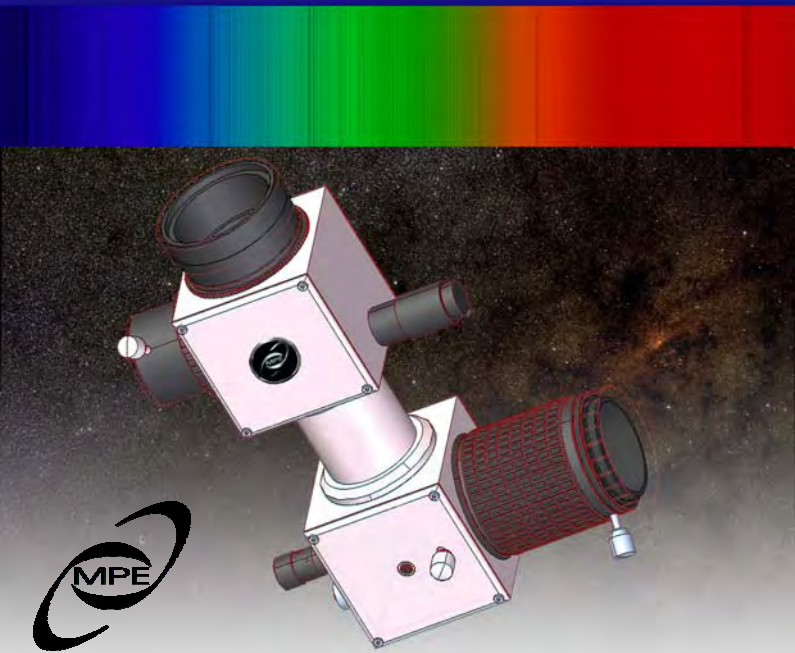
DADOS

Spectrograph



baader planetarium

User's Manual

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The DADOS spectrograph project is a collaboration of:

- **Max-Planck Institut für Extraterrestrische Physik**
  www.mpe.mpg.de
- **CAOS**
  www.eso.org/projects/caos/
- **Baader Planetarium GmbH**
  Zur Sternwarte
  D - 82291 Mammendorf

  Tel.: +49 (0) 8145 - 88 02
  Fax: +49 (0) 8145 - 88 05

  www.baader-planetarium.de

DADOS Spectrograph

User's Guide

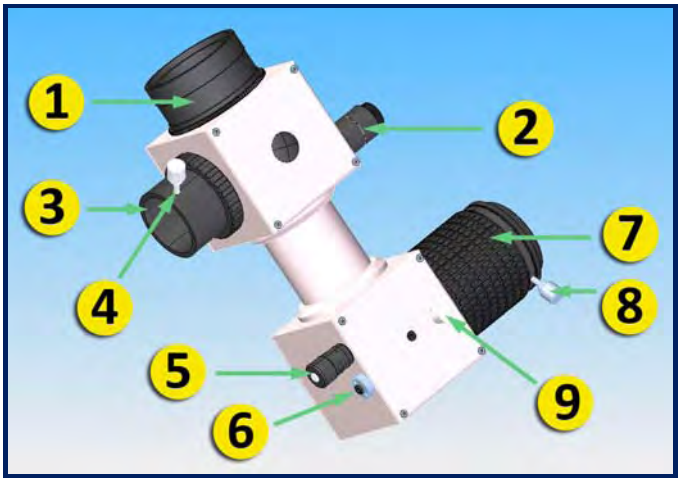
Thank you for purchasing this Baader Planetarium product. To get the most out of your DADOS Spectrograph, please read this instruction manual thoroughly before starting to work with the spectrograph. Keep this User's Guide available for future reference and visit the Baader Planetarium website: http://www.baader-planetarium.de for up to date information about the product.

Unpacking

As you unpack the spectrograph, check the list below and make sure that all items shown above are included. If anything is missing contact your original retailer.

Standard accessories:

- DADOS spectrograph
- Eyepiece 20mm
- Eyepiece 10mm
- Allan Wrench 1.5 mm
- Allan Wrench 1.3 mm
- Slit Viewer Assy
- Focusing eyepiece holder (#2458125)
- 1 ¼" Stop ring
- T-2 Quick changing system (#2456313 + #2456320)



Part description

1. 2” Nosepiece
2. Slit illuminator
3. 1 ¼” Slit viewer port
4. Slit viewer port locking screws
5. Micrometer
6. Rotation stage counter spring
   (pre-adjusted do not touch)
7. Focuser
8. Focuser locking screw
9. Grating angle locking screw

For a full list of accessories see Appendix D

Table of Contents

1. Introduction

The DADOS spectrograph is an instrument which permits to obtain spectra from different light sources.

The name DADOS means “dice” in spanish.
It was designed to be used as spectroscope and as spectrograph mainly for astronomical and didactical purposes. The device is very easy to use, robust, and versatile.

Please carefully read trough this manual to achieve the maximum use from this device.

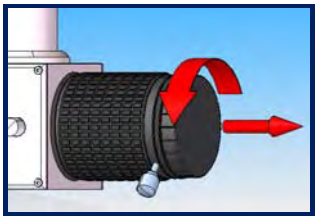
Description of DADOS main features:

- Optimized for telescopes up to 14” aperture at f/10.
- Choice of 3 slits: 25, 35 and 50 µm.
- A Red LED provides back illumination to the slit for easy focusing of a guider camera.
- Default grating of 200 l/mm for low resolution, optional 900 l/mm grating for higher resolution.
- Micrometer for fine positioning of the central wavelength.
- Camera objective with wide focusing range including standard T2 adapter thread (M42 x 0.75).
- Accepts most CCD and DSLR cameras (with optional adapters). The camera interface is a T2 adapter with a standard M42 x 0.75 thread.
- Wide focusing range up to 55 mm, suitable for attaching a DSLR-camera.

