teachers guide

Evolution of the Universe 4: Stars

Components

	NAME	DESCRIPTION	AUDIENCE
	*Stars* teachers guide	This guide shows how imaging of star clusters may be used to introduce students to types of stars and stellar lifecycles.	teachers
	*Imaging star clusters* procedure sheet	This procedure describes how to program the *SPIRIT* telescopes to capture a series of images of a star cluster using red, green and blue filters.	students
	*Image processing* procedure sheet	This procedure describes how red, green and blue images may be combined into a single full-colour image, using photo editing software.	students
	*Life cycle of stars* fact sheet	This fact sheet explains how different types of star form, develop and end.	students
	*Star colours* worksheet	This worksheet leads students to an understanding of star colours and stellar life cycles.	students

Purpose

Students use images captured with the *SPIRIT* telescopes to explain star colours and relate them to stellar life cycles.

Outcomes

Students:

- recognise that stars have different colours;
- describe how development of stars has continued since the Big Bang; and
- understand that star colours are related to surface temperatures and processes that occur in stars at different stages of their life cycle.

Activity summary

ACTIVITY	POSSIBLE STRATEGY
Teacher asks students what they know about star clusters: can they name any star clusters? Do they know any types of star cluster?	teacher to whole class
Teacher introduces star clusters: how they form and why they are of interest to astronomers (see **Background notes**).	teacher to whole class
Teacher introduces task: to capture multiple images of a star cluster, using the *SPIRIT* telescopes, and combine them to form a full-colour image. Teacher hands out procedure sheet, *Imaging star clusters*.	small group work
Students use Stellarium, or other information source, to select a star cluster to image.	small group work
Teacher explains how the image capture process will be managed (see **Information for teachers**). Students plan how to capture their images.	teacher to whole class small group work
Students capture images, as determined by teacher.	small group work
Students process images, as determined by teacher.	small group work
Students display their images and vote to select the best.	small group work
Teachers may choose to submit the best images for publication on the *SPIRIT* website.	teacher with whole class
Students complete worksheet, *Star colours*, using fact sheet, *Life cycle of stars*.	Individual work

Information for teachers

This activity is in three parts:

Image a star cluster

This activity re-introduces students to the *SPIRIT* telescopes, to produce a full-colour image of a star cluster. To do this, students program the telescope to capture a star cluster, at three different exposures, through three different coloured filters, to produce a total of 27 images in total. This is to ensure that at least one image at each exposure is clear of clouds, haze, satellite tracks or other unwanted elements.

The procedure sheet, *Imaging star clusters with SPIRIT*, has been written for students allocated time during an evening to log on to *SPIRIT* and capture their own images. If teachers choose to use ACPlanner these instructions will need to be modified.

For successful completion of this quite complex activity it is important that students complete: *Evolution of the Universe 1: Galaxies* for an understanding of target selection; and *Evolution of the Universe 2: The SPIRIT telescopes* for familiarisation with *SPIRIT.*

Image processing

Students select the best exposure and images from the previous step and combine them to form a full-colour image.

Instructions are provided in the procedure sheet, Image processing, for Adobe Photoshop CS5 Version 12.0.4 x64. If schools use different photo editing software, teachers should replace these with instructions relevant to their students' needs.

Stellar lifecycles

A student worksheet, *Star colours*, and fact sheet, *Life cycle of stars*, provide information and questions that lead students to an understanding of star colours and stellar life cycles. It includes:

- star clusters and what can we learn from observing them;
- star colours and surface temperatures;
- star life cycles and the Sun's stage in its life cycle; and
- what makes stars change throughout their life cycles.

The worksheet includes a set of research topics that can be used as an alternative to questions.

Classroom organisation

Teachers should determine how best to manage the activity, depending upon students involved, weather conditions and availability of computers. It is likely the activity will extend over several days. The following suggestions are offered for consideration.

- Students work together, as a group, on all parts of the activity.
- Students are allocated specific tasks within a group, such as research, image capture and image processing.

Once students have selected their target star clusters, teachers should determine how best to manage the process of image capture. This may involve:

- using ACPlanner to upload image capture plans for the whole class;
- allowing time for students to re-familiarise themselves with the *SPIRIT* telescopes;
- students booking 45-minute intervals in an evening to log on and capture images; and
- developing a contingency plan to allow for equipment problems or unfavourable weather conditions.

In the final part of the activity, students combine red, green and blue images to produce a full-colour image of their chosen star cluster. This requires photo-editing software. Instructions are provided for Adobe Photoshop CS5 Version 12.0.4 x64. If schools use different photo-editing software, teachers should replace these with instructions relevant to their students' needs.

Background notes

Star clusters are groups of stars that formed from the same giant gas cloud and are held together by gravity. They are important to astronomers because all stars in a given cluster formed at about the same time. Consequently they are about the same age, the same distance from us, and are made of the same materials.

Despite this, stars within a cluster vary in brightness and colour. Brightness is related to a star's mass — more massive stars are brighter. Colours vary because more massive stars 'burn up' quicker. As stars go through stages of their life cycle they emit different coloured light.

Because of their properties, star clusters provide astronomers with a unique environment to study age and evolution of stars.

There are two types of star clusters.

- Open clusters are so-named because individual stars can be observed through a telescope. Open clusters eventually disperse, due to gravitational interactions with other objects in their galaxy. They typically contain hundreds of relatively young stars.
- Globular clusters can contain up to a million stars in a spherical array. They contain the oldest stars in a galaxy. Globular clusters contain little free gas or dust, so few new stars are formed in them.

Technical requirements

The guide, procedure sheets and worksheet require Adobe Reader, which is a free download from www.adobe.com. Procedure sheets and worksheet are also provided in Microsoft Word format

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banner image: 'NGC 3372 (Carina nebula)', SPIRIT image by Paul Luckas, all rights reserved

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Associated SPICE resources

Evolution of the Universe 4: Astrophotography may be used in conjunction with related SPICE resources to address the broader topic of how astronomers study the visible Universe and its origins.

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**