

## Star clusters

Star clusters are groups of stars held together by gravity. All stars in a cluster formed from the same gas cloud, at roughly the same time, and have similar composition. However, they vary considerably in colour and brightness. There are two distinct types of star cluster:

- globular clusters are tight groups that contain hundreds of thousands of old stars; and
- open clusters are loose groups that usually contain a few hundred, or less, young stars.

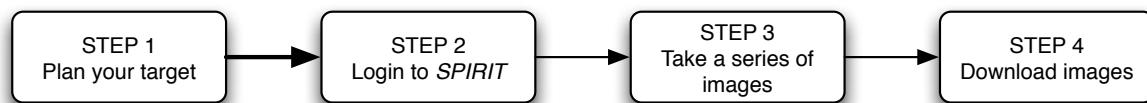
## Photographing a star cluster

In this activity you will use one of the *SPIRIT* telescopes to produce a full-colour image of a star cluster, and find out why stars vary in colour and brightness.

*SPIRIT I* and *II*, like most professional telescopes, are fitted with monochrome (black and white) cameras and coloured filters. Monochrome cameras are used for maximum sensitivity. Your task is to program the telescope to capture images of a star cluster, using red, green and blue filters, then combine them using photo editing software to produce a full-colour image.

The same rules apply when taking filtered images as for basic imaging. Bright objects, such as star clusters, can be imaged in short exposures of 20 seconds or less. Faint objects, such as galaxies and nebulae, require longer exposures of 60 seconds or more.

These are the steps to take a colour series with *SPIRIT*:



### STEP 1: Plan your target

Discuss with your teacher which open or globular star cluster to select as your target.

### STEP 2: Login to *SPIRIT*

The web site for accessing *SPIRIT* is <http://spice.uwa.edu.au/spirit>

Select the link **Telescope access** then choose either *SPIRIT I* or *SPIRIT II*. Enter your user name and password. Once the web site has loaded, you will be asked to enter these details a second time.

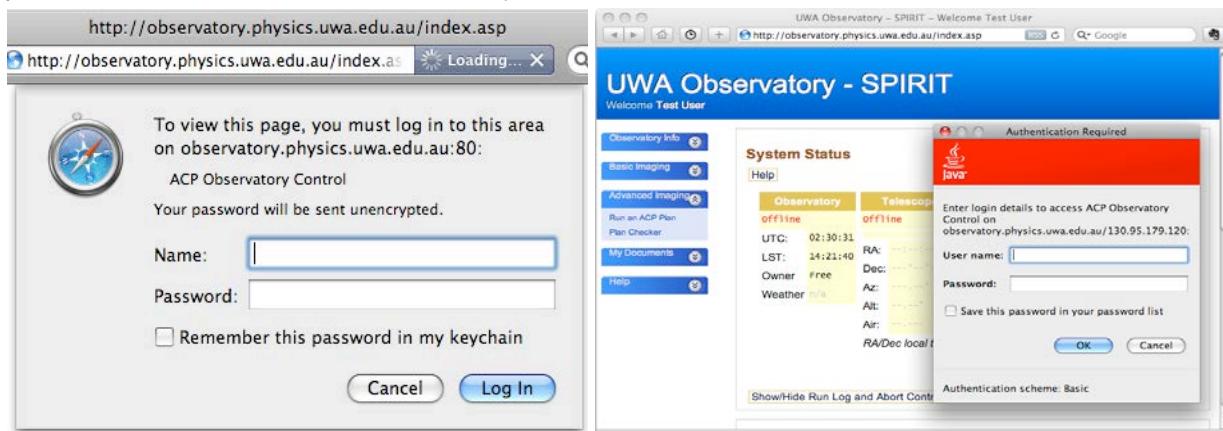


figure 1: Enter your user name and password, twice.

The *SPIRIT* home page ('Observatory Info') displays three panes: **System Status**, **Weather** and **Welcome**. Use the left hand menu to display other pages, such as 'Take a series of images'. Check the weather status before you start imaging.

