

Introduction

Stellarium is planetarium software that can be used to view and identify astronomical objects, and learn about astronomical concepts. In this activity, you will learn about galaxies and how they and other astronomical objects appear to move across the sky each day.

Part 1: Setting up Stellarium for this activity

Stellarium can show the night sky from any location on Earth, at any time of the year.

Press **F6** to show the location window.

Type 'Perth' in the search box then click on 'Perth, Australia'. Select **Set as default**, then close the location window.

Press **F5** to show the date/time window.

Set date to May 15, 2014.

Advance time to 21:00 (9 pm) then close the date/time window.

NOTE

Set your location to Perth when selecting objects to image using the *SPIRIT* remote telescopes. Although you may use these telescopes from anywhere in the world, they are located at The University of Western Australia, in Perth.

Part 2: Exploring Stellarium

The default sky in Stellarium shows stars and planets. To view other objects, such as distant galaxies, press **F4** to open the **View options** window. Select 'Nebulas' in the Labels and Markers box (depending on your version of Stellarium this may be called 'DSOs' - deep sky objects), then close the **Viewing options** window. Zooming in on the sky will reveal an increasing number of labelled, deep-sky objects.

To find astronomical objects by catalogue number press **control F (command F)** to display a search box. Type the name of the object you wish to find, then press **enter**. Use this to find: Mars, Titan (one of Saturn's moons), Sirius, M 20. For a closer look at any object press forward slash (/) to zoom in and back slash (\) to zoom out.

Objects below the horizon can be revealed by pressing **G** to remove the 'ground'. Press **G** again to restore the ground.

Part 3: Exploring galaxies

Galaxies are classified according to their shape, as they appear from Earth. Explore the following galaxies (zoom in) and compare descriptions in the table with each galaxy's appearance.

ELLIPTICAL GALAXIES	SPIRAL GALAXIES	IRREGULAR GALAXIES
elliptical shape, little visible structure, little interstellar matter	rotating discs of stars with a central bulge and arms that spiral out	little or no clearly defined structure
M 49	M 83	NGC 292
M 60	M 90	M 82 (press G to remove the 'ground')

Part 4: Classifying galaxies

1. Find and zoom in on each of the following galaxies. Classify them according to their shape.

NGC 5194 M 91 M 74 M 87 M 110 M 89 NGC 5195

ELLIPTICAL GALAXIES	SPIRAL GALAXIES	IRREGULAR GALAXIES

2. Were any of these galaxies difficult to classify? Why?

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Part 5: Exploring the motion of stars across the sky

Imagine being able to control time. Stellarium allows you to do this, and even make it go backwards! You can make a whole day go by in a few minutes. This is very useful for showing how the Sun and stars appear to move across the sky each day.

The following keys control time.

- J** slows down time and even lets it run backwards to see the past.
- K** resets time to its normal rate.
- L** speeds up time and lets us see into the future.
- 8** resets the current date and time.
- 7** freezes time.

You can also turn daylight on or off by pressing **A**. Try it to view stars during daytime.

- Press **7** to freeze time, then **F5** to display the date/time window. Use the **up/down** arrows to set the date and time to 1 January 2014 and 9:00 pm, then close the date time window.
- Adjust Stellarium to a view of the night sky with the ground and horizon visible.
- Press **Q** to show the cardinal (compass) points if they are not already displayed, then press and hold the **left** mouse button and 'drag' screen so that you are facing west.
- Press **L** two or three times to speed up time.

3. Describe what you see.

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4. Move your cursor so that you are facing other directions, and observe the direction the Sun and stars move across the sky. What do you see when you are facing:

east?

north?

south?

- While you are still facing south, move your cursor to find the point in the sky around which the Sun and stars appear to circle. This is the south celestial pole.
- Press **E** to place a grid on the sky to reveal the actual location of the south celestial pole.
- Reset your location (**F6**) to Singapore (which is near the equator) and repeat your observations.

5. Where is the south celestial pole located when viewed from Singapore?

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6. Describe the movement of the Sun and stars across the sky when viewed from a location close to the equator.

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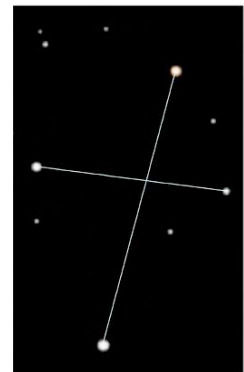
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The Southern Cross (Crux) is an easy constellation to recognise and locate in the southern sky. You can use Stellarium to explore what happens to its position over a period of 24 hours.

- Reset your location to Perth, Australia.
- Press **K** to reset time to its normal rate, then **C** to show constellations and **V** to add their names.
- Press **L** two or three times to speed up time.
- Locate the southern cross (Crux) in the south-eastern sky.



7. What happens to the position of the Southern Cross (Crux) over a period of 24 hours?

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8. At home tonight, if the sky is clear, look at the southern sky and see if you can find the Southern Cross. Sketch the orientation of its four stars in the spaces below, at 8:00 pm, 9:00 pm and 10:00 pm. Choose another constellation (pattern of bright stars) in the southern sky if the Southern Cross is not visible from your location.

