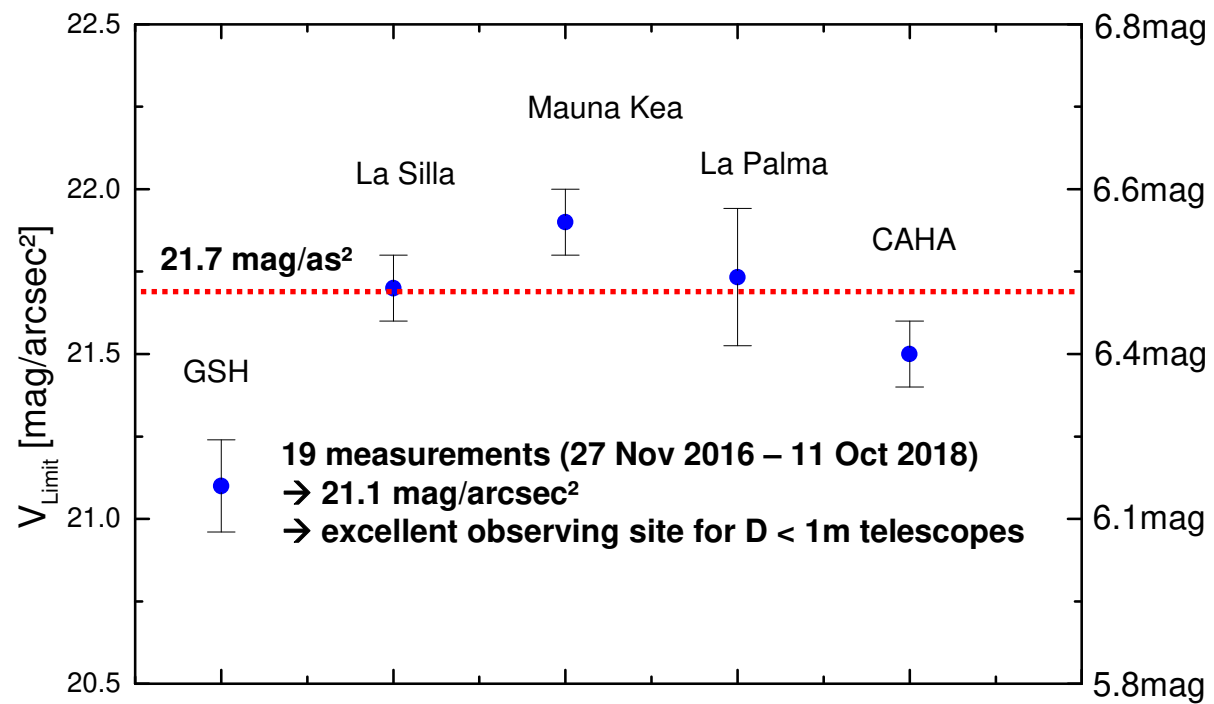
Weather Statistics at the Observatory



Sky Brightness







Dark night sky at the location of the University Observatory Jena

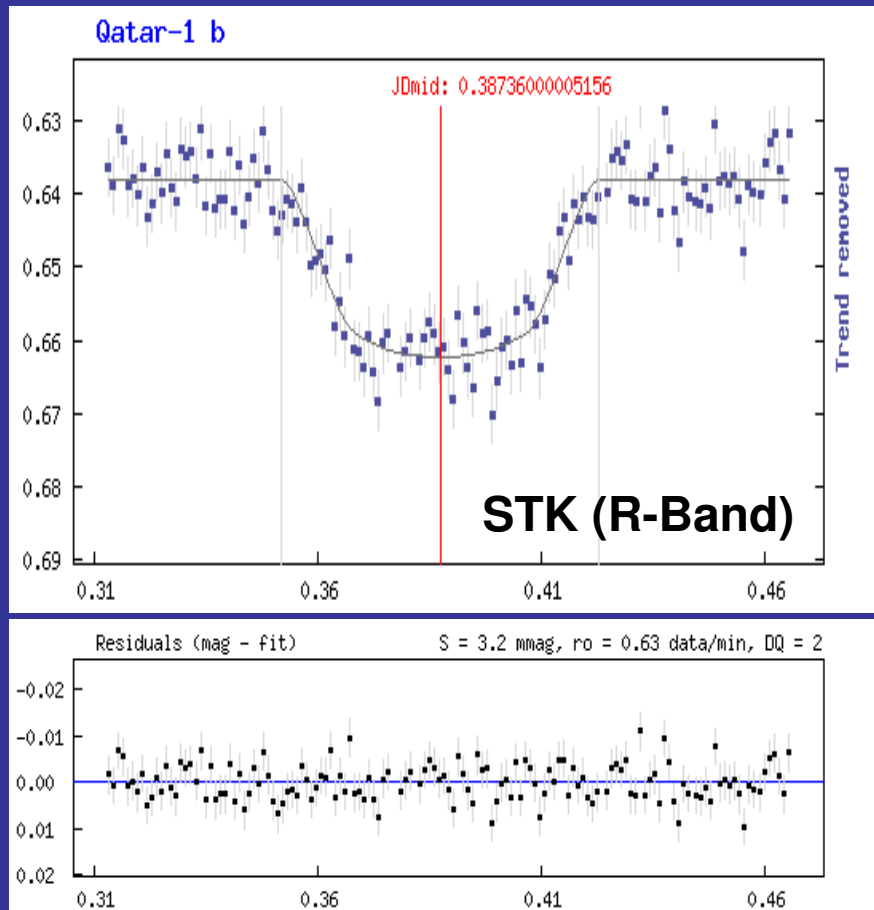
Teaching Activities at the University Observatory Jena



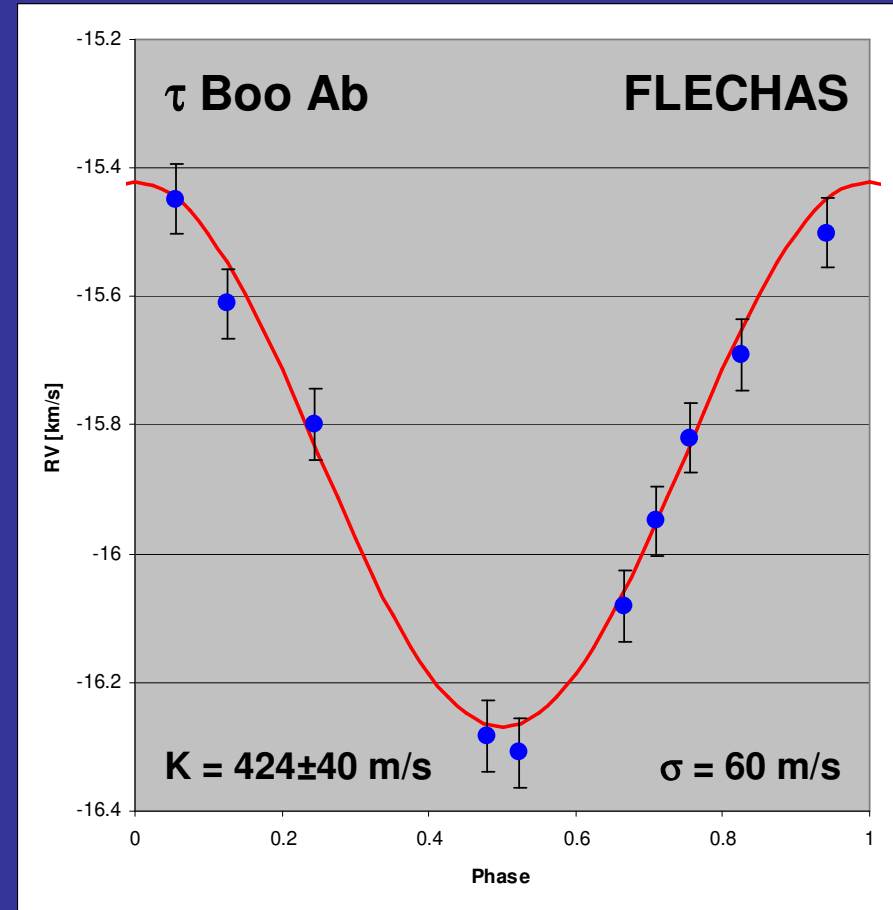
astronomical practical course / 2017

- excursions for students of the astrophysical lectures at the FSU Jena
- training of students in astronomical observing techniques, data reduction and analysis
 - (1) astronomical practical course for students
 - (2) special practical courses for Master students at the FSU Jena
- Bachelor-, Master- theses for students with own observing projects
- observing campaigns for PhD theses
- + public outreach: tours for visitor groups

