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Experiment instructions
Lab course in astrophysics

Setup guide for using the Maksutov-Cassegrain telescope

This manual guides you through the setup of the Maksutov-Cassegrain telescope and forms the fundamentals for the lab course experiments.

Preparations

The observatory is situated on the mountain Schauinsland at a height of 1240m above sealevel. Even during summer seasons the nights can be could and warm clothing is recommended. In spring and fall seasons gloves, a scarf and a cap is usually needed. Reliable weather forecast can be found on http://wetterstationen.meteomedia.de/station=108080&wahl=vorhersage.

During solar observations sunglasses can be helpful, but be aware and never look into the sun with or without using a telescope!

The telescope

The setup consists of a 35cm reflector telescope, a CCD camera and associated control and recording software. In the following chapters we focus on the fundamentals and the using of these components.

Optical setup telescope

The telescope on Schauinsland used for night-time observations is a Maksutov-Cassegrain telescope build by Intes-Micro. A Maksutov-Cassegrain telescope is known for its secondary mirror which is a metallised meniscus lense situated near the focus of the primary mirror. This meniscus lense corrects for the spherical aberrations of the primary mirror, mainly coma. While correcting

Aperture D	35cm
Focal length f	5300mm
Focal ratio f/D	15
Field of view	30"

Table 1: Technical specifications telescope

for aberrations the secondary mirror reflects the light coming from the primary mirror through a hole of the primary mirror. This light is then focused near the back of the telescope, where normally an eyepiece or the CCD camera is installed. There is no need of a spider holding the secondary mirror in this particular setup. Inside the aperture one can see the black coating of this mirror from behind.

Equipment and usage

Maksutov telescopes are catadioptric telescopes known for their superior imaging quality, contrast and flat image. (Leu, 2008) One reason is the missing spider which normally holds the secondary mirror in other setups. This spider generates unwanted diffraction spikes and straylight. Another advantage is the stationary mounting of the secondary mirror, there is no need for further alignment except for the primary. Focusing is done by shifting the primary along the optical axis, a rotatable knob is right next to the focuser.

Technical specifications of the telescope are listed in table 1.

Implementation

First steps

This has to be followed consecutively:

- The key to the observatory (refractor tower) can be found on the key rack inside the office. There is also a WLAN router which should be turned on if needed.

- Inside the refractor tower and next to the entrance the WLAN signal enhancer should be plugged in.

- On the first floor, which is accesible by climbing over the handrail, there is the main power supply for the telscope. This has to be turned on by rotating the red knob.

- The dome of the observatory can be openend by pulling the lever, next to the hand wheel, down and rotating latter.

- If one is sure that nothing can fall onto the telescope (e.g. water, ice) the cover can be lifted (there is also a ladder if needed)

- The telescope control computer can be turned on and also the hand control connected to it. If the operating system is up and running, Autoslew and TheSky can be started.

- There is a cover fitted into the focuser which can be removed by loosing the screws on the side. An eyepiece or the CCD can be used instead. Keep attention to always tighten the screws so nothing can drop to the floor if the telescope is pointed vertically. Do not touch optical surfaces with bare hands!

Solar observations

To observe the sun one has to put the aperture cover with the small opening, covered by sun filter foil, in front of the opening. Do not try to observe the sun without this feature, you can destroy your eyesight or the telescope!

Observing

Referencing

If used correctly the telescope should be referenced at power on. In this case you can skip calculating a pointing model and observe directly. Keep in mind if the telescope is not parked correctly after finishing or behaves inconsistently during observation, the pointing model has to be redone.

Pointing

To point the telescope in a particular direction on the sky, one can use the **hand box** or the control software **Autoslew**.

Autoslew

Double click to start Autoslew. Synchronise with parking position 1 (house 1, top left; object: zenith) Then click the red crosshair, a popup will show up asking for the direction of the mount. If the counterweight is pointing to east, select east, otherwise west.

Start The Sky by double clicking the icon on the desktop. On the top right you find a green telescope icon, press this button to establish the link between Autoslew and TheSky. Please check if the crosshair of TheSky is pointing correctly on the artificial sky, if not you have to resynchronise Autoslew to the parking position.