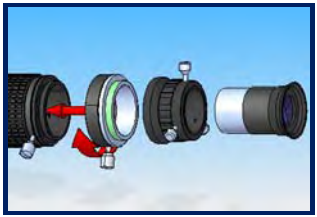

STOP
WARNING
STOP
Never aim DADOS straight to the Sun!
Irreversible eye damage may occur!

2. Quick setup

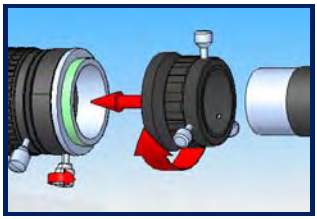
2.1 Attaching an eyepiece to the focuser



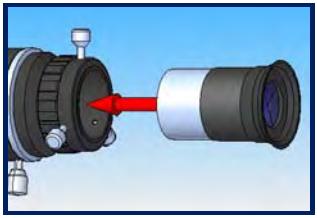
Remove the T-2 dust cap by rotating it counterclockwise.



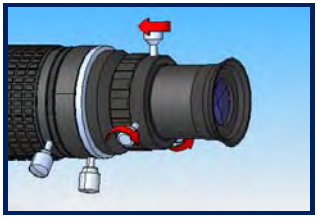
Mount the Baader T-2 quick changing system (#2456313 + #2456320).



Lock the Baader T-2 quick changing system and mount the focusing Baader eyepiece holder (#2458125).

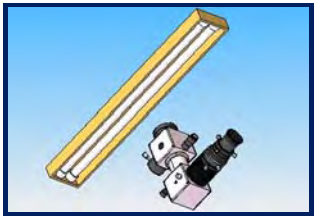


Insert the DADOS 20mm eyepiece into the focusing eyepiece holder.



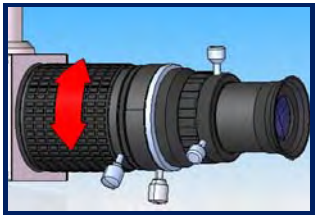
Lock the eyepiece with any of the three lock screws.

2.2 Focusing the spectrum

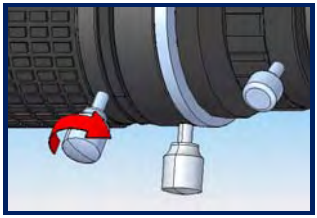


Point the 2” nosepiece (#1) to a fluorescent light source or a Neon lamp.

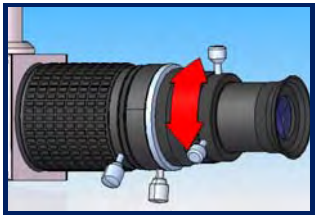
Do not point directly to the Sun



Rotate the focuser (#7) in order to focus onto the spectrum.

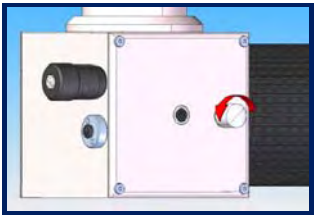


Lock the focus with locking screw once sharp focus is achieved.

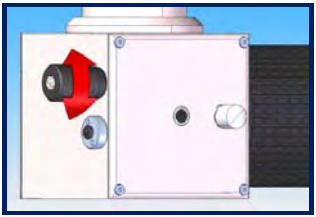


Rotate the focusing eyepiece holder for fine focus adjustments.

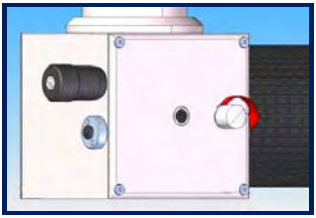
2.3 Changing the spectral range



Slightly loosen the grating angle locking screw (#9).



Center the spectral lines of your choice by adjusting the micrometer.



Tighten the grating angle locking screw (#9) to secure the selected setting.

2.4 Observing some common light sources

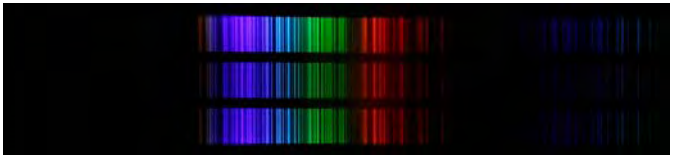
With DADOS you can observe and analyze a large variety of light sources. For a quick set up of the instrument you can observe in particular:

- **Neon lamps**
  (like pilot lamps in multi-socket distributors or washing machines)
- **Fluorescent lamps**
- **Continuous spectral sources**
  (like Tungsten or Halogen lamps)
- **Bright daylight**

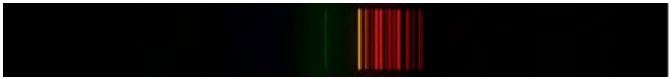
Never point directly towards the Sun.

