15.49° East
47.07° North
493 m.a.s.l.

The Observatory Lustbühel Graz, Austria and its rare BMK Telescope

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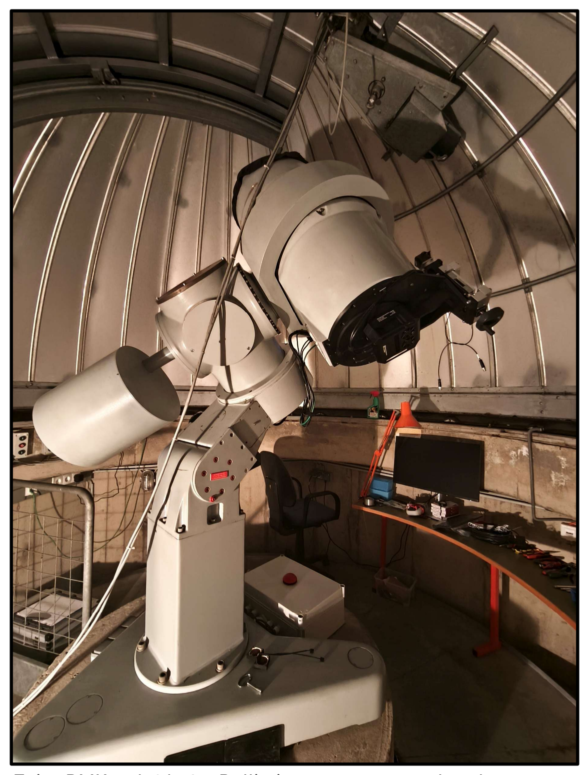
The Astrophysics Group at the University of Graz, Department of Physics, operates an observatory within the city limits of Austria's second largest city. Two main telescopes are installed at this site: A **ASA 50 cm Cassegrain f/9** system and a wide-field refracting telescope known as the **"Ballistische Messkammer" (BMK)**, or Ballistic Measurement Chamber. The table below shows the different capacities of the telescopes and their installed cameras.

	BMK	ASA Cassegrain
Focal Distance	750 mm	4500 mm
Aperture	300 mm	500 mm
Focal Ratio	2.5	9
Camera		
Sensor	Gpixel GSENSE4040 CMOS	SBIG STF-8300M CCD
Image Size	4096 x 4096 px	3326 x 2504 px
Pixel Size	9 × 9 µm	5,4 x 5,4 µm
Sensor Size	37 x 37 mm	18 x 14 mm
Range	16 Bit HDR	16 Bit
FOV	2.82 x 2.82°	0.23° x 0.17°

Comparison of the BMK with the ASA 50 cm Cassegrain

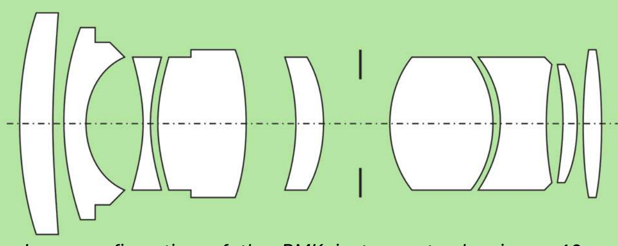
ASA 50 cm Cassegrain telescope (f/9)



