

ACTIVITY 18 - Taking and Analysing a Stellar Spectrum – a simulation program.

Year Level: Years 10 to 12 (typically 15 to 18 years of age).

Background: Spectroscopy is a key tool in astronomy. By obtaining and analysing the spectrum, from a distant object, astronomers can identify what type of object it is and determine a wealth of characteristics for the object. These include its effective temperature, how fast it is rotating and whether it is moving towards or away from us, how large and dense it is and what it is made of. Within the last decade planets beyond our Solar System have been discovered via their effect on the parent star's spectrum.

Aim: To investigate the spectrum of a star using the simulation program CLASSIFICATION OF STELLAR SPECTRA and analyse that spectrum to find out characteristics of that star.

Shape of the Australian Curriculum: Science strands on focus areas.

Content descriptors: Year 10

Science Understanding	Science as a Human Endeavour	Science Inquiry Skills
<p>Yr 10</p> <p>The universe contains features including galaxies, stars and solar systems and the Big Bang theory can be used to explain the origin the universe (ACSSU188)</p>	<p>Yr 10</p> <p>Scientific understanding, including models and theories, are contestable and are refined over time through a process of review by the scientific community (ACSHE191)</p> <p>Advances in scientific understanding often rely on developments in technology and technological advances are often linked to scientific discoveries (ACSHE192)</p> <p>People can use scientific knowledge to evaluate whether they should accept claims, explanations or predictions (ACSHE194)</p>	<p>Yr 10</p> <p>Plan, select and use appropriate investigation methods, including field work and laboratory experimentation, to collect reliable data; assess risk and address ethical issues associated with these methods (ACSIS199)</p> <p>Select and use appropriate equipment, including digital technologies, to systematically and accurately collect and record data (ACSIS200)</p> <p>Use knowledge of scientific concepts to draw conclusions that are consistent with evidence (ACSIS204)</p> <p>Communicate scientific ideas and information for a particular purpose, including constructing evidence-based arguments and using appropriate scientific language, conventions and representations (ACSIS208)</p>

Copyright: This document has been produced by members of the Astronomical Association of Queensland (AAQ) and the Science Teachers Association of Queensland (STAQ). AAQ and STAQ retain copyright of the document. The material in the document may be freely reproduced provided that it is used for non-commercial purposes and the source is acknowledged. Address any request for use of the material for commercial purposes to eclipse@aaq.org.au.

CLASSIFICATION OF STELLAR SPECTRA

So much of the discoveries in the field of astronomy are due to the understanding and development of the field of Spectroscopy. The ability of humans to record the spectrum of Stars or other galactic objects has allowed a deep understanding of the universe from discovering the gases that are contained in the sun to the composition of the atmospheres that make up the recently discovered exoplanets.

The National Curriculum requires that students understand the relationship between the Earth, Moon and Sun as well as between Stars, Galaxies and the Universe. An understanding of Spectroscopy will enable students to understand these concepts and appreciate the role of science as a human endeavour.

A comprehensive explanation of various aspects of spectroscopy can be found at the following web site:

<http://outreach.atnf.csiro.au/education/senior/astrophysics/spectroscopytop.html>

It is the education outreach site of the CSIRO and is a fantastic resource for this and many other topics. Once this is covered in class, students can undertake the simulation of taking a spectrum of a star and then classify that star to find out characteristics such as composition, size and temperature to name a few.

The simulation program “CLASSIFICATION OF STELLAR SPECTRA” can be downloaded from the following website for free and is one of many simulation activities :

<http://www3.gettysburg.edu/~marschal/clea/CLEAhome.html>

Purpose:

- To introduce students to digital spectra and to the process of classifying different spectra by the relative strengths of lines.
- To familiarize students with the sequence of spectral types.
- To teach how spectra are obtained.
- To show how the distance of a star can be estimated from its spectrum and a measurement of its apparent magnitude (spectroscopic parallax).
- To illustrate the need for large-aperture telescopes for the observation of faint objects.

ACTIVITY

1. **Open the CLEA program** on the student drive under the folder Science (You will have to organise this with your computer coordinator).
2. **Click on File** and **log in** under your name in Student # 1: and **click OK and YES**.
3. **Click on File, Run and Take Spectra** and **OK** (Control of the 0.4m etc.)
4. **Click on DOME** which will open the observatory.
5. **Click on Tracking** and then use the E, N, W and S key to move a star to the centre of the red square. Note you can change the speed by increasing the Slew Rate.
6. **Click on change View** and move the star so it is between the parallel lines and centred.
7. You can now **click on Take Reading**. The new window Reticon Spectrometer Reading comes up and **click on Start/Resume Count** and run this for about 30 seconds then **press Stop Count**.
8. **Click on Save** and enter 3 numbers to identify this star. Eg 111 or 222 etc. and **click OK** when told spectrum will be saved as (Your name 111 or 222).
9. Close the Reticon Spectrometer Reading and when it says **Return to telescope window push OK**.
10. **Go to File, Run then Classify Spectra**.
11. Classify Spectra window opens so **click on File, Unknown Spectra then Saved Spectra (*.CSP)** and open your saved spectra.
12. **Click on File, Atlas of Standard Spectra then Main Sequence then OK**. Move the Main Sequence window away from the Classify Spectra window.
13. You can now compare the spectra you have taken (middle one) with known spectra so you can classify your star. **Click on difference** and you will get a red line appear. **Click on the Up and Down** arrow until the red line basically levels out with the central line in the Difference section. This shows the difference between the known spectra and your spectra is nil so you have the same type of star.
14. **Write down** the classification of the star that is highlighted in blue in the Main Sequence window and **go to** the internet and research the characteristics of this type of star. You can close the program when finished.

If you find that you cannot match the spectra you will need to go back to step 12 and try a different classification such as Luminosity near 08 and repeat steps 13 and 14.

EXTENSION

- With the spectrum you have taken research how you can determine the temperature of a star using the Spectrum and compare your calculations with the characteristics of the star you have found on the internet.