

The Faulkes Telescope Project

Advice Booklet 1

**The Basics: How to plan an
observing session**

Table of Contents

1.0 Planning an Observing Session	3
1.1 The Observation Planners	3
1.2 Minimise the time spent moving the telescope.....	3
1.3 Minimise the time spent entering the required data	4
1.4 Ensure that the images you want are visible	6
1.5 Image types and how to use them	6
1.6 The Training Server	7
2.0 Filters	8
3.0 Making Colour Images	10
4.0 Exposure Times	12
5.0 Exposure Times and JPEG Images.....	13
6.0 Importance of Moon phase	17
7.0 Weather.....	21
8.0 Using the Telescopes	25
9.0 Further Information.....	27

Faulkes Telescope Operations Centre
School of Physics and Astronomy
Cardiff University
5 The Parade
Cardiff
CF24 3YB

02920 875121

www.faulkes-telescope.com

1.0 Planning an Observing Session

Your telescope time is valuable, you have paid for your telescope time and you will no doubt want to get the most from it. To do this you may want to consider the following things:

1. The Observation Planners – what to observe
2. Minimise the time spent moving the telescope between objects you are observing
3. Minimise the time spent entering the required data in to the telescope system
4. Ensure that the images you want to observe are visible during the session you have booked
5. Understand how you are going to use your images once you have obtained them
6. Try using the Training Server before doing a real time session

It is very easy to waste the time that you have with the telescope. In this section we will aim to help you get the most out of the time you have available.

1.1 The Observation Planners

Several Observation Planners are available on the website which allow you to find objects visible during your booked session. The objects you want to observe will depend on what project or activity you are doing. The planners are Excel spreadsheets and come in a number of versions related to objects of different types (e.g. galaxies and planetary nebulae). Visit the following weblink to use this feature:

http://www.faulkes-telescope.com/projects/spreadsheets/planner/current_objects.htm

Once your observation session has been planned, you can run a test with the Real Time Interface (RTI) training server.

1.2 Minimise the time spent moving the telescope

Depending on the images you want to acquire via the telescopes you may be able to significantly reduce the amount of time you spend moving the telescope to different objects. Look at the list of objects below, they are all visible in the sky at the same time (i.e. observable during a session with the telescope) and shown on the illustration below.

- Whirlpool Galaxy
- Jupiter
- Sunflower Galaxy
- Saturn
- M81
- M3



If you were planning to observe the objects in the order above you would find yourself moving the telescope considerable distances across the sky between objects. This wastes telescope time as it takes time for the telescope to slew (move) from one object to the next. A better order of observing would be:

- Whirlpool Galaxy
- Sunflower Galaxy
- M3
- Jupiter
- Saturn
- M81

It is a good idea to think about the order you take your images in so that you do not have to move backwards and forwards across the sky too many times.

1.3 Minimise the time spent entering the required data

The Faulkes Telescopes operate in two modes, real-time (controlling the telescope live using the Real Time Interface) and off-line mode where the telescope completes observations that are in a queue.

The off-line mode is much more efficient as it does not require a human to input data in to a website. Instead the telescope uses its automatic scheduler to put the observations in the best order before they are taken. This means observations can be completed more quickly in off-line mode than real-time mode. It is the need for human input in to the system that slows down the process.

Now that we realise this it is easy to understand why it is important to know what you are doing during an observing session and have all the information the system is going to ask for ready so that you can minimise loss of time inputting data in to the system.

The data you will be asked for is:

- Object name or Right Ascension and Declination (the object's position in the sky), unless you are using a Guided Tour
- The filter type(s)
- Exposure time per filter (in seconds)

It is useful to keep an observing log during your session so that you can see what it is you have observed and the details of each observation plus comments. In fact, it could be very useful to have a partly completed observing log prior to using the telescope. You can then use this log to make notes or comments during observing, and can fill in any missing details. You will then have a completed observing log when you finish your session with the telescope.

A typical observing log may look as follows:

Time	Object	RA	Dec	Filter	Exposure	Comments
10:00	M16	18:18:51	13:50:05	B	60s	Eagle Nebula, Slight Cloud Cover
10:04	M27	19:59:36	22:43:00	V	30s	Dumbbell Nebula

If you were to use the observing log to help you plan your observing session, you could do this by filling in the Object, Right Ascension (RA), Declination (Dec), Filter and Exposure columns before your session with the telescope. This would then mean all you had to do was fill in the Time and Comments column during the session. Doing things this way means you can plan which objects to look at and in what order and also have all the relevant details to hand when entering information in to the telescope interface.

You could do your observing log on paper or as an Excel document.

1.4 Ensure that the images you want are visible

It would be very easy to pick a list of objects that you want to observe during a live session and then find out that they are not observable at your chosen time of day or year.

There are a number of ways you can check that your observations are possible. Some of the methods you can use are:

- The Real Time Interface Training Server
- The Observation Planners
- Computer software (e.g. Starry Night)

1.5 Image types and how to use them

Two types of files are made for each observation which are used and viewed in different ways.

1. **A JPEG image.** This is an image that is easily viewed in any image viewer and is returned to you during your observing session
2. **A FITS file.** This is a much larger file that is available for download the day after your observation. This is the format that the telescope system first creates. The JPEG image is then created from the FITS file. Access the FITS file by finding the JPEG image in the Image Archive (<https://www.faulkes-telescope.com/control/Index.isa>). The FITS files can be used to do your own image processing and for scientific research

You need to consider very carefully exactly how you will use the images you are planning to obtain. If you are working from one of our activities or projects you will be given a lot of help and advice on what you can do with the JPEG images and FITS files.

The sorts of things you need to consider are how you are going to use these images with students. How are you going to distribute the JPEG images to students during an observing session? You may want to carry out your observing in an ICT room where students have access to computers. You could then download the images from the Real Time Interface and save them in to an area on your computer network where students can access them.

1.6 The Training Server

It is well worthwhile trying out the Real Time Interface (RTI) on the training server before you do a live observing session. You can find the training server and instructions at the link below

<https://www.faulkes-telescope.com:8443/control/Index.isa>

The training server is able to approximate the experience you will have with the real system during a live observing session. It does not however return you with a real-time image. You are returned an archived image which will not relate to the exposure time you have entered.