Because synchronising to the parking position can lead to inaccurate pointing, one can synchronise to a star at the sky. Please check beforhand that there are no objects blocking the telescope, because it will move autonomously. This is done by selecting a bright star (e.g. Vega, Arcturus) inside TheSky. A popup window will show up giving you information about the selected object. If
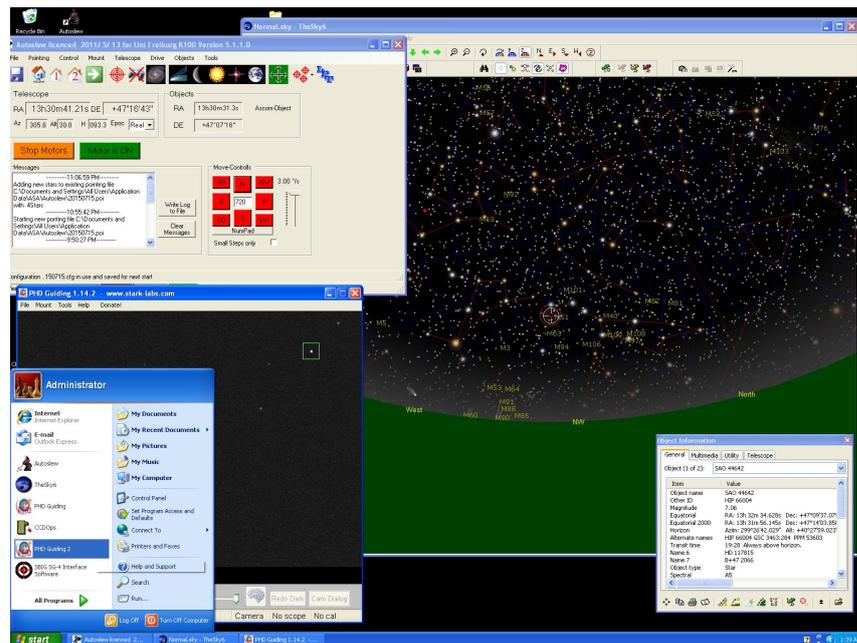
it is your object of choice, click the green telescope on the bottom of the window and the telescope will slew to the position. You might have to rotate the dome so nothing is blocking the aperture. If the star is visible inside the FOV of the eyepiece you can continue synchronising, othwerwise you have to find the star manually by moving the telescope via the handbox. To synchronize the star, you have to check that it is centered in the FOV, for this the eyepiece with builtin crosshair is suited ideally (MicroGuide). The final step is then to select the same object in Autoslew by clicking on the galaxy, finding the object in of the catalogues offered in the popup window and synchronising the telescope with this position.

Handbox

With the help of the handbox one can move the telescope in various velocities in declination or rectascension. The two horizontal buttons move declination while the vertical move rectascension. You can choose the speed by holding the button on the left side of the control and pressing the vertical buttons. On the display the current speed will be displayed.

SBIG CCD camera

The telescope is equipped with a SBIG CCD camera for long exposure imaging, attached to the camera is a filterwheel with broadband RGB filters and several narrowband filters. To use this camera this steps should be followed:
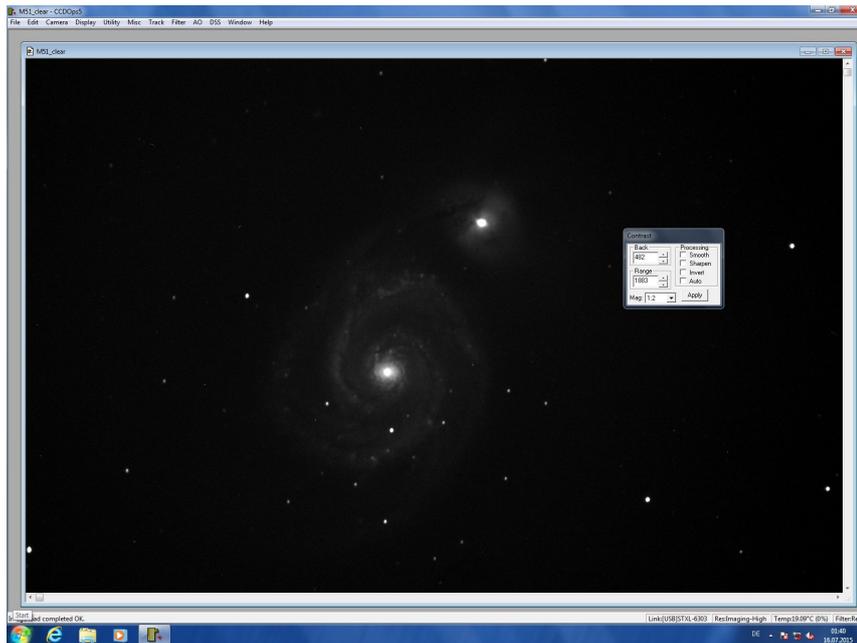
Figure 1: screenshot of the camera control computer. Inside the window a image of the whirlpool galaxy is visible.

