Planewave CDK 20 First Light at College CFG Wuppertal/Germany

Realization of three Project Works 2016/17 with the Baader Planetarium BACHES Echelle Spectrograph at College Carl-Fuhlrott-Gymnasium, Wuppertal/Germany

Diplom-Physiker Bernd Koch

Installation of the new 0.5m-Telescope at the Student Laboratory

At the end of September, the company Baader Planetarium GmbH, Mammendorf/Germany delivered the long-awaited large telescope, which allows us a deeper view into the cosmos and to establish new horizons for our project course students in astronomy.

For the many astronomy students at Carl-Fuhlrott-Gymnasium it was as if Christmas and birthday fell to one day. For two years now, we Michael Winkhaus and Bernd Koch have been working to expand the observatory into a modern student research facility, and now it has finally come to fruition: On Thursday, September 29, the new telescopes together with a new telescope mount and pillar were supplied and installed by Baader Planetarium. Over a ton of total weight had to be lifted to the student observatory on the highest roof of the school.

Like so many times, the CFG got help from local companies. This time the company Autokranverleih Neeb GmbH supported this action and provided the load crane completely free of charge, with which the heavy equipment was lifted from from the ground into the observatory building. A spectacular action for the nearly 1500 students of the CFG college at this sunny Thursday.

Web link to a video of the hovering telescope: 2016-09-29_CDK20.mp4, © Bernd Koch

In time for the rain at 8 pm, Michael Risch and Goran Aladzic of the company Baader Planetarium finished the installation. Cordial thanks to both! A detailed report has been published on our school website (October 3, 2016): http://www.cfg.wtal.de/fset.htm

The main telescope of the observatory of the Student Laboratory Astronomy is now a Planewave CDK 20 telescope with 50cm aperture on a 10Micron GM4000HPS mount.

The 10Micron GM4000HPS mount is characterized by absolute encoders on both axes, which allow precise pointing to heavenly bodies. We could not test that on the installation evening because of the coming rain.

Now it was necessary to polar align the GM4000HPS the next clear evening and to create a star alignment model (pointing model) for finding celestial objects. In the first attempt, the polar alignment succeeded to 5 arcminutes, the pointing model created after that already allows a pointing to 30 arcsec (RMS). This is very precise. And this was only achieved by visual means without a crosshair eyepiece. Further improvement of the pointing model will be sought at the next opportunity.

In addition to precise pointing of the mount, it was important for us during the planning phase, that the mount can be controlled with a manual control unit (keypad) completely independently of a computer. This allows independent observations with groups directly at the telescope.

All optical tubes attached to the mount are designed in such a way, that we can be quickly switch between visual observation (eg with visitor groups), astrophotography and videography as well as star spectroscopy with the BACHES echelle spectrograph. Care should be taken to ensure that the telescope is well balanced for the best run. Experience has shown, however, that the drive forgives a slight imbalance. Once again a key point for group observations, if you have to change accessories quickly.

In addition to the CDK 20, an apochromatic TEC160FL fluorite refractor, a Celestron ED 80/600 and a Pentax 75 refractor were mounted. The refractors are used for astrophotography, videography and solar observations, and can be interchanged with all existing accessories. This includes a 0.5Å SolarSpectrum Hα filter, now also with 160mm Energy Rejection Filter (ERF) for use at the TEC160FL.


(c) Bernd Koch

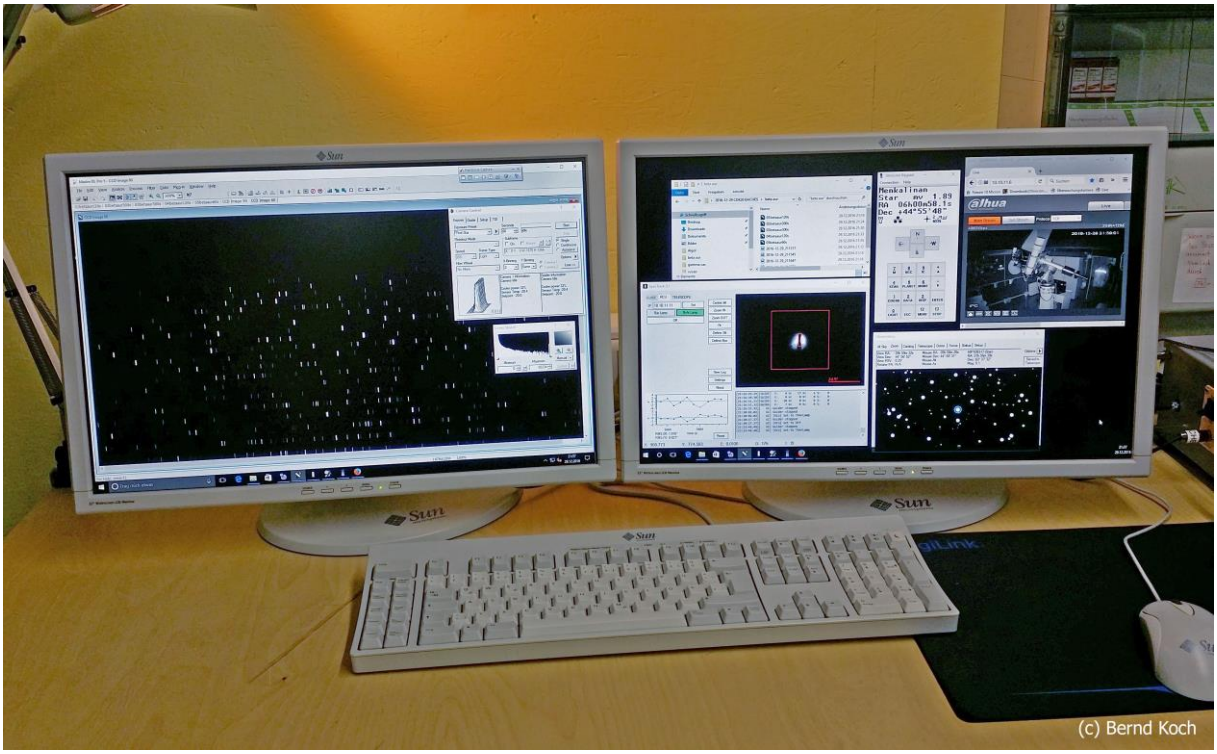

(c) Bernd Koch

The Control Room

In the control room, also warm-up room in cool nights, all telescopes and the accessories used for the observations at the six observation platforms are stored. The same accessories are available for each platform.