Teaching Activities at the University Observatory Jena



Observation of transiting exoplanets



RV-monitoring of spectroscopic binaries and of exoplanets

Teaching Activities at the University Observatory Jena



astronomical practical course / 2017

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PhD students of DFG SPP 1992 / 2018



Visitor group / 2017

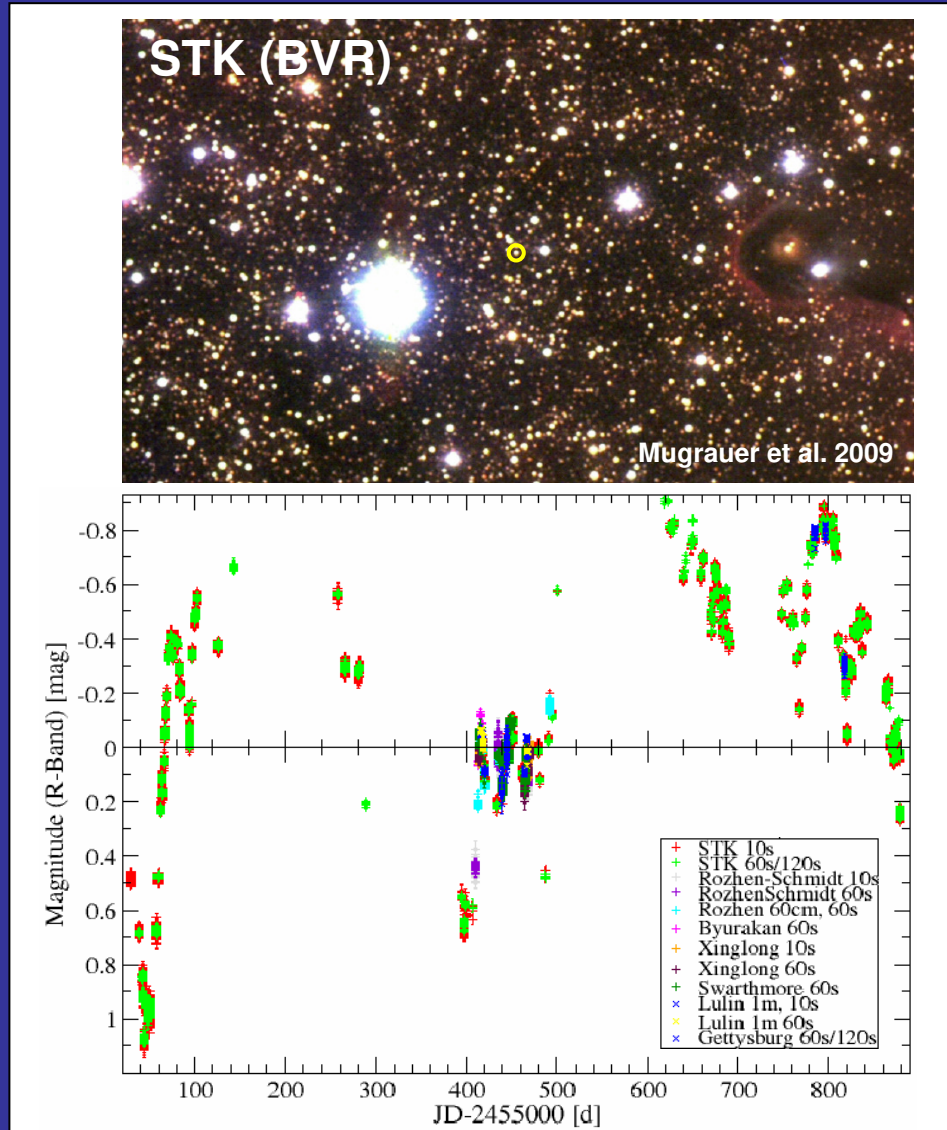
Scientific Projects at the University Observatory Jena

- photometric long-term monitoring of:

(1) young stars, e.g.: GM Cep (Huang et al. 2018, ApJ sub.)



Photometric long-term monitoring of GM Cep



- CTTS in Tr 37 & UX Ori variable star
- SpT: G7 – K0
- $M \sim 2.1 M_{\odot}$, $R = 3 - 6 R_{\odot}$
- high mass accretion: $\dot{M} < 10^{-6} M_{\odot}/\text{yr}$
- fast rotating star: $v \sin(i) \sim 43 \text{ km/s}$

• YETI monitoring (2009 – 11) →

- (1) sporadic flare events lasting for days due to increased accretion activity
- (2) dimming in LC $\sim 1 \text{ mag}$ lasting for 1 month & annual recurrence due to obscuration of the star by an orbiting protoplanetary clump

