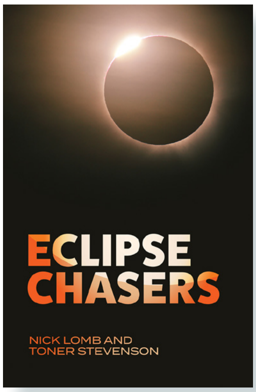
Teacher Notes



Eclipse Chasers

Nick Lomb and Toner Stevenson

About the book

Witnessing a total solar eclipse is a wondrous and unforgettable event!

Eclipse Chasers is a guide to past and future Australian total solar eclipses, exploring historical and cultural knowledge, as well as featuring five upcoming eclipses that will be visible in Australia.

The science of eclipses is explained, as well as how to prepare for an eclipse and view it safely. For upcoming eclipses the best locations to view each one are revealed, alongside tips for taking photographs.

The book also reveals untold stories of how past Australian astronomers observed the total eclipses that have occurred since European settlement, and how these eclipses were celebrated in popular culture, poetry and art. It explores the great significance of solar eclipses for First Nations peoples, and their observations and cultural meanings.

Eclipse Chasers showcases the drama and beauty of total solar eclipses and is essential for anyone fascinated by these amazing events.

Recommended for

Readers aged 15 to 17 (upper secondary: Years 10 to 12)

Themes

- Significance of eclipses across diverse cultures.
- Advances in scientific knowledge and technology on space and optics.
- Use of records and science to predict future eclipses.

Key learning outcomes

- The predicting and observing of solar eclipses has led to significant advances of scientific theory in physics and astronomy.
- Through what is largely a coincidence, the Moon's relative size compared with that of the Sun's – both as seen from Earth's surface – means total solar eclipses block enough of the Sun's glare for us to directly observe its corona and surrounding sky for a brief period.
- Explanations of solar eclipses have different purposes across diverse cultures, involving different forms of story-telling.
- Solar eclipses occur sporadically according to complex patterns that allow them to be accurately predicted.

Key curriculum areas

- **Science:** Science Understanding (Physical sciences); Science as a Human Endeavour; Physics Units 3 and 4
- **English:** Language; Unit 2
- **Modern History:** Unit 1: Understanding the modern world
- **Cross-curriculum Priority:** Aboriginal and Torres Strait Islander Histories and Cultures

Publication details

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CSIRO Publishing
Private Bag 10
Clayton South, VIC 3169, Australia

Website: www.publish.csiro.au
Tel: 1300 788 000 (local call in Australia)
Email: publishing.sales@csiro.au

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About the authors

Astronomy Professor Dr **Nick Lomb** has guided Australians in all things astronomical for decades. Nick was the Powerhouse Museum/Sydney Observatory Astronomy curator for 30 years, and is the author of the annual *Australasian Sky Guide*.

Dr **Toner Stevenson** is an honorary History affiliate at the University of Sydney, and has over 30 years' experience working in museums and heritage sites in Australia and the UK.

Pre-reading questions or activities

Ask students to share their experiences watching eclipses, both solar and lunar. Where were they? What did they see? How long did it last, approximately? Did they happen to be in the right place by accident, or did they take action to see it on purpose? What emotions did they feel while watching it?

Invite students to draw a diagram of a total solar eclipse (as they recall from previous years of study) on paper or a white board. Prompt them to label as much of it as they can, describing objects involved, relative sizes and approximate distances. Use this to gauge an understanding of the class's prior knowledge on eclipses. Expand on their diagram by asking why we don't see eclipses frequently, such as once every month.

Instruct the class to use the internet to research the next total solar eclipse that will be viewable from Australia. Extend the request by asking whether it would be seen in its totality from the school's location, or if travel would be required.

Discussion questions

Science

1. Solar eclipses as seen on Earth might be among the rarest phenomena in the Universe. Read the second paragraph of *Eclipse Chasers*' Foreword, noting the 'coincidence' required for the Sun's bright body to be nearly perfectly covered by the Moon. Discuss how similar eclipses might look on other planets in the Solar System, such as Mars or Jupiter.
2. Read the first few pages of Chapter 1 and list the major differences between solar and lunar eclipses. Encourage the students to consider things like when they appear, their frequency, appearance and arrangement of planetary bodies.