The main telescope of each platform is a Celestron 11 EdgeHD optical tube assembly. The accessories include the Celestron ED 80/600 and Pentax 75 refractors, as well as the complete visual, photographic, spectroscopic (DADOS) and electrical accessories.

All cameras connected to the CDK 20 telescope or TEC160FL etc. as well as the GM4000HPS mount are connected to a PC (Windows 10 prof. x64) which is located in the adjacent control room. With a second PC monitor it is possible to perform data recording (left) and complete control of the telescope (right).



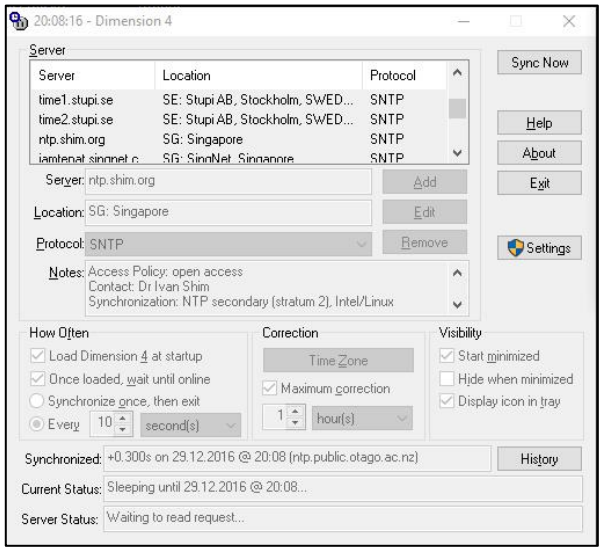
The desktop of one of the two monitors is duplicated on the monitor in the observation room. If you stand next to the telescope, you can do all settings in the observation room by mouse and keyboard before you enter the control room. This is particularly useful for observations directly at the telescope.

Telescope access by TeamViewer® has already been successfully tested in the course room 327, which is one floor below the telescope in the school building. The following picture shows participants of the autumn course “Stellar Spectroscopy” (conference language German), which traditionally takes place

in the first week of the North Rhine-Westphalia autumn school holidays. Thus, in a later course, it will be possible to operate the telescope from the course room 327 in support of a course content. Only the observatory roof still can't be remotely controlled. Once the roof is motorized, the telescope can also be controlled from outside.

Time Synchronization of Control PC and 10Micron GM4000HPS Mount with the Standard Time

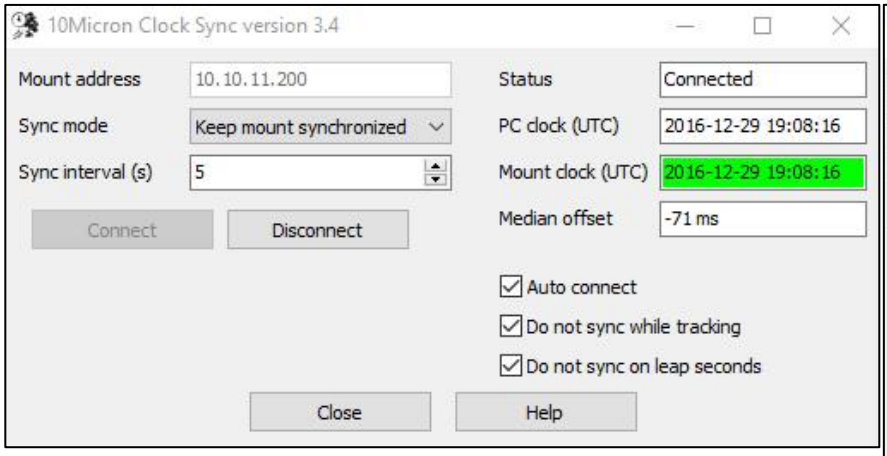
The key to a precise pointing to a heavenly body is, that the clock of the mount is synchronous with the standard time. Why is this necessary? It has already been mentioned. that the mount has absolute encoders. The keypad is a small LINUX computer of its own with an internal lithium battery. The internal clock ticks, even if the mount is switched off. When the mount is turned on, the keypad is booted and the time is displayed.

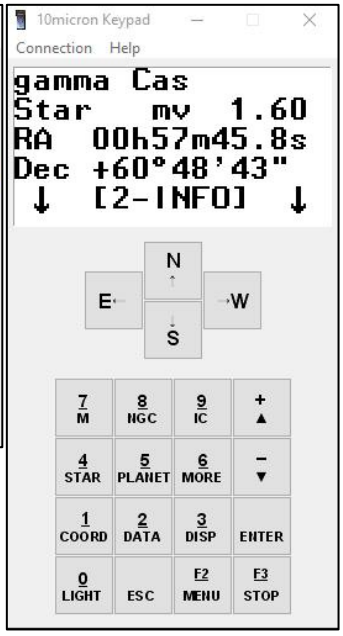


If the displayed time deviates from the standard time, the time of PC and GM4000HPS mount must be synchronized first. If this is omitted, pointing to a star is inaccurate: the maximum positioning error is 15 arcsec per second deviation!

Recommended is the app *Dimension 4*[1]. This application searches for an accessible time server on the Internet and synchronizes in a user-defined time interval.