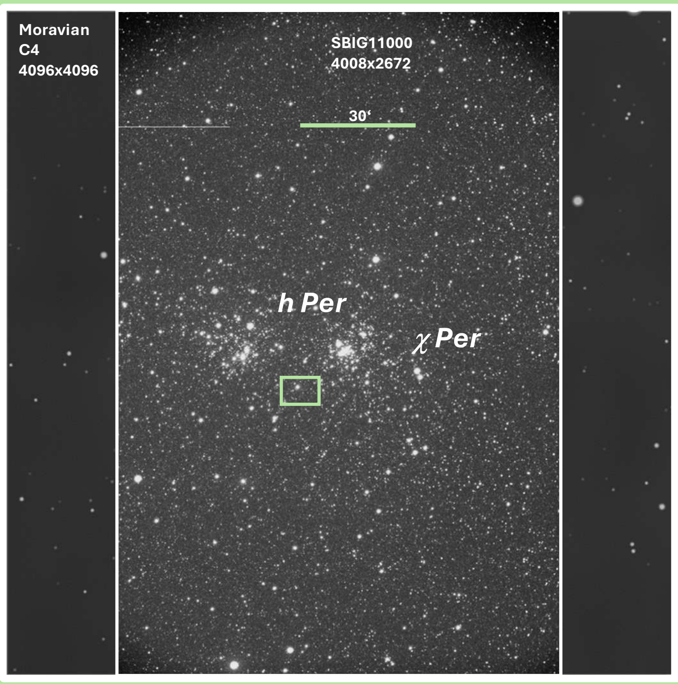
Zeiss BMK 75/18/1:2.5 Ballistic measurement chamber

Introduction to the BMK

The BMK units were custom-built in the 1970s by Carl Zeiss Jena for imaging laser-illuminated satellites to support orbital determination. Their optical design prioritizes **astrometric and photometric precision**. Aberrations (e.g. chromatic aberration, especially in blue wavelengths due to its photographic design; distortion; and field curvature) are minimal, ideal for astrometric measurements [1].

