

CAMBRIDGE UNIVERSITY ASTRONOMICAL SOCIETY

Observing Guide

Members of CUAS have the opportunity to use both the Northumberland and the Thorrowgood telescopes whenever they like, as well as all the other observing equipment stored in the alcove in the Northumberland dome. To do this, you will need an ObsCard, and to get an ObsCard, you need to have attended two ObsDemos for the Northumberland and passed a test (ObsTest). For access to the Thorrowgood, you must additionally do a Thorrowgood-specific Demo and Test.

Firstly, this guide will go through how to get hold of the keys, and general housekeeping points about observing once you have an ObsCard. The second part of the guide will go through all you will need to know about the telescopes in order to pass your ObsTest.



The Northumberland dome, containing the historic Northumberland Telescope.

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The smaller dome opposite the Northumberland contains the Thorrowgood Telescope.

1 Observing On Your Own

The Northumberland telescope is over 180 years old, and the Thorrowgood is only 30 years younger; both are historical relics in their own right, and still provide fantastic views of the night sky. For many years, CUAS members have had full use of the telescopes.

1.1 Before Going to the Telescopes

You cannot open the roof of the telescopes if it is raining, not to mention that it would be too cloudy to see anything anyway. This means you need to check the weather first, by looking out of the window before you leave, and/or using one of the other options:

- **Checking in advance**

For the general forecast, check any decently reliable local weather forecast, like at the **Met Office website**. For more detailed information on clouds, rain and wind (the clouds being the most relevant ones for observing, of course), you can check **Clear Outside**, or one of the models available at **WXCHARTS**. It is usually possible to do some observing if there is only high cloud.

- **Current weather situation**

The Institute of Astronomy (IoA) has an online all-sky camera at <http://tel05.ast.cam.ac.uk>. <https://www.netweather.tv/live-weather/radar> is useful to see where it is currently raining in the UK. The satellite image at <https://www.sat24.com/en-gb/country/gb> shows the cloud cover above the UK, although low cloud is not visible on infrared images.

You may need a torch once you are there, but remember to use a red light to save your night vision (e.g. the rear bike light may be useful for that). Note that the telescopes are used by the IoA for **Public Observing** on Wednesday evenings from October to March in conjunction with the Cambridge Astronomical Association (CAA), and so the telescopes are unavailable for individual use then - however, you should feel free to join those events if you have time; usually a large array of IoA and CAA-owned telescopes is used, and the events can give you more insight into the sky-watching community.

While CUAS does not run a booking system themselves - so you never need to book anything - you can check IoA advance telescope bookings at: <https://www.public.ast.cam.ac.uk/ioa-telescopebookings>. Additionally, the Cambridge Astronomical Association (CAA) occasionally runs its own events and courses at the IoA, which may include the use of Northumberland and Thorrowgood telescopes: <https://www.cambridgeastronomicalassociation.com/>

1.2 Getting Hold of the Key & the Alarm Code

To get hold of the key, go to **Churchill College** Porters' Lodge. You must hand over your ObsCard and sign for the key there. Make sure you have the key with you at all times, particularly when you leave the domes. The entrance doors to both domes lock upon closing, and you don't want to be stranded outside at night.

(If you do get stranded outside, you have three options: A. If you're at the telescopes during working hours (9-5) for some reason when this happens, go to the reception of the IoA (Hoyle Building) and ask for help. B. If you have a phone on you, or you somehow managed to leave the door to Northumberland open, you can contact University Security at 01223 331818. C. If you do not have a phone on you and can't easily get hold of one, go to Churchill College Porters' Lodge and ask the porters to call University Security for you.)

It goes without saying that you should never hand the key over to anyone that doesn't have their ObsCard, but if you wish to hand over the key to another observer, this second observer will need to have signed, as otherwise the first observer will be held accountable if the key is missing. If need be, the second observer can sign at Churchill and then instead hand their ObsCard to the first observer, who can then swap their ObsCard when they get back to Churchill. The second observer can then pick up their ObsCard at the end when they hand back the key. If such an event occurs, it should be documented in the book in the Northumberland annexe and countersigned by both parties.

Bringing along a few friends is fine, but if you would like to bring a large group, i.e. more than 5 people, please ask the Observation Secretaries (ObsSecs) first: the email address is at the end of the guide. **Alcohol and observing do not mix, so don't try it.** Remember that you are dealing with very precious, historical instruments!

If you wish to use the Northumberland dome, make sure you know the code to disable the alarm in it. The alarm was installed mainly due to the refurbishment of the dome in 2013 (it is now made of copper) and starts sounding immediately when you unlock and open the door. Upon request by the Institute of Astronomy, the code will only be given to you when you complete the ObsTest. If you forget the code, email the ObsSecs.

If you do accidentally open the Northumberland dome without knowing the code, **don't panic!** Enter the dome, turn on the lights and use the telephone installed there to call **University Security** at **31818**. Explain the situation to them, and they should be able to advise you further. As the alarm is rather loud, it may be difficult to have a conversation from within the dome, so alternatively you can call them from your mobile phone; the external number is **01223 331818**, you may wish to save this number. If you allow the alarm to go for more than 20 seconds, security will automatically be called – if you subsequently disable the alarm yourself, call security yourself and explain to them what has happened.

1.3 Keeping Record

Before observing, head straight to the Northumberland dome. To the right of the alcove with the computer in it, there is a desk with two books that need to be filled in.