[1] http://www.thinkman.com/dimension4/



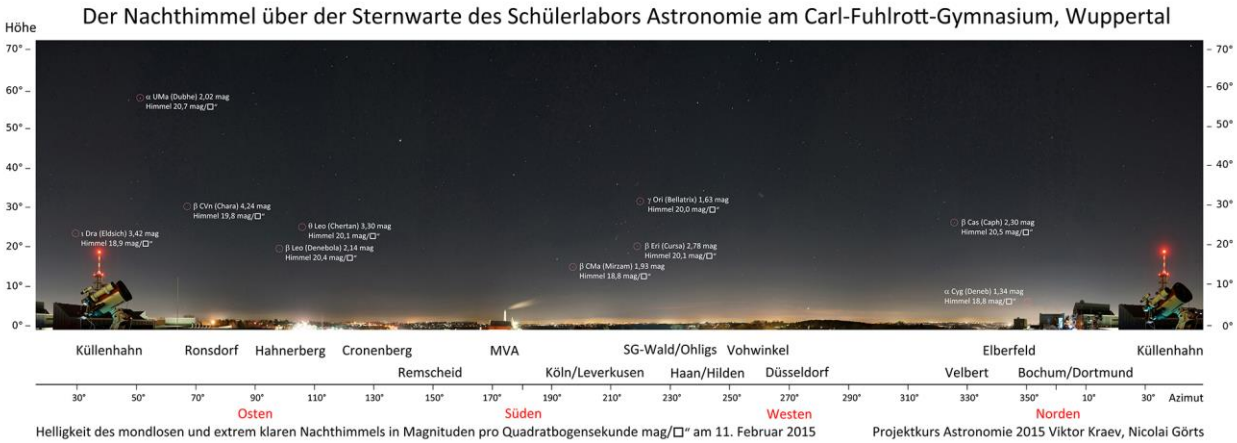


Next, the mount is synchronized with the PC time. This can be accomplished by the application *10Micron Clock Sync*. And finally the *10Micron Virtual Keypad* is started, whose menus are identical with the real keypad.

How Dark is the Night Sky at the Observatory?

The observatory is located on the roof of the Wuppertal college Carl-Fuhlrott-Gymnasium, 350m above sea level on the southern elevations in the Küllenhahn district. The bright city center (Elberfeld) lies in the valley in the north direction. To the east towards Bergisches Land and Oberberg the sky is the darkest, the visual limit is about 4 mag. The largest light pollution comes from the cities of Cologne and Leverkusen in the southwest, and Düsseldorf in the west along the “Rheinschiene”, a city-row along the river Rhine.

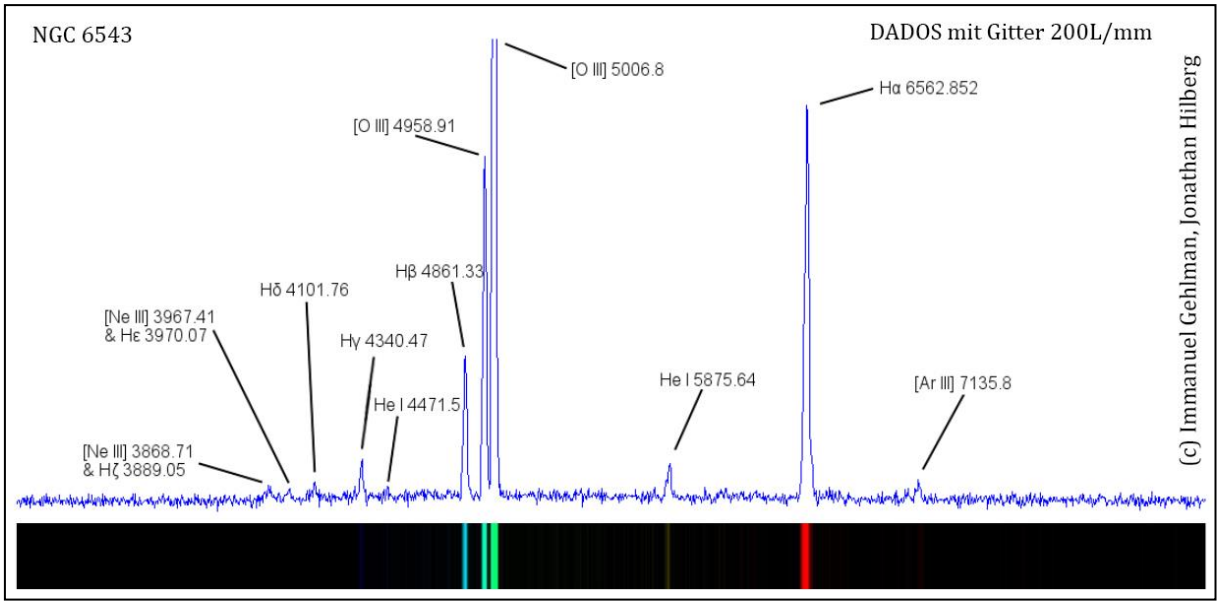
In a project work of the project course astronomy in stage Q1 (11th class), the students Viktor Kraev and Nicolai Görts in 2015 have found, that the relatively high elevation of the observatory in comparison to the urban environment has a positive effect on the visual and photographic limiting magnitude. The result of their work suggests, that a telescope with a large aperture is extremely useful even under a bright urban sky.



Visual First Light

Our visual "First Light" at the Planewave CDK 20 and the TEC160FL refractor took place in October 2016 on the evening of the polar alignment of the mount. We observed at the same time with the CDK 20 and the TEC160FL. The moonless sky was crystal clear, but brightened by city lights.

Our first target was the Cat's Eye nebula NGC 6543 in the constellation Draco. We knew from the results of a recent spectroscopic student project work[2] on NGC 6543 that the emission of the two turquoise forbidden [OIII] lines is high as compared to the Hα emission. Fortunately, the eye is most sensitive in that green-blue spectral range.