The training simulator is a completely separate system to the telescope, so no matter whether you have a real session booked you will need to rebook the session on the simulator (in exactly the same way that you did on the real telescope). If you want to simulate the session that you have booked, your simulated session will need to be booked for the same time. Once you have booked your session, you can change the simulator clock to the time of your booking.

You can access the simulator as often as you like once you have an active registration, no matter how much time your account has left. You can also log into the simulator from more than one computer at a time, using the same username and password.

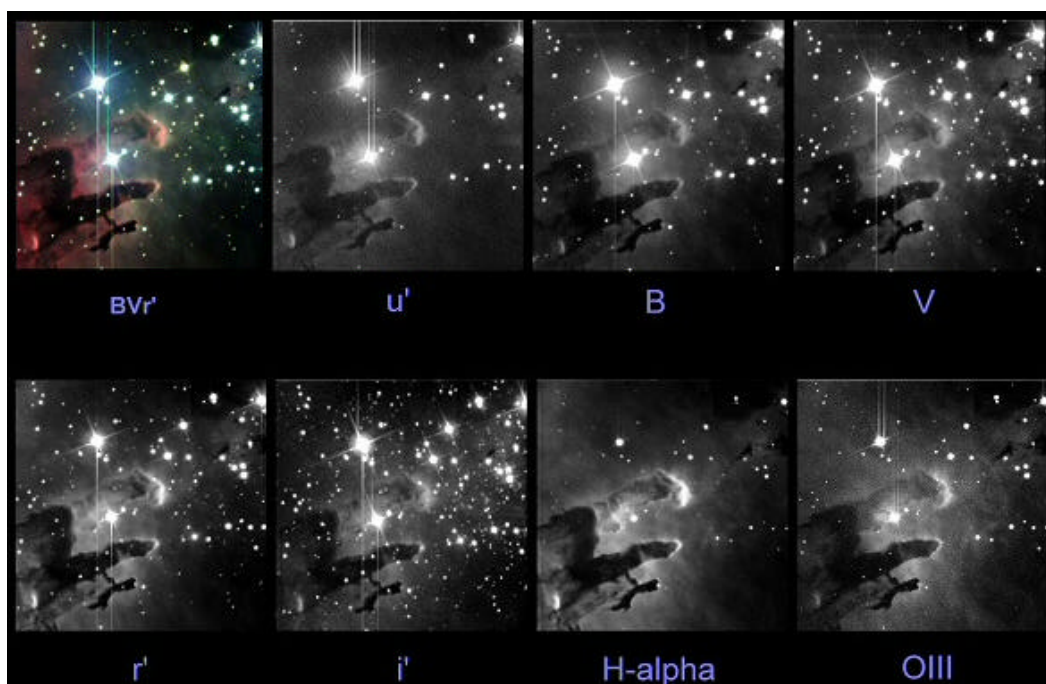
2.0 Filters

Filters are used on telescopes in order to select light of particular range of wavelengths, rather than collecting light of all the wavelengths that make up the optical part of the electromagnetic spectrum. For information on how colour images are please see the section on 'Making Colour Images'.

The filters available to you are listed below along with the peak wavelength (in nanometres) that is let though by the filter. The filter lets through a small range either side of this wavelength.

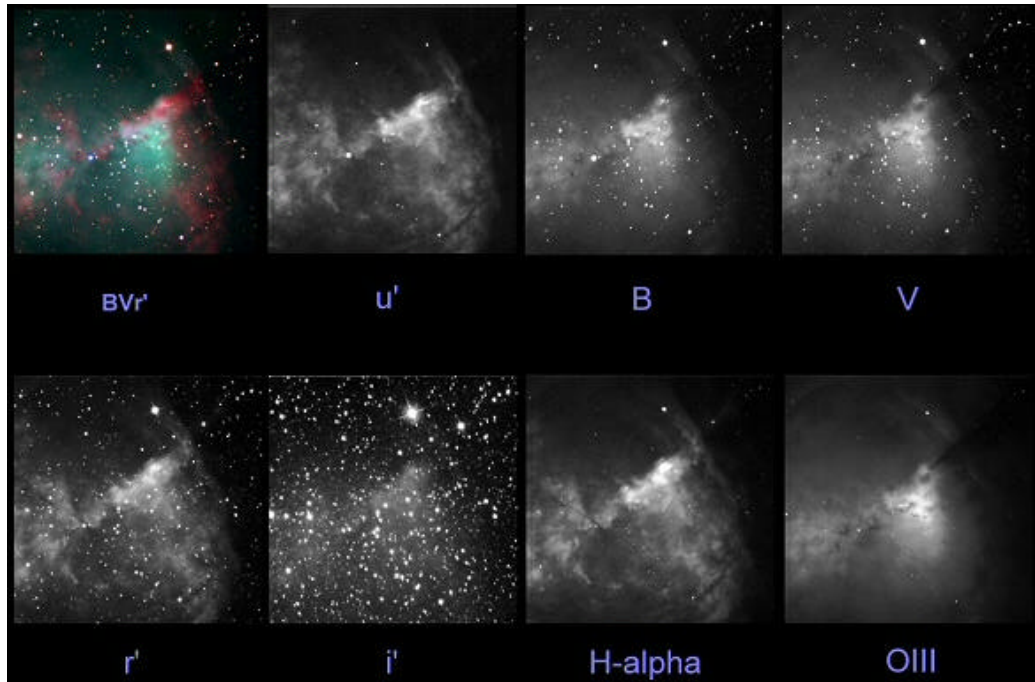
Portion of spectrum	Filter	Peak Wavelength
Ultraviolet	u'	365 nm
Blue	B	440 nm
Green	V	550 nm
Red	r'	640 nm
Infrared	i'	790 nm
Hydrogen Alpha	H-alpha	656 nm
Oxygen III	OIII	500 nm
Neutral density filter, light reduction	All	

The image below shows a comparison of what the same object looks like in colour and then in seven of the individual filters. The image is M16 - The Eagle Nebula.



It is quite easy to see that different things are visible when you use different filters. Most obvious are the larger number of stars visible in the infrared image and the gases that are more visible in the H-alpha and O III images. The top left image shows the result when combining the B, V and r' images to make a standard colour image.

Another similar example is M27 - The Dumbbell Nebula, below.

