Lifecycle of a star – Intermediate Module

<table>
<tr><td colspan="2">Program overview
Lessons required – 3
In this sequence of lessons students will learn about the lifecycle of stars. Students will learn about a stars' lifecycle in lesson 1 and then take and process images of different stages using SPIRIT in lessons 2 and 3. Further developments on this concept include discussions/debates surrounding the idea 'we are star stuff' and exploration of what the future of the universe may look like.
It is assumed teachers have a background knowledge of using Stellarium and SPIRIT to guide their students through it. If you need assistance don't hesitate to contact spirit@icrar.org for guidance and support.</td></tr>
<tr><td>Skills focus:
Lifecycle of stars
Coding (optional- only if using live viewing)
STEM skills
Critical analysis
Independent thinking
Digital literacy
Creativity
Communication</td><td>Required digital resources:
Device (laptop, computer, tablet) with internet access
Stellarium – (free software) http://stellarium.org
A FTP program (recommended free software Filezilla https://filezilla-project.org)
If you are choosing to process your images:
FITS liberator – (free software- converts FITS files to TIF files to use in photoshop)
https://noirlab.edu/public/products/fitsliberator/
Photoshop or a free photo processing software such as GIMP or Photopea.com</td></tr>
<tr><td colspan="2">Curriculum links:
Science
The universe contains features including galaxies, stars and solar systems, and the Big Bang theory can be used to explain the origin of the universe (ACSSU188) Year 10

ATAR Physics- year 12, unit 3- Gravity and electromagnetism

Communicate ideas, findings and evidence-based solutions to problems using scientific language, and representations, using digital technologies as appropriate (ACSIS133 and ACSIS148) Year 7 and 8</td></tr>
</table>

<table>
<tr><td colspan="2">Evaluate conclusions, including identifying sources of uncertainty and possible alternative explanations, and describe specific ways to improve the quality of the data (ACSIS171 and ACSIS205) Year 9 and 10

Advances in scientific understanding often rely on developments in technology and technological advances are often linked to scientific discoveries (ACSHE158 and ACSHE192) Year 9 and 10</td></tr>
<tr><td>Science Inquiry Skills – year 7-10
• Questioning and Predicting
• Planning and Conducting
• Processing and Analysing Data and Information
• Evaluating
• Communicating
Digital Technologies – year 7 – 10
• Collecting, managing, and analysing data
• Digital implementation
• Creating solutions</td><td>General capabilities:
Numeracy
ICT capabilities
Critical and creative thinking
Literacy</td></tr>
<tr><td>Lesson 1 (60 minutes)
Prequisites:
• Internet enabled devices that are able to scan QR codes
• Stellarium downloaded
• QR codes printed and ready to use</td><td>1. Ask students to brainstorm, on a piece of paper or in a digital format, everything that they know about the lifecycle of stars. This could be writing sentences, terms they know, diagrams or attempting to pull out the lifecycle itself in a variety of ways. This can be done individually or in small groups.
2. Allow students time to share some of the ideas they have written down.
3. Introduce the phrase ‘we are all star stuff’ and discuss what that means. Does it have any meaning in a science context? Who agrees or disagrees with the statement and why?
4. Watch https://www.youtube.com/watch?v=4xIQGbYur9Q (16.35) to give an overview of the lifecycle of stars.
5. If needed, go through vocabulary that was brought up throughout the video. Find an extensive list of vocabulary in the appendix.</td></tr>
</table>

	6. Using the picture QR cards, students can put the lifecycle in order and then scan the QR codes to learn more about each stage by watching a video. Students may want to work in groups to watch one or two videos each and share some of their findings. 7. Discussion questions: How do we know the lifecycle of a star given how long stars take to complete the cycle? Are there any other types of science where we make observations in a similar way? Do bigger stars have shorter or longer life cycles than smaller stars? Why might that be? 8. Using the internet, and Stellarium, students should research different stages of a stars lifecycle that can be viewed from the southern hemisphere, e.g. nebulas, supernova remnants, planetary nebula, high mass main sequence stars. Students can also use the viewing guide provided for guidance. **Extra activities:** a) Interactive program Star in a Box: https://starinabox.lco.global/# allows students to simulate the life cycle of stars at different solar masses. b) Students can test their knowledge with the following interactive games: https://wordwall.net/resource/22083521/science/life-cycle-of-a-star https://wordwall.net/resource/10808358/physics/life-cycle-of-star-processes
Lesson 2 (60 minutes) **Prequisites:** • Internet connected laptop or computer for students • Stellarium downloaded on devices	1. Review the last lesson and discuss the stages of a star's lifecycle. 2. Discuss why we are not able to image every stage of a star's life cycle. E.g. why can't we image black dwarfs or neutron stars? 3. Use Stellarium to double check the objects from the last lesson. Students can use the list provided for guidance. They may want to fill out the My Viewing Plan sheet to write down exposure time etc. 4. Use SPIRIT to get images by: *a) Live viewing- If you are using live viewing and would like students to create a plan to practice their coding skills use the information here.* **Please note: If using live viewing teachers need to book the appropriate time on SPIRIT 2. Students or teachers will need to log in at the requested time to complete their viewing plan and live viewing.** *b) Scheduling- If you are using the scheduler then students should follow the instructions here.* **Please note: Students or teachers will need to include an email address in the schedule browser section of the web interface to make sure they get notified when the images are ready.**