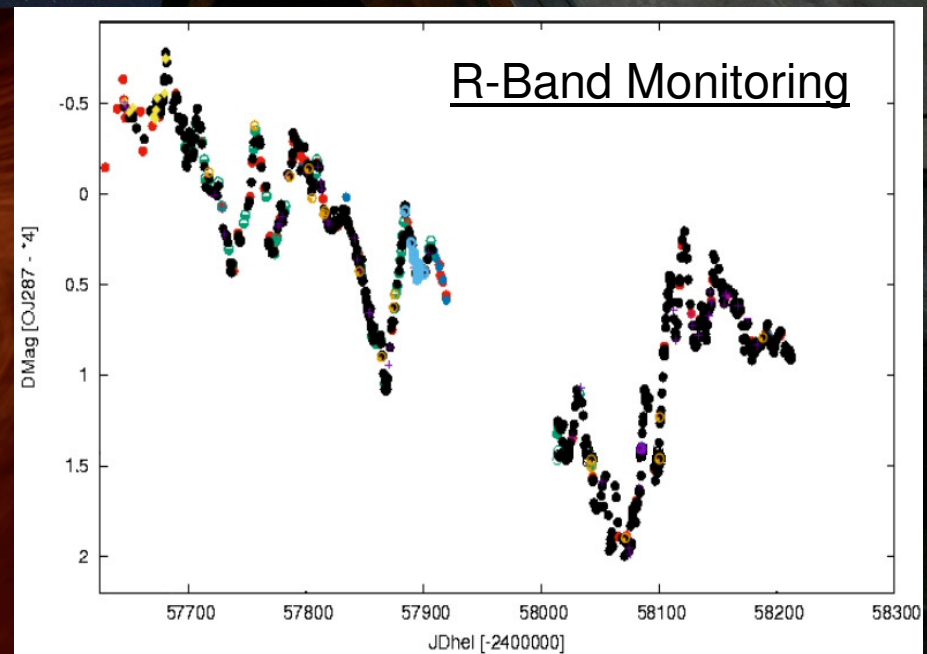
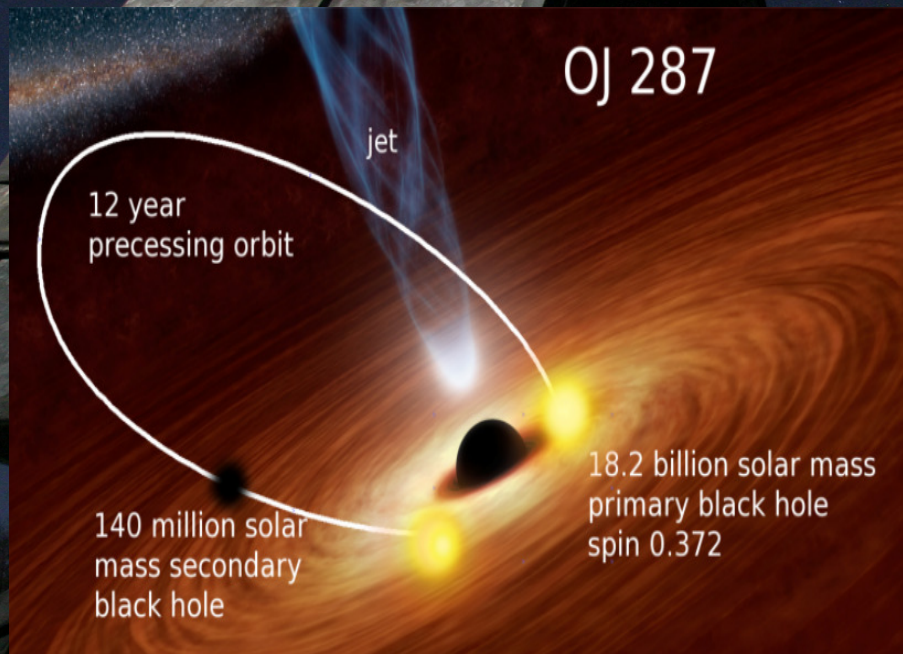
Refs: Chen et al. 2012, ApJ 751, 118
Huang et al. 2018, ApJ sub.

Scientific Projects at the University Observatory Jena

- photometric long-term monitoring of:

(1) young stars, e.g.: GM Cep (Huang et al. 2018, ApJ sub.)

(2) Blazar OJ 287 (Valtonen et al. 2016, ApJ 819L, 37)

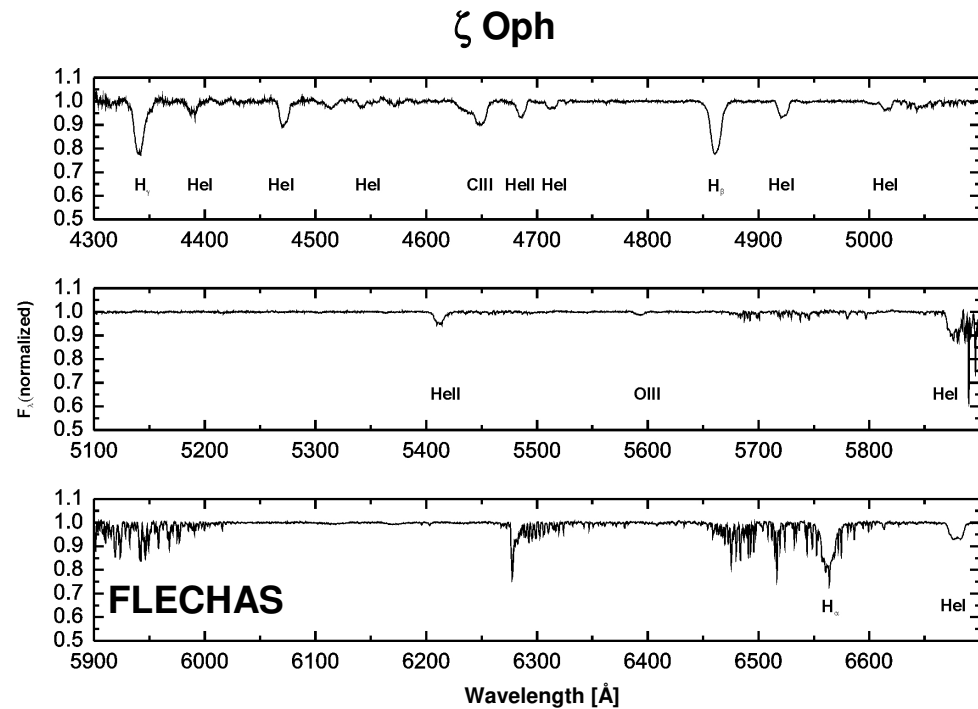
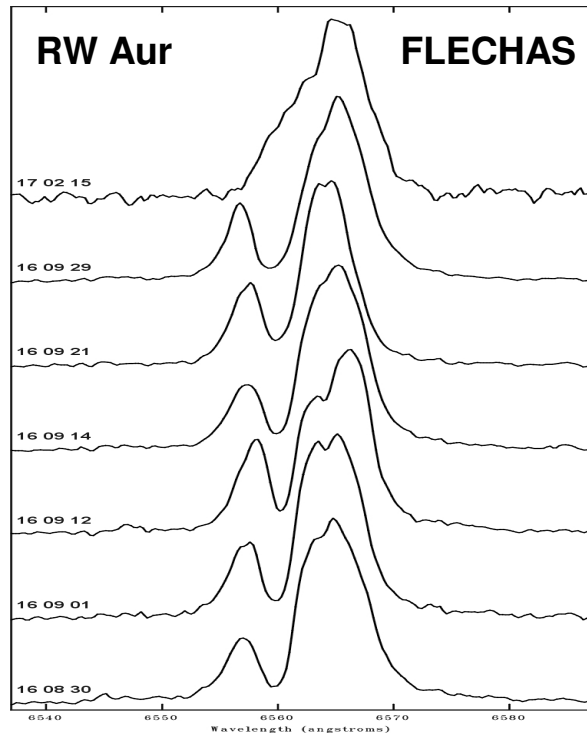


Scientific Projects at the University Observatory Jena

- spectroscopic long-term monitoring of:

(1) young T Tauri stars, e.g.: RW Aur (Lux et al., in prep.)

(2) massive stars, e.g.: ζ Oph (Zehe et al. 2018, AN 339, 46)