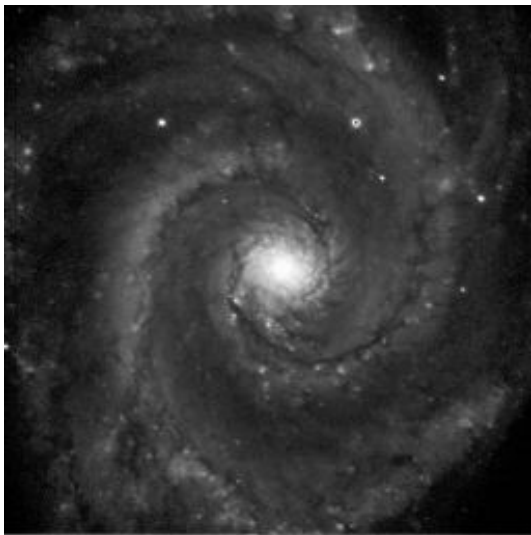


The H-alpha and O III filters are regarded as narrow band filters and show light being emitted by particular gases, such as hydrogen or ionised oxygen. You can find out more about when to use these filters in the various projects and activities on the Faulkes Telescope website.

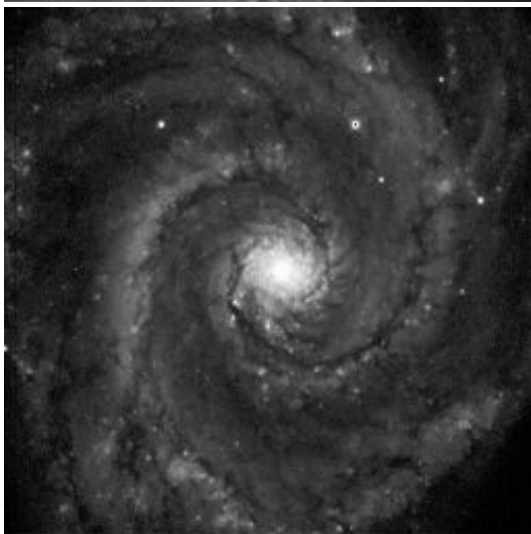
3.0 Making Colour Images

As you may or may not know, the Faulkes Telescopes do not take a colour image in the same way a digital camera does. Instead it must take three separate red, green, and blue images through different filters and combine them together to make a colour image. The names of the filters used are r' (red), V (green) and B (blue).

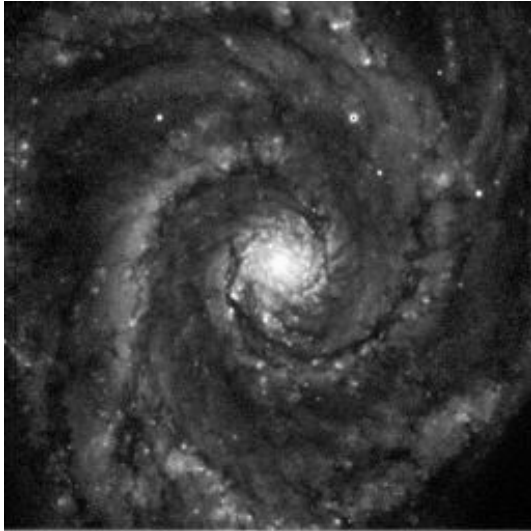
It uses this method because in a digital camera, the CCD is made up of red, green and blue pixels which are all it needs to make a colour image. The CCD in a FT camera CCD does not have separate red, green and blue pixels but pixels that are sensitive to a wide range of light. This has the advantage of providing astronomers with a wider range of options to investigate astronomical images and also has benefits in terms of the resolution that is achievable in an image. Here are three images that you would get from a Faulkes Telescope using the 3 filters:



Red (r')



Green (V)



Blue (B)

The previous three images are taken through the r' (red), V (green) and B (blue) filters. However, they do not look red, green or blue because the FITS files contain data regarding charge collected across the CCD. What you see when you look at a FITS file is the intensity of light (brightness) across the image.

4.0 Exposure Times

Pointing the telescope at the object you want to image is only the first part of getting a successful image. You also need to know how much light to collect from your object.

Many of the objects you will image are actually very faint. Because they are so dim, they give off very little light (which is in the form of photons) and hence we have to make sure we use long enough exposures to ensure enough photons are received by the telescope camera to form a useable image.

The table below shows some typical exposures PER FILTER for astronomical objects being imaged with the Faulkes Telescopes.

Object Type	Lower Limit (seconds)	Usual Exposure Range (seconds)	Better Images (seconds)
Galaxy	30s	60s	at least 120s
Nebula	30s	60s	at least 120s
Star Cluster	2-5s	5-30s	-
Planetary Nebula	10-20s	30-40s	-
Asteroids		1-60s	
Planets	-	0.01	-
Bright Stars	Do not image bright stars, see here for information why this should not be done: http://www.faulkes-telescope.com/projects/advice/ct_res_imgs.htm		
The Moon	The Moon is too large and too bright to be imaged with a Faulkes Telescope.		
The Sun	The Sun is much too bright to be imaged with a Faulkes Telescope. The telescope will not allow this to happen.		