Exciting question: what would we observe visually of NGC 6543 with the big 50cm mirror?

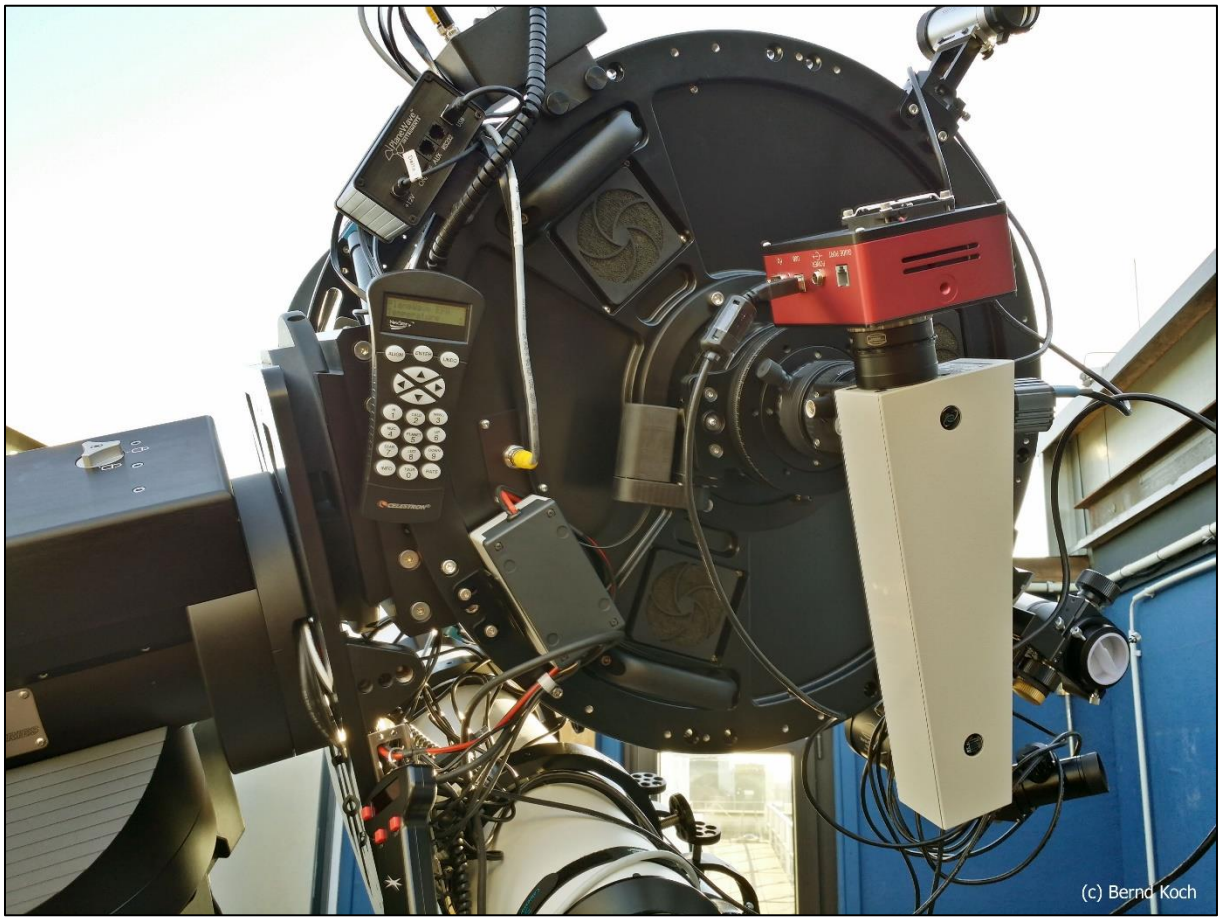
First of all, we noticed that the Planetary Nebula was slightly structured in the center .... and then colored, indeed! We could see a light greenish turquoise color of the nebula. A spectacular view for city observers. The view through the much smaller TEC160FL showed neither structure nor color. Conclusion: Even in a large city, a large aperture telescope is very useful.

Then we observed the much fainter Planetary Nebula NGC 1501 in the constellation Camelopardalis. With the CDK 20, we meant to recognize the mottled structure, however, colorless. With the much smaller TEC160FL, NGC 1501 was just as a featureless disc.

[2] http://baader-planetarium.de/carl-fuhlrott/download/Spektroskopie%20des%20Katzenaugennebels%20NGC%206543%20-%20Immanuel%20Gehlmann,%20Jonathan%20Hilberg.pdf

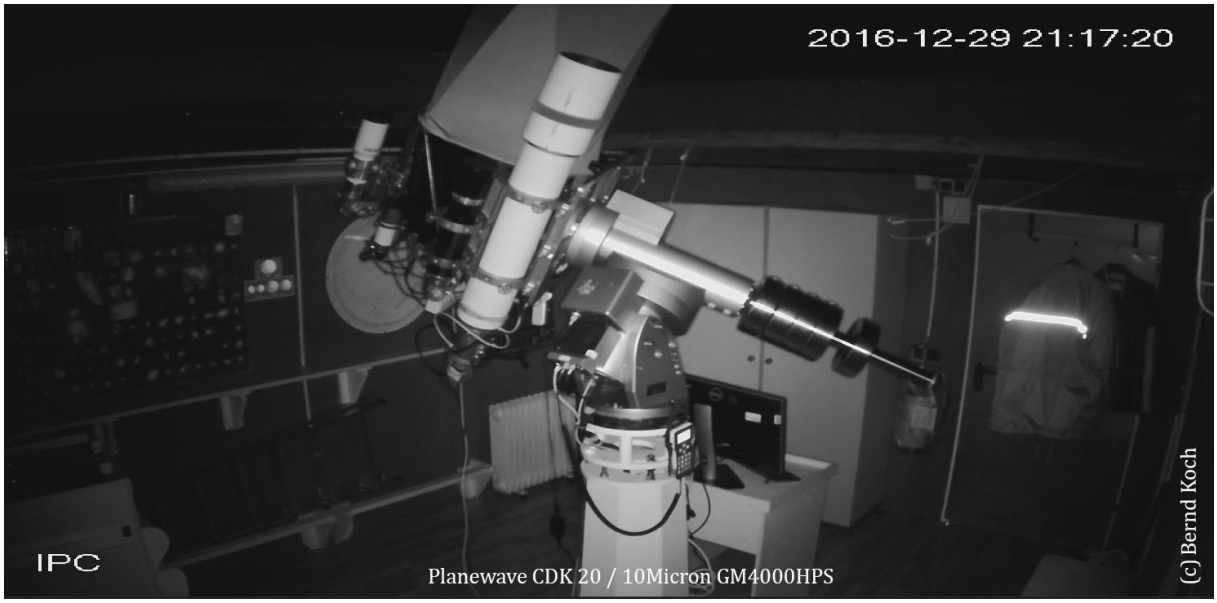
BACHES Echelle Spectrograph First Light at Planewave CDK 20