Examples of spectra taken with DADOS and a 200 lines/mm grating

HeAr calibration lamp



Neon



Continuous 1st and 2nd order

Solar spectrum

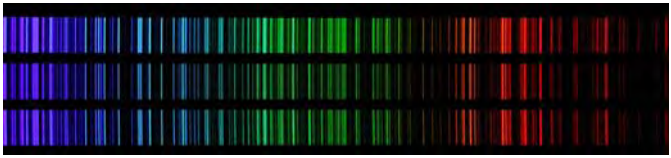
Note:

Spectra obtained w. Canon 10D EOS Camera at different grating angles.

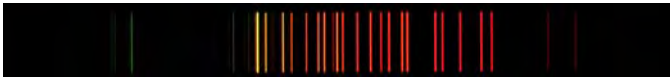
Calibration Lamp only glows in the dark. Shield it from daylight or connect it to DADOS.

Examples of spectra taken with DADOS and a 900 lines/mm grating

HeAr calibration lamp



Neon



Fluorescent

Continuous

Solar spectrum

Note:

Spectra obtained w. Canon 10D EOS Camera at different grating angles.

Calibration Lamp only glows in the dark. Shield it from daylight or connect it to DADOS.

3. Configuring DADOS for astronomical observation

The spectrograph should be setup correctly to ensure proper function.

3.1 Coupling a detector to DADOS

3.1.1 Astronomical CCD camera

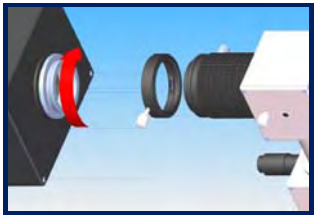
DADOS optical design is optimized to cover the field of SBIG ST-8 or ST-1603ME cameras.

Detectors having larger chip size than 13.8 x 9.2 mm may be used; however the optical image quality will slightly decrease at the edges and therefore the resolving power as well.

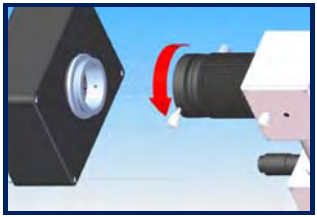
Prepare the detector to be used in the observation, prefarably:

SBIG ST-8 XME / ST-1603ME / ST-7 XME / ST-402ME

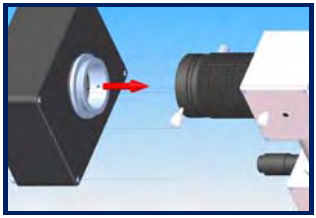
Use the Baader T-2 quick changer system as ideal device for coupling and rotating the camera without loss of focus.



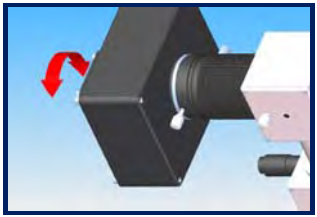
Mount the T-2 change ring onto the SBIG detector.



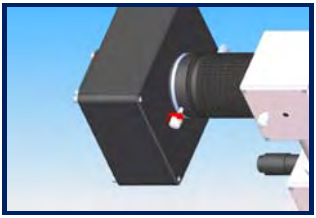
Mount the quick changer onto the T-2 male thread of the DADOS collimator focuser (#7).



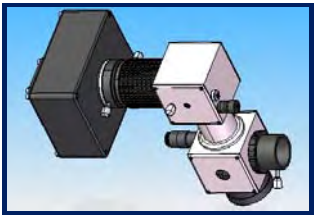
Join the detector and the change ring combo.



Rotate the camera into the desired orientation.



Clamp the camera by tightening the locking screw of the T-2 quick changer.



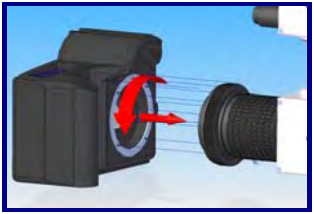
DADOS with imaging detector mounted.

3.1.2 SLR or D-SLR body

Obtain the appropriate T-Adapter for your type of camera.

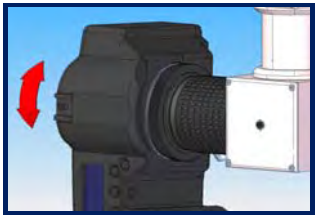
Prepare the DSLR camera body to be attached to the spectrograph.

Screw the DSLR T-Ring on the spectrograph focusing unit.



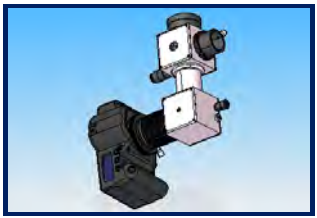
Attach the camera to the T-Ring adapter.

Open the three set screws of the Camera T-Ring.



Rotate the camera body into the desired position.

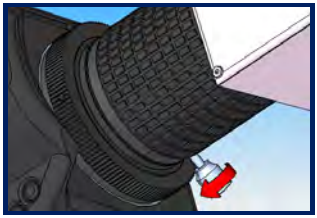
Lock the three sides set screws of the camera T-Ring.



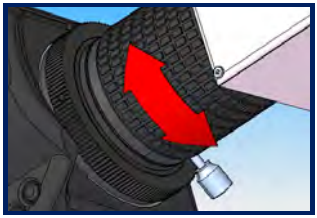
DADOS with mounted DSLR camera.

3.2 Fine focusing of the camera objective

Either you have an astronomical CCD camera or a SRL body, follow the instructions below to achieve the best possible focus of the instrument.



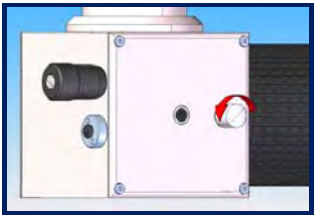
Loosen the focuser locking screw (#8) to focus the detector.