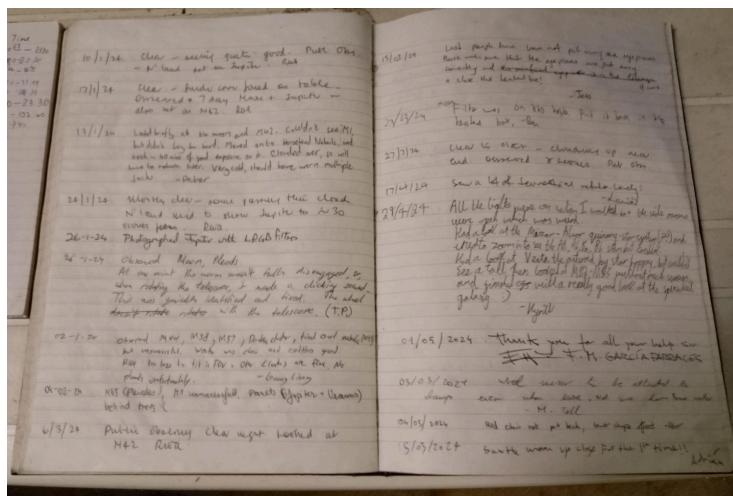
• Attendance Book

Sometimes called the "LogBook". This must be filled in every time you use the telescopes. Fill it in with your name (full name, not initials), the number of observers (yourself + any guests), the activity you're doing (you will be observing, so write obs), the telescope you're using (e.g. N for Northumberland, T for Thorrowgood), and the time you arrive and leave. **Note that all ObsCard holders should individually sign in and out with the time they arrive and leave.**

• ObsBook

Put in here notes about any observing you did, and also any problems you noticed with the telescopes, like the RA screen in Northumberland not working, or the RA cylinder of Thorrowgood not being calibrated properly. If you notice that the telescope had not been properly put away by the person before you, or if you notice any defect or even if you happen to break something, do report it. Be honest, everybody makes mistakes and it is very important that everything is documented so that the people at the IoA who look after the telescopes have it easier to fix it. If you find a problem with the telescopes you should also email the ObsSecs, as they will know whether it is a serious issue and can pass it on to the right people if necessary.

If you are using the Thorrowgood, you must instead sign in to the Attendance Book on the table there. You must still sign into the Northumberland book if you enter that dome for other equipment.



1.4 General Observational Equipment

1.4.1 Binoculars

If you use the large Vixen binoculars, record all observations in the ObsBook – they are on loan from Jonathan Shanklin (the CUAS Senior Treasurer). They should be used with the large wooden tripod and binocular mount found in the Northumberland dome alcove. Only use them if you are confident you are able to handle them properly; you should contact the ObsSecs if you are unsure. Note the Vixen binoculars are misaligned so it may be more comfortable shutting one eye and using them as a monocular. Feel free to use the other binoculars at your leisure.



The Vixen binoculars, in their case (above), and set up on their mount (right)



1.4.2 The David Payne Telescope

A 12.5 inch handmade Dobsonian telescope which has been donated to CUAS. It is stored in the side room of the Northumberland dome, alongside a lot of IoA equipment that we cannot use. It is quite simple to use, but please bear these points in mind:

1. Firstly, remove the telescope tube from the base, then take the base outside and then the telescope. This is most easily done with more than one person. Set it up on the grass, not on the cycle path – you don't want to be run over by a cyclist while you're observing
2. There are some eyepieces for it in a plastic box in the alcove (the one labelled "David Payne"). The eyepiece holder doesn't hold the eyepiece in very securely, so make sure the telescope is the right way up such that the eyepiece points upwards so it can't fall out. It is best to only put the eyepiece in once you have the telescope set up.
3. Moisture may form on the mirror when you bring the telescope if it is much warmer inside the dome than outside. You will need to wait for this to evaporate before replacing the caps on the ends of the tube. You may need to come back in the morning to replace the caps if there is a lot of moisture.

It is an altitude-azimuth mounting so bear this in mind when trying to find objects using star charts. This particular Dobsonian is not especially well balanced, so sometimes a hand gently rested on top of the tube is needed to keep the telescope in place. There is a plate at the back held on by friction, without which the telescope will not balance at all, if this falls off then put it back on again. If the image quality seems poor, please contact the ObsSecs. They will then investigate the state of collimation and correct it if necessary, or look into cleaning of the main mirror. The telescope has a finderscope which is not very well aligned. Dobsonian telescopes (a type of Newtonian, or reflecting, telescope) are ideal for observing deep sky objects.



The David Payne telescope all set up, alongside its own eyepiece box.

1.4.3 Meade LX200 and Celestron CPC800

These are 8-inch modern computerised Schmidt-Cassegrain telescopes. The Meade is on loan from Jonathan Shanklin, and the Celestron was donated by Prof. David Cope. They are stored disassembled in the Northumberland dome alcove and are used as additional telescopes for ObsNights, **but they are not available to general members of the society.**

1.4.4 Personal Solar Telescope (PST)

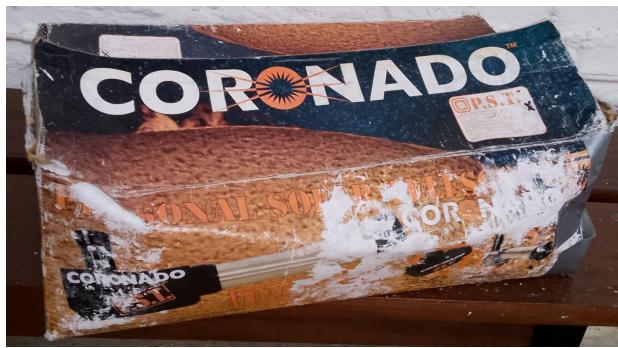
CUAS has use of a Coronado Personal Solar Telescope (PST), which is stored in the Northumberland alcove. It is simple to use but follow these guidelines:

1. It is mounted on a tripod which is stored in the Northumberland alcove – it uses a standard photographic tripod mount head. **You will need a flathead screwdriver or a coin to attach the telescope to the tripod** – a 2p coin works quite well.
2. The easiest way to find the sun is to point the PST such that the shadow is minimal size – this will get you close, you can then fine tune your aim by using the sol finder window; adjust the telescope until the sun is in the centre of this window.
3. The PST is a H-alpha telescope, so it has a very narrow bandpass internal filter. The exact wavelength passed can be adjusted by the tuning ring at the junction of the cylindrical and square parts of the tube – this may need to be adjusted to achieve maximum contrast.

It goes without saying that you should not look directly at the sun with your eyes, or binoculars, or any other observing equipment unless it is specifically designed for the purpose! This could severely damage your eyes.

The PST will show various details on the Sun, such as prominences, filaments, sunspots and granulation. Many of the features you see are not visible with a normal white light solar filter.

Note that the PST is **very expensive and very difficult to repair**. If you're not sure on any aspect of PST use, email the ObsSecs.



(Above) The box containing the PST. (Right) The PST and associated mount, set up and ready to use.