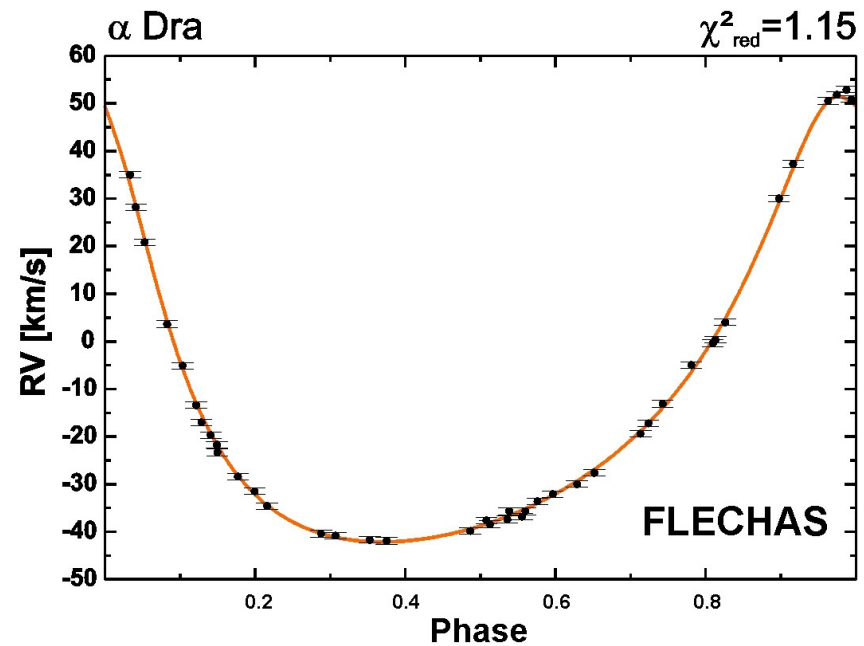
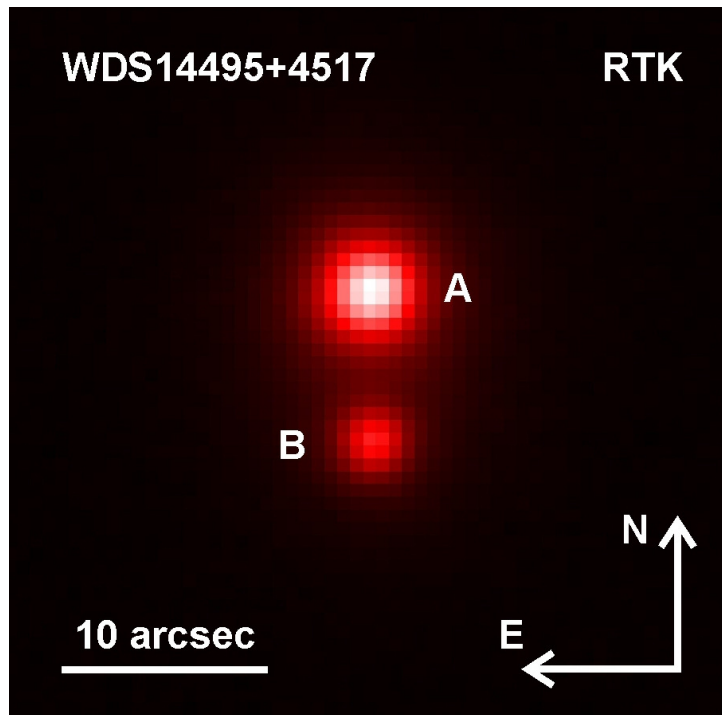
Scientific Projects at the University Observatory Jena

- observations of binary stars for orbit determination and/or refinement

→ GSH Binary Survey

a) astrometry & photometry (Mugrauer et al. 2017, AN 338, 61)

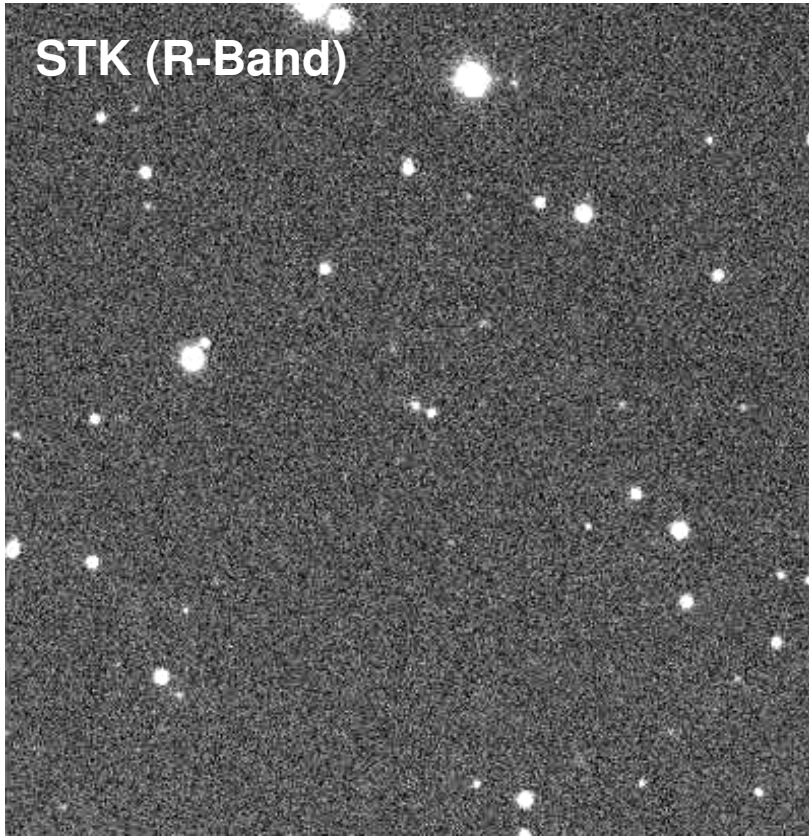
b) spectroscopy (Bischoff et al. 2017, AN 338, 671, Heyne et al. in prep.)



Scientific Projects at the University Observatory Jena

- observations of unusual or distant asteroids for orbit refinement
→ astro + photometry, see e.g.: Mugrauer et al. in MPCs

STK (R-Band)



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only 5 latest publications listed:

MPC 110641-111804

MPC 107743-108698

MPC 106507-107122

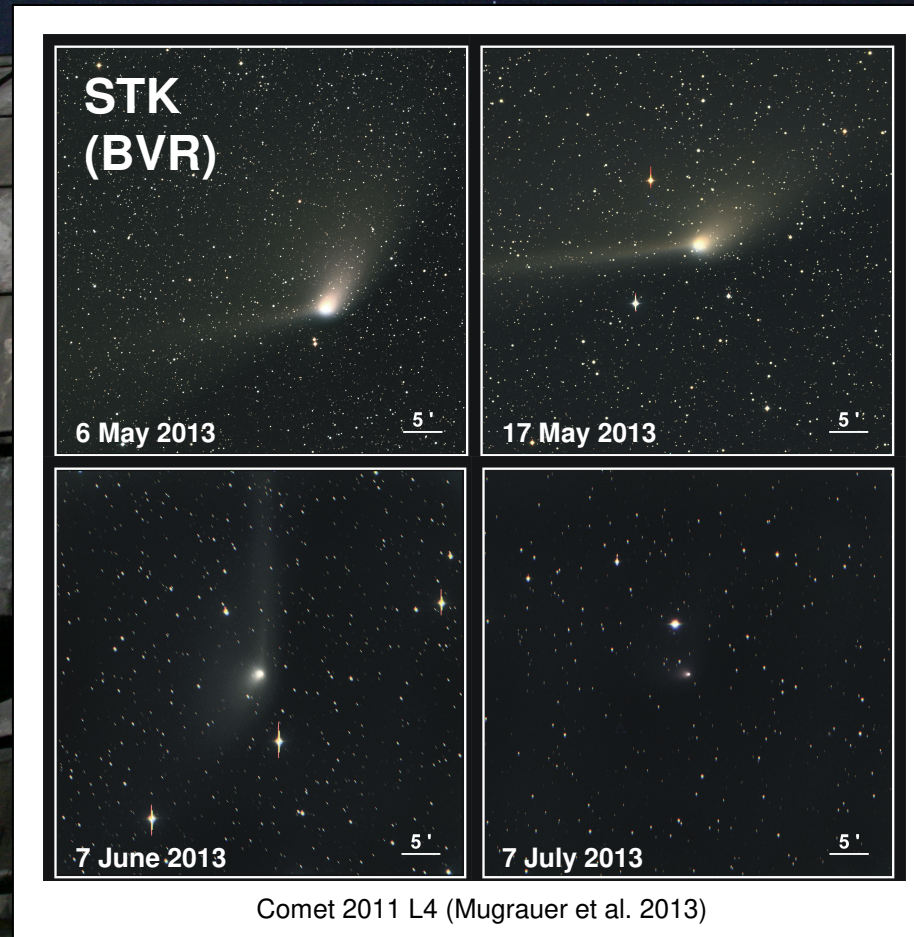
MPC 100611-101214

MPC 100319-100610

+ ...