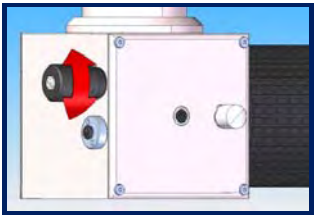
Rotate the focuser (#7) in order to focus onto the spectrum.

Lock the focus with locking screw (#8) when sharp focus is seen or recorded.

3.3 Selecting wavelength range

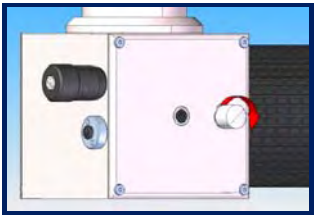


Slightly loosen the grating angle locking screw (#9).



Center on certain spectral lines by rotating the micrometer (#5).

Prepare spectral charts of lab lamps*

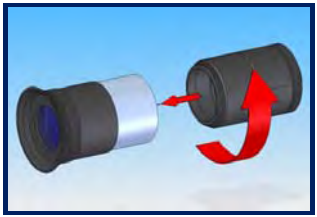


Tighten the grating angle locking screw to secure the selected setting.

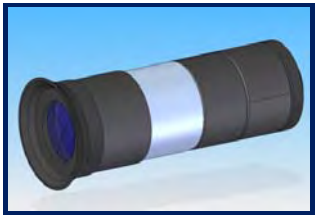
* If you want to download the spectral charts of some laboratory lamps go, for example, to http://www.eso.org/projects/caos/

3.4 Using the slit-viewer

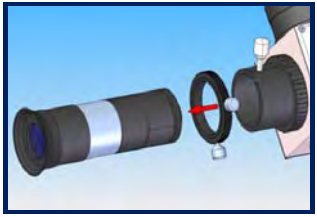
3.4.1 Attaching an eyepiece to the slit-viewer



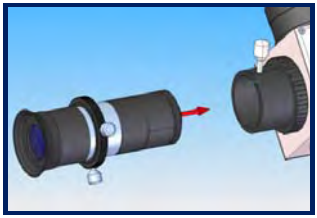
Mount the slit viewer assembly onto the 20mm DADOS pointing eyepiece.



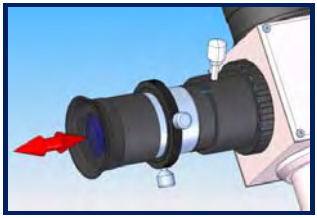
Slit viewer assembly with eyepiece.



Slide the 1 ¼" stop ring onto the eyepiece chrome sleeve and lock it.

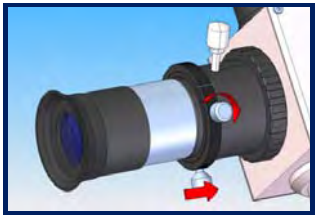


Insert the eyepiece assembly into the 1 ¼" slit viewer port (#3).

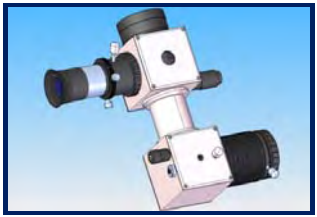


Focus onto the slit by manually pushing or pulling the eyepiece.

After having focused the image of the three slits, lock the eyepiece by using the locking screw (#4) of the 1 ¼" slit viewer port (#3).



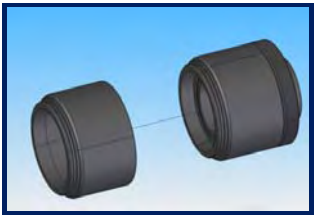
Open the set screws of the stop ring and move the stop ring down to sit flush on top of the eyepiece holder. Tighten the stop ring to secure proper focus position.

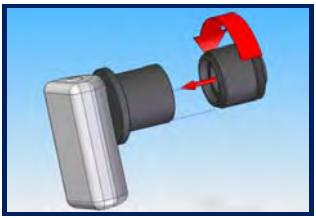


DADOS with mounted slit viewer assembly.

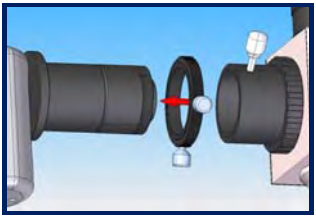
3.4.2 Attaching a webcam to the slit-viewer

Remove the 18mm long 1 ¼" extension tube of the slit viewer assy.

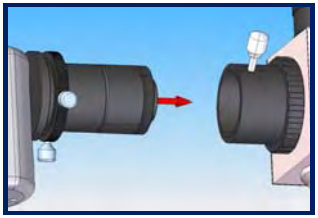




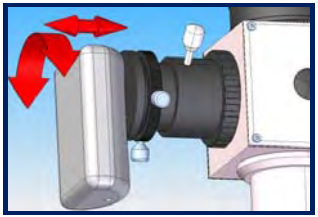
Mount the remaining body of the slit viewer onto the 1 ¼" nosepiece of the webcam. Example: Celestron NexImage w. 1 ¼" nosepiece #825100



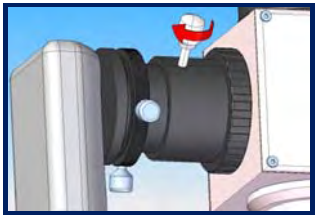
Slide the 1 ¼" stop ring onto the webcam nosepiece.



