**teachers guide**

**Evolution of the Universe 1:**

**Galaxies**

# Components

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|  | NAME | DESCRIPTION | AUDIENCE |
|  | *Galaxies*teachers guide | This guide shows how students may be engaged in astronomy through use of virtual planetarium software to study galaxies and the motion of celestial objects. | teachers |
|  | *Galaxy classification*background sheet | This background sheet provides information on the structure and classification of galaxies. | teachers |
|  | *A guide to using Stellarium*manual | This manual introduces users to Stellarium, guides them to select target objects and plan the best time to observe them at night. | teachers students |
|  | *Stellarium*quick guide | This quick guide provides a summary of Stellarium’s features and a list of navigation commands. | students |
|  | *Looking at galaxies*worksheet | This worksheet guides students to explore galaxies; investigate their apparent movement across the sky; and determine the best conditions to observe them. | students |

Purpose

To **Engage** students interest in astronomy through use of virtual planetarium software; to investigate the apparent movement of celestial objects across the night sky; and to determine the best conditions for viewing deep sky objects.

# Outcomes

Students:

* familiarise themselves with Stellarium planetarium software;
* use Stellarium to explore and classify galaxies;
* investigate the apparent movement of celestial objects across the night sky;
* explore the celestial sphere and RA/DE coordinate system; and
* determine the best conditions to observe celestial objects.

# Activity summary

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| ACTIVITY | POSSIBLE STRATEGY |
| Teachers should familiarise themselves with Stellarium virtual planetarium software, prior to undertaking this activity. Working through *A guide to using Stellarium* will be useful. | teacher preparation |
| Teacher divides class into groups of two or three students, allocates them to a computer, instructs them to open Stellarium and explains the purpose of the program and worksheet activities. | teacher to whole class |
| Teacher distributes worksheet, *Looking at galaxies*, and quick guide to Stellarium and guides students through **Part 1: Setting up Stellarium for your location** (if required) and **Part 2: Exploring Stellarium**. | small groups |
| Students work through **Part 3: Exploring galaxies** and **Part 4: Classifying galaxies**. | small groups |
| Teacher explains Messier (M) and New General Catalogue (NGC) numbers for identifying galaxies and other stellar objects. | teacher explanation |

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| ACTIVITY | POSSIBLE STRATEGY |
| Students describe: what galaxies are; what they are made of; how they are classified using Hubble’s classification scheme; and why some galaxies are difficult to classify. | teacher/whole class discussion |
| Students work through **Part 5: Exploring the motion of stars across the sky**. | small groups |
| Students call out Part 5 answers. Teacher emphasises significance of South celestial pole and focuses on their suggestions (hypotheses) for why the Sun and stars move across the sky every day. | teacher-led questions and answers |
| Teacher introduces the celestial sphere as a means of describing the position of objects in the sky and explains the RA/DE systems. | teacher explanation |
| Students work through **Part 6: The celestial sphere**. | small groups |
| Students call out Part 6 answers, emphasising the value of the RA/DE system as a common language amongst astronomers. | teacher/whole class discussion |
| Students work through **Part 7: What is the best time to image a celestial object?** | small groups |
| Students call out Part 7 answers, explaining their reasons for deciding on which conditions provide the best results for imaging galaxies. | teacher/whole class discussion |
| Students summarise their findings. | individual work |

Information for teachers

Stellarium is planetarium software that enables users to view and identify astronomical objects and gain understanding of a range of astronomical concepts. It can be downloaded, free of charge, from [www.stellarium.org.](http://www.stellarium.org/)

Teachers may download the Stellarium user’s guide in PDF format from [www.stellarium.org/wiki/index.php/](http://www.stellarium.org/wiki/index.php/) Main\_Page to familiarise themselves with the program. Alternatively, an introductory manual and quick guide to Stellarium are included with this SPICE resource.

The quick guide, *Stellarium*, may be photocopied for students to use as a reference.