3. Solar eclipses provide researchers with opportunities to study astronomical phenomena that they wouldn't otherwise be able to see. Ask the class to consider what 'seven minutes of night' in the middle of the day might help researchers see more clearly. Instruct students to read pages 4 and 5, and then return to the discussion with fresh suggestions.
4. Some seemingly unrelated innovations are sometimes required before fields of science can rapidly advance. Read the start of Chapter 3 and discuss how improvements in transport and communication were almost as important as better telescopes for studying solar eclipses.
5. Read 'Scott's observations' on page 27. Solar eclipses were just as important for studying the Moon as they were the Sun. Discuss what William Scott might have been trying to learn about the Moon in his frustrated attempts to study the eclipse on a cloudy Sydney day.
6. Better mirrors provided a significant advance for Australian astronomers in the lead-up to the early 20th century eclipses. Read page 56 and ask the class to share how these simple materials made for better astronomical observations.
7. Read pages 35 to 37, and pages 81 to 83. Both sections describe the press and public's responses to a pending eclipse, each with different amounts of enthusiasm. Discuss with the class why each eclipse might have been celebrated so differently at different times. Ask how the media might respond to future solar eclipses, whether with indifference or enthusiasm. Will it caution viewers on how to observe them safely, or contain misinformation?
8. With Einstein's publishing of his general theory of relativity in 1916, the 1922 eclipse in Australia was seen as a perfect opportunity to test its predictions. Read pages 83 to 86 and discuss what his theory predicted, and why the 1922 eclipse was so useful for testing it.
9. Read pages 137 and 163 to 165, and discuss the stages of the eclipse. Ask the students why it's unsafe to watch an eclipse without suitable vision protection. When is the one time the eclipse is safely seen with the naked eye? Why might it be a good idea to avoid looking at an eclipse at any point in an eclipse, even at 'safest' moments?

Teacher Notes

English

1. Turn to pages 35 and 36, and read the excerpts from the *Sydney Morning Herald* on the 1857 eclipse as seen from Sydney. Note the choice of words, style of language and length of the sentences. Are there any words which are unfamiliar? Look for a similar commentary in a newspaper discussing a more recent solar eclipse, such as the 2012 event as seen from northern Australia. Compared the texts. Why might features such as the sentence length and word choice differ between them?
2. Read the poem 'The Passing Show' on pages 105 and 106. The testing of Einstein's hypothesis on general relativity is a scientific event – why might somebody write a poem about it? What features of the text tell you it's a poem, and not a scientific commentary?

Modern History

1. Early in the book, most observers of eclipses are people with wealth, or at least time and resources. While there were paid astronomers, like William Scott (page 27), some amateur astronomers such as John Tebbutt (page 33) had sufficient wealth to purchase their own equipment and spend time studying the stars. Others, like the Reverend William Branwhite Clarke (page 30), had careers in other fields and observed the sky in their spare time. Discuss how professional science might have changed between the 19th century and today. Are amateur astronomers still as important today? Could anybody become an astronomer in the 19th century? What about today?

Aboriginal and Torres Strait Islander Histories and Cultures

1. Read Chapter 2 and discuss why First Nations peoples might personify celestial objects, including the Sun and the Moon. Discuss how story-telling in our society can incorporate elements of community values, as well as important information about an environment or a history. How much easier is it for us to share important information when it's in the form of a narrative?

Activities

Science

Pinhole camera

Safety: Observing the Sun directly during a solar eclipse poses risks of irreversibly damaging your eyesight. Never look at the Sun at any time before, during or after an eclipse. Use alternative tools, such as a pinhole camera, to see the shape of the Moon transit across the Sun.

In constructing the camera, take care when cutting with scissors and pressing the sharpened pencil through the aluminium foil to avoid cuts and injuries.

When observing the Sun, be sun smart. This doesn't just mean avoiding looking at the Sun directly; it means wearing a hat, sunscreen, collared shirt and sunglasses.