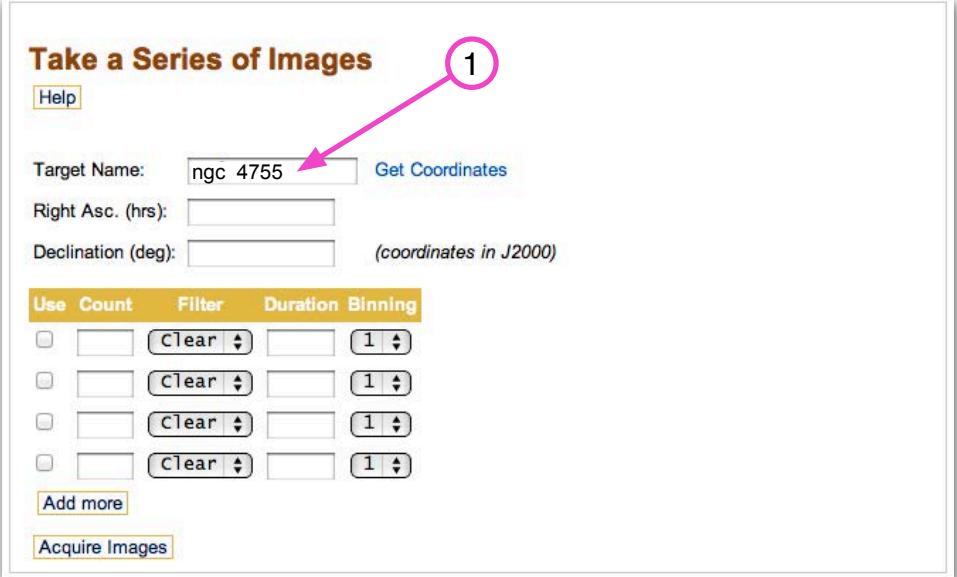
figure 2: *SPIRIT* home page

### STEP 3: Take a series of images

Select **Take a series of images** from the left hand menu.

figure 3: Select 'Take a Series of Images' from the left hand menu.

1. Enter your target name. Be sure to leave a space between the catalogue and number (eg 'ngc 4755', not 'ngc4755').



**Take a Series of Images**

Target Name:  Get Coordinates

Right Asc. (hrs):

Declination (deg):  (coordinates in J2000)

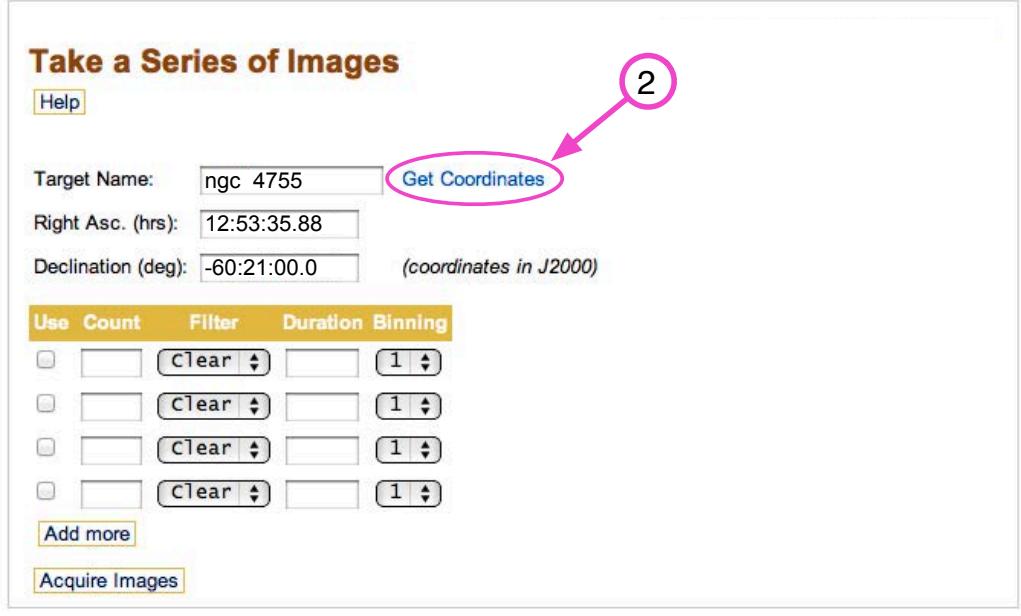
Use	Count	Filter	Duration	Binning
<input type="checkbox"/>	<input type="text"/>	Clear <input type="button" value="▼"/>	<input type="text"/>	1 <input type="button" value="▼"/>
<input type="checkbox"/>	<input type="text"/>	Clear <input type="button" value="▼"/>	<input type="text"/>	1 <input type="button" value="▼"/>
<input type="checkbox"/>	<input type="text"/>	Clear <input type="button" value="▼"/>	<input type="text"/>	1 <input type="button" value="▼"/>
<input type="checkbox"/>	<input type="text"/>	Clear <input type="button" value="▼"/>	<input type="text"/>	1 <input type="button" value="▼"/>