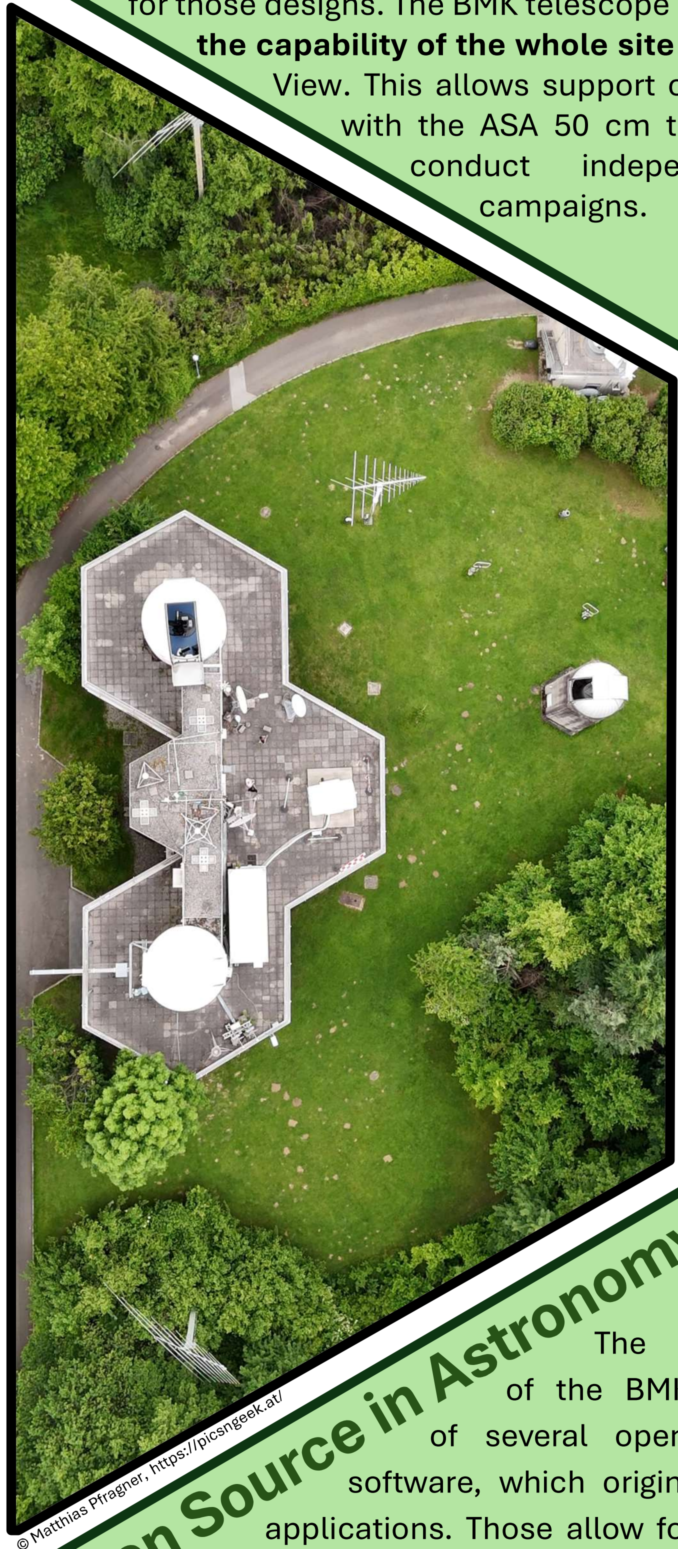


Lens configuration of the BMK instrument, showing a 10-element Astro-Topar [1]



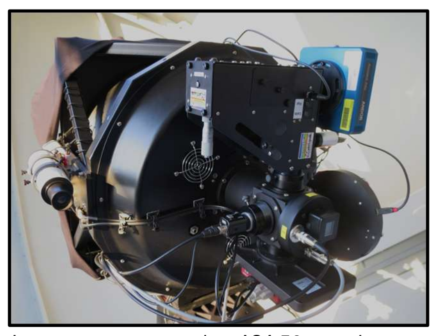
Comparison of the FOV of the BMK instrument and the ASA 50 cm telescope

The power of the BMK telescope is showcased in this collage: In the centre, an image taken with an old SBIG CCD camera renders the open clusters h and chi Persei at once. The new Moravian C4 CMOS camera will extend the field of view (FoV) to **2.8x2.8 degrees**. The green rectangle represents the rather small FoV of the ASA 50 cm telescope, which is typical for those designs. The BMK telescope and camera will **significantly enhance the capability of the whole site** due to its unusually large field of View. This allows support observations in combination with the ASA 50 cm telescope as well as to conduct independent research campaigns.



The image to the right shows the instruments mounted on the ASA 50 cm telescope:

- SBIG STF-8300M, ATIK 383L-Mono, cameras for filter photometry, FoV 0.23° x 0.17°
- LHIRES III PF0001 spectrograph with Apogee Alta F47 camera
- WATEC WAT-910HX video camera

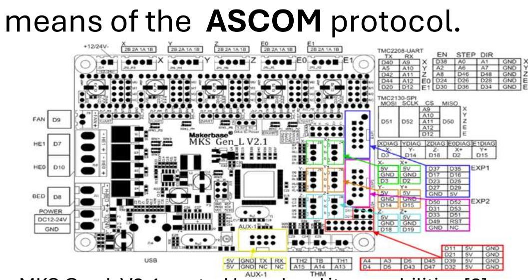


Instruments mounted on ASA 50 cm telescope

Refurbishment

The goal was to adapt the existing mechanical setup to support remote control. Therefore, electrical modifications to the dome control and a fully restructured mount control were implemented. To be remotely controllable, all components were connected in a Deep Sky Objects (DSO) Imaging software called **Nighttime Imaging 'N' Astronomy** (N.I.N.A) [2]. This allows for fully automated observing programs to be predefined and executed. The connection to the components is provided by means of the **ASCOM** protocol.

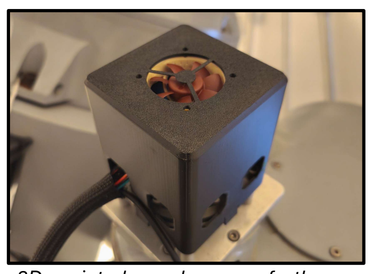
BMK instrument with added computer and control electronics



MKS Gen L V2.1 control board and its capabilities [3]

Mounted camera and filter wheel with focusing mechanism

The mount control was implemented using an open-source solution provided by **OpenAstroTech** [3]. This features a MKS Gen L V2.1 control board, usually found in 3D-printers. It controls the motors of the two axes of the mount as well as the motorized focuser.