We had to skip the photographic first light (astrophotography): instead of using a CCD camera to record "pretty pictures", we used the BACHES Echelle spectrograph at the CDK 20. December 29, 2016 was the first opportunity to obtain stellar spectra for ongoing project works. High-resolution spectroscopy enjoys currently the highest priority at the CDK 20.

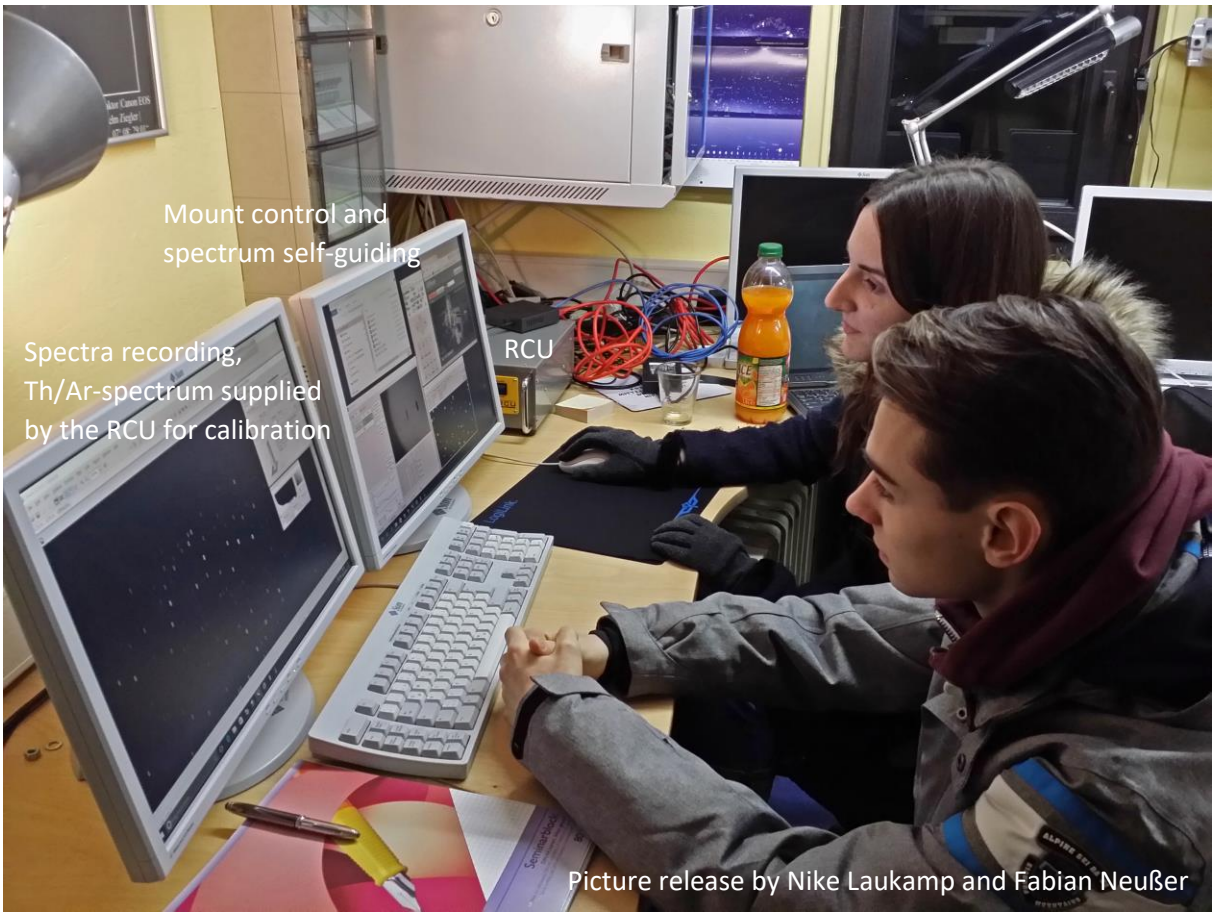


BACHES spectra are recorded with the STF-8300M CCD camera in 2x2-binning mode (effective pixel size 10.8µm). The monochrome Celestron Skyris 274M video camera serves as a guider camera. The Remote Calibration Unit (RCU) is located in the adjacent control room next to the right monitor and is controlled by PC. From there, the light from the Thorium-Argon/Halogen calibration lamps is conducted to the BACHES via a fiber cable.