8:00 pm
S

9:00 pm
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10:00 pm
S

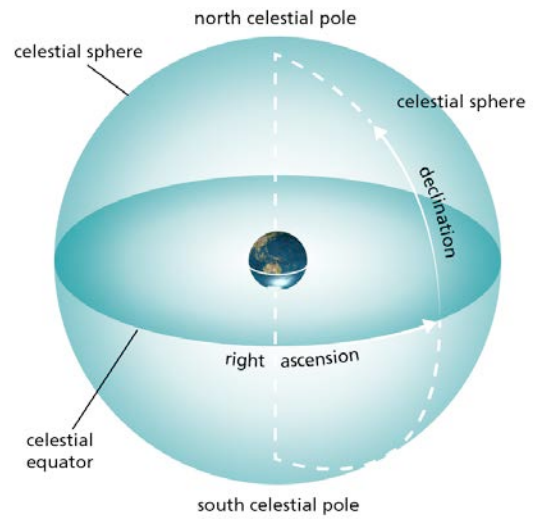
Make a prediction about where the Southern Cross (or your chosen constellation) will be at 9.00 am tomorrow. Sketch its orientation in the space below:

9:00 am
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Part 6: The celestial sphere

Geographers locate places on Earth by their longitude (degrees east or west of the prime meridian) and latitude (degrees north or south of the Equator). Astronomers locate objects in the sky by their position on the celestial sphere. This is an imaginary sphere, with Earth at its centre, that rotates on the same axis as Earth. All objects in the sky can be thought of as being located on the surface of the celestial sphere.

To observers in the southern hemisphere, stars appear to rotate once a day around the south celestial pole, a point on the celestial sphere directly above the South Pole. The north celestial pole is a point directly above the North Pole, and the celestial equator is a circle on the celestial sphere corresponding to the Earth's Equator.



Exploring the celestial sphere

- Ensure your location is set to Perth, Australia.
- Press **K** to reset time to its normal rate, then press **7** to 'freeze time'.
- Set the date and time to 1 January 2014 and 21:00 (9:00 pm) then close the date/time panel.
- Press **control F (command F)**, select the star Sirius then press **enter**.

The top left of the screen shows information about Sirius, including its magnitude (brightness) and location on the celestial sphere. Astronomers describe location using:

- right ascension (RA) - similar to longitude (ie an object's position east or west on the celestial sphere); and
- declination (DE) - similar to latitude (ie an object's position north or south of the celestial equator).

'J2000' refers to Sirius' position at noon on 1 January 2000, while 'of date' information gives its position right now.

- Zoom out sufficiently so that you can see the ground and the horizon together with Sirius.
- Press **E** to show the celestial sphere if it is not already displayed.

9. Write down the RA/DE (J2000) information for Sirius at 9:00 pm.

RA = h..... m s DE = - ° ' "

- Press **L** three times to speed up time.

10. What do you notice about Sirius' position, in relation to the celestial sphere?

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11. Find the RA/DE (J2000) information for Sirius at 11:30 pm. (Hint: Press K to stop time).

RA = h..... m s DE = + ° ' "

12. These two sets of RA/DE values are the same. Why do you think this is so?

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13. Why do you think astronomers use the celestial sphere and RA/DE coordinates to describe the position of objects in the sky?

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Part 6: What is the best time of night to image a celestial object?

Celestial objects are best viewed when they are at their highest point in the sky (where the distance light travels through the atmosphere is smallest), away from dust and pollutants, and away from other sources of light, such as city lights or the Moon.

Objects are at their highest in the sky when they cross the celestial meridian. This is an imaginary line across the sky, from a point due north on the horizon to a point due south, that passes directly overhead.

Task: Use Stellarium to investigate the best time of night to image an object (NGC 2237) using *SPIRIT*.

- Set your location to Perth and the date and time to 15 January 2014 and 21:00 (9:00 pm).
- Press **control F (command F)**, select NGC 2237 (the Rosette Nebula) then press **enter**.
- Press forward slash (/) to zoom in for a close look. Press **backslash (\)** to zoom out again.
- Zoom out slightly so that you can see the ground, horizon and NGC 2237, then press **spacebar** to centre NGC 2237.
- Press **semicolon (;)** to display the celestial meridian line.
- Advance time slowly using the **L** key. Stop time by pressing the **K** key as the target reaches the celestial meridian. Note the time in the toolbar at the bottom of the screen.

14. The Rosette nebula crosses the celestial meridian at

This is the best time to image it on 15 January 2014 because:

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Exploring the best time to image an object

Will this always be the best time to image the Rosette nebula? Will it be the same time next week, or next month? Stellarium lets you explore this by adjusting dates and times.

- Press 7 to freeze time and adjust the date and time to 25 January 2014 and 21:00 (9pm).
- Advance time slowly using the L key to determine when the Rosette nebula crosses the meridian (press K to stop as the target reaches the Celestial Meridian).

15. Write your answer in the table below. Repeat for other dates in the table.

DATE AND TIME	TIME ROSETTE NEBULA CROSSES THE MERIDIAN
30 January 2014	
5 February 2014	
15 February 2014	
1 March 2014	

16. The best time to image an object is when it crosses the meridian. What do you notice about this time, as you advance the date and time?

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17. Does this same observation apply to the time the Rosette nebula crosses the meridian throughout the rest of the year?

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18. Do other celestial objects follow this pattern? Pick one or two objects to try. Record some values 1-2 months apart. (Hint: Don't use the Sun or planets

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