Macarthur Astronomical Society

Student Projects in Astronomy

A Guide of Teachers and Mentors

2020

The following Project Overviews are based on those suggested by Dr Rahmi Jackson of Broughton Anglican College.

The Focus Questions and Issues section should be used by teachers and mentors to guide students in formulating their own questions about the topic.

References to the NSW 7-10 Science Syllabus have been included. Note that only those sections relevant are included. For example, subsections a and d may be used, but subsections b and c are omitted as they do not relate to this topic.

A generic risk assessment is provided, but schools should ensure that it aligns with school-based policies.

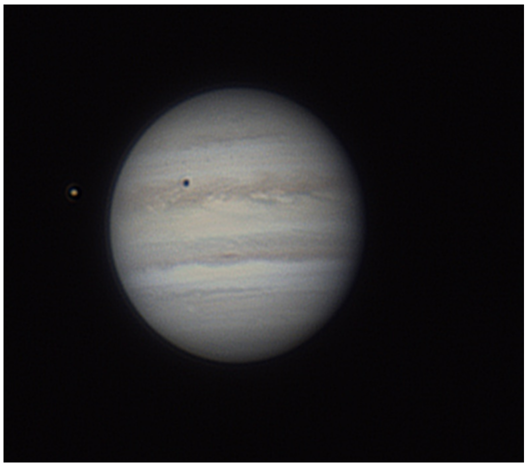
Project overviews Semester 1, 2020:

	Project	Stage			Technical difficulty
		4	5	6	
1	The Moons of Jupiter NOT available Semester 1	X	X	X	Moderate to high (extension)
2	Astrophotography	X	X	X	Moderate to high
3	Light pollution	X	X		Moderate
4	Variable stars		X	X	Moderate to high
5	Spectroscopy		X	X	High
6	A changing lunarscape *Recommended project*	X	X		Low to moderate
7	Magnitude of stars Recommended for technically able students		X	X	Moderate to high
8	A survey of southern skies	X	X		Low to moderate
9	Double Stars		X	X	Moderate to high
10	The Phases of the Moon *Recommended project*	X	X		Low to moderate
11	Observing the Sun	X	X		Moderate

Project overviews Semester 2, 2020:

	Project	Stage 4	5	6	Technical difficulty
1	**The Moons of Jupiter**	**X**	**X**	**X**	**Moderate to high (extension)**
2	**Astrophotography**	**X**	**X**	**X**	**Moderate to high**
3	**Light pollution**	**X**	**X**		**Moderate**
4	**Variable stars**		**X**	**X**	**Moderate to high**
5	**Spectroscopy**		**X**	**X**	**High**
6	**A changing lunarscape** *Recommended project*	**X**	**X**		**Low to moderate**
7	**Magnitude of stars** Recommended for technically able students		**X**	**X**	**Moderate to high**
8	**A survey of southern skies**	**X**	**X**		**Low to moderate**
9	**Double Stars**		**X**	**X**	**Moderate to high**
10	**The Phases of the Moon** *Recommended project*	**X**	**X**		**Low to moderate**
11	**Observing the Sun**	**X**	**X**		**Moderate**

1. The Moons of Jupiter



Jupiter is the largest planet of the Solar System. It has many moons (79 as at April 2019), with the largest four being observable with a small telescope. The first recorded observation of these moons (Callisto, Ganymede, Europa and Io) was in 1609 by Galileo, and they are known as the Galilean Moons in recognition of the importance of his observations as they challenged the understanding of the universe.

In this project, students will make nightly observations of the four Galilean moons over a period of 2 to 3 weeks, recording the positions of each moon and features such as shadows of the moons cast on the surface of Jupiter. Students use their observations to plot a line graph of the distance from Jupiter (in units of "Jupiter diameter") against time. This will allow students to determine the period (time for the moon to orbit Jupiter) and the radius of the orbit for each moon.

Extension: those students proficient in Stage 5 trigonometry and algebra should use data from the graph and Kepler's Third Law of planetary motion to estimate the mass of Jupiter**.**
Extension is recommended for advanced year 9-11 students.

Equipment: This project required observations using a telescope. Students may need to borrow a telescope and phone adapter from MAS. MAS mentors will provide training in the setting up and use of the telescope and phone adapter. MAS mentors will help students plan observing and locating Jupiter.

Background research. Secondary sources: These relate to secondary sources including internet, books, magazines etc.

What are the features of Jupiter that can be seen with a telescope? Who was Galileo? What impact did his observations have on our understanding of the universe and personally for Galileo? Who was Kepler? What was significant about his laws of planetary motion?

Focus questions for observing. Primary sources: These relate to the practical use of the telescope and use of the data by the student

Can the moons of Jupiter be viewed from earth? What is the best technique for recording observations of the moons of Jupiter? Can the orbital period of the moons be determined from observations using a telescope? Can the orbital radius of the moons be estimated? Can the orbital period and radius give useful information about the mass and density of Jupiter?

Thoughts and Issues:

Jupiter transit times need to be assessed for each project session. Transits of 8.00 pm to 11.00 pm will give time for observations with Jupiter near the zenith.