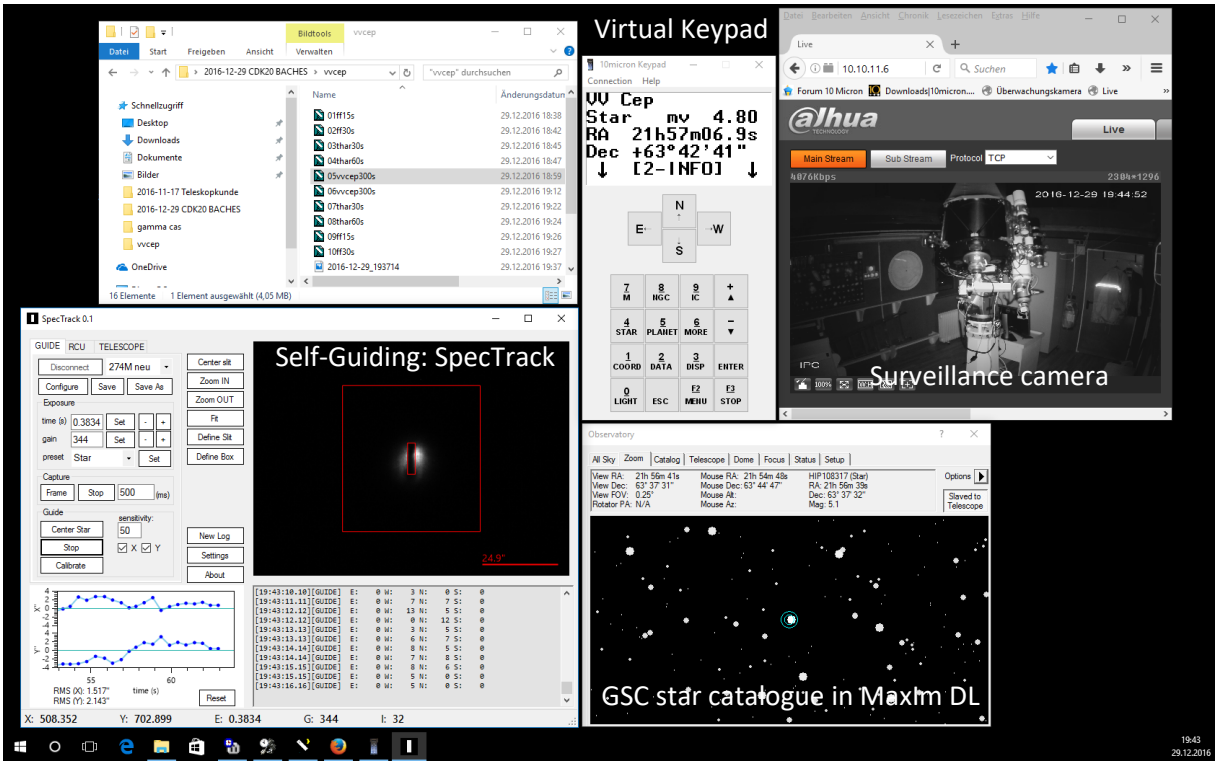
A night vision surveillance camera serves as visual observatory control:



Obtaining spectra (left) and control of cameras and telescope mount (at right).

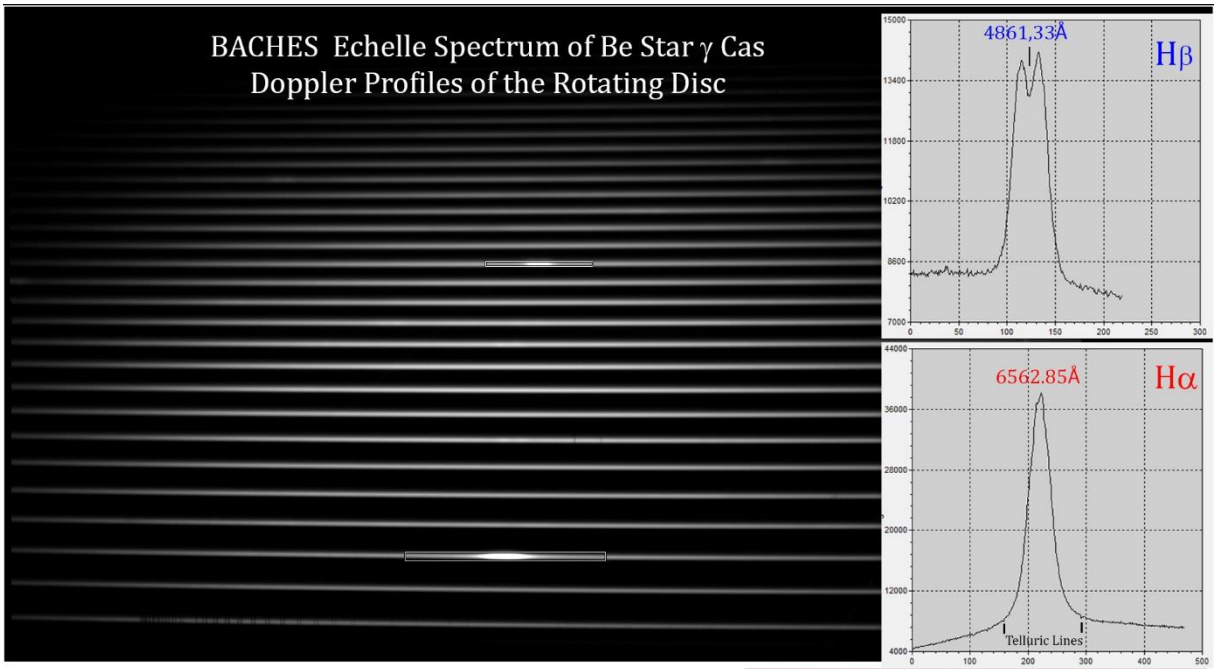


The right-hand monitor displays the control software

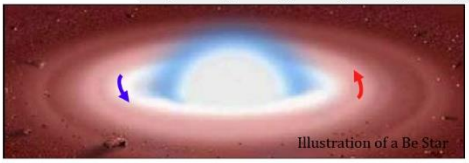


On the evening of the 29th of December, 2016, spectra were obtained by students of the project course astronomy Q1 (class 11).