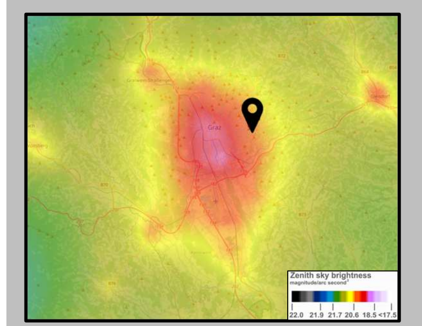


3D printed enclosure of the stepper motors for the mount

The **dome** is powered by three smart switch arrays with integrated microcontrollers and power metering. They are relayed through an ASCOM compatible central controller. The power metering enables fault detection during operation.

The system is controlled via a **standalone computer** that runs the DSO imaging software. This computer is accessible for all staff remotely via **Internet**.

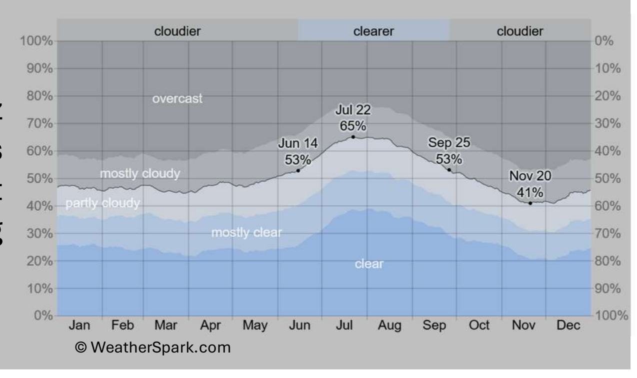
Observing Conditions



Light Pollution at the observatory [4]

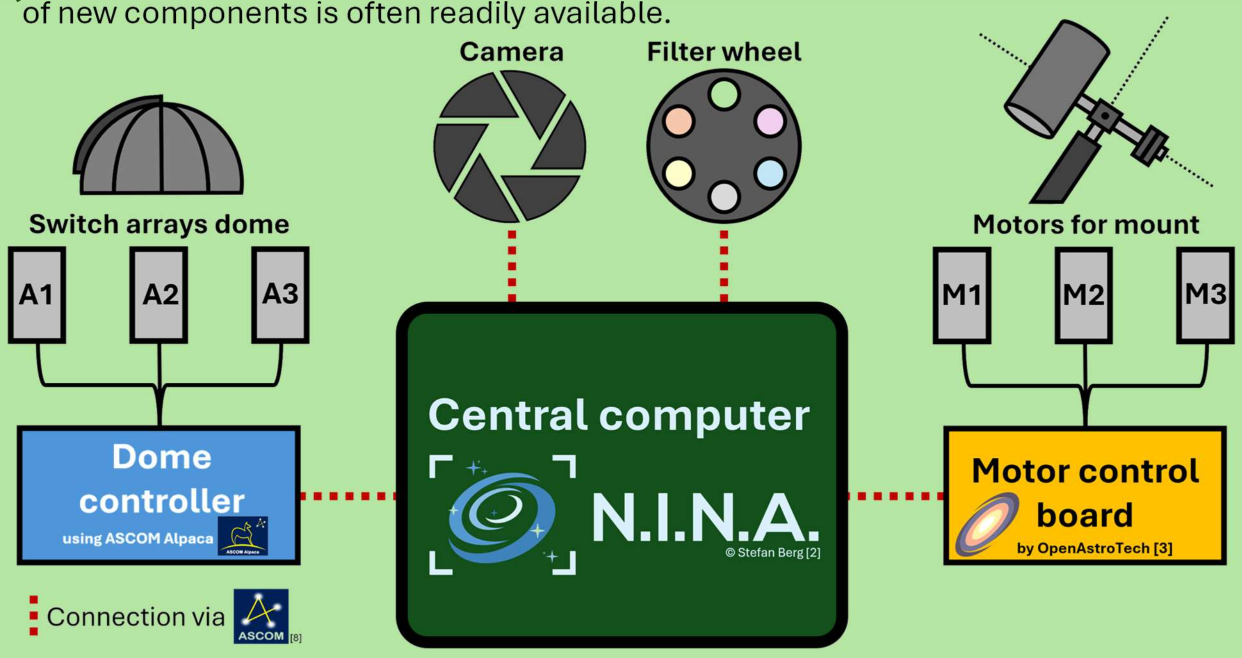
The observatory operates within the city limits of the second largest city in Austria. Even though a rating of 5 on the Bortle scale and an artificial brightness of the nightsky of 586 µcd/m² is limiting, observation of stars of up to 12th magnitude is possible (see "Research at Observatory Lustbühel").