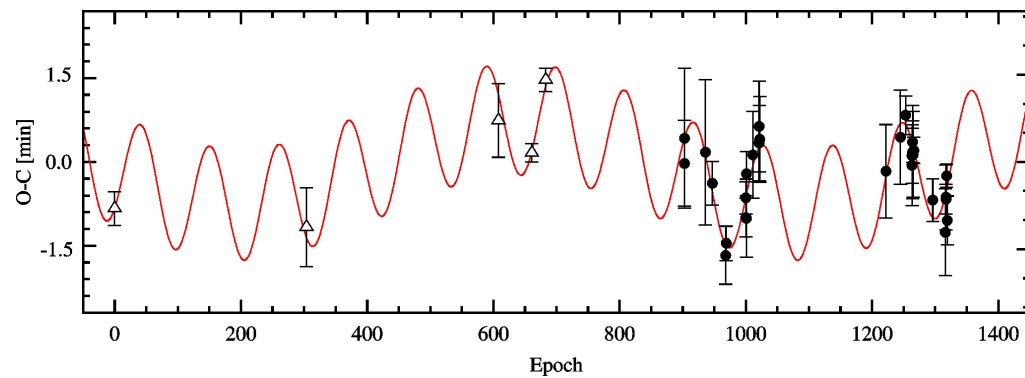
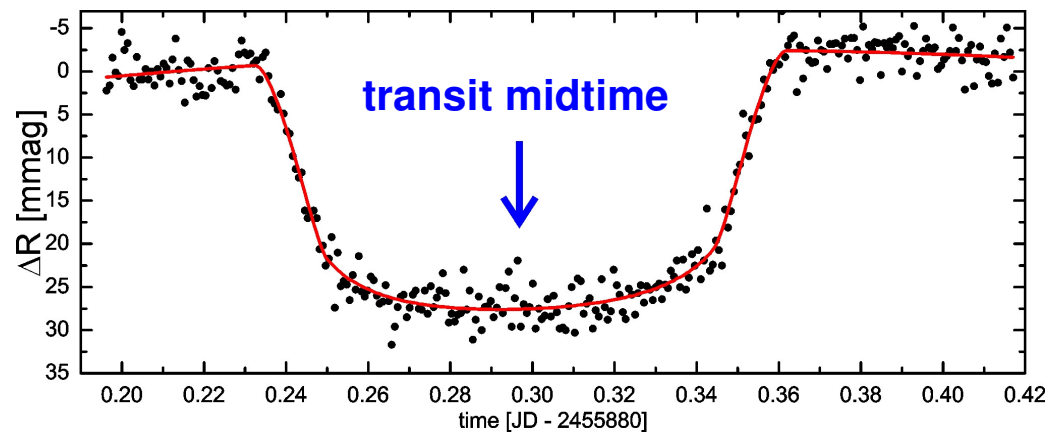
Scientific Projects at the University Observatory Jena

- follow-up observations of comets for orbit refinement & activity studies
→ astro + photometry, see e.g.: Mugrauer et al. 2009, AN 330, 425



Scientific Projects at the University Observatory Jena

- multiple epoch transit observations to detect and/or constrain TTVs
see e.g.: Maciejewski et al. 2013, A&A 551, 108



Scientific Projects at the University Observatory Jena

- follow-up photometric and spectroscopic observations of novae

SN 2011dh in M51

STK
(BVR)

2009

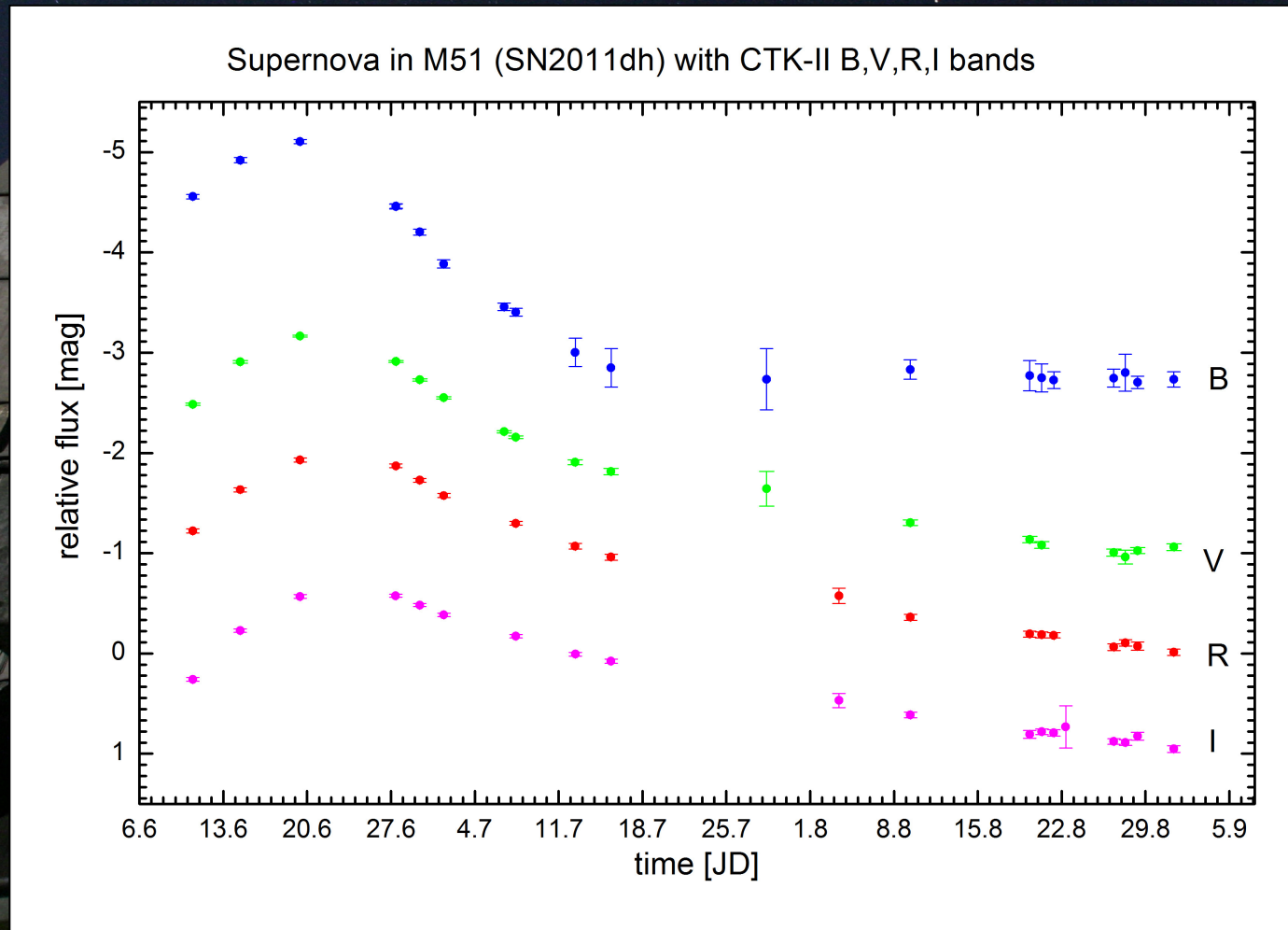
STK
(BVR)