Jupiter IS in a favourable position for student viewing in the second half of 2020.

During Semester 1, however, Jupiter is observable only in the early morning, making it unsuitable for projects planned for Semester 1.

Month	Timing	Month	Timing
Mid July	Rise 5 pm Transit midnight Set 7 am	Mid Aug	Rise 3 pm Transit 10 pm Set 6 am
Mid Sept	Rise 1 pm Transit 8 pm Set 2 am	Mid Oct	Rise 12 am Transit 7 pm Set 2 am

Syllabus references:

Stage 4:

ES2 Scientific knowledge changes as new evidence becomes available. Some technological developments and scientific discoveries have significantly changed people's understanding of the solar system.

c. compare historical and current models of the solar system to show how models are modified or rejected as a result of new scientific evidence

d. describe some examples of how technological advances have led to discoveries and increased scientific understanding of the solar system

WS7 Students process data by:

b. using a range of representations to organise data, including graphs, keys, models, diagrams, tables and spreadsheets

Stage 5:

ES1 Scientific understanding, including models and theories, are contestable and are refined over time through a process of review by the scientific community

b. describe, using examples, some technological developments that have advanced scientific understanding about the universe

Stage 6 Physics:

- investigate the relationship of Kepler's Laws of Planetary Motion to the forces acting on, and the total energy of, planets in circular and non-circular orbits using: (ACSPH101)
  - $v=\frac{2\pi r}{T}$ $\frac{r^3}{T^2}=\frac{GM}{4\pi^2}$

2. Astrophotography

The use of modern photographic techniques in astronomy, and the stunning images obtained by amateur astronomers have revolutionised the study of faint objects such as galaxies and nebulae. In this project students will learn how to use a telescope to obtain digital images of a chosen object (or objects), use freely available software to merge and edit the photographs, then seek to explain the features of the object(s).

The project involves students using technical aspects of photography and photo editing and will possibly include workshops at school from MAS mentors. Students have the flexibility to choose the number and type of objects they wish to image depending on their interest and the time available for telescope viewing and imaging.

Background research. Secondary sources: These relate to secondary sources including internet, books, magazines etc.

How does a digital camera work? What free software is used to capture and process images taken through a telescope? How are the objects tracked as the earth rotates? How was the object I am imaging formed? What are some of the images I could record? Where in the sky is the object(s) I want to image?

Focus questions for observing. Primary sources: These relate to the practical use of the telescope and use of the data by the student

What length exposures are needed? How is the noise in a digital image reduced? How are images stacked in software? What types of images can be captured? How can the features in images be enhanced? How many individual exposures are needed? Does the telescope need guiding for this image?

Thoughts and Issues:

Many MAS mentors are involved in astrophotography and are confident in capturing and processing images. Telescope/camera combinations need to be matched to the objects students want to work on.

This project may also be appropriate for students studying visual arts or photography.

Syllabus References:

Stage 4

ES2 Scientific knowledge changes as new evidence becomes available. Some technological developments and scientific discoveries have significantly changed people's understanding of the solar system.

d. describe some examples of how technological advances have led to discoveries and increased scientific understanding of the solar system

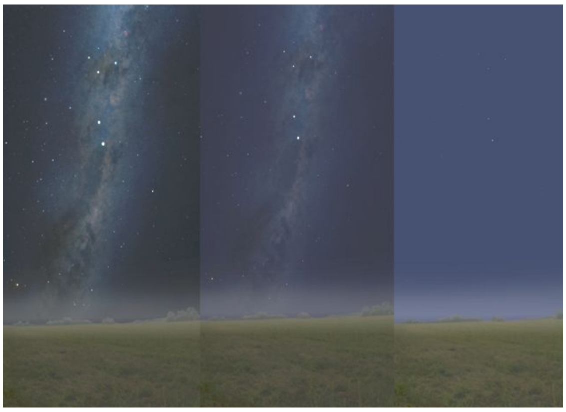
Stage 5:

ES1 Scientific understanding, including models and theories, are contestable and are refined over time through a process of review by the scientific community. (ACSHE157, ACSHE191)

Students:

a. outline some of the major features contained in the universe, including galaxies, stars, solar systems and nebulae (ACSSU188)
b. describe, using examples, some technological developments that have advanced scientific understanding about the universe

3. Light Pollution



Throughout history, humans have gazed in awe at the spectacular sight of the sky in a truly dark location. The stars have been an important part of all cultures and have inspired questions about the nature of the sky and our place in the universe. Our ancestors lived with the clear sky above, but as a sign of a technological society, however, we have turned light upwards and diminished the spectacle above us, and as a result many adults have never seen a truly dark sky. Instead, people now must travel far from cities and towns to experience the same skies as our ancestors.

In this project students will observe the night sky from urban and dark sites and measure the 'light pollution' at these locations. The sky will be recorded using photographs and measurements made from these of the light pollution, leading to an assessment of the light pollution in our region. Students should identify areas or sites of concern and outline possible solutions for local council to consider. Students reports may be submitted to local council members.