Weather conditions in Graz allow for almost 120 nights of observations, excellent for extended observing campaigns.



Open Source in Astronomy

The refurbishment of the BMK included the use of several open-source solutions and software, which originates from amateur astronomy applications. Those allow for a cost-efficient and easy adaption of existing hardware. Due to the **large and growing community**, the integration of new components is often readily available.



Combination of components of the refurbished BMK as an integrated system using open-source software and hardware

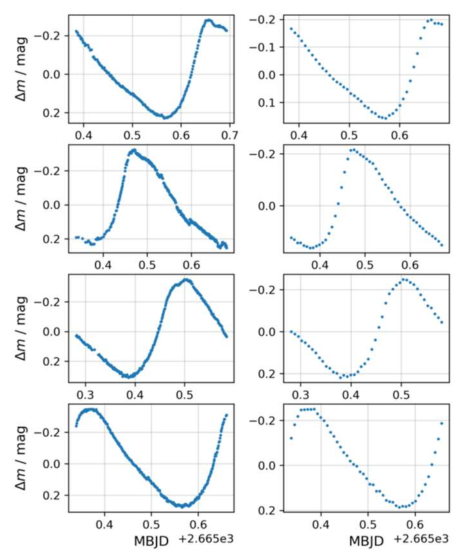
Through the **ASCOM interface**, which is also used in professional astronomy, all types of components can be easily integrated into a combined system. Due to the standardized functionality of all components, it is possible to exchange and upgrade them without the need to make adaptions to the whole system. Software such as **N.I.N.A.** allows for the combination of ASCOM devices (dome, mount, ...) to an integrated system.

Outside proposals for observations, individually or as part of a network, are welcome.

Research at Observatory Lustbühel (OLG)

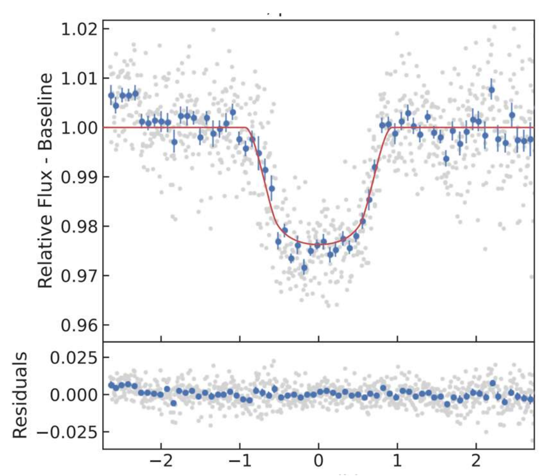
Light curves of RR Lyrae Stars

The left column in the graphic on the left side shows photometric data obtained from the RR Lyrae star TV Bootis at OLG with the ASA 50 cm telescope and a SBIG STF8600 camera. In the right column, contemporarily observations from the TESS satellite are presented. This work was done by a bachelor thesis from Johanna Reinprecht in 2024 at the University of Graz [5].