- switch on the camera control computer (the computer to the right; user: observer; password: fp1fp2)

- connect the camera via usb to the camera computer and connect the power supply to the pillar of the telescope mount

- start CCDOps via double click

- camera → establish com link

- camera → setup → temperature regulation → active OK

- unscrew the camera cover, face the camera to the ground while doing so

- screw the 2" aluminum adapter to the camera

- insert the camera into the eyepiece holder and fix the screws

- you can focus the camera in a special focusing mode of CCDOps: camera → focus

Guiding and long exposures

Because the FOV is limited to the dome opening, longer exposures are limited to a few minutes. Exposures of 5 minutes for each color channel have been proven to be successful for a range of targets. To achieve better signal to noise ratios one can use multiple exposures and stack them.

Although the tracking of the mount is good the long focal length does not allow exposures of more than a minute without guiding. Therefore a guiding camera can be used to achieve longer exposures.

To setup the guiding these steps should be followed:

guiding camera

- connect the guiding camera via usb to the telescope control computer.

- start PHD guiding

- inside PHD: Connect to Camera → SBIG → USB → OK.

- insert the guiding camera with the 2" to 1.25" adapter into the finder telescope

- inside PHD: Connect to Telescope → Astrooptics Server Telescope → OK.

- inside Autoslew: click on Check for High accuracy tracking → if turned on it will be lighted green

- inside PHD: take darks

- focus the telescope: click the loop inside PHD and rotate the knob at finder telescope

- the focus can be optimized via the tool "star profile"

- select a star and calibrate: PHD Guiding → Calibration.

- wait until the calibration is finished

possible error sources

- the light should be turned off to minimize straylight and to get used to low light level

- during exposures one should not walk inside the dome to minimize vibrations

- the dome should only be moved inbetween exposures

- the door to the tower should be closed to minimize seeing inside the dome

Under some circumstances it can be possible that the telescope is about to crash into someone or something. If this is the case immediately press STOP MOTORS on the telescope cotrol computer screen! To avoid these situations the telescope has certain limits which can not be moved to, always check that these limits are enabled, especially if you are about to create a new pointing model.

End of observation

- cover the opening of the telescope and eventually remove eyepieces or cameras

- move the telescope into park position 1

- backup your data and shut down the computers

- cover telescope and mount with the plastic cover

- close the dome and move the opening to west

- cut off the main power supply

Creating pointing model

To create a pointing one has to follow the instructions carefully or otherwise the pointing can be off by some arc minutes. This is enough to bring the desired object outside of the eyepiece's field of view, while not crucially for observing bright objects. It can be helpful during imaging of dim objects, which are not visible by the human eye. First off, one synchronises the telescope to the park position 1 which is zenith. Near the end of the eyepiece side of the tubus there is a bubble level installed on the side. A second bubble level is installed on the pole which holds the counterweight. These bubble levels can be used to point the telescope to zenith roughly. Check that the tracking is off during trimming the position otherwise the telescope will move away in few minutes. In this position the software Autoslew can be synched to park position 1 by clicking the house 1 button and clicking the synch button. A popup will show up and ask which direction the telescope is pointing. If the counterweight points to west then click west if not otherwise. Afterwards one can turn on the tracking again.

Now the telescope and the software are in a defined situation and one can begin to create a pointing model. Therefore one has to click the button pointing to the top right in Autoslew and choose "Start Pointing File". The button will then change from red crosshairs to red crosshairs with a green checkmark. Autoslew will ask you to point to the first star, this can be done by selecting one in TheSky and slew to it. If one is sure that the selected star is visible and centered inside the MicroGuide eyepiece, one can click on synchronize. Autoslew records the difference in positions between the selected object and the current position of the telescope. This can be done for several other stars to achieve good pointing, from experiences 4-5 should be enough. After several stars are synchronized one has to stop the pointing file by pressing the button and selecting

"Stop Pointing File". To calculate the pointing model one has to click the button again and select "Calculate Configuration". A dialog window will open and one can configure the calculation, the standard configurations should be suitable and one can start the calculation by clicking start. Autoslew will then calculate a pointing model and ask if you want to use it immediately. After you confirm the telescope should be setup with the new pointing model.

Literaturverzeichniss

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