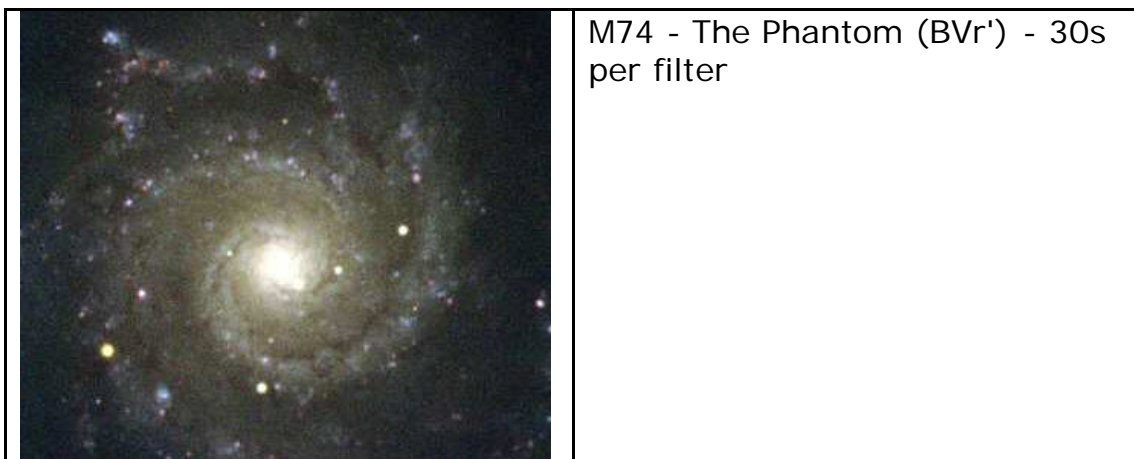
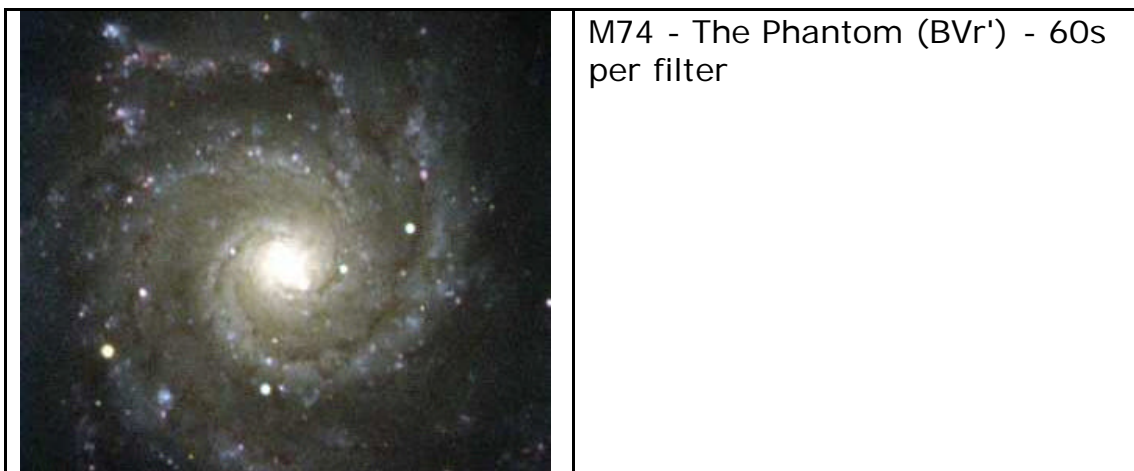
As you can see, the exposure ranges used are very broad.

The image processing systems at the telescope have very powerful processing software that make JPEG images from the original FITS files that the telescope writes when it images the objects you choose.

5.0 Exposure Times and JPEG Images

For many of the Faulkes Telescope users the JPEG images will be the main product that you use from the telescope. It is therefore worthwhile spending some time just looking at how JPEG images of different objects are affected by exposure time.

The images below show how exposure time affects the production of a JPEG image of the galaxy M74 - The Phantom. Each successive exposure is half the length of time than the one before it. Each image is a composite colour image using red (r'), green (V) and blue (B) filters.





M74 - The Phantom (BVR') - 15s per filter



M74 - The Phantom (BVR') - 8s per filter



M74 - The Phantom (BVR') - 4s per filter

It is quite obvious that as the exposure time is shortened there is less detail visible and more noise visible in the images. However, the first two are similar and it may be that you will need to consider whether an exposure that is half the length of another is sufficient for your purposes. The obvious benefit being that you are using less of your observing time in this way and can image more objects in a session.

The following images show a variety of objects imaged with the Faulkes telescopes and for each there is an explanation of what the images show and how this corresponds to the exposure time.

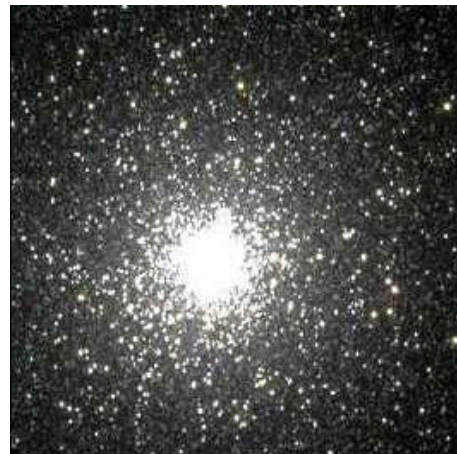
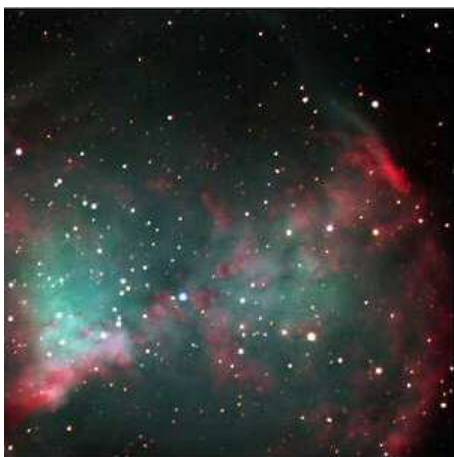


Exposure time of 10 seconds

Exposure time of 20 seconds

The two images above are colour images of M72. The first image uses a 10s exposure per filter and the second is a 20s exposure per filter. You can see that the second image is brighter and this may be what you want. However, the first image has more detail in the centre of the cluster. It is up to you to decide how you want your image to look and where you want the detail.

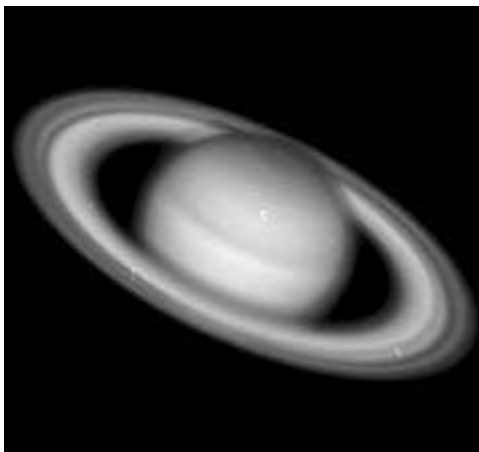
The image on the left is a colour image of the Dumbbell Nebula, using 60s exposure time through each filter. The image on the right is a colour image of M15 using 30s exposure time per filter. As you can see there are a lot of stars clumped together in this image and the centre section looks very white. A shorter exposure would show more detail in the centre part of the image whereas a longer exposure would show more of the fainter stars around the outside of the image. Again it is your choice as to where you want the detail in your images.