**Add more**

**Acquire Images**

figure 4: Enter your target name.

2. Select **Get Coordinates**. This will automatically put values into fields for 'Right Asc.' (RA) and 'Declination' (Dec).



**Take a Series of Images**

Target Name:  **Get Coordinates**

Right Asc. (hrs):

Declination (deg):  (coordinates in J2000)

Use	Count	Filter	Duration	Binning
<input type="checkbox"/>	<input type="text"/>	Clear <input type="button" value="▼"/>	<input type="text"/>	1 <input type="button" value="▼"/>
<input type="checkbox"/>	<input type="text"/>	Clear <input type="button" value="▼"/>	<input type="text"/>	1 <input type="button" value="▼"/>
<input type="checkbox"/>	<input type="text"/>	Clear <input type="button" value="▼"/>	<input type="text"/>	1 <input type="button" value="▼"/>
<input type="checkbox"/>	<input type="text"/>	Clear <input type="button" value="▼"/>	<input type="text"/>	1 <input type="button" value="▼"/>

**Add more**

**Acquire Images**

figure 5: Get the coordinates of your target.

3. Enter values for Count (the number of images to be taken), Filter and Duration (exposure length). Leave Binning set to its default value ('1' for *SPIRIT I* and '3' for *SPIRIT II*).

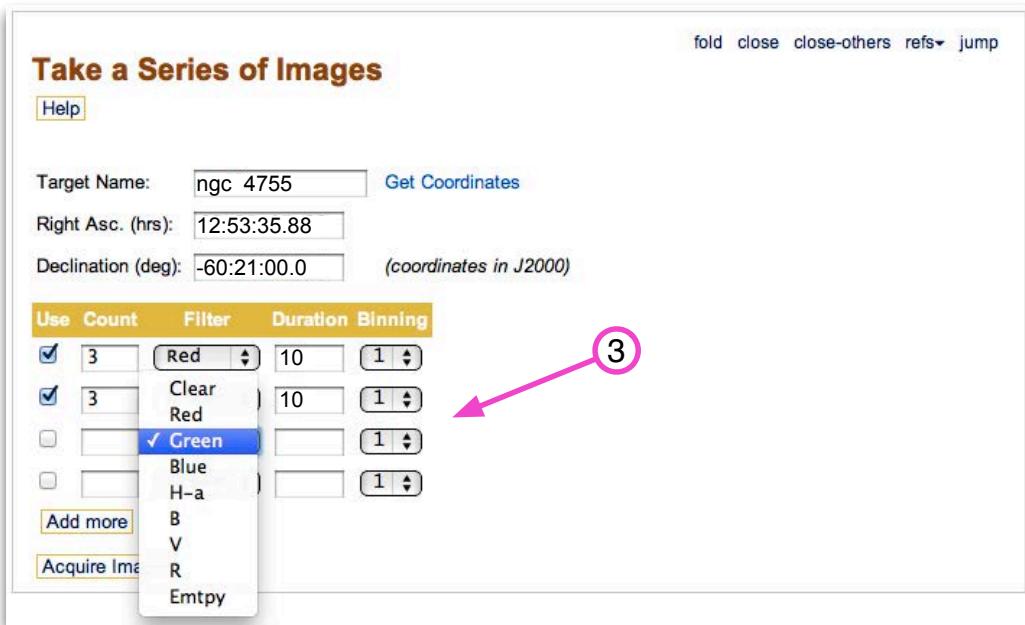


figure 6: Select exposure details, such as filter choice, for each image set.