The worksheet for this actity contains five separate activities:

1. exploring galaxies,
2. classifying galaxies,
3. exploring the motion of stars across the sky,
4. exploring the celestial sphere and the Right Ascension/Declination (RA/DE) coordinate system, and
5. investigating the best conditions for imaging celestial objects.

The background sheet, *Galaxy classification*, contains information about galaxies and Hubble’s classification scheme in which galaxies are classified as elliptical, lenticular (lens-shaped), spiral or irregular. Images and descriptions are provided for each class of galaxy. Finally, information is provided about our own galaxy, the Milky Way.

# More information

If you would like to know more about galaxy classification, check out [http://www.galaxyzoo.org.](http://www.galaxyzoo.org/) This citizen science project includes activities for school classes to investigate galaxy characteristics.

# Extension activities

The following extension activities use Stellarium.

## The Local Group

Students explore some members of the Local Group of galaxies:

* The Andromeda Galaxy (M 31) is the largest galaxy in the Local Group and the nearest spiral galaxy

to the Milky Way. In summer, M 31 can be viewed from Perth low in the northern sky, but it is better observed from northern hemisphere locations. It can be viewed in Stellarium by ‘removing’ Earth (press **G**).

* The Large Magellanic Cloud (LMC) is an irregular satellite galaxy of the Milky Way. It is visible as

a faint cloud in the night sky of the southern hemisphere.

* The Small Magellanic Cloud (SMC or NGC 292) is a dwarf irregular galaxy and one of the Milky Way’s nearest neighbours. However it only appears as a hazy, light patch in the sky and is best viewed from a dark location.

## Common constellations

Students find (**control F**) and explore constellations such as the Southern Cross (Crux), Orion, Scorpius or constellations that make up the zodiac. Using keyboard actions, they can view them, display lines joining stars (press **C** on the keyboard), add their names (**V**) and display art forms (**R**). Tasks may include investigating whether a constellation can be viewed from Perth and the best time of year to view it.

## Explore the azimuth/altitude coordinate system

Students locate a deep sky object and observe changes in RA/DE and Az/Alt coordinates over time. Students may research advantages and disadvantages of the Az/Alt coordinate system.

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# Technical requirements

The guides, background sheet, manual and worksheet require Adobe Reader, which is a free download from [www.adobe.com.](http://www.adobe.com/) The worksheet is also provided

in Microsoft Word format. Activities in this resource require Stellarium software, which is a free download from [www.stellarium.org.](http://www.stellarium.org/)

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Web: spice.wa.edu.au Email: spice@uwa.edu.au Phone: (08) 6488 3917

Centre for Learning Technology (M016) The University of Western Australia

35 Stirling Highway

Crawley WA 6009

# Associated SPICE resources

*Evolution of the Universe 2: Galaxies* may be used in conjunction with related SPICE resources to address the broader topic of how astronomers study the visible Universe and its origins.

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| DESCRIPTION | LEARNING PURPOSE |
| *Evolution of the Universe (overview)*This learning pathway shows how a number of SPICE resources can be combined to teach the topic of the origin and evolution of the Universe. |  |
| *Evolution of the Universe 1: Galaxies*Students are introduced to astronomy through use of Stellarium planetarium software to classify galaxies visible in the night sky. | **Engage** |
| *Evolution of the Universe 2: The SPIRIT telescopes*Students explore the night sky using a remotely-operated telescope. They image deep sky objects in real time; research these objects; and publish their images. | **Explore** |
| *Evolution of the Universe 3: History of the Universe*The Big Bang theory is used to explain the origin and subsequent development of the Universe. | **Explain** |
| *Evolution of the Universe 4: Stars*Students use filters on the *SPIRIT* telescopes to capture images of a star cluster and compile a full-colour image. They use this image to discover why stars differ in colour, and relate star colours to stages in stellar life cycles. | **Elaborate** |