Be-Star γ Cassiopeiae. Project Work Q1 (class 11) by Nike Laukamp



2016-12-29 | Mid-Exposure 17:18:28 UT | BACHES Echelle Spectrograph
Exposure: 60s minus Darkframe | Self-Guiding: SpecTrack Software
0.5m Telescope Planewave CDK20 | Mount: 10Micron GM4000HPS
Spectrum by Nike Laukamp (Astronomy Student) at College Carl-Fuhlrott-Gymnasium, Wuppertal/Germany under the Direction of Bernd Koch
Contact: Bernd.Koch@astrofoto.de



For the wavelength calibration with the software ESO-MIDAS, running under Linux FEDORA, a Thorium-Argon spectrum and a halogen flatfield spectrum were recorded:

Presently we perform the calibration of the spectra with ESO-MIDAS and the evaluation with VisualSpec. ESO-MIDAS is part of the software package **MIBAS**, which is supplied by Baader Planetarium, along with the BACHES Echelle spectrograph. NOAO-IRAF, the North American counterpart to the European ESO-MIDAS, is also included as an addition. MIBAS is based on the Linux distribution FEDORA 20.

```
                ESO-MIDAS version 13SEPpl1.1 on PC/Linux64
*******************************************************************************
**                                                                           **
**       Copyright (C) 1996-2013 European Southern Observatory               **
**                                                                           **
**   ESO-MIDAS comes with ABSOLUTELY NO WARRANTY; for details type           **
**   `@ license w'. This is free software, and you are welcome to            **
**   redistribute it under certain conditions; type `@ license c'            **
**   for details.                                                            **
**                                                                           **
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Midas 001> set/cont baches
******** TEMPLATE application package version 1.0 enabled **********
commands available:

CALIBRATE/BACHES executes baches_calib.prg
PIPELINE/BACHES executes baches_pipeline.prg
RESOLV/BACHES executes baches_resolving_power.prg
RECAL/BACHES executes baches_recalib.prg
CLEAN/BACHES executes baches_clean.prg
COMPUTE/BACHES executes baches_compute_fits.prg
FILE/BACHES executes baches_file_ext.prg
Midas 002>
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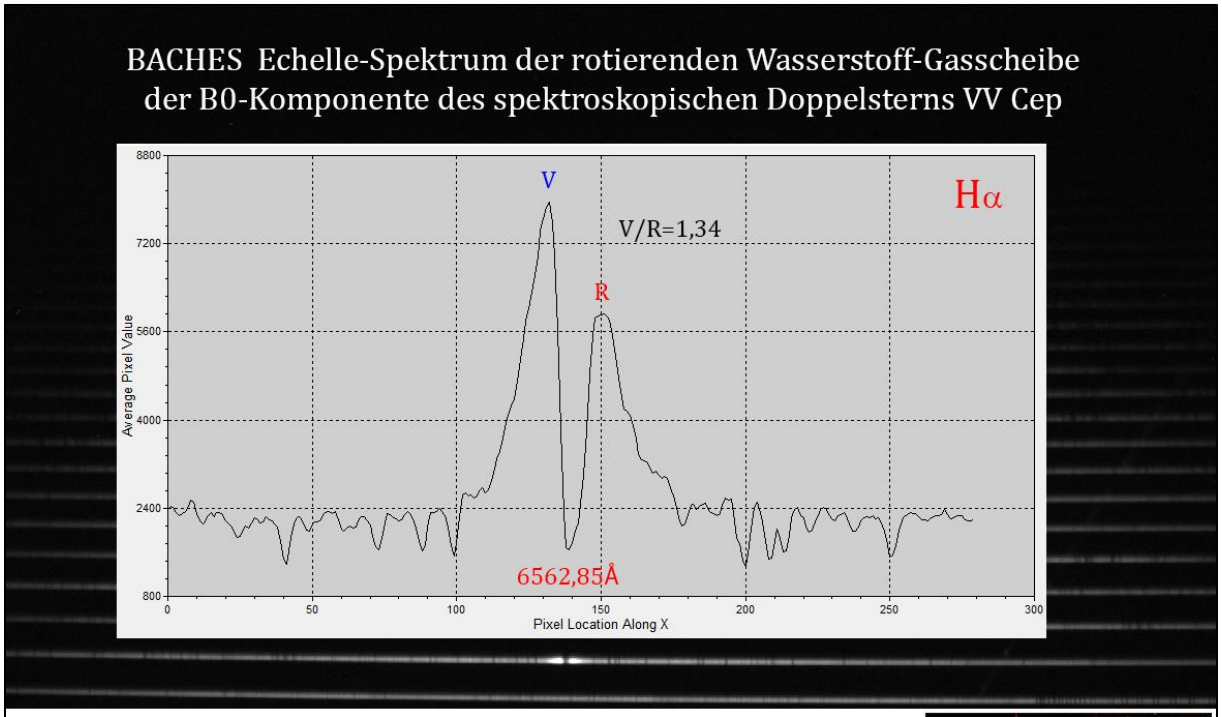
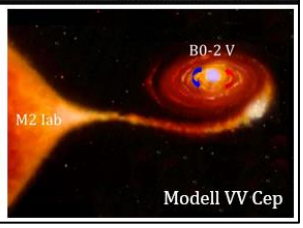
Monitoring of the Spectroscopic Binary VV Cephei:
Project Work (Class 11) by Fabian Neußer und Kevin Pixberg



2016-12-29 | Mitte der Aufnahme 18:07:57 UT | BACHES Echelle-Spektrograf
Belichtung: 300s minus Darkframe | Self-Guiding: SpecTrack Software
0,5m-Telekop Planewave CDK20 | Montierung: 10Micron GM4000HPS