1.5 Astrophotography

Both Northumberland and Thorrowgood can be used for astrophotography. We are in possession of a camera adapter suitable for compact cameras and quite possibly smartphones. This may be used with each of the telescopes for astrophotography via the afocal method – i.e. photographing the image produced by an eyepiece. This is best performed on bright targets, especially the Moon. The adapter, found in the Northumberland alcove, simply clamps on the telescope extension tube. A 1/4" 20TPI standard tripod screw enables the attachment of a camera. Adjustment knobs allow centring of the camera lens along the image axis of the eyepiece.

In 2017 we obtained a 2"-to-T adapter to enable more advanced astrophotography using digital SLR cameras, for which you will require appropriate adapters: a T-mount ring for your brand of camera. We have a T-mount ring for Canon cameras, but you will need to buy your own if you have a different brand. This will allow "prime focus" astrophotography on Northumberland. Please be careful with the mounting, as heavy items may fall out of the focuser if not secured properly. The weight of the camera could also cause the focus to slip, so the focus lock may be useful. The focuser for Thorrowgood is of a non-standard size, thus the only adapter we have is the push-fit eyepiece holder. It is not recommended to connect heavier cameras to this 1.25" adapter.

We would very much like to see the results of such sessions, and – if permitted by you – share them with the rest of the society.



The 2"-to-T adapter and Canon T-mount ring for use with DLSRs

2 Using the Telescopes

This will guide you through how to use the telescopes in the domes, and should contain everything you need to operate them safely, although it is no substitute for two ObsDemos. Many initially find observing difficult, but with much practice get better. When observing, please remember:

- Never leave the domes unattended! Close the door of the Northumberland dome when you are going to use the Thorrowgood telescope, and vice versa (again: don't forget to take the key with you!).
- In the case of rain, close all domes immediately.

2.1 The Northumberland Telescope

This is the large telescope in the large dome. It is a 12-inch refractor, and has a 20 ft focal length (6096 mm, f/20). It was built in 1838, from a design by George Airy. The telescope is very famous, and was one of the largest when it was built. Interestingly, James Challis observed Neptune with it before its discovery but didn't report it (For the exceptionally curious, Challis' account of this is available at <https://zenodo.org/records/1431903>. The telescope has been refurbished, and its copper dome is relatively new (2013). It is on an English equatorial mount. This means it is easy to use, but has the disadvantage that objects close to the north celestial pole cannot be observed.

Upon arrival, turn on the red lights with the switches to the right of the door (or use a red torch if you prefer). There is also a white light switch to the left of the door, operated by a small metal "key" that flicks up and down. If possible the white light should not be used at night, even if you have finished observing, as if someone else arrived it would ruin their dark adaptation. Even the red lights will prevent you from becoming completely adapted to the dark, so it is best to turn them off when you do not need them. Once the lights are on, **fill in the Attendance Book**. Check everything is left properly. If not, note this in the ObsBook. In particular **make sure the telescope is unclamped at the base before moving it**.

Always move the telescope slowly. Only move in right ascension (RA) by turning the main column, rather than pulling the telescope tube. **Only move it in RA if the clamps are unclamped and, more importantly, the worm from the motor is disengaged.** Move in declination (DEC) by grabbing the main telescope tube or the brass knobs on either side of the focuser; use the rope if necessary, but be careful about the momentum of the tube. **Do not move the telescope by holding the eyepiece, focuser or finderscope**, as this could cause damage in the long term.

- **Never ever point the telescope below the horizontal** (roughly below the metal railing on the dome wall). The lens is not secured and will misalign or even fall out if you do this!
- **Make sure that the telescope does not crash into anything while you are moving it**, as this could cause significant damage. For example, there is a risk of the eyepiece hitting the observing chair apparatus in certain positions.
- **Do not move the telescope tube through to the other side of the frame**, unless someone else has done this and it needs to be corrected (see later).

2.1.1 Opening the Dome

1. Point the telescope away from the slit, so that debris cannot fall towards the lens.
2. Unlock the dome by pulling the rope on the left of the slit with the metal latch locking it. Sometimes this can take some force, but make sure you are pulling it in the right direction; the side of the rope with the weight attached is the one to pull to unlock the latch.
3. Open the slit of the dome using the pulley to the right of the slit. Make sure the latch does not fall back, preventing you from opening it. Don't open the slit beyond the point when it is not at all visible from the inside, but open it far enough that the edge of the slit has moved beyond the edge of the dome at the bottom. This is because if it has recently rained then water may drip into the dome from partway down the slit. Open the slit slowly. If it is opened too vigorously it may jump off its track and you will be unable to open or close it.

To rotate the dome roof, use the pulley to the left of the rope with the latch. Rotate the dome roof slowly. You cannot move it through the north part where there are struts, so beware the momentum of the dome, or it will jam.



*The three ropes for controlling the dome. From left to right:
Large rope and pulley for rotating the dome.
Small rope and latch for unlocking/locking the slit.
Medium rope and pulley for opening the slit.*

2.1.2 Removing the Lens Cap

There is a plastic bag covering the end of the telescope, which also has a lens cap underneath; both must be removed. In order to do so, you will need to bring the end of the telescope quite low; be very careful not to point the telescope below the horizontal.



Photo demonstrating how to remove/replace the lens cap on the Northumberland.

2.1.3 Finding Your Object

Many people will use star charts to find objects, but using the computer is quite simple and quick to find any object in the sky. In most cases, the program ("tcs") will already be running (it may be hidden at the bottom of the screen). If not, to start it up, double-click on "Telescope Information Panel" on the desktop. There may already be a terminal window open; again, it may be hidden at the bottom. If there is no terminal window, bring one up using the shortcut button on the taskbar at the top.

"**Telescope**" gives the telescope's current Right Ascension, measured in hours, minutes and seconds, which can also be read from the display above the computer. It also gives a declination value, in degrees, minutes and seconds, but this is made up by the computer.

"**Target**" gives the right ascension and declination of the target. "Obs Place" is virtually identical to this.

There is no electronic sensor on the declination axis; instead, the telescope's declination can be read from the scale which matches up with the central rib of the telescope. The scale will normally be easily visible, but occasionally it will be on the wrong side (facing towards the roof) because someone has passed the telescope through the frame. In this case, you will need to move the telescope back through the frame and out to the other side, and then rotate the frame by 180 degrees. Be careful not to point the telescope below horizontal while doing this.