The image on the left is of part of the Veil Nebula and is also in colour using an exposure time of 60s per filter.

When it comes to imaging objects such as planets, things are very different. Planets are very bright objects but do not have the pinpoint brightness of stars. Images of planets are taken with an exposure measured in **fractions of a second** rather than seconds. A typical exposure for a planet such as Jupiter or Saturn would be 0.01 to 0.1 seconds.



The image of Saturn to the left (taken in the early days of FT commissioning) was a 0.15s exposure through a single filter (therefore it is not a colour image).



This image of Jupiter was taken with a similar length of exposure but through three filters to make a colour image.

6.0 Importance of Moon phase

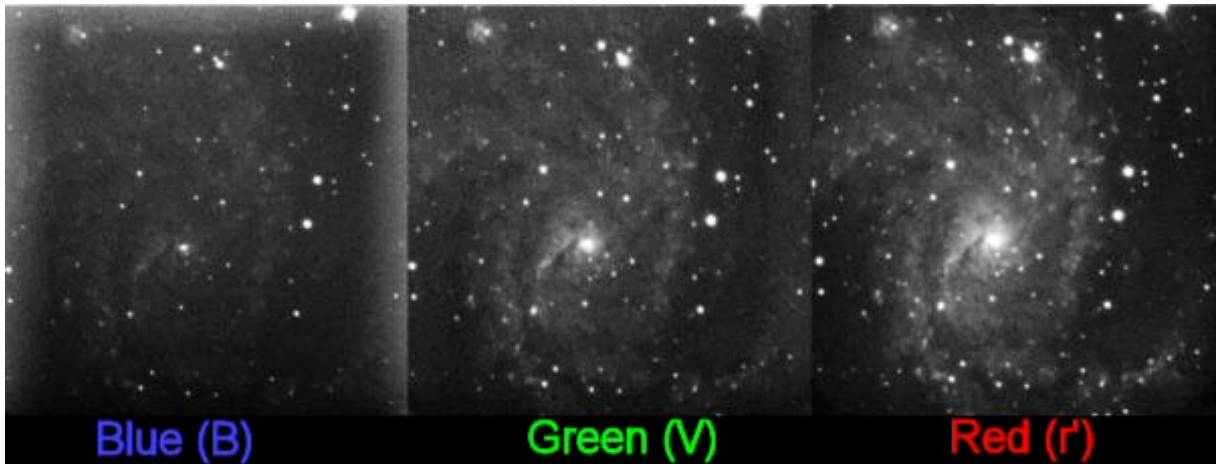
Days around Full Moon (Bright Time)

This is quite possibly one of the most important things to take account of when planning your observing sessions. For a number of days each month the Moon is in a phase where it is either full or very nearly full. You can normally check the phase of the Moon in your diary. This can have serious implications for the type of observing you may want to do. In this section we will show you some of the side effects of moonlight, and explain what you can do to get better images under such conditions.

The image below (NGC 6946) shows one of the effects of moonlight on an image taken with Faulkes Telescope North. The image is a colour composite taken with red, green and blue (BVR') filters.



You can see from the image that there is less contrast than you would perhaps like and that the image appears to have a blue border around it. This is not a very acceptable image. However, it is always worth looking at what can be achieved in each waveband in case there is the possibility that imaging in a different part of the electromagnetic spectrum is any better. The next three images show how the object looks through the red, green and blue filters separately.



Immediately you can see a number of useful things. The blue image clearly has a very light border which would explain the blue border in the colour image. It also contains very little detail in the galaxy. The green filter is better. It has less of a bright border (although there is still one present) and has more galaxy details. The red image is the best. There is no border that is visible and there is much more detail in terms of number of stars and the structure of the galaxy. In this case it is clear that the image taken through the blue filter is most affected by moonlight as it "washes out" the detail, green is next most affected image and red is affected the least.

From this example, it is clear that when imaging faint objects when moonlight may be a problem, the red filter is the best to use as it is affected less by moonlight.

The following images were also taken during "bright time" when the Moon was in the sky.

Dumbbell Nebula



Globular cluster, M3



The Dumbbell was taken through red, green and blue filters using 30s per filter, the image of the globular cluster (M3) was taken through red, green and blue filters using 30 seconds per filter.

You can see from these two images that some objects are affected less by moonlight. There is some evidence of interference in these images but it is less obvious than with the images of NGC 6946. These two objects are much brighter than NGC6946 and it is worth bearing in mind that bright objects will be less affected by moonlight as you will use a shorter exposure time. This limits the amount of moonlight that reaches the CCD chip in the camera.