The project involves students using technical aspects of photography and photo editing and will possibly include workshops at school from MAS mentors. This is a flexible project as students do not require access to a telescope necessarily and may take their measurements at any location just using a digital camera.

Recommended for all students.

Background research. Secondary sources: These relate to secondary sources including internet, books, magazines etc.

What is light pollution? What causes it? How does it affect the visibility of stars in the night sky? How can it be estimated or measured? What is the Bortle scale? What effect could the weather have on light pollution? What measures can be taken to reduce light pollution?

Focus questions for observing. Primary sources: These relate to the practical use of the telescope or camera and use of the data by the student

What length exposures are needed? How can I compare the sky at different locations? How can I compare the sky on different nights? What effect does light pollution have on the visible stars? What effect does the brightness of the Moon have on visibility of objects in the sky?

Thoughts and Issues:

Students could begin the project by comparing stars shown in freely available software such as *Stellarium* with the observable stars from their own location, noting the magnitudes of recognizable stars from the brightest to dullest observable.

Recording of the sky photographically should be done with a camera with selectable exposure settings so the brightness of stars from different locations and different times can be compared. Cameras with automatic exposure will not necessarily show the stars equally as they may set their exposure longer or shorter depending on the surrounding brightness in the area. This means that recording using a mobile phone camera may not be as useful as using a digital camera.

Students could extend this project by designing and making a model street light shroud that would reduce light pollution.

Syllabus References:

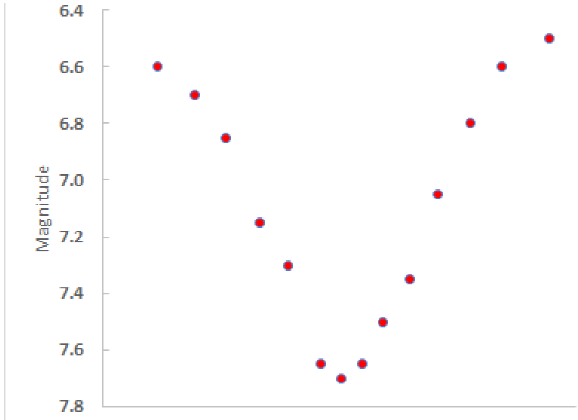
SC4-3VA, SC5-3VA
demonstrates confidence in making reasoned, evidence-based decisions about the current and future use and influence of science and technology, including ethical considerations

STAGE 5 **Additional content**

Additional content is not prerequisite knowledge for following stages, but may be used to broaden and deepen students' skills, knowledge and understanding in Stage 5.
Students:

- discuss technological developments that have extended the ability of scientists to collect information about, and monitor events in, the natural world
- relate scattering and dispersion of light to everyday occurrences

4. Variable stars



Many stars are not as constant as they might first appear. Instead, some pulsate and physically expand to several times their original size, only to rapidly collapse again, and others accrue mass from other nearby stars, eventually exploding in dazzling nova eruptions. The light from may stars is reduced when a planet orbiting the star moves in front of the star. In this project students will measure the brightness of selected variable stars over several days. Plotting the brightness over time for each star (the light curve) students will be able to determine the period of variable star, the type of variable star and other features of the star.

This project is both technical and mathematical in nature. Students may need to borrow a telescope from MAS. MAS mentors will provide training with that telescope, planning the best viewing periods, how to measure brightness visually, selecting appropriate variable stars and locating them. *Recommended for advanced 9-11 students.*

Background research. Secondary sources: These relate to secondary sources including internet, books, magazines etc.

Are stars constant? How does the magnitude of stars vary over periods of time? How can the brightness of stars be compared? Do different stars have different light curves?

Focus questions for observing. Primary sources: These relate to the practical use of the telescope or camera and use of the data by the student

How can the magnitude of a star be determined visually? What adjacent stars can be used to estimate magnitude?

Thoughts and Issues:

Selection of suitable short period variable stars.

Name of Star	***HD number***	***Period (days)***	***Mag Max***	***Mag Min***	***Best Observing Months***
W Sagittarii	164975	7.59503	4.29	5.14	Jul - Sep
kappa Pavonis	174694	9.09423 CWType	3.91	4.78	Aug - Oct
beta Doradus	37350	9.8426	3.46	4.08	Dec - Mar
VY Carinae	93203	18.99	6.87	8.05	Mar - May
RZ Velorum	73502	20.39824	6.42	7.64	Mar - June
U Carinae	95109	38.7681	5.72	7.02	Mar - May
RS Puppis	68860	41.3876	6.52	7.67	Feb - May
V Centauri	127297	5.493839	6.43	7.21	May - Aug
Y Sagittarii	91595	5.77335	5.25	6.24	June - Sep
S Triang Aust	142941	6.32344	5.95	6.81	June - Sep

X Sagittarii	161592	7.01283	4.2	4.9	Jul - Sep
eta Aquilae	187929	7.176641	3.48	4.39	Aug - Oct
R Muscae	110311	7.510211	5.93	6.73	May - Jul
S Muscae	106111	9.66007	5.89	6.49	May - Jul

Best Observing is months when star is highest in sky at approx. 8pm

Star maps with comparison stars and other support can be found at:
https://www.variablestarssouth.org/project-bright-cepheids
To successfully study variables using visual techniques, students should be confident in estimating the visual magnitude of stars, perhaps by completing the *Magnitude Of Stars* project.