The computer interface, with relevant sections highlighted.

1: The current object selected.

2: The current Right Ascension of the telescope in hours, minutes and seconds. This is the same number shown on the 'clock' above the computer alcove.

3: The Right Ascension of the target, in hours, minutes and seconds. **2.** and **3.** should be within a few (~10) seconds to be able to see the object.

4: The Declination of the target, in degrees, minutes and seconds.

5: Example (previous) commands finding Messier 97 (a nebula) and Merak (a star).

6: Example of the planet command, to find Venus.

7: Enter commands here.

To find a target using the computer, use the following commands in the terminal:

- **Deep sky objects and stars**

Type `gocat x` where `x` is the name of the object, followed by RETURN. If the name contains a space, it must be enclosed in quotation marks.

- **Planets (and the Moon)**

Type `planet x` where `x` is the name of the planet, followed by RETURN. Then type `next` and hit RETURN. **Do not forget to type next**, as otherwise the computer will not correct for the telescope's polar alignment (see below).

- **Comets and asteroids**

First find the RA and DEC of your object, using the Minor Planet Center's **ephemeris service** (or you can use an app, but some do not always give good positions). Make sure that you are using "J2000" coordinates (the MPC service uses these). Enter the coordinates by typing

`object x hh mm ss <sign>dd mm ss J2000`, followed by RETURN. Here `x` is the name of the object (any string of text without spaces will do), `hh` and so on are the coordinates (RA then DEC), and `<sign>` is the sign of the DEC (+ or - as appropriate). Finally, type `next` followed by RETURN.

The axis of the telescope is not perfectly aligned with the Earth's axis, and the computer corrects for this. It is therefore essential to type `next` after using `planet`, and to use `object` for comets and asteroids (and anything else that `gocat` and `planet` won't find): just aiming at the correct coordinates is not enough.

Once you have selected your target, move the telescope to around 30 seconds below the right ascension given in "Target". This gives time for the object to move into the correct position while you are turning on the motor.

Please **do not** turn off the computer: it is the one running the right ascension display, and you do not have the password to turn it back on. If the computer is turned off, or the RA display is otherwise faulty, note that in the ObsBook and email the ObsSecs.

(Sometimes an incorrect RA reading can be fixed by moving the telescope by an hour or so; this 're-jigs' it when it reads wrongly after the automated Sunday morning reboots.)

Alternatively, there are several useful apps available for smartphones, and programs for laptops (e.g. **Stellarium** is a free, open-source one). There is a large star chart next to the computer, and several star atlases which you can use if you know how to. There is a finderscope, which may be of assistance if you are using charts; however, it is bolted on to the tube and is slightly out of alignment.

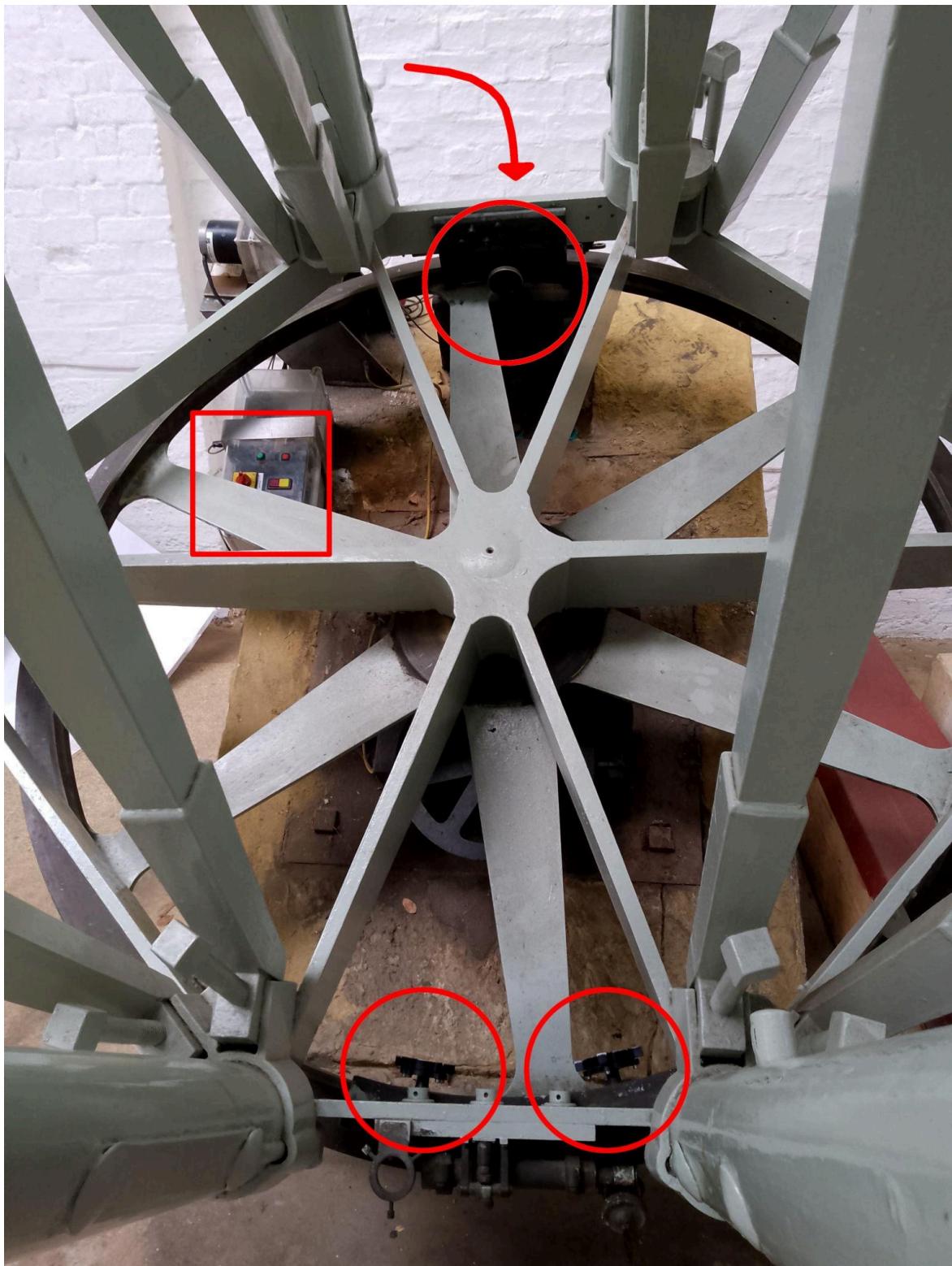
2.1.4 Using the Motor Drive

When the motor is engaged, the telescope will move with the sky, keeping your object in view. This new drive system was installed in October 2009, and to ensure it lasts many years, we need to take care to ensure the various parts do not get worn down.