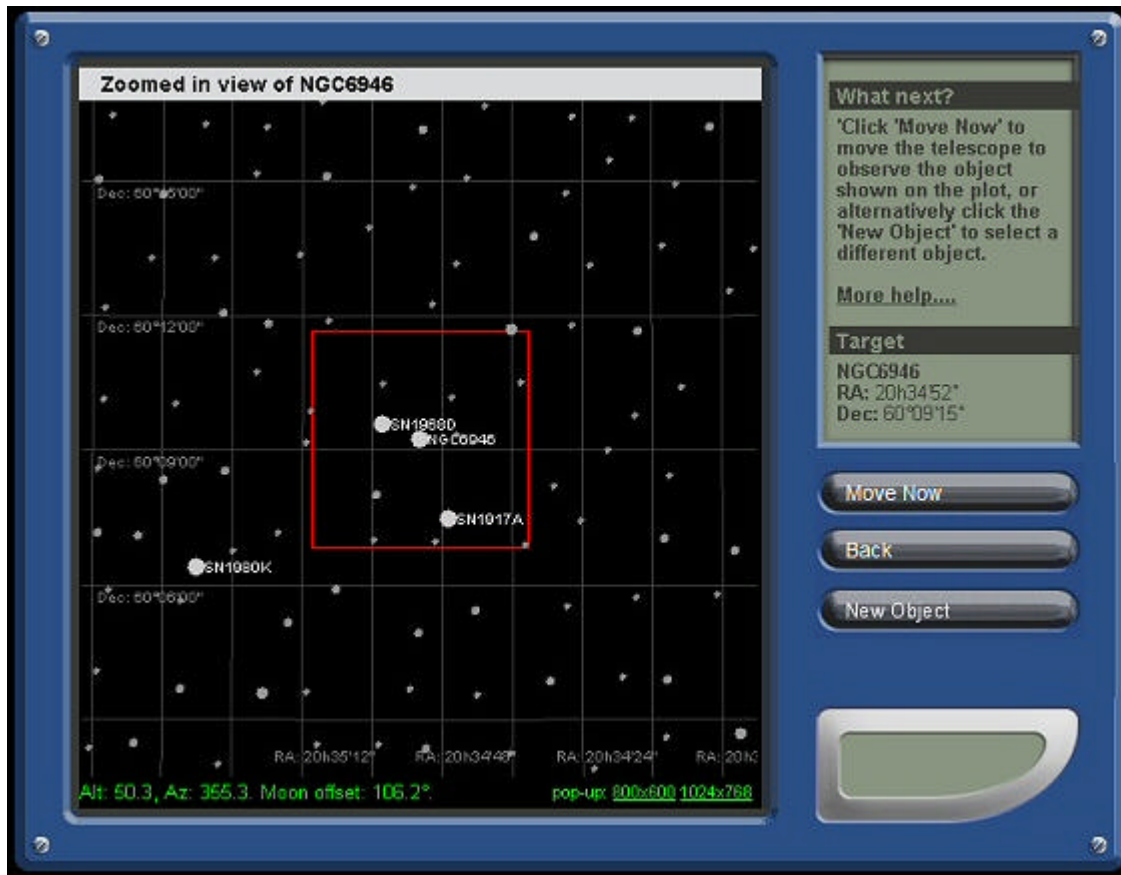
In general it is better to avoid faint extended objects such as faint galaxies. Try instead to image objects that are points of light (such as star clusters) or fairly bright, such as the Dumbbell Nebula. If you find colour images are poor or are washed out, you should try imaging using a filter away from the colour of moonlight such as red (r') or infrared (i').

There is no one rule that will always work for everything as there are so many factors that can affect the outcome of the image. One other factor is the distance the object is from the Moon. This is the topic of the section below.

Moon Avoidance Angle

The affect that moonlight has on an image is also related to how far away the moon is from your chosen object. There is an area around the Moon that you are not allowed to image in. It is currently set to 30 degrees. This is to stop you imaging something in an area that we know is unlikely to result in a satisfactory image. However, that is not to say that everything outside of this is going to be satisfactory.

You can find out how far away the Moon is from your chosen object in the Real Time Interface (RTI). You can see from the screenshot below that the Moon Offset is shown at the bottom of the screen. The Moon Offset is the angle between your chosen object and the Moon. In the example below the Moon Offset is 106.2 degrees.



.....it's also worth remembering.....

If there is thin high cloud in the sky while you are observing, the moonlight will be scattered even more and will affect your observations more.

7.0 Weather

This section gives information about the weather at the Faulkes Telescope North site on Haleakala, Hawaii and at the Faulkes Telescope South site at Siding Spring, Australia.

The two sites are very different and have very different weather. Haleakala is 3000m above sea level and is a very dry site whereas the Siding Spring site is 1000m above sea level and much more humid. The "seeing" (the steadiness of Earth's atmosphere) is very good



at the Haleakala site and not so good at the Siding Spring site. This is mostly due to the telescope at Siding Spring looking through more atmosphere and there being a greater amount of water vapour to look through.

The first place you should look for information about the weather:

<https://www.faulkes-telescope.com/control/Weather.isa>

Most of the information you would need immediately prior to an observing session is on that page. However, if you would like to find our more information about current and future weather conditions you could use the links below. In particular the two sky cameras are very useful. The cameras are not operated by the Faulkes Telescope Project and require some interpretation. More information about cloud cameras is below.

Faulkes Telescope North - Hawaii

Haleakala Fish-Eye CONCAM

<http://nightskylive.net/hl/>

Infrared Cloud Monitoring at the MAGNUM observatory

<http://banana.ifa.hawaii.edu/cloud/>

Haleakala Observatories Weather Page

<http://deneb.bu.edu/swobserv/haleakala/>

Weather Page for Haleakala from www.weather.com

Faulkes Telescope South - Australia

Siding Spring Fisheye CONCAM <http://nightskylive.net/sd/>

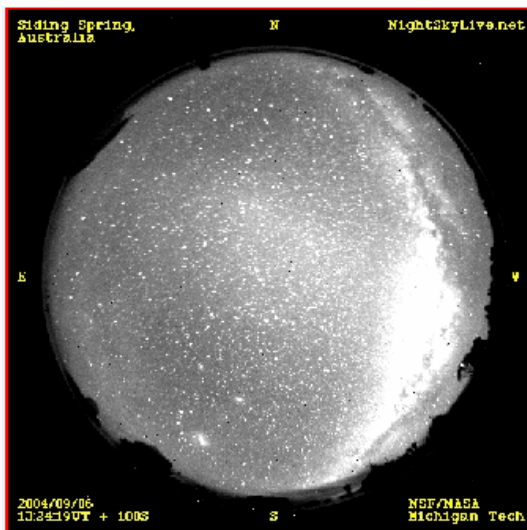
Anglo-Australian Observatory Weather Page