Program *SPIRIT* to capture three images, at three different exposures, for each filter, to ensure that you capture at least one image at each exposure that is clear of clouds, haze, satellite tracks or other unwanted elements. Star clusters are relatively bright, so most can be imaged with exposures of less than 10 seconds.

Select **Add more** to create additional rows, if required. Figure 7 shows *SPIRIT* programmed to capture three images at 10 and 15 second durations for the red, green and blue filters. This will produce 18 images in total.

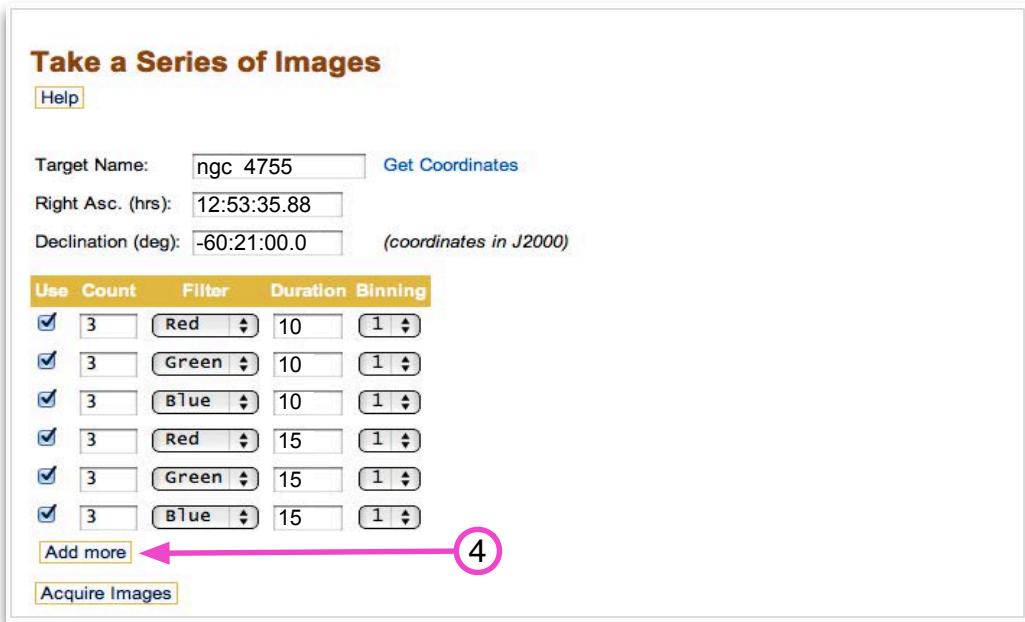
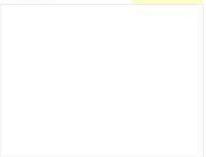


figure 7: Add as many rows as required.

4. Select **Acquire Image** when you have finished adding exposure details. The sequence of commands to take the images will now commence. You can monitor progress in the ‘System Status’ pane. Select **Show/Hide Run Log and Abort Control** to expand the progress window.

**System Status**

[Help](#)

Observatory	Telescope	Imager	Activity
In use	Stopped	Shutter Closed	Observing
UTC: 15:02:32	RA: 03:04:32.04	Filter Clear	<b>Target</b> M31  <b>Last image preview</b> Click to see larger image
LST: 00:18:01	Dec: -25°13'21.2"	Binning 1:1	
Owner Paul Luckas	Az: 090.32°	Cooler -15°C/49%	
Weather Clear Wind	Alt: 53.06°		
Shutter Open	Air: 1.251		
Dome Slave	<i>RA/Dec local topo</i>		

Show/Hide Run Log and Abort Control

**Stop Run**

```

;-----;
; This plan was generated by ACP Planner 4.1.1
;-----;

; For: Administrator
; Location: Perth, Australia
; Coords: Lat = -31° 56' 00" Lon = -115° 50' 00"
; Targets: 7
; Start Imaging: 23:40:18 (local)
; Total Time: 00:36:33
;
; User Comments:
;   Test Plan 14th Oct. 2010
;-----;

;
; === Target M31 ===
;
; (wait until 15:40:18 UTC)
; (turning tracking off)

```

figure 8: Monitor the progress of image acquisition.