2011



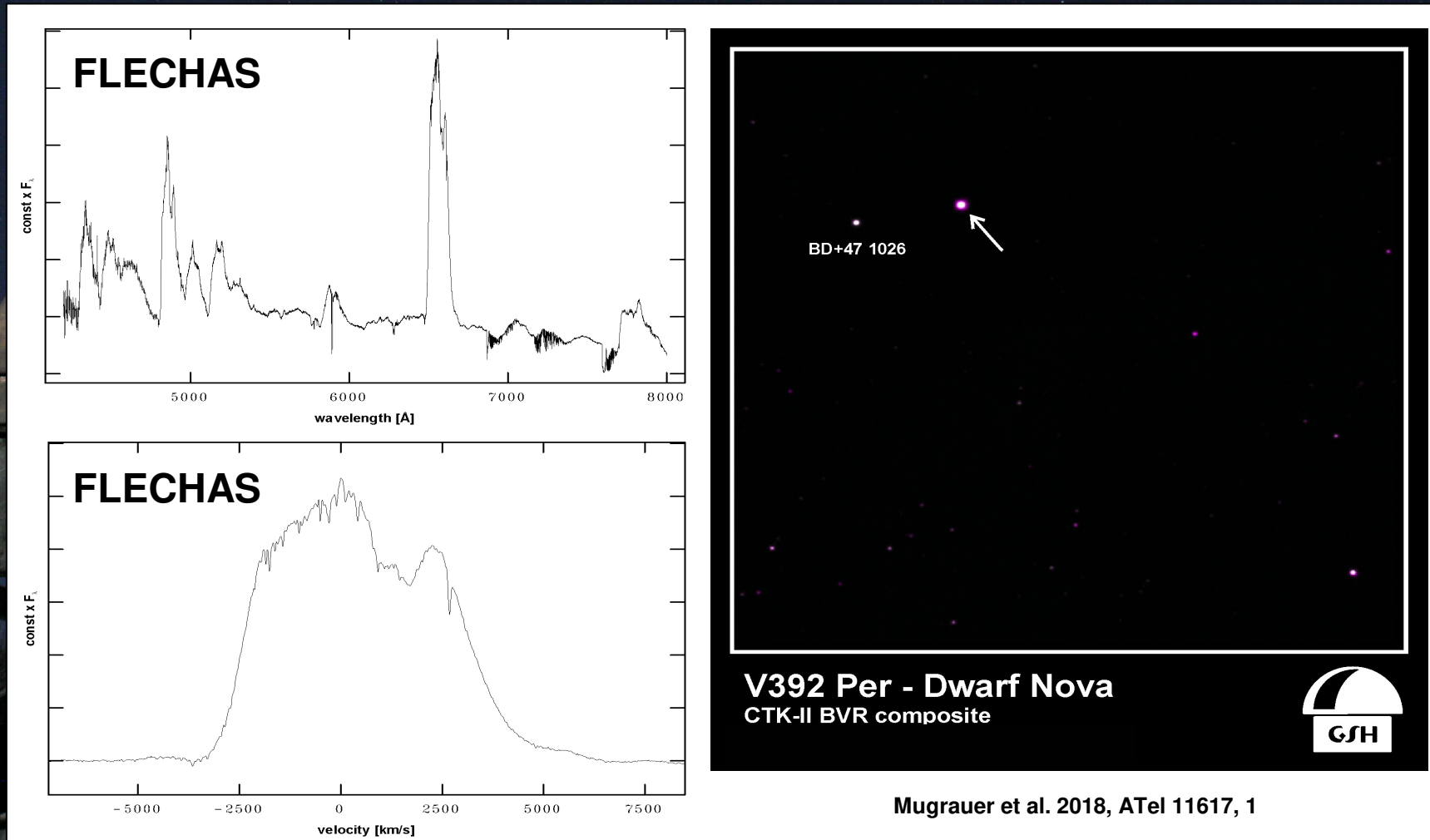
Scientific Projects at the University Observatory Jena

- follow-up photometric and spectroscopic observations of novae



Scientific Projects at the University Observatory Jena

- follow-up photometric and spectroscopic observations of novae

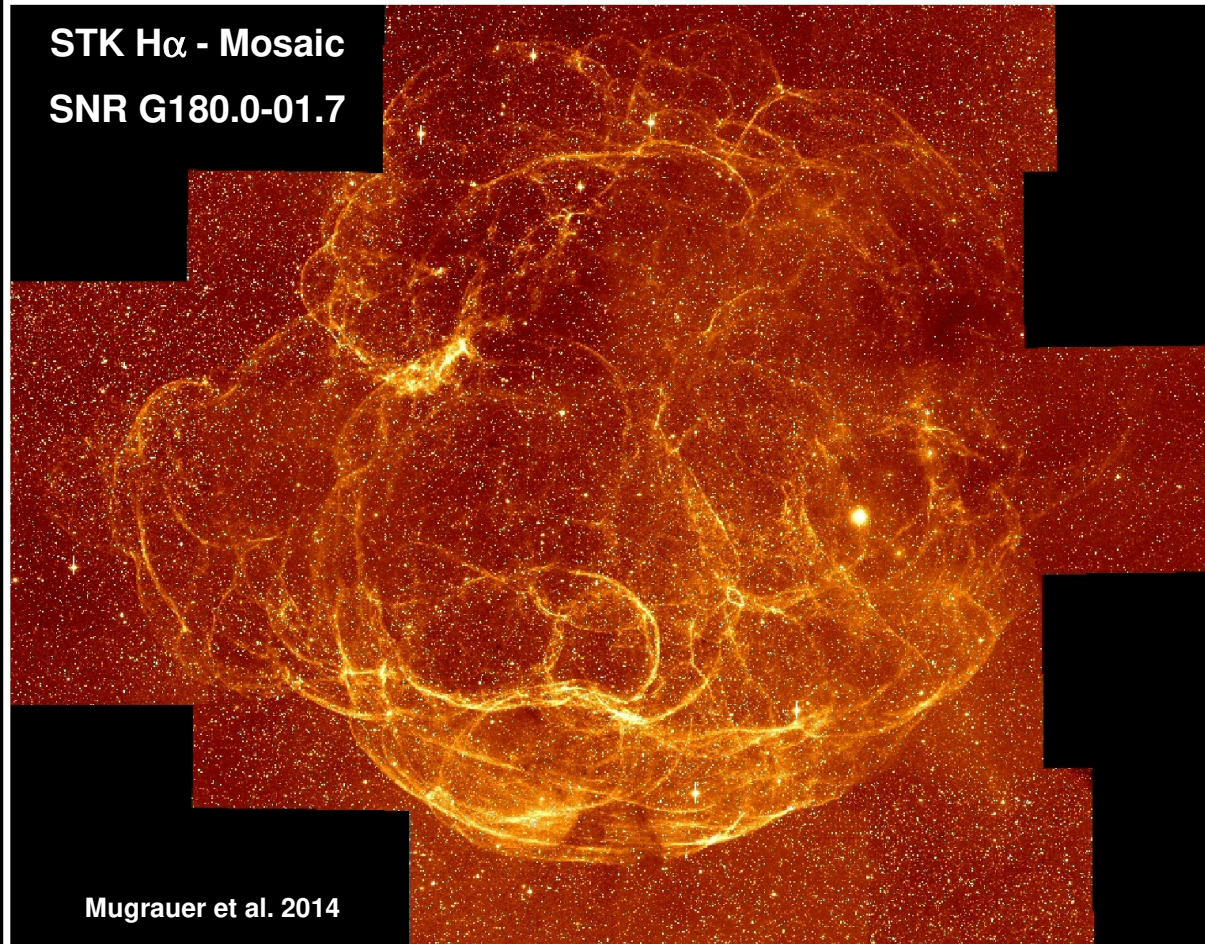


Mugrauer et al. 2018, ATel 11617, 1

Scientific Projects at the University Observatory Jena

- search for runaway stars (RS) in SNRs → deep H α -imaging of SNRs
see e.g.: Dincel et al. 2015, MNRAS 448, 3196