<http://www.aao.gov.au/local/www/cgt/aoarea/ausweather.html>

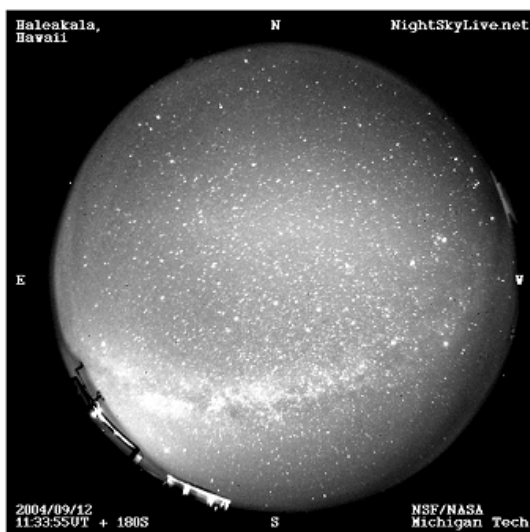
Interpreting the Cloud Cameras

The CONCAM (CONTinuous CAMera) Images at Siding Spring and Haleakala

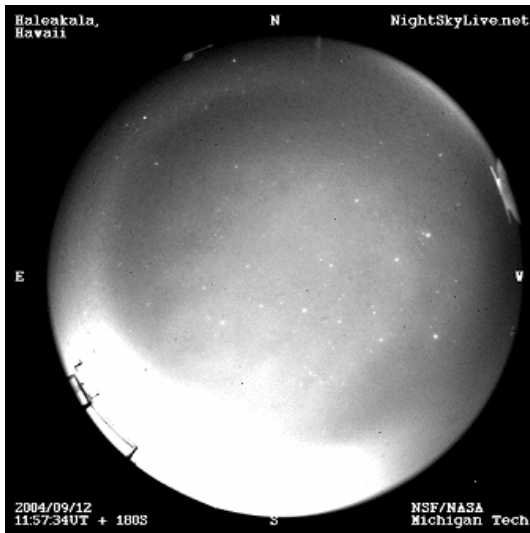
These are part of a network of fisheye lens cameras that aim to continuously monitor the night sky around the World. The CONCAMs are very useful for being able to see the weather conditions. The camera turns on at the beginning of an observing night and off at the end of the night. The camera does not use infrared like the MAGNUM camera (explained below) and it is a little more difficult to spot very high cirrus cloud.



This image shows a clear sky above Siding Spring the bright area to the right is our own galaxy the Milky Way. You can also see the large and small Magellanic Clouds.



The image below shows a clear sky above Haleakala. Again the Milky Way is clearly visible.

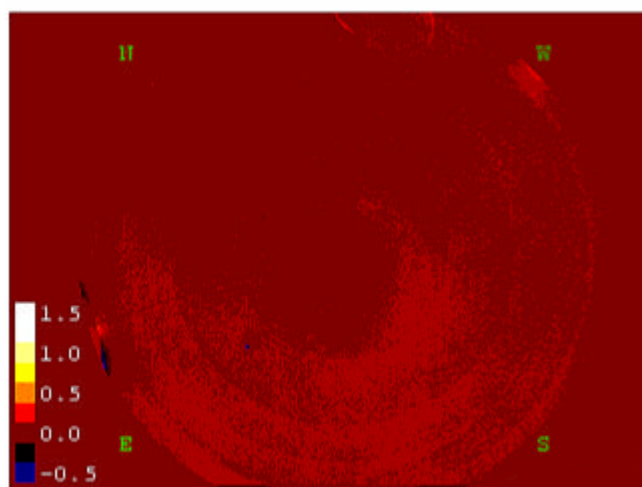


This image shows partly cloudy weather on Haleakala.

MAGNUM (Multicolor Active Galactic NUclei Monitoring) Infrared Cloud Camera on Haleakala

The MAGNUM camera measures the temperature of the sky above it. It is a fisheye camera so sees all of the sky with the point above the camera being in the very centre of the image and the ground around the edge. The image is circular. When there is no cloud cover the image shown is dark brown (the same colour as around the edge of the box you see the camera image in). When there is cloud cover the cloud shows up as a lighter colour because it is warmer than the clear sky. Some example images from the camera are shown below.

Infrared Cloud Monitoring at MAGNUM Observatory

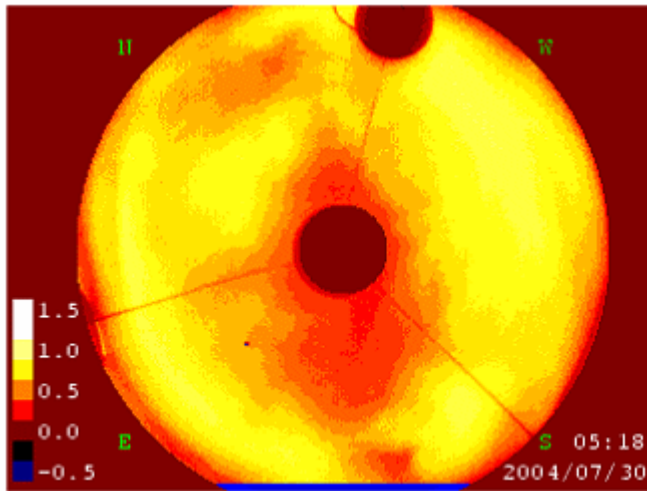


This image shows a mainly clear sky. It doesn't usually get much better than this! It is possible for it to go totally clear but this is rare.

url: http://www.nso.edu/magma/

Internet

Infrared Cloud Monitoring at MAGNUM Observatory

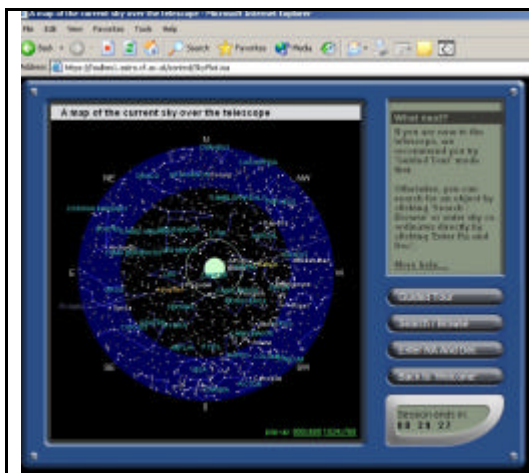


Email inquiries: webmaster@hawaii.ifa.hawaii.edu

This image shows some considerable cloud but not all of it is dense cloud and there are some gaps. Very dense cloud is shown as bright white.

8.0 Using the Telescopes

When you have been issued a username and password you can log in to the restricted area of the website and book a session to use the telescopes. When the time of your session comes around, log in several minutes before. Details of the process that you will go through to take an observation are shown below.



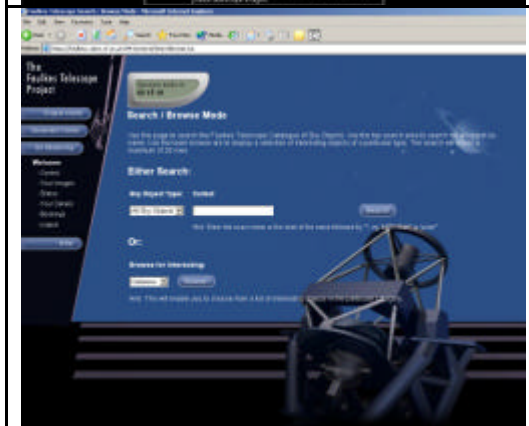
The first page that you see is map of the sky above the chosen telescope. It gives you an idea of the constellations and planets visible, as well as the position of the Moon. On the right-hand side is a menu bar. You are given the option of '**Guided Tour**', '**Search/Browse**' or '**Enter RA and Dec**'.