## STEP 4: Download images

Once imaging is complete, a low quality image thumbnail appears in the 'System Status' pane. Select the image to enlarge the view.

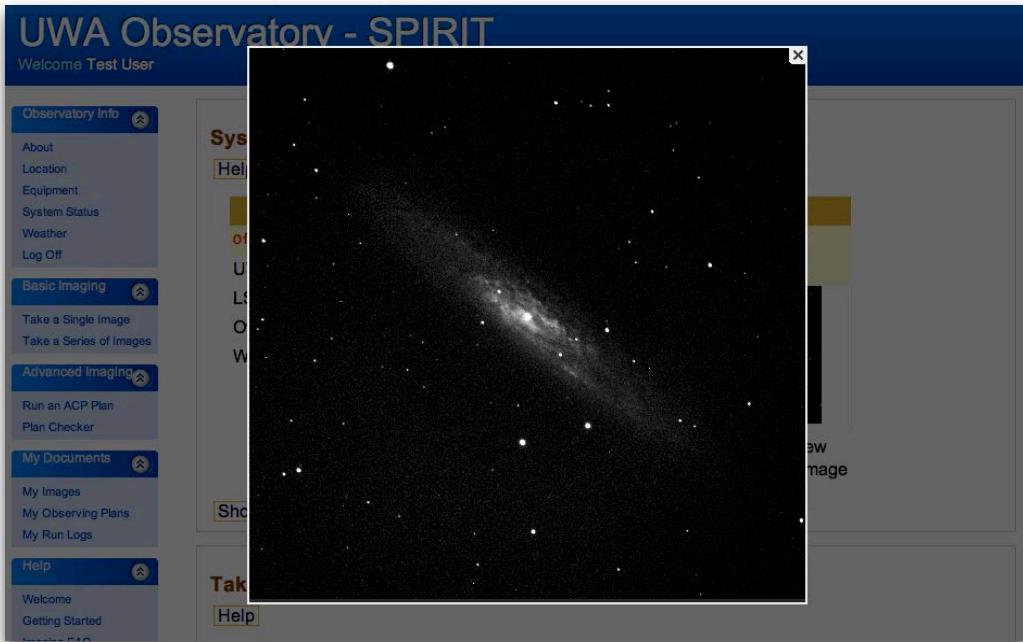


figure 10: Preview your image.

Your images can be viewed and downloaded from **My Images** under 'My Documents'. Images are grouped into folders, by date.

figure 11: Display a list of your images.

Navigate to the folder containing images you wish to download. JPEG versions of images may be downloaded and viewed without special software.

View your images and decide which exposure duration produced the best images. From these, select the best image taken with the red, green and blue filters. Be patient, downloading multiple images takes time!

Name	Type	Date Modified	Size	Action
m 73-S001-R001-C001-Clear.fits.zip	Compressed (zipped) Folder	15 Sep 2010 12:12:12 UTC	3.36Mb	Delete
m 73-S001-R001-C001-Clear.jpg	JPEG image	15 Sep 2010 12:12:12 UTC	699.70Kb	Delete
ngc 253-S001-R001-C001-Clear.fits.zip	Compressed (zipped) Folder	15 Sep 2010 12:24:06 UTC	3.11Mb	Delete
ngc 253-S001-R001-C001-Clear.jpg	JPEG image	15 Sep 2010 12:24:05 UTC	780.54Kb	Delete
RAW-m 73-S001-R001-C001-Clear.fits	MaxIm DL Image	15 Sep 2010 12:12:09 UTC	2.01Mb	Delete
RAW-ngc 253-S001-R001-C001-Clear.fits	MaxIm DL Image	15 Sep 2010 12:23:55 UTC	2.01Mb	Delete

figure 12: JPEG images can be viewed without special software.

## STEP 5: Log out

Log out of *SPIRIT* so others can use the telescope.

## STEP 6: Process images

The final step in this activity is to combine red, green and blue images into a single full-colour image. To do this, you will:

1. import three selected images (taken with red, green and blue filters) into a photo editing software package;
2. adjust brightness and contrast of each image to increase detail; and
3. combine and align images to produce a full-colour image.

These steps are described in the quick guide, *Changing Universe 4: Image processing*.