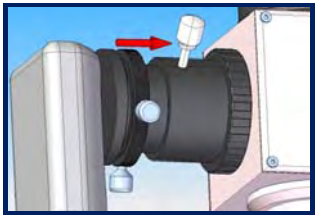
Attach the webcam combo into the 1 ¼” slit viewer port (#3).



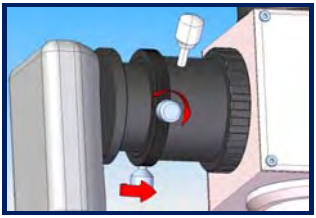
Focus the Webcam by manually pushing or pulling it. Rotate the Webcam body until it is approximately aligned with the major axis of DADOS.



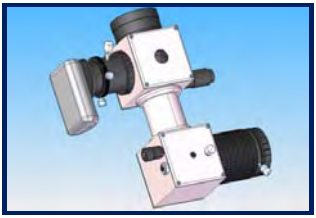
After having focused the image of the three slits, lock the webcam combo by using the locking screws (#4) of the 1 ¼” slit viewer port (#3).



Open the set screws of the stop ring and move it to sit flush on top of the eyepiece holder / slit viewer port.



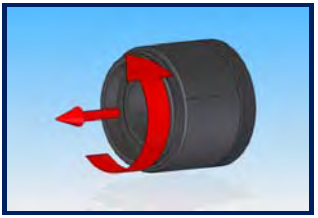
Tighten the Stop Ring to secure proper focus position. Realign the orientation of the slit by rotating the Webcam.



DADOS with Webcam mounted on to the slit viewer port.

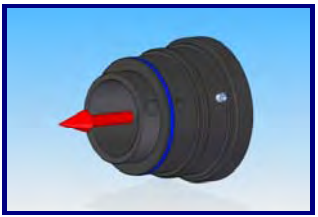
3.4.3 Zoom in/out of the slit view

The lens inside the slit viewer can be adjusted in order to magnify the image size of the 3 slits on the detector of the Webcam.

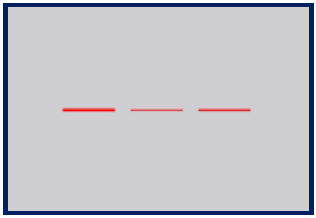


Remove the second 1 ¼" extension tube from the slit viewer body.

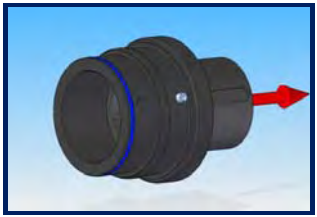
Loosen the headless set screw inside the slit viewer body by only ½ turn, using the supplied Allen wrench (1.3mm).



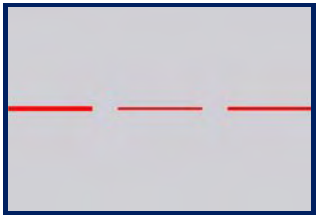
Slide the lens holder tube towards the Webcam to reduce image size.



Minimum magnification as seen by the CCD chip.



Slide the lens holder tube away from the Webcam in order to magnify the image.

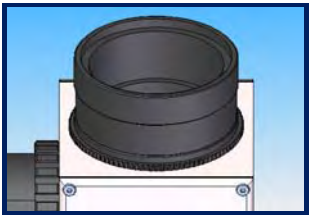


Maximum magnification as seen by the CCD chip.

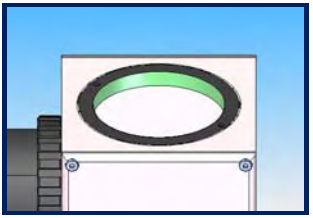
Lock the new position of the lens holder tube by tightening the headless set screw.

Remount the slit viewer body onto the webcam with one 18mm extension tube.

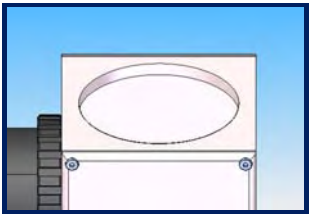
3.5 Coupling the spectrograph to the telescope



Use the provided 2” nosepiece to attach DADOS to your telescope.



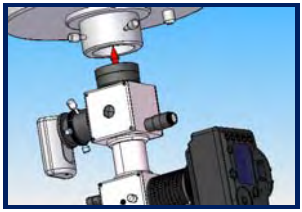
Alternatively use the female T-2 thread (M42 x 0.75), by removing the 2” nosepiece.



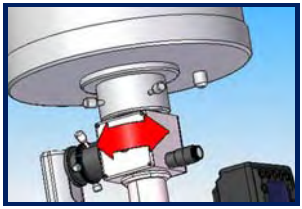
Or remove the female T-2 thread adapter to get access to a female 2” thread in DADOS body.

3.6 Operating the spectrograph at the telescope

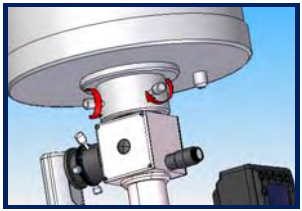
Before attaching DADOS to the telescope, make sure you have previously focused the spectrum on the camera with the proper orientation.



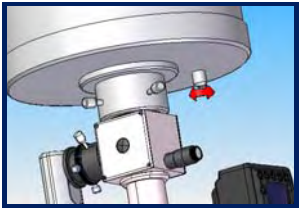
Attach DADOS onto the Telescope with a 2” interface if using the 2” nosepiece.