Guided Tours:

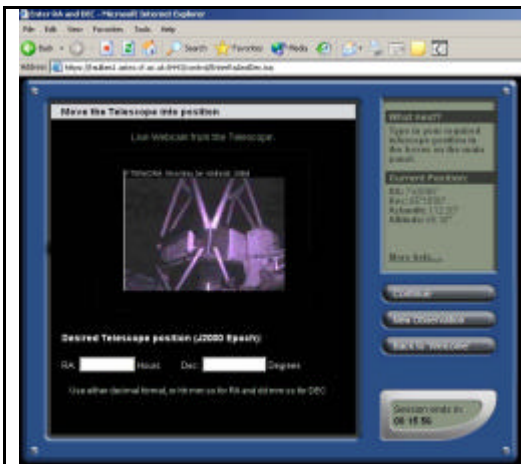
These give you a list of objects (within a theme) that are visible. It is useful if you are new to astronomy and are unsure of how to find out what is visible in the sky.

To select an object, click on its name in the first column.



Search/Browse:

You can use this option to type in the name, Messier or NGC number of the object you wish to observe. After typing in the object and clicking search you will be shown a table. This gives details about the object and whether it is visible or not. To select the object, click on its name in the first column.

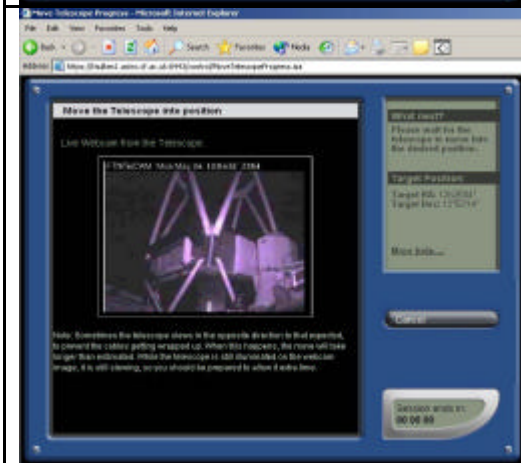


Enter RA and Dec:

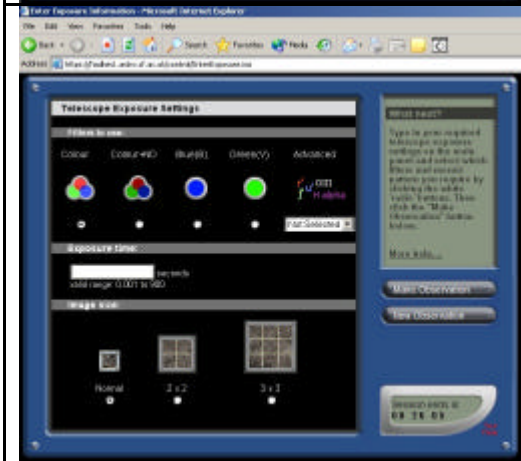
This option allows you to type in the celestial co-ordinates of the object you wish to observe. This is the page you will need to use if looking for asteroids or comets.



Once you have selected the object to observe you will be shown a chart of where the object will appear in the field of view of the telescope. The information at the base of the chart tells you useful information such as how far the object is from the horizon, and how close the Moon is to the object selected. Click **'Move Now'**.

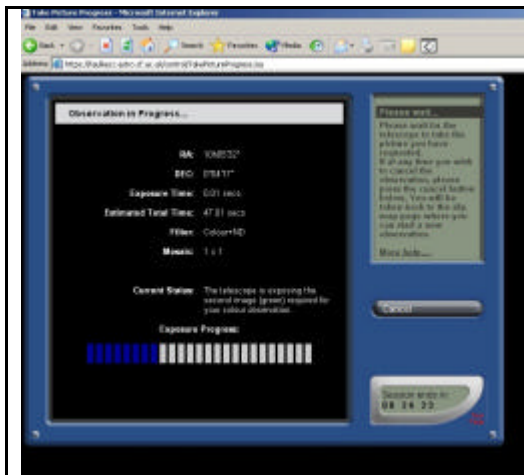


You will now see a screen which shows the telescope moving. This is a web cam image, with the web cam mounted inside the telescope enclosure. Once the telescope is in position an alert will appear telling asking you to choose your parameters. Click **'ok'**.

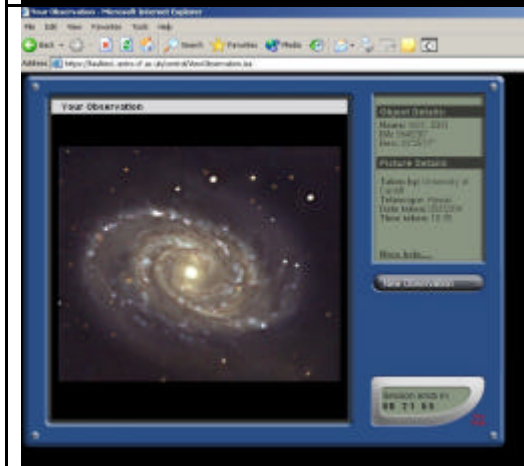


You now need to set the telescope exposure settings. Firstly, select which filter(s) you wish to use. Then you need to choose an exposure time.

Once you have chosen your parameters click **'Make Observation'**.



The next page shows your observation in progress, with a timeline measuring the progress of the observation. The page will tell you the status of the observation including which filter is being used and when your image is being downloaded. Once the image is downloaded an alert will appear to tell you the observation is complete. Click **'ok'** to view the image.



Your image will appear in the window. This is automatically saved and you are able to view it from the **'Your Images'** option which appears when you log into the website at the beginning of the process.

Click **'New Observation'** to repeat the observation process.

9.0 Further Information

If you have any serious questions about how the issues detailed here might affect your observing, please contact the Faulkes Telescope Operations Centre at support@faulkes-telescope.com or 029 2087 5121