1. With the worm disengaged, and the 3 hand-wheel clamps unclamped, verify that the wheel is free to rotate independently of the polar axis of the telescope.
2. Engage the worm with the wheel, and allow it to mesh fully, so that the load is not taken only on the tips of the threads.
3. Switch on the power to the controller box, by turning the rotary switch clockwise.
4. Tighten the hand-wheel clamps at the lower edge of the wheel, as well as the clamp at the top edge. You should notice the right ascension display slow down and stop.
5. Your target will have moved in RA since you located it: use the guiding and setting motions provided on the hand-paddle, with the buttons labelled "+" and "-". Guiding motion lasts only for about the first two seconds; after that the motor accelerates (or slows down) smoothly. Ensure that the buttons are held down, so that the motor rate changes smoothly. Watch the RA display to see how far you have moved.
6. There is a large rectangular push button (half red, half yellow) near the rotary switch. These select either a **sidereal rate** (red) or a **lunar rate** (yellow), which is 3 percent slower and should only be used when observing the Moon. The default is the sidereal rate, but it changes instantly and you will see the result in the RA display.
7. When packing away, first disengage the wheel from the telescope via the clamps. Then disengage the worm. Finally, turn off the motor. **Note that this is not the reverse of the procedure to turn the motor on.**

It is very important that you get this procedure right, and so if you have any questions contact the ObsSecs. Overall, remember:

- **Do not move the telescope manually in right ascension while the worm is engaged and the clamps are fixed!** You are free to move it in DEC – in fact, you should be careful not to accidentally nudge the telescope while observing, as it can get off the target quite quickly, especially at high magnifications.
- If you wish to observe a new object, follow point 7 above, move the telescope in RA as required, and then continue with steps 1 through 6 as before.



The locations of all the parts necessary for the motor drive.

The arrow points towards the worm gear and associated lever, behind the frame.

The square shows the motor control box. The large red knob must be turned a quarter turn clockwise to turn on.

Circled are the three clamps. These will rotate around with the telescope, so may not be where you expect!



The worm gear and lever, showing it both disengaged (left) and engaged (right). Make sure it is always left disengaged, except when the motor drive is engaged



The hand-paddle, for fine RA adjustments. Make sure to leave it here, with the wire off the floor, when you leave.

2.1.5 Eyepieces and Filters

Eyepieces are very delicate, just as the telescopes are. Never touch the glass surfaces. The lower the focal length of an eyepiece, the higher the magnification: the magnification can be calculated by dividing the focal length of the telescope (6096 mm for the Northumberland) by that of the eyepiece. With the long focal lengths of Northumberland and Thorrowgood, longer focal length (i.e. low power) eyepieces are best suited for most objects. There are two main boxes of eyepieces:

- **Ordinary Eyepieces**

For ordinary use, take the ones which are in the box labelled "Northumberland Dome" on the main shelves of the alcove. They are a mix of Orthoscopic and Kellner eyepieces and should usually be sufficient for most observations. Note that the box lid is currently broken; make sure it covers the box well whenever you close it (so as to prevent dust settling onto the eyepieces)



*Above) The main eyepiece box.
(Left) Inside the box, showing the five eyepieces:
60mm, 25mm, 18mm, and 2x 12.5mm*

- **Meade Eyepieces**

The other box, on a separate low shelf at the right of the alcove, contains more modern Meade Plössl eyepieces. Do not move that box or turn off its heating. These eyepieces need extra care in handling as they are expensive to replace. In particular, be extra careful not to touch the lenses as they are coated and it could damage the coating. The Meade eyepieces have their own cases; do not remove these from the box.



*The heated box of Meade Plössl eyepieces, containing:
40mm, 36mm, 32mm, 25mm, 15mm, 12.5mm*

There is a mix of eyepieces with narrower (1.25") and wider (2") barrels. To use the 2" eyepieces, it is necessary to remove the 2"-to-1.25" adapter from the tube that it fits in (the "extension tube"). Eyepieces must be screwed in, or they will fall out. There is a screw on the adapter which holds 1.25" eyepieces in place, and another on the extension tube which holds the adapter and 2" eyepieces in place. **Do not confuse these two screws:** you do not want a 1.25" eyepiece falling out when you are trying to remove the adapter. Also, **do not over-tighten the screws** as this may cause them to get stuck. **When removing an eyepiece, hold on to it so that it does not fall out as you loosen the screw!**

The screw which holds the eyepieces on the 1.25 inch adaptor is currently bent. Be careful and do not overtighten it!

When you have inserted the eyepiece, the image will probably need to be brought into focus. A new dual-speed focuser has recently been installed (December 2018), so if you are used to the old focuser please note that the procedure has changed.