Spektrum aufgenommen von Fabian Neußer (Projektarbeit Q1) am
Schülerlabor Astronomie des Carl-Fuhlrott-Gymnasiums, Wuppertal unter
der Leitung von Bernd Koch. Kontakt: Bernd.Koch@astrofoto.de



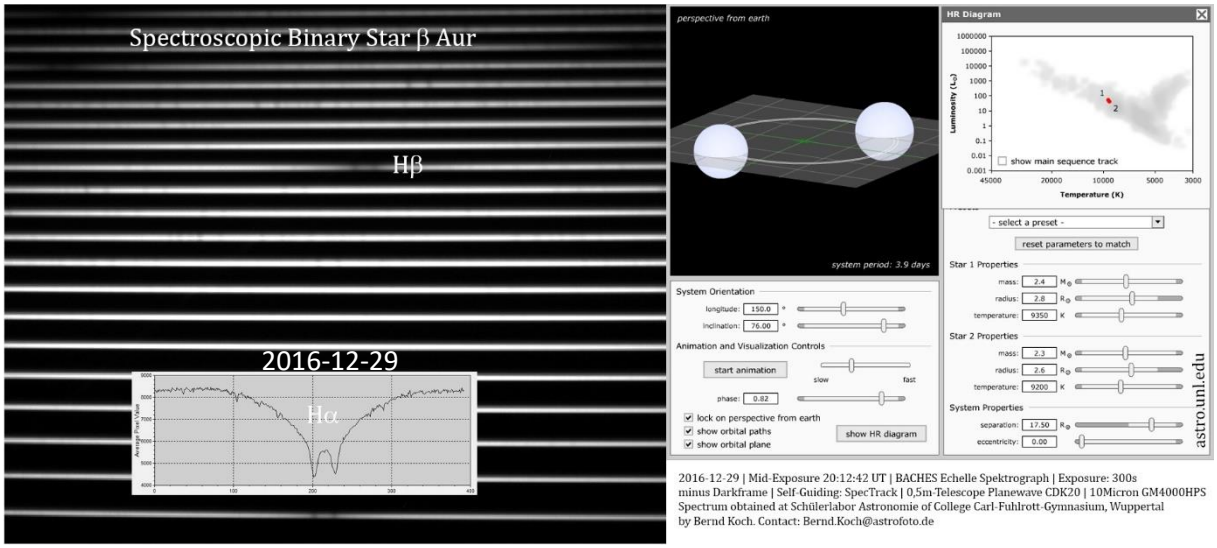
Every 20 years and 3 months, a grazing occultation of the B-star by the giant M2-star takes place. The next cycle begins in August 2017 and ends in May 2019. The B-star with its gas disk shines through the thin, semi-transparent Photosphere of the M2 supergiant.

The change will be noticeable in the spectrum: The V/R intensity ratio changes at the entrance and exit, and it will be exciting to see to what extent the B-star is able to shine through the atmosphere of the M2 supergiant star.

With this work, we contribute data to a long-term monitoring of the VV Cephei system. V/R intensity ratio, equivalent width EW, and finally the radial velocity of the central absorption will be measured at Hα. Ernst Pollmann (Leverkusen) coordinates an international long-term monitoring of predominantly amateur astronomers, which has already produced interesting results of the VV Cephei system[3].

[3] http://ibvs.konkoly.hu/cgi-bin/IBVS?6156

Spectroscopic Binary Stars
Project Work Q1 (Class 11) by Marius Bröcker und Samuel Striewski

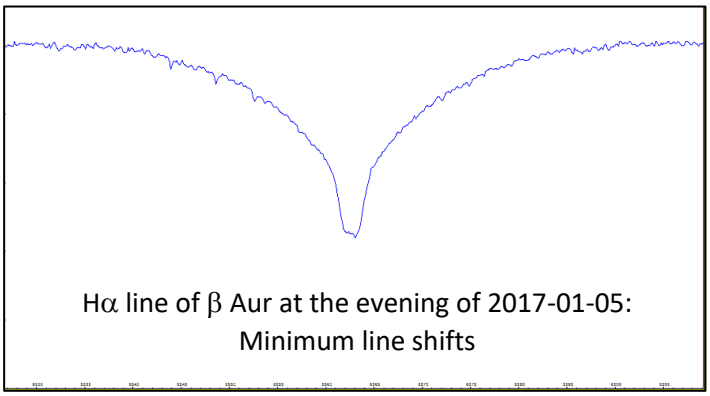


The spectroscopic binary star β Aurigae (Menkalinan) is an approximately equal-sized stellar system of similarly bright stars of spectral class A with around 9,300K photospheric temperature. Characteristic of this class are the Balmer lines of Hydrogen. During a complete orbit of just under 4 days, the absorption lines are shifted blue or red due to the Doppler effect, pretending a splitting up, which is not real.

From β Aurigae a series of spectra is now available obtained at different times. After measuring the radial velocity, a heliocentric correction due to the movement of the earth around the sun will be performed. These corrected data can be used to calculate the radial velocity Vrad, to fully characterize the physical Binary system: stellar masses, distance, ratio of diameters[4].

$$V_{\mathrm{rad}} = K\left[\cos\left(\nu+\omega\right)+e\cos\left(\omega\right)\right]+\gamma$$

V_{rad} = observed radial velocity
K = semi-amplitude
e = eccentricity
ω = longitude of periastron
ν = true anomaly
γ = systemic velocity



Hα line of β Aur at the evening of 2017-01-05:
Minimum line shifts

Dipl.-Phys. Bernd Koch, Director of the Project Course Astronomy Q1 (class 11. Director of the Student Laboratory Astronomy at Carl-Fuhlrott-Gymnasium, Wuppertal: StD. Dipl.-Phys. Michael Winkhaus)

Contact: Bernd.Koch@astrofoto.de, Michael.Winkhaus@t-online.de

[4] http://www.vub.ac.be/STER/JAD/JAD10/jad10_3/jad10_3.pdf