You will need:

- 2 × sheets of stiff, white card (at least 30 cm × 30 cm)
- Scissors
- Ruler
- Sharpened pencil
- Sticky tape
- 10 cm × 10 cm square of aluminium foil

What to do:

1. Draw a square (about 5–8 cm × 5–8 cm) in the approximate centre of one of the white pieces of card.
2. Use the scissors to neatly and carefully cut the square from the card.
3. Use the sticky tape to secure the square of aluminium foil over the top of the square window cut into the card. Make sure the foil is stretched tight with no wrinkles.
4. Carefully poke a small (about 1 mm across), neat hole into the centre of the aluminium foil using the tip of the sharpened pencil.

Using the camera:

1. During a solar eclipse, find an open space outside clear of any large objects that can cast a shadow over your camera.
2. Place the second, uncut piece of white card on the ground.

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3. Put your back to the Sun, and hold the card with the pinhole so its shadow more or less aligns with the card on the ground. Do not look at the Sun while you try to align the cards – rely only on their shadows.
4. Angle the card with the pinhole so a bright circle is seen in the centre of its shadow. This bright circle is the Sun – during an eclipse, it is possible to see the Moon's shadow block out the Sun's light as it moves across the Sun's path.

What's happening?

The pinhole in this camera is what is known as an aperture – a small window that restricts the amount of light passing through an opaque barrier. By limiting the concentration of light rays passing through the barrier, it's possible to keep the light aligned in a way that resembles an image of their source.

In this case, a few of the Sun's rays passing through the aperture describe the shape of the Sun. In some cases, it may even be possible to see darkened patches in the bright circle, which are cooler areas on the Sun's surface known as sunspots.

Since this method of viewing the Sun uses only what little light reflects from the card, it's far safer than using your body's own pinhole cameras (with built-in lenses) – your eyes.

Cosmic ratios

Safety: Take care when holding the skewer near your eye, to avoid injury.

When outside, be sun smart and wear a hat, sunscreen, collared shirt and sunglasses.

You will need:

- 2-metre-long rope
- A sheet of grid paper
- Scissors
- Ruler
- A wooden skewer
- Plasticine
- An open distance of around 200 metres
- Two volunteers

What to do:

1. Cut a small square of paper 5 mm × 5 mm from the grid paper.
2. Stick a tiny piece of plasticine to this paper, and secure it to the tip of the skewer.

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3. (Alternatively, use the grid paper to measure a 5 mm × 5 mm ball of plasticine, which can be secured to the tip of the skewer instead.)
4. Take the skewer with plasticine outside to a wide, open space.
5. Measure out 200 large steps (about 1 metre per step) across the space. Instruct the two volunteers to stand 2 metres apart at the end of this distance (they can hold the 2-metre length of rope between them).
6. Stand at the other end of this 200-metre distance. Hold the skewer out at arm's length, so it aligns with the volunteers and their rope. Close one eye to make the small square of paper on the end of the skewer align with the rope and block it from sight.
7. Bring the skewer in closer to your closed eye slightly, so the distance from your eye to the skewer is about half a metre.
8. How similar do the two sizes look?
9. Consider the ratio of half a step to 200 steps.
10. Consider the ratio of 5 mm to 2 metres.

What's happening?
Side by side, the tiny piece of paper and the long piece of rope couldn't look more different in size.

Separated by a distance of 200 metres, the 2-metre rope looks comparatively shorter – short enough that its perspective more or less matches the width of the 5 mm piece of paper.

The sizes of the Moon and the Sun share a similar ratio to the width of the piece of paper and the length of the rope – about 1:400.

By coincidence, right now in Earth's history the distance from Earth to the Moon, and the Moon to the Sun, is also about 1:400. This matching ratio means that like the paper and the length of rope, the Moon comes close to matching the apparent size of the Sun as seen from Earth, in spite of being so much smaller.

English

A new perspective
Read the section 'Nick and the 2012 eclipse' starting on page 150, and consider the author's expectations and emotions over observing a solar eclipse.

Consider how you'd feel in the author's position. What might your expectations be? How would you feel?