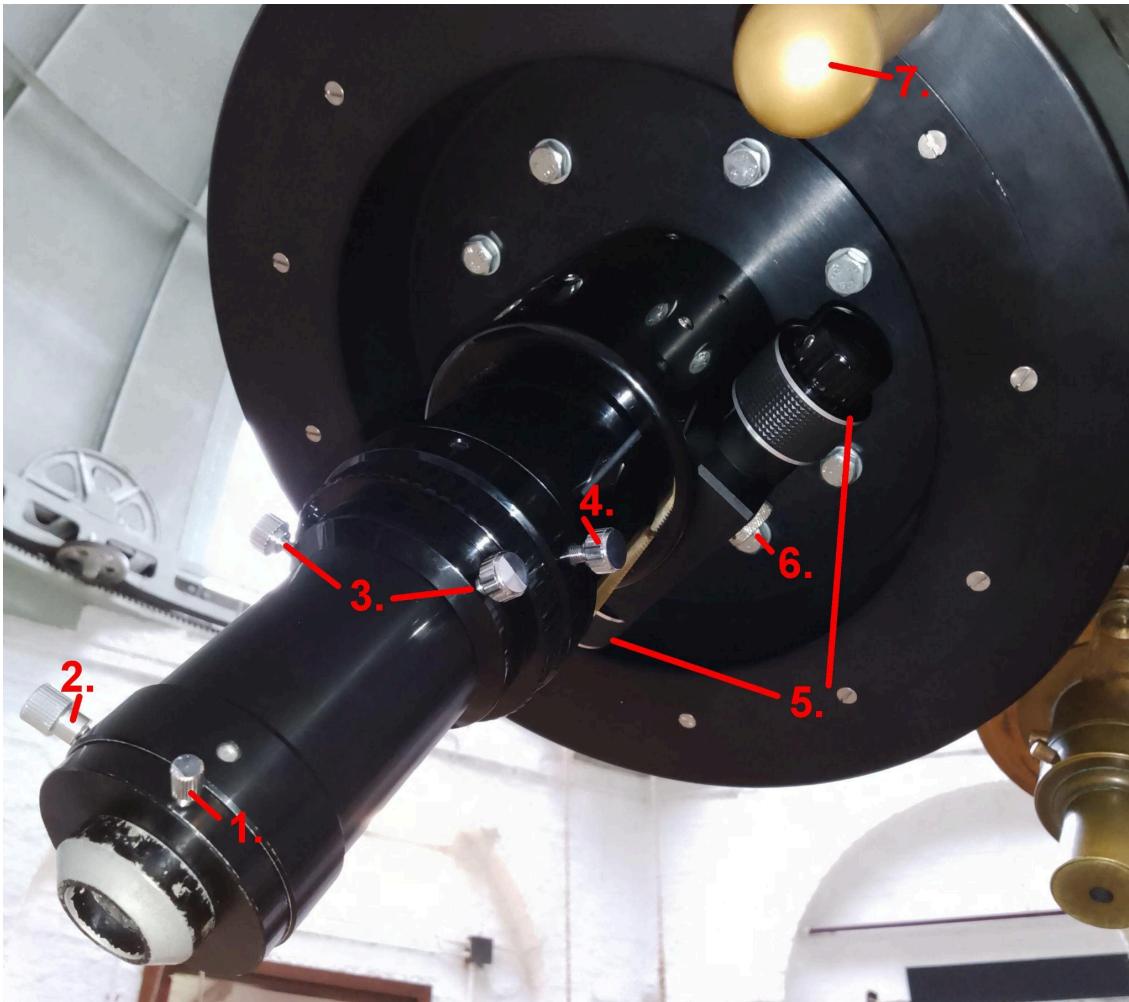
- To adjust the focus, twist the black knobs on the side of the focuser. The knob on the right hand side of the focuser is double: the larger knob is for coarse focusing and the smaller knob for fine adjustments. If perfect focus cannot be obtained even with the focuser racked all the way out, you will need to screw in the eyepiece partway down the barrel rather than pushing it all the way in. If focus cannot be obtained even with the focuser all the way in, then the extension tube must be removed from the focuser, and the eyepiece or adapter should be inserted directly into the focuser. Always remember to replace the extension tube when you pack up.
- The small knob on the back of the focuser at the top can be used to lock the focus. If you are only doing visual observing you should not need this, but it may be useful for astrophotographers. Remember to unlock the focus before you try to adjust it, and make sure it is unlocked when you finish.

Never attempt to clean any lens or eyepiece yourself. If it is dirty, note it in the ObsBook and email the ObsSecs, and someone will do it properly.



CUAS has a 2 inch 13% neutral density filter which can be used to make Lunar observations more comfortable by reducing glare.

Filters should be screwed into the threads at the base of the extension tube. To do this, you will need to remove the extension tube, screw in the filter then replace the extension tube. The filter can therefore be used with both 1.25 inch and 2 inch eyepieces. You should handle the filter by the edges, make sure you don't touch the glass since it is coated and you will damage the coating. **Remember to remove it and return it to its case when you're finished using it.**



The dual-speed focuser and eyepiece holder, with various important knobs labelled. It is important not to mix these up, otherwise components can unexpectedly come loose, fall and break.

1: 1.25-inch adapter screw, used for changing 1.25-inch eyepieces. 2: Extension tube screw, used to remove the adapter and attach 2-inch eyepieces. 3: Pair of screws for removing the extension tube. Necessary to insert filters and prime-focus cameras, otherwise they can't get close enough to focus. 4: You shouldn't need to touch this. 5: Focus knobs; used to adjust focus with both coarse and fine control. 6: Focus Lock; generally unnecessary unless you have a heavy camera that causes focus to slip. Make sure to keep this loose (but not over-loose). 7: Brass Handle for moving the telescope in declination (NOT RA!).

2.1.6 Observing Chair and Ladder

For many objects, the eyepiece will be higher than head height and you will need to use the ObsChair or Ladder.

The ObsChair

The ObsChair is a large wooden chair, which rotates on a central pivot. You should rotate the ObsChair around the pivot by pushing it. For objects which are high in the sky, you can lie on the lower chair, and for objects low in the sky you can sit on the upper chair. You can adjust the headrest height of the lower chair by sliding the wooden blocks to the appropriate position. You can adjust the lower chair laterally by pushing or pulling it to the appropriate position. You can raise the upper chair using the winch on the left hand side (as seen from the pivot), and lower it by disengaging the ratchet and slowly letting the chair down. You can alternatively sit or stand on the steps of the ObsChair.

The Ladder

The ladder can be used as an alternative to the ObsChair. Note that it is unwise to stand on the top platform of the ladder since you then have no handholds.