As an extension, photometry measurements can be used, but MAS mentor needs to have the equipment and expertise in the photometry of variable stars.

Syllabus References:

STAGE 4

ES2 Scientific knowledge changes as new evidence becomes available. Some technological developments and scientific discoveries have significantly changed people's understanding of the solar system.
Students:
d. describe some examples of how technological advances have led to discoveries and increased scientific understanding of the solar system

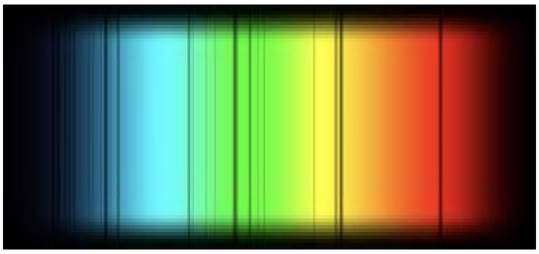
STAGE 5

ES1 Scientific understanding, including models and theories, are contestable and are refined over time through a process of review by the scientific community. (ACSHE157, ACSHE191) . Students:
a. outline some of the major features contained in the universe, including galaxies, stars, solar systems and nebulae (ACSSU188)
b. describe, using examples, some technological developments that have advanced scientific understanding about the universe
f. outline how scientific thinking about the origin of the universe is refined over time through a process of review by the scientific community

Additional content
Additional content is not prerequisite knowledge for following stages, but may be used to broaden and deepen students' skills, knowledge and understanding in Stage 5.
Students:

- relate colours of stars to their age, size and distance from the Earth

5. Spectroscopy



Newton's famous experiment used a prism to show white light dispersing into the colours of the rainbow. When the same white light shone through a spray of different elements the dispersed light (the rainbow) contains a unique pattern of dark absorption lines. When this process is applied to star light these patterns of fine dark lines are also seen. By comparing the patterns from stars with those created by chemicals on earth, the chemical composition of the star can be determined. The majority of a star (including the Sun) is hydrogen. Helium was first discovered in the spectrum of sunlight before it was discovered on Earth.

In this project students use a spectroscopic grating to allow them to take photographs of stellar spectra and compare the spectra from a variety of stars. The spectral class of the star and its chemical composition can then be determined. This project will be primarily technical in nature and is one of the most challenging project listed here, *recommended for advanced year 10-11 students only.*

Background research. Secondary sources: These relate to secondary sources including internet, books, magazines etc.

What is a spectrum? How can the spectrum of a star be observed? What does the spectrum of a star tell us about the nature of the star? How does a prism disperse light into its colours? What is a diffraction grating?

Focus questions for observing. Primary sources: These relate to the practical use of the telescope or camera and use of the data by the student

What software can be used to analyse the spectrum? What exposure length gives the best images? How many stars can be images at once? Can the spectrum be compared to elements in the laboratory?

Thoughts and Issues:

MAS mentor needs to have the equipment and expertise in the imaging and analysis of the spectra of stars.

Syllabus References:

STAGE 4

ES2 Scientific knowledge changes as new evidence becomes available. Some technological developments and scientific discoveries have significantly changed people's understanding of the solar system.
Students:
d. describe some examples of how technological advances have led to discoveries and increased scientific understanding of the solar system

STAGE 5

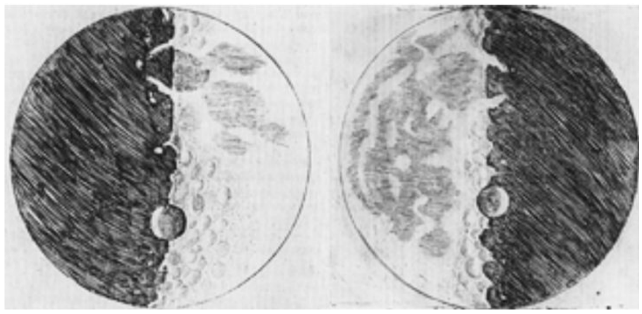
ES1 Scientific understanding, including models and theories, are contestable and are refined over time through a process of review by the scientific community. (ACSHE157, ACSHE191)
Students:
b. describe, using examples, some technological developments that have advanced scientific understanding about the universe
e. use scientific evidence to outline how the Big Bang theory can be used to explain the origin of the universe and its age (ACSSU188)
f. outline how scientific thinking about the origin of the universe is refined over time through a process of review by the scientific community

Additional content
Additional content is not prerequisite knowledge for following stages, but may be used to broaden and deepen students' skills, knowledge and understanding in Stage 5.
Students:

- relate colours of stars to their age, size and distance from the Earth
- discuss technological developments that have extended the ability of scientists to collect information about, and monitor events in, the natural world

6. A changing lunarscape

When Galileo first used his telescope to view the Moon, he discovered vast landscapes showing mountains, valleys, and an amazing number of circular features we now know to be craters. The moon was not the perfectly smooth object the scientific knowledge of his time predicted, and this observation significantly challenged the model of the universe.