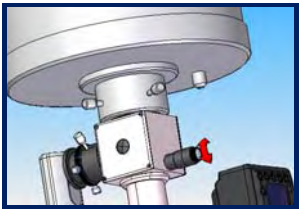
Select the alignment between telescope and instrument. With equatorial mounts the best orientation of the instrument is that the slit is parallel to the right ascension axis of the telescope.



Ensure the attachment of the instrument to the telescope by locking the proper adapter screws. Then, slew the telescope to a bright star.



Use the focusing screw of the telescope to focus the star in the middle of the slit by observing its image through an eyepiece or webcam.



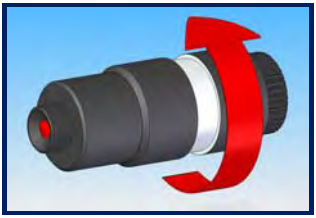
Use the slit illuminator (#2) to illuminate the slits and slowly slew the telescope to bring the star inside one of the slits. Switch off the slit illuminator before starting an exposure with the detector.

Appendix A: Maintenance

A.1 Battery replacement

Simply turn the back of the Illuminator counterclockwise approximately three turns to open the battery compartment.

Replace worn-out batteries with two round “hearing aid” batteries 1.5V (such as Camilion AG 3 LR 41 #2454306).



Then turn the back of the illuminator clockwise till it is completely closed.

A.2 Grating replacement

 **Attention**

Touching the grating will destroy it beyond repair!

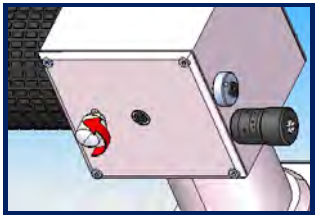
Do not attempt to remove dust by breathing or blowing air onto the grating! Small droplets of moisture and saliva can permanently damage the grating as well.

Do not use compressed or canned air! This will likewise transport moisture, grease or flocks of gas propellant onto the grating.

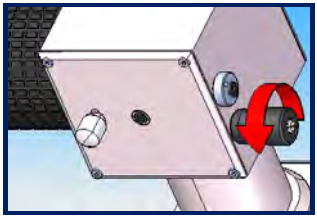
Any exchange of grating holders should always be performed in clean surroundings, free of dust and static build up.

Arrange your workplace for ensure a quick and tidy grating exchange.

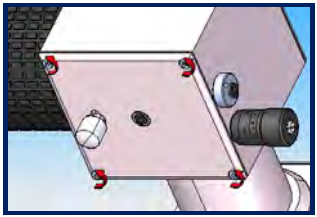
Have the 900L grating with holder readily available.



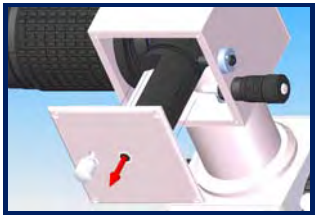
Loosen the grating angle locking screw (#9) by one turn only.



Rotate the micrometer backwards to show an 8mm setting on the Vernier scale.

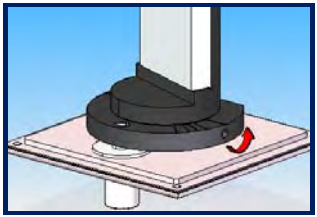


Use the 1.5 mm Allen wrench to remove the four Hex-Head screws.

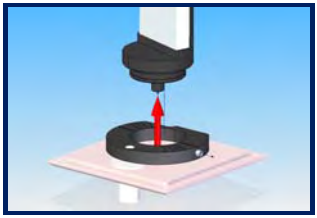


Take off the side plate with the complete grating holder assembly.

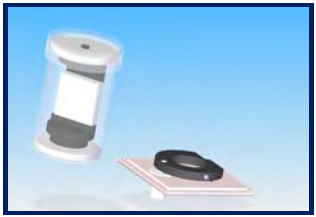
Be careful not to touch the grating.



Release the headless set screw inside of the pressure plate by 2 full turns counterclockwise using the 1.5 mm Allen wrench.



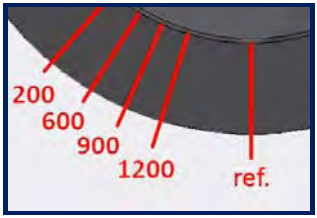
Remove the grating holder from the pressure plate.



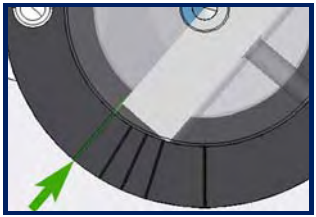
Take the 900L grating holder out of the storage container and store the 200L grating in it.

Place the 900L grating holder into the pressure plate.

Rotate the grating holder to adjust the proper position in regard to the markings in the pressure plate.

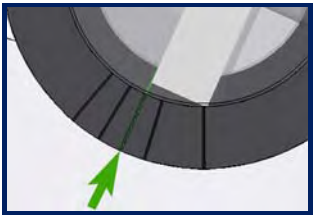


Each mark indicates the position of a specific grating. Be sure to use the proper one to achieve the optimal throughput.



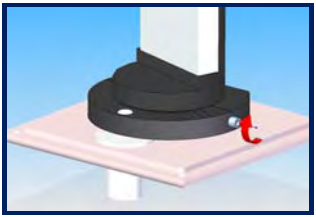
Example of position:

200 lines/mm grating.