Imagine you're a travel writer for the *Sydney Morning Herald*. Write a few hundred words detailing your own hypothetical experience of the 2012 solar eclipse as seen in far north Queensland. What might you recommend to your readers? How would you describe the eclipse?

Following this column, you've been asked to write a shorter text for a children's section of the newspaper. How would your language differ? What would you say differently?

Modern History

Technobabble

Innovations in technology mean just about every solar eclipse provides opportunities to advance scientific knowledge in some way.

Below is a list of instruments that provides observers of solar eclipses with a means to measure something they once couldn't detect in detail.

Write each word on a small card (roughly 10 cm × 20 cm). Hand each student (or group of students) an individual card, and instruct them to research the instrument. They are to find details on an approximate date (or century, if a precise date isn't known) explaining when it was first applied to a solar eclipse, a rough description of how the instrument functions, and its role or purpose in studying solar eclipses. Ask them to write down their findings on a separate sheet of paper, or in a workbook.

Hand students five additional white cards. Ask them to write down individual notes from their findings on individual cards (they don't need to use all of the cards) – these will be 'summary cards'.

Collect the summary cards at the end of the session.

Collect the word cards and shuffle them. Hand them out to each student or group, so they get a different card to before.

Ask them to find summaries they think suit their new card.

- Thermometer
- Siderostat
- Spectrograph
- Coronagraph
- Chronograph
- Camera
- Telescope

- Barometer
- Coelostat
- Aircraft
- Rocket

Aboriginal and Torres Strait Islander Histories and Cultures

Language map

There are a number of language groups and First Nations cultures mentioned in Chapter 2, such as the Wiilman people in Western Australia and the Arrernte traditions of the Central Desert.

List the cultures mentioned, and locate their country on a map of Australia. Research other stories, words and traditions embraced by the people, and discuss how their stories about the Sun, Moon and eclipses might communicate important information, cultural values, or even warnings about the dangers of viewing solar eclipses.

Australian curriculum links (Secondary)

Year level	Learning area: Science	Other learning areas
Year 10 [Version 9.0]	**Science Understanding: Physical sciences** • Investigate Newton's laws of motion and quantitatively analyse the relationship between force, mass and acceleration of objects (AC9S10U05) **Science as a Human Endeavour: Nature and Development of Science** • Explain how scientific knowledge is validated and refined, including the role of publication and peer review (AC9S10H01)	**English: Language** • Use an expanded technical and academic vocabulary for precision when writing academic texts (AC9E10LA08)
Senior (11 and 12) [Version 8.4]	**Physics: Unit 3: Gravity and electromagnetism** • Use science inquiry skills to design, conduct, analyse and evaluate investigations into uniform circular motion, projectile motion, satellite motion and gravitational and electromagnetic phenomena, and to communicate methods and findings **Physics: Unit 4: Revolutions in modern physics** • Understand how models and theories have developed over time, and the ways in which physical science knowledge and associated technologies interact with social, economic, cultural and ethical considerations	**English: Unit 2** • Compare texts in a variety of contexts, mediums and modes by: explaining the relationship between purpose and context (ACEEN021) • Analyse and evaluate how and why responses to texts vary through: the ways ideas, attitudes and voices are represented, for example, how events are reported differently in the media (ACEEN029) • Reflect on their own and others' texts by: analysing the values and attitudes expressed in texts (ACEEN038) **Modern History: Unit 1: Understanding the Modern World** • Identify links between events to understand the nature and significance of causation, change and continuity over time (ACHMH001) • Analyse and account for the different perspectives of individuals and groups in the past (ACHMH010)
All	**Cross-curriculum Priority: Aboriginal and Torres Strait Islander Histories and Cultures** A_TSICP1 • First Nations communities of Australia maintain a deep connection to, and responsibility for, Country/Place and have holistic values and belief systems that are connected to the land, sea, sky and waterways.	

Teacher Notes

Related titles from CSIRO Publishing

For readers aged 5–8:

- *Shine, Star, Shine!* (https://www.publish.csiro.au/book/8089)

For readers aged 8–12:

- *How to Survive on Mars* (https://www.publish.csiro.au/book/8011)

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