In this project students will view the moon to create a detailed map of the moon's surface and/or using observations of the 'degree of cratering' to estimate the age of the moon. In addition, students should view the moon at different phases to collect observations that prove the moon is not uniform or smooth. Students may take photographs or make sketches to assist.

This project requires students to work with their mentor to view the moon at various phases and take photographs or make sketches. It is observational and technical in nature, possibly requiring simple calculations such as comparing the diameter of the Moon to the diameter of craters.

Background research. Secondary sources: These relate to secondary sources including internet, books, magazines etc.

What features of the Moon are visible when observing with binoculars and/or telescopes? How can they be recorded?

Focus questions for observing. Primary sources: These relate to the practical use of the telescope or camera and use of the data by the student

How can the brightness of the light from the Moon be overcome for visual work? How can an image of the Moon be taken? Do the shadows inside craters change over the observation period? Can features observed on the surface of the Moon be placed into chronological order?

Thoughts and Issues:

Who will select lunar objects to image/observe/sketch. Timing of a suitable lunar phase to best observe the selected feature(s). Recording of the feature(s) with suitable telescope/camera combination

A moon phase calendar:

https://maas.museum/sydney-observatory/astronomy-resources/moon-phase-calendar/

Syllabus References:

STAGE 4

ES2 Scientific knowledge changes as new evidence becomes available. Some technological developments and scientific discoveries have significantly changed people's understanding of the solar system.
Students:
a. explain that predictable phenomena on the Earth, including day and night, seasons and eclipses are caused by the relative positions of the sun, the Earth and the moon (ACSSU115)

c. compare historical and current models of the solar system to show how models are modified or rejected as a result of new scientific evidence

d. describe some examples of how technological advances have led to discoveries and increased scientific understanding of the solar system

STAGE 5

ES1 Scientific understanding, including models and theories, are contestable and are refined over time through a process of review by the scientific community. (ACSHE157, ACSHE191)
Students:
a. outline some of the major features contained in the universe, including galaxies, stars, solar systems and nebulae (ACSSU188)

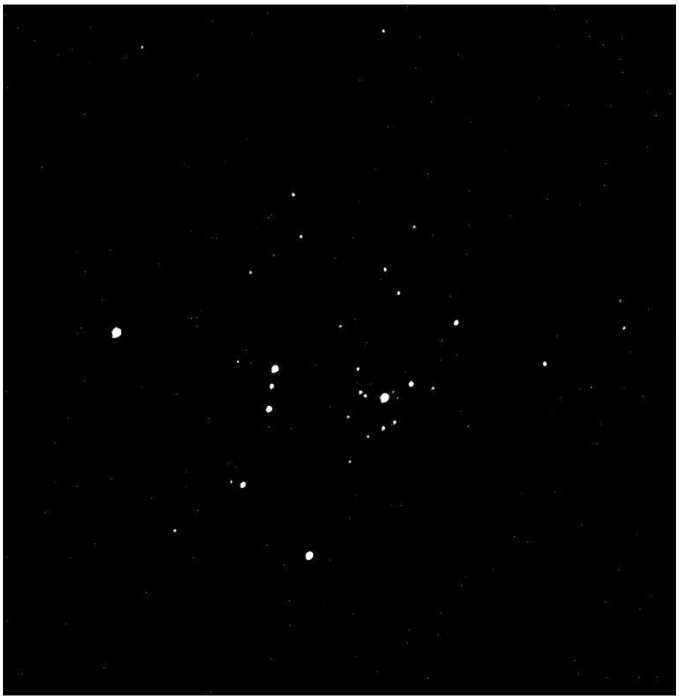
b. describe, using examples, some technological developments that have advanced scientific understanding about the universe

c. use appropriate scales to describe differences in sizes of and distances between structures making up the universe

Additional content
Additional content is not prerequisite knowledge for following stages, but may be used to broaden and deepen students' skills, knowledge and understanding in Stage 5.
Students:

- describe evidence used to support estimates of time in the universe
- discuss technological developments that have extended the ability of scientists to collect information about, and monitor events in, the natural world

7. Magnitude of stars



Astronomers use an unusual measuring unit for comparing the brightness of stars. Students will explore the history and importance of this unit, then collect measurements of apparent magnitude for celestial objects and explain possible reasons for the differences in brightness.

This project requires students to work with the mentor to select and measure the brightness of a range of objects. It is observational in nature and is *recommended for all students.*

Background research. Secondary sources: These relate to secondary sources including internet, books, magazines etc.

What is meant by the "magnitude" of a star? What is the difference between absolute and visual magnitude? What is the magnitude scale?

Focus questions for observing. Primary sources: These relate to the practical use of the telescope or camera and use of the data by the student

How can the magnitude of a star be estimated or measured? Which nearby stars can be used to estimate magnitudes? Can an image be analyses to determine the magnitude of stars?