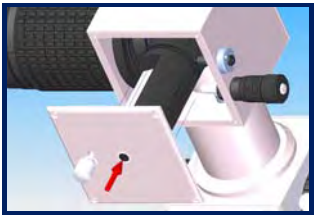


Example of position:

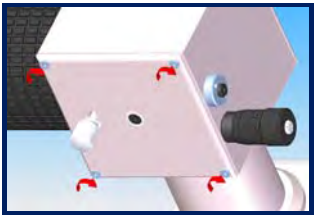
900 lines/mm grating.



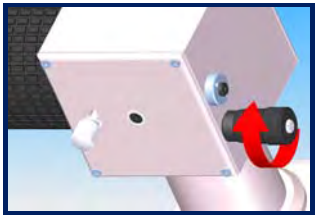
Lock the pressure plate by tightening the headless set screw clockwise.



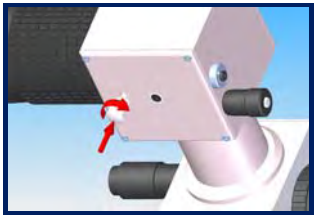
Carefully relocate the side plate with the new grating.



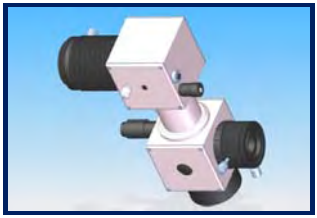
Relocate the 4 screws that secure the side plate.



Retighten the micrometer into a Vernier position of 2.5 or around.



Lock the grating tilt mechanism by rotating the grating angle locking screw clockwise.



DADOS with grating exchanged.

Appendix B: Care of the Optical components

If you always use dust caps after finishing on working with the DADOS, no cleaning will be necessary.

Grating and slit can only be cleaned from dust by Baader-Planetarium. Do not clean gratings or slit, it may void the warranty.

Lenses cannot be cleaned with common cleaning agents.

Only use Baader Planetarium Optical Wonder fluid (#2905007) to clean the lenses.

Appendix C: Specifications

Mechanical

Weight (without cameras and eyepieces)	0.85 kg
Dimensions (see Figure in Part Description)	80 × 150 × 205 mm

Electrical

Red LED Battery	LR 41 or equivalent

Environmental

Operating temperature	-10 to +30^{o}C
Storage temperature	-30 to +35^{o}C
Humidity (relative)	0 to 80 %
Storage humidity	0 to 60 %

Optical

Collimator aperture	f/10 *
Collimator focal distance	80 mm
Objective focal distance	96 mm
Collimator – Camera angle	90^{o}
Dispersion on axis at 550 nm	
- 200 lines/mm grating	39.7 nm/mm
- 900 lines/mm grating (optional)	10.6 nm/mm

* Operating at lower f/# degrades the resolving power and increases the vignetting

Performances

Resolving power λ / Δ λ on camera objective axis and 25 µm slit

Grating of 200 lines/mm		
Theoretical	**Measured**	**λ (nm)**
396	542	@ 416
606	647	@ 616
668	723	@ 697

Grating of 900 lines/mm		
Theoretical	**Measured**	**λ (nm)**
2038	2000	@ 371
3910	3000	@ 561
5376	5000	@ 800

Limiting magnitude for a 30 cm Ø telescope with S/N 50 and 20 minutes of exposure time.

For the 200 lines/mm grating :	$m_v = 8$
For the 900 lines/mm grating :	$m_v = 6$

Note:

Measurements performed w. ST-8 XME w. 9 micron pixel size.

The measured resolving power of the 900L grating was limited by the pixel matching.

With smaller pixels a higher resolution can be measured.

Appendix D: Optional accessories

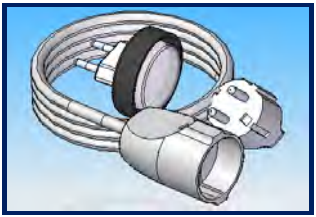
T2 adapters for many SLR camera models. Examples:

Nikon	Ref. 240 8300
Canon EF	Ref. 240 8319

Look at Baader Planetarium Web site for a complete list.

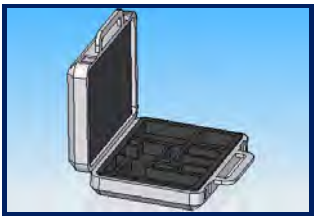
Reflection grating
25 x 25 x 9mm, 900 lines/mm mounted in quick exchanger.

Ref. 245 8555



Calibration Neon lamp for DADOS with 220V power cord and 2" adapter.

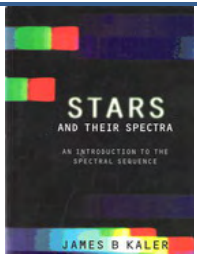
Ref. 245 8590



Travel case for DADOS with flexible compartments for tools.