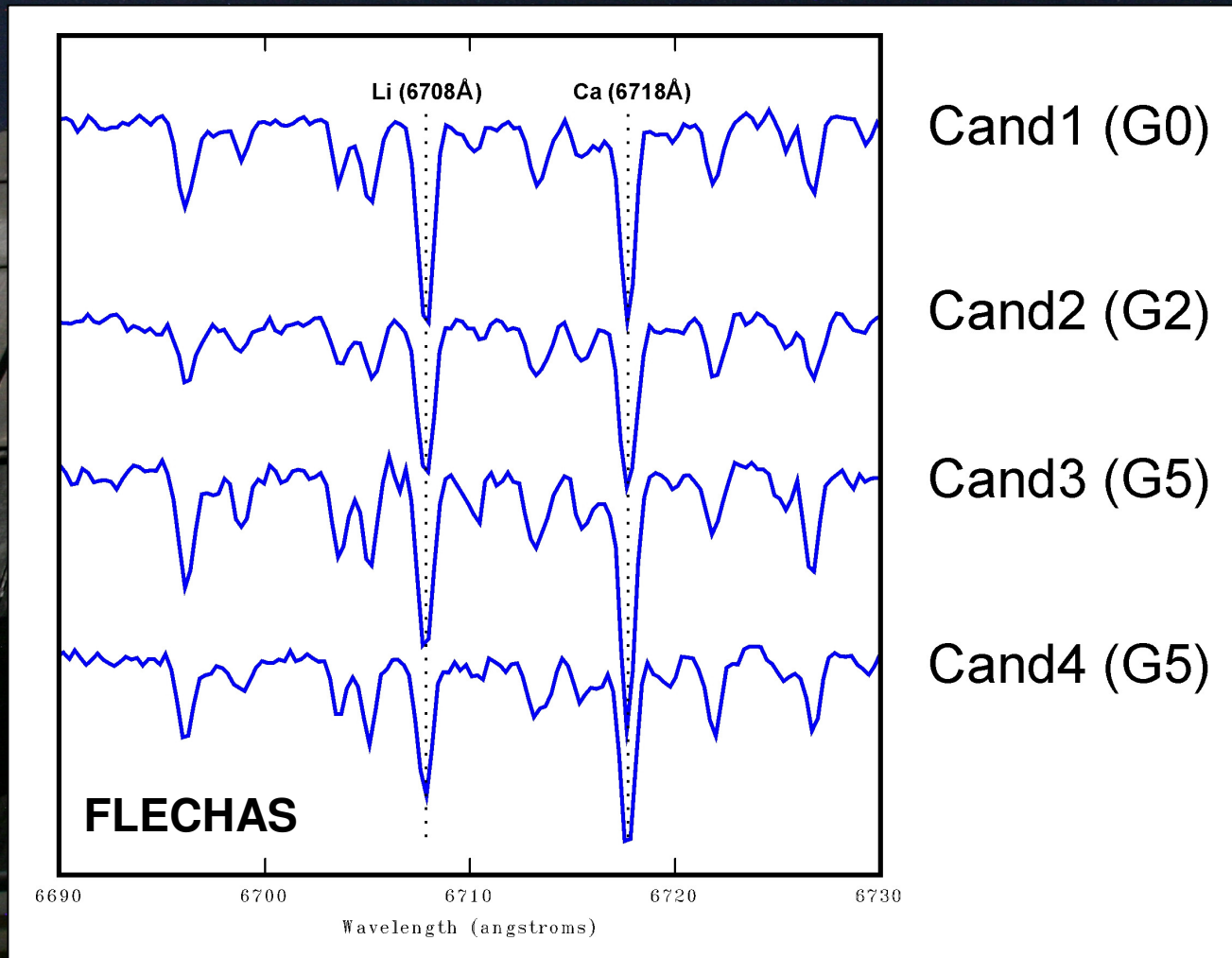
STK H α - Mosaic
SNR G180.0-01.7



Mugrauer et al. 2014

Scientific Projects at the University Observatory Jena

- search for RSs in the field → spectroscopic test of youth (Li detection)
see e.g.: Munz, Trepanovski et al., in prep.



YETI Cluster Monitoring at the University Observatory Jena

Primary Goal:

- find and characterize young transiting exoplanets
 - (1) to study planet radii and planetary interiors
 - (2) to test/constrain planet formation & evolutionary models (e.g. via time-scales)
 - (3) to investigate the architecture of young planetary systems (→ test migration theories) and compare them with the solar system



YETI Cluster Monitoring at the University Observatory Jena

Primary Goal:

- find and characterize young transiting exoplanets

Secondary Goals:

- detailed study of detected eclipsing binaries + determination of the orbital and physical parameters of detected companions (exoplanets, BDs & low-mass stars)
- investigation of any kind of stellar variability (pulsations, flares, etc.) on time-scales from minutes up to years



YETI Cluster Monitoring at the University Observatory Jena

Observing strategy:

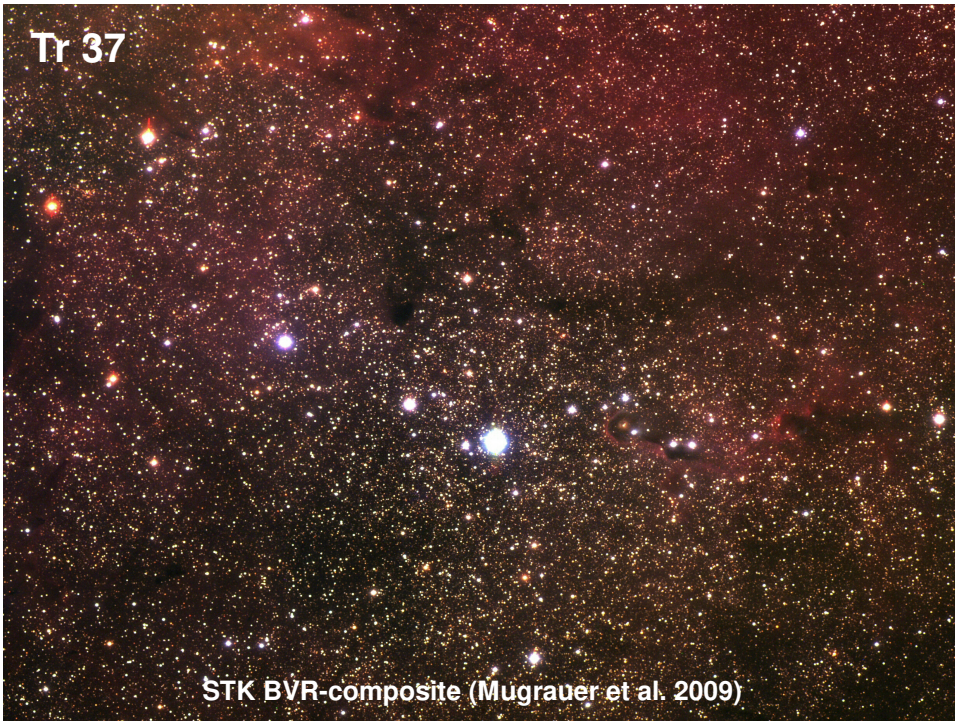
- photometric cluster monitoring over ~ 3 years
- 2 – 3 runs per year (each run lasts for about 1 – 2 weeks)
 - sufficient observing time guaranteed, taking into account weather statistics
 - long-term continuous photometric monitoring of clusters feasible within the YETI telescope network (→ no gaps in LCs!)
- R-band observations in YETI campaigns with alternating integration times to optimally observe bright and faint cluster members
- additional UBVI observations outside of the YETI campaigns