2.1.7 After Observing

When you have finished observing, follow this procedure:

1. Make sure the motor is switched off and all three clamps and the worm are disengaged. **Do not turn the motor off at the plug.**
2. Ensure the computer monitor is left on, as otherwise damp may affect the electronics.
3. Replace the lens cap and the bag (and the finderscope cap if you used it).
4. Make sure the focuser is unlocked, and the extension tube and the worn silver-topped 40 mm eyepiece are in the telescope (to prevent spiders and insects getting into the telescope). Usually that is the eyepiece in place in the telescope when you arrive.
5. Make sure the eyepieces are returned to their boxes, the newer (heated box) eyepieces are put back facing upwards in their plastic cases (if applicable), and the boxes are closed.
6. Rotate the dome so that the slit is over the door. This makes sure that it is away from any electrical equipment in case it rains.
7. Point the telescope away from the slit before closing the dome.
8. Close the dome and lock the latch. Be gentle but firm when doing this.
9. Return the telescope to a vertical position, as there is least mechanical strain on the lens in this position.
10. Return the large observing chair to the West, (that is, opposite the door)
11. Return any other observing equipment you were using.
12. **Sign out in the Attendance Book on the desk with the time you leave** (and make an entry in the ObsBook if you want).
13. Turn off the lights.
14. As the last thing to do before you exit the dome, **turn the alarm back on**. You can do that by keying in the code. The alarm will start sounding immediately; you have around 20 seconds to leave the building before the University Security is notified, in which time you should exit the dome and close the door (**don't forget the keys!**). With everyone outside and the door closed, the alarm should change its tone and then stop sounding. It will still be primed to sound when the door is opened again (e.g. when another visitor wants to use the telescope: see **Section 1.2**).
15. Return to Churchill to hand in the key and collect your ObsCard.



The alarm panel. You need only type in the code to lock or unlock - no need to press 'YES' or anything else.



The Northumberland telescope in its vertical resting position, showing the declination meter on the side, along with the ObsChair and storage alcove in the background.

2.2 The Thorrowgood Telescope

This is the smaller of the two telescopes, found in the smaller wooden dome. It is an 8-inch refractor, built in 1864. The focal length is 114 inches (2896 mm, f/14). It was bequeathed to the RAS in 1928, and is now actually on extended loan to the IoA from them. Due to its analogue dials and specifics of the dome, it is somewhat more comfortably used if two experienced people work on it at the same time, though it is very much possible for one person to operate it all, too.

A new dome was built around the telescope to replace the old, broken dome, finishing in 2024, which no longer has the problem of being too small. Now, hitting the end of the telescope into the dome, which has previously caused damage to the dew shield (the cylinder of metal that the lens cap fits on to), is not a problem anymore.

This dome is rotated by pulling the chains connected to pulleys, similar to the Northumberland. The chains grate on your hands quite a bit more than the Northumberland's rope, so gloves and/or multiple people are advised, especially for long moves.

Before using the Thorrowgood, **fill in the Attendance Book** on the desk in the Thorrowgood dome. When you enter the dome, turn on the red lights with the **second switch** to the right of the door. The white light switch is the **first switch** and is very easy to accidentally press; once again, it should not be used at night where possible.



Photos showing how the hooked pole can be used to unlock (left) and move (right) the lid of the slit. The pole is quite heavy and a bit fiddly to fit into the holes, so be careful!

2.2.1 Moving the Telescope

When first arriving at the telescope, you should find that there is a wooden apparatus affixed to the viewing end. This is the solar projection unit, and the telescope is not balanced without it – **it must be clamped in DEC unless it points vertically upwards or you are moving it**. Use the octagonal knob (the shortest handle) to do so. As with the Northumberland, **never point the telescope below the horizontal**.

The telescope should be moved in both axes by the main tube, rather than the eyepiece assembly. Be sure to move the telescope slowly.

The telescope has a German equatorial mount. This means that – unlike the Northumberland – you can observe all parts of the sky, including the northern celestial pole. However, the telescope must be on the eastern side of the pillar in order to observe objects on the western side of the sky, and vice versa, otherwise the tube will collide with the mount (which is not good). To move the tube across the meridian from the eastern to the western side of the pillar, you have to move it via south, i.e. over the pillar. This process is called a **meridian flip**.

To open up the dome and prepare the telescope:

1. Point the telescope away from the slit, so that debris cannot fall towards the lens.
2. Open the slit by first unlocking it with the hooked pole in the dome. This is done by pulling the sprung lock down and twisting anticlockwise, such that it is wedged under the metal plate. The slit is then opened from outside the dome, using the same hooked pole to drag the slit door to the left, along the exterior rails.
3. Remove the lens caps on the main telescope and the finderscope. It is safer to do this whilst the solar projection unit is still inserted, as the balance results in the telescope pointing upwards if the DEC is left unclamped whilst near the horizontal. Note that the finderscope is bolted on to the telescope and is slightly out of alignment, but it is still very useful once you work out where the centre is.
4. Remove the solar projection unit. To do this, first point the telescope vertical and leave it unclamped in DEC (to reduce strain). Next, loosen the screw holding the unit in place, and simply remove the entire drawtube and the wooden section as one, or – if you know what you are doing – remove the wooden unit itself: first pull out the metal pins and then pull the two wooden parts of the unit apart. The eyepiece itself is a wide-angled one, suitable for e.g. observation of comets.
5. Insert the drawtube from the wooden box, tighten the screw, and place one of the eyepieces in the tube, where it stays via friction. Alternatively, you could just use the solar projection eyepiece for its wider angles of view. Focusing is by moving the drawtube and/or eyepiece in and out. Be careful not to pull the eyepiece out so much that it falls out!



The box containing the drawtubes and eyepieces, kept on the desk in the dome.



The three knobs on the telescope body:

1. Slight adjustments in Declination. Used to centre the object.
2. Slight adjustments in Right Ascension. Used to centre the object, although the motor paddle does this as well.
3. Declination lock. This is the important one, used constantly, and required for the telescope to not topple over.



(Above) The light switches beside the door. Don't ruin your night vision by pressing the wrong one!

(Left) Photo demonstrating how to remove/replace the telescope cap, while making sure the telescope stays above the horizontal.

2.2.2 Reading the DEC and RA Dials

The declination (DEC) dial is part of the large wheel on the opposite side of the mount from the telescope tube, so you cannot see it directly when you move the telescope in DEC. On the dial, there are two short, diametrically opposite metal sections with engraved notches for precise determination of current DEC. The arrow at one end of that section (as opposed to the zero at the other end) marks the current declination of the telescope. Both sections show the same DEC reading, so you only need to check one of them.

To aid the reading of the dial in the dark, there are two magnifying glasses with red lights beside them, one on each side of the dial, which can be, if required, moved around the circle independently of the DEC of the telescope and positioned where convenient.