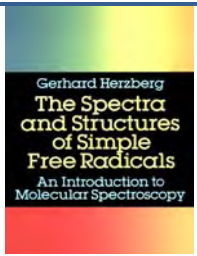
Ref. 245 2110

Appendix E: Bibliography



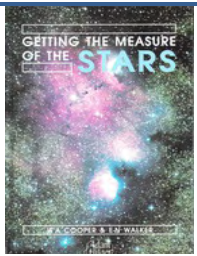
Stars and their spectra: An introduction to spectral sequence

Author:	James B. Kaler
Pub	1989
Pages:	300
ISBN:	0521304946



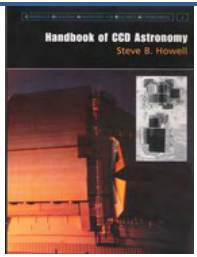
The spectra and structures of simple free radicals: An introduction to molecular spectroscopy

Author:	Gerhard Herzberg
Pub	1989
Pages:	300



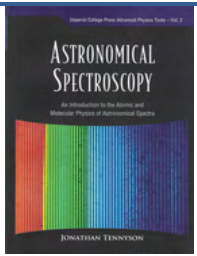
Getting the measure of the stars

Author:	W.A. Cooper
Pub	1989
Pages:	293
ISBN:	0852748302



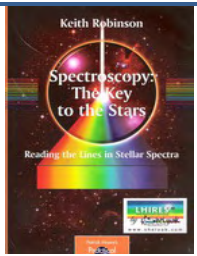
Handbook of CCD astronomy

Author: Steve Bruce Howell
Pub 2006
Pages: 208
ISBN: 0521852153



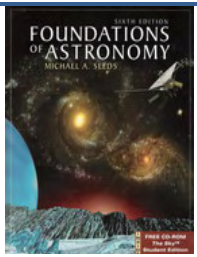
Astronomical spectroscopy : An introduction to the atomic and molecular physics of astronomical spectra

Author: Jonathan Tennyson
Pub 2005
Pages: 192



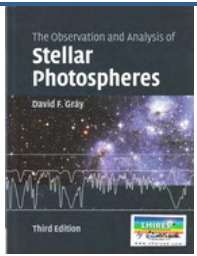
Spectroscopy : The key to the stars: Reading the lines in stellar spectra

Author: Keith Robinson
Pub 2007
Pages: 160
ISBN: 9780387367866



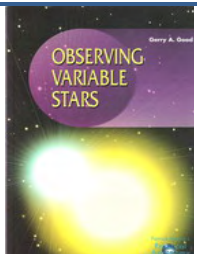
Foundations of astronomy.

Author: Michael A. Seeds
Pub 2000
Pages: 656
ISBN: 0534378552



The observation and analysis of stellar photospheres

Author: David F. Gray
Pub 2005
Pages: 533
ISBN: 0521851866



Observing variable stars

Author: Gerry A. Good
Pub 2003
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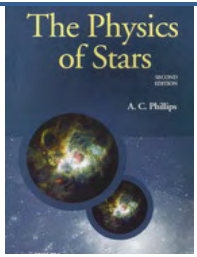
ISBN: 1852334983



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Author: Francesco Palla
Pub 2002
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Pub 1987
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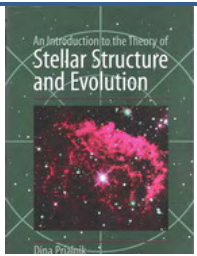

An introduction to the theory of stellar structure and evolution

Author: Dina Prialnik
Pub 2000
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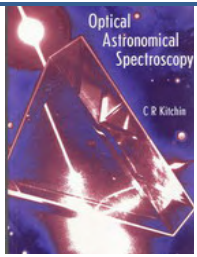
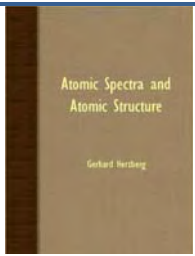


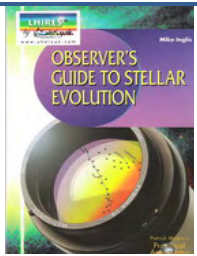
Optical astronomical spectroscopy

Author: Christopher R. Kitchin
Pub 1995
Pages: 272
ISBN: 0750303468



Atomic spectra and atomic structure

Author: Gerhard Herzberg
Pub 2007
Pages: 527
ISBN: 140675322X



Observers Guide to Stellar Evolution

Author: Mike Inglis
Pub 2007
Pages: 236
ISBN: 1852334657

Spectrograph Design Fundamentals

Author: John James
Pub 2007
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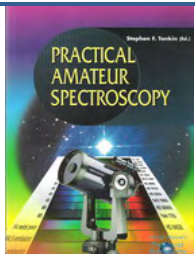
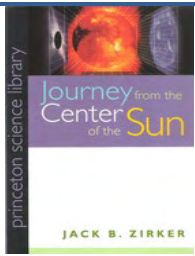
ISBN: 10-0521864631



Practical amateur spectroscopy

Author: Stephen F. Tonkin et al.
Pub 2002
Pages: 210
ISBN: 1852334894



Journey from the center of the sun

Author: Jack B. Zirker
Pub 2002
Pages: 302
ISBN: 0691057818

The behavior of chemical elements in stars

Author:	Carlos Jaschek
Pub	1995
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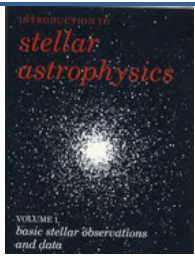
ISBN:	052141136X

The classification of stars

Author:	Carlos Jaschek
Pub	1990
Pages:	413
ISBN:	0521267730



Introduction to Stellar Astrophysics. Vol.3: Stellar structure and evolution

Author:	Erika Boehm-Vitense
Pub	1992
Pages:	285
ISBN:	0521348714

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Micrometer position	Central Wavelength

Camera Model:_____ Grating:_____

Micrometer position	Central Wavelength

Camera Model:_____ Grating:_____

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Baader Planetarium GmbH
Zur Sternwarte
D - 82291 Mammendorf

Tel.: +49 (0) 8145 - 88 02
Fax: +49 (0) 8145 - 88 05

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