Thoughts and Issues for:

A straight forward project requiring binoculars and/or a telescope. Students need to select stars, then be given/locate star maps with the magnitude of adjacent stars (but not the selected target stars). Areas of the sky near Orion or Crux should give a range of stars close enough to compare magnitudes. Open clusters such as the Jewelbox have a range of stars in close proximity.

As an extension, DSLR photography of the Jewel Box through a telescope (1 second exposure through f10 200 mm SCT and APS-C chip) analysed through *AstroImageJ* (freeware), checked with comparison stars and plotting integrated counts against magnitude of comparison stars gave reasonable visual magnitudes for many stars in the cluster. This may be worth further investigation.

Syllabus References:

STAGE 4

ES2 Scientific knowledge changes as new evidence becomes available. Some technological developments and scientific discoveries have significantly changed people's understanding of the solar system.
Students:
c. compare historical and current models of the solar system to show how models are modified or rejected as a result of new scientific evidence

d. describe some examples of how technological advances have led to discoveries and increased scientific understanding of the solar system

STAGE 5

ES1 Scientific understanding, including models and theories, are contestable and are refined over time through a process of review by the scientific community. (ACSHE157, ACSHE191)
Students:
a. outline some of the major features contained in the universe, including galaxies, stars, solar systems and nebulae (ACSSU188)

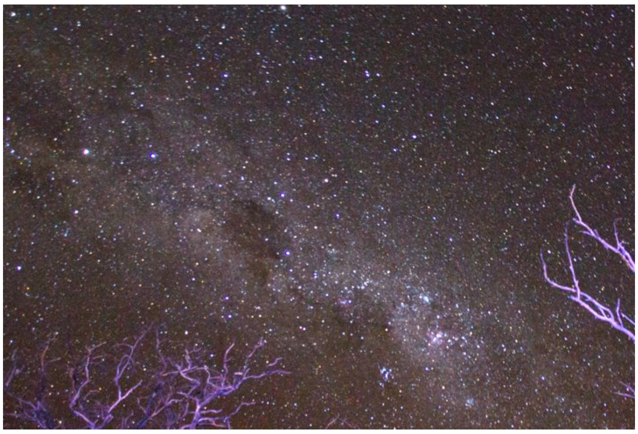
b. describe, using examples, some technological developments that have advanced scientific understanding about the universe

c. use appropriate scales to describe differences in sizes of and distances between structures making up the universe

Additional content
Additional content is not prerequisite knowledge for following stages, but may be used to broaden and deepen students' skills, knowledge and understanding in Stage 5.
Students:

- relate colours of stars to their age, size and distance from the Earth
- discuss technological developments that have extended the ability of scientists to collect information about, and monitor events in, the natural world

8. A survey of southern skies



One of Australia's unique but often unrecognized scientific resources is our access to the southern night skies. The northern hemisphere's skies have been studied in great depth, but often stars in the southern hemisphere have not been exposed to the same level of vigorous research, which provides a special opportunity to Australian researchers. In this project students will explore the objects present in the southern night skies, explain their importance to astronomy/astrophysics. Students will take photographs of some of these objects and constellations (with or without telescopes as necessary) and create a map of the unique objects in the southern skies.

This project requires students to work with the mentor to identify celestial objects viewable in the southern skies and take observations or photographs of those objects and constellations. The project is both observational and technical in nature. This project is *recommended for all students*.

Background research. Secondary sources: These relate to secondary sources including internet, books, magazines etc.

What are some of the features of the southern sky? How can they be recorded? What is a planisphere? How large are some of the features of the sky compared to the size of the Moon? What features can be observed using naked eye, binoculars, telescope?

Focus questions for observing. Primary sources: These relate to the practical use of the telescope or camera and use of the data by the student

How do you use a planisphere to navigate the night sky? What do constellations look like?

Thoughts and Issues for:
Students could start with wide field photographs taken with a camera on a tripod, then move to selected objects and use higher magnification to focus on specific features of the objects.

Syllabus References:

STAGE 4

ES2 Scientific knowledge changes as new evidence becomes available. Some technological developments and scientific discoveries have significantly changed people's understanding of the solar system.
Students:
a. explain that predictable phenomena on the Earth, including day and night, seasons and eclipses are caused by the relative positions of the sun, the Earth and the moon (ACSSU115)

b. demonstrate, using examples, how ideas by people from different cultures have contributed to the current understanding of the solar system

c. compare historical and current models of the solar system to show how models are modified or rejected as a result of new scientific evidence

d. describe some examples of how technological advances have led to discoveries and increased scientific understanding of the solar system

STAGE 5

ES1 Scientific understanding, including models and theories, are contestable and are refined over time through a process of review by the scientific community. (ACSHE157, ACSHE191)
Students:
a. outline some of the major features contained in the universe, including galaxies, stars, solar systems and nebulae (ACSSU188)

b. describe, using examples, some technological developments that have advanced scientific understanding about the universe

c. use appropriate scales to describe differences in sizes of and distances between structures making up the universe

9. Double Stars

Many stars in the night sky are double or triple stars. Some are the chance alignment of two stars separated by long distances, while others are star systems in which both stars orbit each other. This project looks at the nature of a selection of reasonable bright double stars in order to estimate their brightness, colours (ie temperatures) and separation. Students could then research the nature of binary stars and how some binaries can provide information of the size and mass of the stars.