The RA dial, or as it should be called for the reasons explained here, the hour angle dial (hereby abbreviated to H.A.), sits at the bottom of the equatorial column of the telescope. While the RA display in Northumberland automatically tracks the RA of the direction the telescope is pointing towards at any given time, Thorrowgood is rather more analogue in that respect, which means that to properly position it towards an object in the sky you either need a program which gives you the current hour angle of any chosen object (**Stellarium**, for example, is good for that), or else you must delve into a small amount of maths, the inverse of which the computer terminal in Northumberland is doing for you all the time.

For a chosen object, and modulus 24 hours,

$$\text{H.A.}_{\text{object}} = \text{LST} - \text{RA}_{\text{object}}$$

where LST stands for **Local Sidereal Time**, which is what the black GPS-controlled clock shows. This can also be found in the "tcs" window of the computer terminal in Northumberland, or in several dedicated webpages and phone apps. LST is, essentially, set such that at noon (GMT), the hour angle of the Sun is zero, which in turn means that LST gives you the RA of the objects passing through the zero meridian at any given time.

The hour angle is read on the dial directly. Similarly to the DEC dial, there are two short metal segments above the dial, one labelled B, and the other one labelled A diametrically opposite it. The dial itself remains stationary when the telescope is moved in RA, and the two metal segments above it move together with the circular disk they are attached to. There are two arrows, A and B, which are 12h away from each other: these are for use when the telescope is on the western and eastern sides of the mount respectively. When the telescope motor drive is engaged, the A and B markers will slowly progress around the dial (one minute per minute), following the hour angle of the observed object.

The metal segment attached below the dial is only used for calibrating the dial. The dial itself should not be turned, as it will then not be calibrated any more. Like the DEC dial, this one also has an independent movable section with a magnifying glass and a red light, which can be used to aid the reading of the dial in the dark. If the light does not seem to be working, the problem may be in the contact of the batteries in the black box beneath the magnifying glass.

As an alternative to using RA and DEC (which is not as simple as in the Northumberland!), especially for brighter objects, it can be worth 'star hopping' to find objects. This involves heavy use of the finderscope and star charts, but with a bit of experience, you can get quite fast at it.

2.2.3 Using the Motor Drive

This will track your object round the sky for you. The motor drive in the Thorrowgood is quiet, so to check it is running, check that the sidereal/lunar rate light is switched on, or that the small cogs are turning.

1. **Turn the rotary switch on the wall to the "1" position** (see photo). Sometimes it takes a while before the telescope starts tracking properly, so it may be necessary to get your desired object back into the field of view. On the front of the telescope there is a button that is usually lit up in red when the motor is on, indicating **sidereal rate**. If you are observing the Moon, press the button and the motor will switch to **lunar rate**, indicated by a yellow light.
2. **Engage the right ascension clamp** (see photo). This is the T-shaped brass clamp. Use the step-ladder if the clamp is out of reach, which will always be the case if the telescope is on the western side of the pillar.
3. **Use the hand-paddle for fine adjustments in RA.** Do not attempt to pull the telescope manually in RA while the motor is tracking. Due to people attempting that in the past, the RA axis is already loose, so the telescope can be accidentally (by nudging the main tube) moved in RA even when the system is securely clamped; note that in your observations, but **do not purposefully nudge the tube even more**.

The two remaining knobs by the telescope tube are for slow-motion fine adjustments in DEC (the long one) and RA (the shorter one). These tilt the telescope on its mounting and can be used safely whilst the motor is switched on. There is a limited traverse, so if the telescope reaches a hard stop, the slow motion handles must be turned the other way. These do not change the position as read on the setting circles so introduce an offset to the readings. Don't forget to re-centre the slow motion controls between objects or after a session to make objects easier to find.

Unlike with the Northumberland, it is not necessary to turn off the motor when moving between objects; it is only necessary to disengage the RA clamp. The procedure for turning off the motor is the reverse of that for turning it on: first disengage the clamp, then turn off the rotary switch, and finally turn off the switch on the wall.



The wall switch and rotary switch for the motor (left), and the right ascension clamp (right). These are used in step 1 and 2 of turning on the motor, respectively.

2.2.4 Solar Observations

Can be very hazardous, so be careful. Use the solar projection unit in tandem with the eyepiece for solar projection. Do not use another eyepiece, as it may be damaged. It hardly needs to be said, but please:

- **Do not look directly into the Sun, especially not through a telescope. This may immediately cause severe damage to your eyes!**

There are cardboard aperture-reducing plates ("stops") for solar observations. The chart on the wall tells you which you need to use at what times of day and year.

2.2.5 Closing Thorrowgood

1. Make sure the motor is switched off.
2. Return the eyepieces and drawtube to the wooden box and close it.
3. Point the telescope vertical towards the zenith, leaving it unclamped.
4. Replace the solar projection unit. Be careful to place the wooden parts together the right way, if you took them apart. The side saying TOP should point upwards.
5. Replace both lens caps. The main cap is somewhat battered and broken; rotate it round until it fits on nicely.
6. Close the slit, by doing the steps to open it in reverse. First, go outside and use the hooked pole to pull the slit door to the right, until it is closed. Then, back inside, use the same pole to pull down, twist clockwise, and release the latch to lock the slit. Make sure the telescope is pointing away from the slits while you are closing them.
7. Despite what has been said at some ObsDemos in the past, the slits need not be left in the south (although it is courteous to leave it around there, since many observations start near there). At the very least, make sure neither of the chains are hanging down over the door or the desks.
8. Leave the telescope vertical and unclamped in both axes.
9. **Sign out in the logbook within the dome.**
10. Turn off the lights on your way out.



The Thorrowgood Telescope, in its resting position.

So, that is (hopefully) all you need to know about using the telescopes, though it does not replace the practice of actually using them. This guide will be updated if/when required. You can print it out as a reference for when you've done both of your ObsDemos and want to observe on your own, though there should always be a copy of it in Northumberland and Thorrowgood. If you have any queries whatsoever, or just want some ideas about observing, feel free to contact us using the contact details below. If you think that this guide is missing something, i.e. something has changed that we're not aware of, or is unclear anywhere, please send us an e-mail at cuasobserv@gmail.com and we'll make sure to update it. Apart from that – happy observing!

CUAS Observation Secretaries 2025-2026

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