Comparison of measured light curve of RR Lyrae Star TV Bootis at OLG with TESS data [5]

Planetary Transits

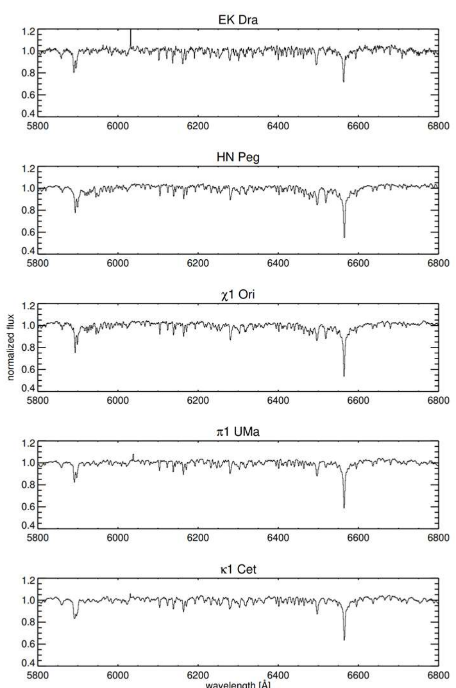


Light curve of planetary transit of HD189733b [6]

The diagram on the left shows a light curve, measured by an SBIG STF8600 camera mounted on the ASA 50 cm telescope in September 2023 at OLG. It shows a full transit of HD189733b – a hot Jupiter – covered that night. The residual noise from that V= 8.7 mag system is ~1 mmag. The grey points are the individual measurements. The blue points are bins with error bars. The red curve is the best model fit. This is an excerpt of a master thesis done by Rafael Goldgruber in 2024 at the University of Graz. [6]

Photometry and Spectroscopy of Flare Stars

Example of normalized spectra of young solar analogues EK Dra (top), HN Peg, χ^1 Ori, π^1 UMa, and κ^1 Cet (bottom) obtained with the LHIRES spectrograph (R ≈ 2700) on the 50 cm ASA telescope at OLG during a three-year monitoring campaign from June 2018 to September 2021. The spectra span ~5800-6800 Å, centred on the Hα line at 6563 Å, showing absorption profiles in quiescent states used as templates for flare and CME detection in residual analysis. These quiescent spectra serve as baselines to identify enhancements or asymmetries indicative of stellar activity in subsequent observations, with the study deriving upper limits on massive CME occurrence rates from non-detections on most targets. The research also incorporates scaled solar Hα events from MEES observatory data to evaluate detectability thresholds. It revealed that solar-sized flares would be undetectable on these stars without significant active region coverage. From the paper "Observations and detectability of young Suns' flaring and CME activity in optical spectra" by Leitzinger et al. [7]



Example of normalized spectra of young solar analogues [7]

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References

[1] J. Weingrill, 2007, "Adaption einer CCD Kamera an eine Großfeldoptik am Beispiel des Zeiss BMK 75/18/1:2.5"
[2] N.I.N.A (Nighttime Imaging 'N' Astronomy, 2025, https://nighttime-imaging.eu/
[3] OpenAstroTech, 2025, https://openastrotech.com/
[4] LightPollutionMap, 2025, https://lightpollutionmap.info
[5] J. Reinprecht, 2024, Differential Photometry for the RR Lyrae star TV Bootis
[6] R. Goldgruber, 2025, "Transit follow-up observation and analysis of HD 189733 b"
[7] M. Leitzinger, P. Odert, R. Greimel, 2024, "Observations and detectability of young Suns' flaring and CME activity in optical spectra"
[8] ASCOM, 2025, https://ascom-standards.org/