Background research. Secondary sources: These relate to secondary sources including internet, books, magazines etc.

What is a double star? Are double stars the same as each other? Are they the same colour as each other? Are they the same distance apart? Do they orbit each other? What information about stars can we get from observing double stars?

Focus questions for observing. Primary sources: These relate to the practical use of the telescope or camera and use of the data by the student

Can the components of the double stars be identified visually? Can they be recorded using a camera? Can the separation angle of the stars be determined? Can the relative brightness of the two components be estimated?

Thoughts and Issues

Some possible target double stars:

Star	Magnitudes		Separation (arcmin)	observation months
	brightest	dullest		
Gamma Volantis	3.9	5.4	14.1"	Mar-June
Gamma Velorum AB	1.8	4.1	41.4"	Feb - June
Gamma Velorum CD	7.3	9.4	22.2"	Feb - June
Upsilon Carinae	3.0	6.0	4.8"	Mar-June
Alpha Crucis AB	1.3 (blue-white)	1.6(blue-white)	4.0"	Mar - Aug
Alpha Crucis AC	1.3 (blue-white)	4.8	90.0"	Mar 0- Aug
Gamma Crucis NOT A DOUBLE!!!	1.8 (orange)	6.5 (white)	125.4"	
Beta Muscae	3.5 (blue-white)	4.0 (blue-white)	1.4"	Mar - Aug

Mu Crucis	3.9	5.0	34.6"	Mar 0- Aug
Alpha Centauri	0.0	1.4	13.3"	Mar - Sept
Alpha Circini	3.2 (yellow)	8.5 (red)	15.6"	Apr - Sept
Theta Indi ***	4.5	6.9	6.7"	July - Nov
Delta Tucanae ***	4.5 (white)	8.7 (red)	7.0"	Aug - Oct

*** Not easily visible during the first half of the year.

Photography of the double stars could allow students to determine the magnitude of the two components by comparison with known stars. Using the field of view of the frame could let them estimate the angular separation.

A useful starter for teachers supervising the double stars project could be:
https://www.skyandtelescope.com/observing/celestial-objects-to-watch/southern-double-star-gems/

Syllabus references:

STAGE 5

ES1 Scientific understanding, including models and theories, are contestable and are refined over time through a process of review by the scientific community. (ACSHE157, ACSHE191)
Students:
a. outline some of the major features contained in the universe, including galaxies, stars, solar systems and nebulae (ACSSU188)
b. describe, using examples, some technological developments that have advanced scientific understanding about the universe
c. use appropriate scales to describe differences in sizes of and distances between structures making up the universe
d. identify that all objects exert a force of gravity on all other objects in the universe

Additional content
Additional content is not prerequisite knowledge for following stages, but may be used to broaden and deepen students' skills, knowledge and understanding in Stage 5.
Students:

- relate colours of stars to their age, size and distance from the Earth
- discuss technological developments that have extended the ability of scientists to collect information about, and monitor events in, the natural world

10. The Phases of the Moon

The Moon undergoes phases over a monthly cycle (almost). The phases tell us the relative positions of the Earth, Sun and Moon. The terminator (shadow line) gives the best images of the features of the lunar landscape. In this project, students will observe and record the lunar phases during its cycle with and/or without a telescope at the same time each night and record the phase shape and the compass direction of the Moon from their location.

A simple sighting device made using a protractor, a drinking straw, a piece of string and a weight can be used to measure the elevation angle of the Moon. This angle and the compass direction can be plotted to give a map of the path of the Moon across the sky.

This project can be extended to more technical aspects of imaging if photographs are taken using a telescope.

This project is recommended for all students.

Background research. Secondary sources: These relate to secondary sources including internet, books, magazines etc.

What causes the phases of the Moon? Over what time period does the Moon go through the complete phases cycle? What is a waxing and waning Moon? What is a "gibbous" Moon? What does the information tell us about the relative motions of the Earth, Sun and Moon?

Focus questions for observing. Primary sources: These relate to the practical use of the telescope or camera and use of the data by the student

When will the Moon be visible? What dates will give a good range of observations. Is it best to start with the Full or New Moon? Why should I take the observations at the same time each night? How can the observations be recorded?

Thoughts and Issues

A moon phase calendar:
https://maas.museum/sydney-observatory/astronomy-resources/moon-phase-calendar/

Syllabus References:

STAGE 4

ES2 Scientific knowledge changes as new evidence becomes available. Some technological developments and scientific discoveries have significantly changed people's understanding of the solar system.
Students:
a. explain that predictable phenomena on the Earth, including day and night, seasons and eclipses are caused by the relative positions of the sun, the Earth and the moon (ACSSU115)

11. Observing the Sun

The Sun is the ultimate source of most of the energy we use. It is a dynamic body with features that affect our lifestyle, even though we live far from the Sun. The features on the surface give clues to the processes that give the Sun its energy.