The YETI Clusters & Monitoring Campaigns

Selected Targets: 8 young ($\tilde{a}ge = 8 \text{ Myr}$) nearby ($\tilde{d} = 0.4 \text{ kpc}$) open clusters, namely:

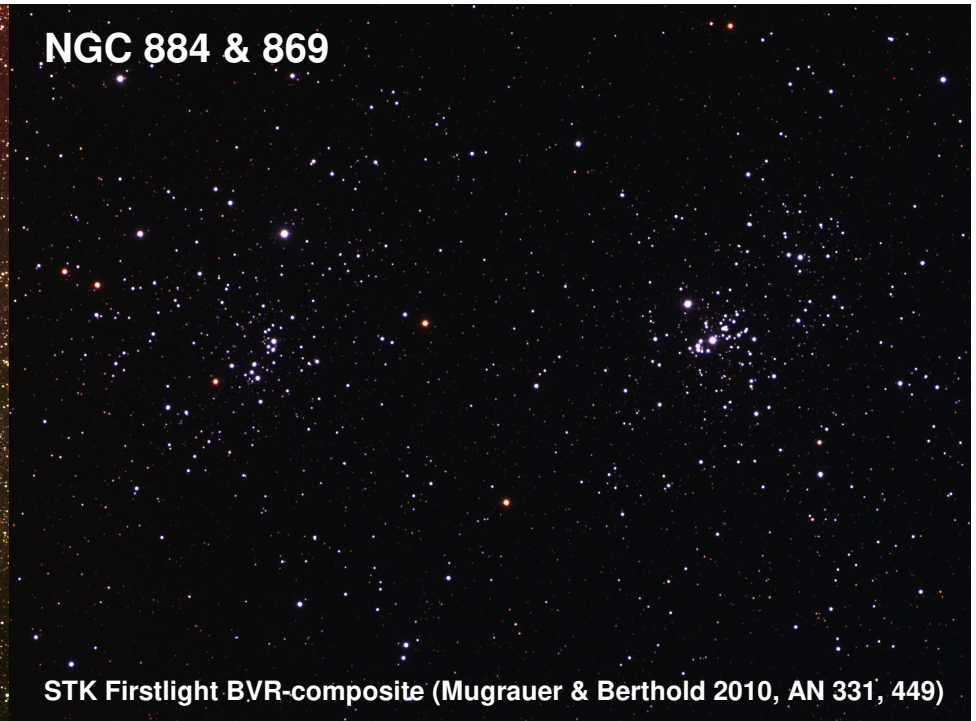
Cluster	RA / Dec	YETI Campaigns	Age [Myr]	Distance [kpc]
IC 348	03h 44m / +32° 10'	2012 – 14	~ 2	~ 0.3
Tr 37	21h 39m / +57° 29'	2009 – 11	~ 4	~ 0.9
Collinder 69	05h 35m / +09° 56'	2012 – 15	~ 5	~ 0.4
NGC 1980	05h 35m / -05° 55'	2013 – 15	~ 5	~ 0.4
25 Ori	05h 25m / +01° 51'	2010 – 13	~ 10	~ 0.3
NGC 869 & 884	02h 20m / +57° 08'	2016 – 18	~ 10	~ 2.2
IC 4665	17h 46m / +05° 43'	2017 – 18	~ 40	~ 0.4
NGC 7243	22h 15m / +49° 54'	2013 – 15	~ 80	~ 0.8

Tr 37



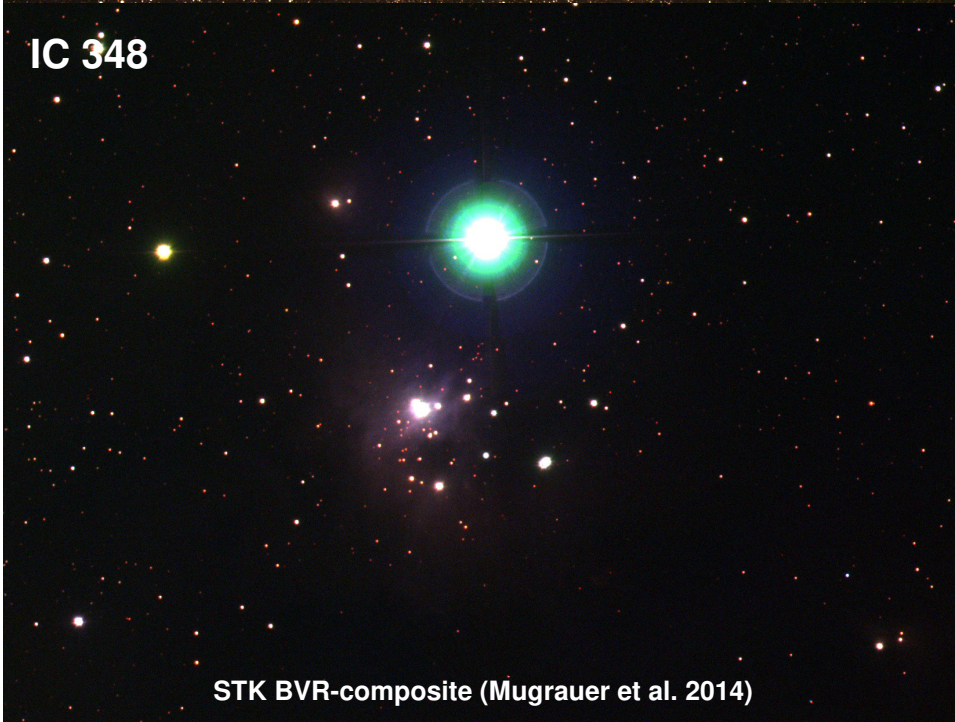
STK BVR-composite (Mugrauer et al. 2009)

NGC 884 & 869



STK Firstlight BVR-composite (Mugrauer & Berthold 2010, AN 331, 449)

IC 348



STK BVR-composite (Mugrauer et al. 2014)

NGC 7243



STK BVR-composite (Mugrauer et al. 2013)

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Instrument:	STK	CTK + CTK-II	RTK
Monitoring Period:	2009 – 18	2009 – 18	2009 – 12
Nights:	607	585	115
Frames:	140521	122689	240837
Data Volume [GB]:	1152.3	268.7	184.2

Cluster:	Monitoring Period	Nights [Frames] STK	Nights [Frames] CTK & CTK-II	Nights [Frames] RTK
IC 348	2012 – 2015	90 [22460]	88 [9013]	2 [115]
Tr 37	2009 – 2011	190 [37417]	160 [31693]	113 [240722]
Collinder 69	2012 – 2015	19 [5757]	18 [2664]	0 [0]
NGC 1980	2013 – 2015	14 [2968]	14 [7301]	0 [0]
25 Ori	2010 – 13 + (2017 – 18)	114 [31081]	114 [47367]	0 [0]
NGC 869 & 884	(2009 – 10) + 2016 – 18	56 [21880]	77 [13079]	0 [0]
IC 4665	2017 – 2018	75 [10858]	66 [6524]	0 [0]
NGC 7243	2013 – 2015	49 [8100]	48 [5048]	0 [0]

YETI (Young Exoplanet Transit Initiative)

Latest News:

- project approved in the DFG SPP 1992 “Exploring the diversity of exoplanets”
PhD students @ AIU (observations) and @ Uni Rostock (theory), namely:

R. Bischoff @ AIU, started in 2017 (SV: R. Neuhäuser + M. Mugrauer)