	Extra activities: a) Research the life of Annie Jump Cannon, a female pioneer in the classification of stars. b) In small groups discuss the effect that a star's mass has on its lifecycle e.g. timespan, luminosity and temperature. What type of star would have the longest lifecycle?
Lesson 3 (60 minutes) **Prerequisites:** • Internet enabled devices • Filezilla downloaded • Photoshop if using Teachers will need to be familiar with how to use Filezilla to access the FTP where SPIRIT files are kept. Please contact us for FTP information. Teachers should check that the images are ready to be viewed.	1. Review phases of a star's lifecycle as covered in the last two lessons. 2. Use Filezilla to access images. Information can be found here. 3. If you are choosing to process the images into colour then use Photoshop, or a free program such as GIMP or Photopea. Information on using Photoshop can be found here, and using Photopea can be found here. 4. Ask students to share their images in small groups or as a whole class and discuss what part of a star's lifecycle they have, and a few things about what they know about that part of the lifecycle. How many parts of the lifecycle have you imaged as a class? 5. Revisit the concept of 'we are star stuff'. Discussion questions: What are students' opinions now? Has anyone changed what they originally said/thought in the first lesson? Is the statement scientifically accurate? What does it mean to be 'star stuff'? Watch https://www.youtube.com/watch?v=Vyq3YYFlzpQ for a summary of the role that 'star stuff' plays in our day to day lives. 6. Now that we know the lifecycle of stars, have a discussion of what the universe may look like once all the stars have died. Ask students to make a hypothesis. What kind of objects will still exist? Will there be any light? What kind of elements, and in what quantities will be around? Will life be possible in these conditions? This video outlines possible ends to the universe based on current theories: https://www.youtube.com/watch?v=itpLU7OzNV8

<table>
<tr>
<td></td>
<td>Extra activities:
a) Discuss what parts of the lifecycle couldn’t be imaged and why. (Some parts don’t exist e.g. black dwarf and others need to be imaged with radio waves, or infrared.) Use https://gleamoscope.icrar.org/gleamoscope/trunk/src/ or the Gleamoscope app to explore different parts of the EM spectrum and what different celestial objects may look like using them.
b) As a class work through the following play for the licecycle of stars: https://mcdonaldobservatory.org/sites/default/files/pdfs/teachers/GalaxiesPDFs/LivesOfStars-SG_072110.pdf Alternatively write your own play in small groups.</td>
</tr>
<tr>
<td colspan="2">What next:
Using SPIRIT, students can undertake more astronomy research projects such as investigation the formation and evolution of galaxies.
If you are looking for ideas or support on how to use SPIRIT in your classroom, please contact us at any time at: spirit@icrar.org</td>
</tr>
</table>

Glossary of terms

Definitions mainly adapted from ASPIRE – University of Utah

Interstellar medium- The interstellar medium is made up of small particles of dust and gas that exists in the space between stars. Although it is mostly made up of hydrogen, events like supernovae will blast heavy elements like iron out into space where they become part of the interstellar medium. These elements will then be pulled in by new protostars to form new stars and planets.

Nebula- a nebula is an area where the interstellar medium has clumped together to form a huge cloud of dust and gas. Nebulae are the birthplace of most protostars.

Protostar- A protostar is a ball of dust and gases that has not yet reached a high enough temperature to begin hydrogen fusion and become a star. It will continue to accrete more matter and heat up until it reaches about 10 million degrees kelvin.

Main sequence- the main sequence is the name for the longest stage of a star's lifecycle when it is burning hydrogen at its core. More massive stars with spend less time in the main sequence, while stars smaller than our sun could spend trillions of years as main sequence stars.

Brown dwarf- Brown dwarfs are protostars that never got hot enough to ignite hydrogen fusion. They glow very dimly, making them very hard to detect.

Red giant- Stars that have begun to fuse helium at their core expand to become red giants. As the surface of the stars expand, they begin to cool, giving the star and orange or red colour. Red giants are not as stable as main sequence stars, and most will eventually blow their surface off into space forming a planetary nebula.

Supergiant- The most massive stars will leave the main sequence relatively quickly, becoming supergiants. A supergiant star has enough mass that it will be able to fuse not only helium but heavier elements, as well. When iron begins to build up in the star's core it will be unable to maintain equilibrium and collapse, resulting in a supernova.

Planetary nebula- when the outer shell of a red giant drifts off into space, it forms a planetary nebula.

White dwarf- White dwarfs are the cores of red giants that have lost their outer layers. White dwarfs are no longer capable of fusion, but they are incredibly hot, which means that they will shine brightly for a very long time.

Black dwarf- Once a white dwarf has cooled so much that it is no longer giving off light, it is called a black dwarf.

Supernova- A supernova is the explosion that occurs when a supergiant star's core collapses. The tremendous amounts of energy released in this explosion allow elements heavier than iron to be formed.

Neutron star- A neutron star is the core of a star has gone supernova. The pull of gravity has crushed the matter together so tightly that individual atoms are forced together, losing their electrons. The resulting matter is made up of tightly compressed nucleons, mainly neutrons. Even though it might have more mass than the sun, it is compressed to a tiny ball only about 24 kilometres across.

Pulsar- Pulsars are neutron stars which spin rapidly and produce huge electromagnetic radiation along a narrow beam. Neutron stars are very dense, and have short, regular spins.

Magnetar- A type of neutron star with an extremely powerful magnetic field.

Black hole- A black hole is a remnant of a supermassive star's core. A black hole is so small and dense that even light can't escape from it. The intense gravitational field of the black hole simply bends the light back inside before it goes anywhere.

Solar mass- the term solar mass refers to the mass of our own sun. We compare the mass of other stars to the sun by measuring how many 'solar masses' it is.

Standard candles- A standard candle is an astronomical object that has a known absolute magnitude (luminosity). These standard candles can then be used to figure out the magnitude of other objects and thus calculate the distance of objects in space.