In this project, students work with their mentor to make observations of the Sun using a dedicated solar telescope. They identify the surface features and look for patterns over days of observing.

Background research. Secondary sources: These relate to secondary sources including internet, books, magazines etc.

How can the Sun be observed safely? How large is the Sun? Can its diameter be estimated? What is the angular size of the Sun at Noon when it is directly overhead, and at sunset? What does this indicate about the distance to the Sun?

Focus questions for observing. Primary sources: These relate to the practical use of the telescope or camera and use of the data by the student

What are the surface features of the Sun? How can they be observed and recorded? Does the Sun rotate on its axis?

Thoughts and Issues
Detailed observations require either appropriate solar filters or a dedicated solar telescope. Observations are during the day, so will happen at schools. This will require the mentor to be available during the day, student observations during lunchtime requiring appropriate supervision, or perhaps for students to be withdrawn from classes to observe at the same time each day. Supervising teachers will need to be able to accommodate the availability of the mentor.

Students can begin with observing the Sun with a pin-hole camera. Simple geometry can be used to estimate the diameter of the Sun given its distance using a pin-hole camera.
Solar observing can be carried out using a telescope with appropriate SOLAR FILTER, or by using a dedicated solar telescope. Features observed can be sketched or photographed. The size of the features can be estimated by comparing the feature's size with the diameter of the Sun (perhaps found earlier by using the pin-hole camera). The period of rotation can be determined by observing the features each day.
More data can be collected from Solar Satellites and Observatories – for example the velocity of expansion of solar prominences can be measured:
https://spacemath.gsfc.nasa.gov/sun/6Page152.pdf

Note hazards to eyesight of solar viewing that must be addressed at all times.

Syllabus References:

STAGE 4

ES2 Scientific knowledge changes as new evidence becomes available. Some technological developments and scientific discoveries have significantly changed people's understanding of the solar system.
Students:
a. explain that predictable phenomena on the Earth, including day and night, seasons and eclipses are caused by the relative positions of the sun, the Earth and the moon (ACSSU115)
d. describe some examples of how technological advances have led to discoveries and increased scientific understanding of the solar system

STAGE 5

ES1 Scientific understanding, including models and theories, are contestable and are refined over time through a process of review by the scientific community. (ACSHE157, ACSHE191)
Students:
a. outline some of the major features contained in the universe, including galaxies, stars, solar systems and nebulae (ACSSU188)
b. describe, using examples, some technological developments that have advanced scientific understanding about the universe
c. use appropriate scales to describe differences in sizes of and distances between structures making up the universe

Additional content
Additional content is not prerequisite knowledge for following stages, but may be used to broaden and deepen students' skills, knowledge and understanding in Stage 5.
Students:

- discuss technological developments that have extended the ability of scientists to collect information about, and monitor events in, the natural world

Generic mentoring risk assessment

Task/Activity	Hazard Identification & Associated Risk Type/Cause	Assess Risk* use matrix	Elimination or Control Measures
Travel to and from observing venue by parent's car	Dark site, leaving with low lights	5	All cars of parents face exit
	Rough track at entry	6	Advice to parents driving students to site
	Wombats and other animals	6	Advice to parents driving students to site
Insect bites and stings	Anaphylactic reactions	4	Parents to ensure students with known allergies have EpiPen if required, and are able to administer it. Parents to inform mentors of allergies . Advice to parents' nearest hospital is Camden Hospital
	Insect bites	5	Parents to provide students with appropriate insect repellent. Students are to wear enclosed footwear, long pants and other protective clothing.
Trip hazards		4	Students are required to wear substantial footwear
			Students and mentors exercise care in movement around telescopes and equipment, especially tripod legs
Dark site	No white lights in use	5	Students to provide a red torch for student use.
Cold	Observing nights will be cold, and there is little if any shelter	6	Students advised to wear warm clothing: jackets, beanies, gloves etc
Direct sunlight (Solar Project)	Direct viewing of the Sun will lead to permanent damage to eyes.	2	At no time are students to be able to directly observe the Sun through any telescope
			Dangers explained clearly to students prior to viewing
			Solar scope arranged to prevent unfiltered views of the Sun
Inclement weather	Rain, thunderstorms etc	6	Check weather forecast for observing sessions and contact parents if this will impact students.
			Cancel viewing in poor weather conditions.

Risk Assessment Matrix

How serious could the injury be?	***How likely is it to be that serious***			
	Very Likely	Likely	Unlikely	Very Unlikely
Death or permanent injury	1	1	2	3
Long term illness or injury	1	2	3	4
Medical attention & several days off	2	3	4	5
First aid needed	3	4	5	6

Severity – is how seriously a person could be harmed

Likelihood – is an estimate of how probable it is for the hazard to cause harm.

Legend

1 and 2	Extreme risk; deal with the hazard immediately
3 and 4	Moderate risk; deal with the hazard as soon possible
5 and 6	Low risk; deal with the hazard when able.