SCIENCE ARCHIVES AND VO TEAM

→ ESAC VOSPEC

SCIENCE TUTORIAL

COMPARING SPECTRA OF THE SUN AND SIMILAR STARS
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Tutorial Edited and Reformatted By: Olivia Carrington, as part of an ESAC Trainee Project 2014 (ESA Student Placement)

Acknowledgements would like to be given to the whole Science Archives Team for the implementation of the SOHO archive and VOSpec. http://archives.esac.esa.int

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The overall goal of this tutorial is to compare a spectrum of the Sun, taken by the SOHO satellite, with spectra from two similar type stars: Alpha Centauri and Capella.
PERFORMING THE EXPERIMENT

Tools Used

**VOSpec**: This is an ESA Virtual Observatory tool used for multi wavelength spectral analysis. It has access to spectra, theoretical models, experimental photometry services and atomic and molecular line databases in the VO.

Loading and Saving Spectra


2. In the Target field type 'Capella' and click the 'Query' button. The Server Selector window opens.

3. Select the Observational Spectra Services, in the left-hand side of the window in the 'Query by Service' region, by opening up the Observational Spectra Services tree. Select the service called 'Far Ultraviolet Spectroscopic Explorer'.

4. Click the 'Query' button.

5. Open up the tree structure to display the three available spectra.

6. This list can also be viewed as a table by clicking the 'Tree/Table view' icon on the top right of the main VOSpec window.

7. Change the view to table. Expand the 'Name' column to show the full name. Click on the Name column and other columns and see how they can be sorted.

8. Select one of the spectra in the table and click the 'RETRIEVE' button

9. Select one of the spectra in the table and click the 'RETRIEVE' button
The spectrum is now displayed in the main VOSpec window.

10. On the left hand side, towards the top, untick the 'Log' box next to the 'Wave Unit'.

Once unticked the spectrum will redisplay with the x-axis (the wavelength axis) in linear, instead of logarithmic scale.
10. Try changing how the spectra are drawn, e.g. from points to lines, to dots.

11. Save the spectrum by selecting File -> Save as in the main menu (or by clicking the save icon), select ‘SDM 1.03 VOTable’ and click the ‘Go’ button. Save the spectrum as ‘Capella.xml’.

12. Click the ‘Reset’ button in the main VOSpec window.

Repeating the process for Alpha Centauri.

Now we will repeat the same for the star Alpha Centauri:

13. In the target field type ‘Alpha Cen’ and click the ‘Query’ button.

14. When the Server Selector window opens. Select the Observational Spectra Services, in the left-hand side of the window in the ‘Query by Service’ region, by opening up the Observational Spectra Services tree. Select the service called ‘Far Ultraviolet Spectroscopic Explorer’.

15. Click the ‘Query’ button. The spectra are again loaded into the ‘Spectra List’ region of the main VOSpec window.

16. Change the view to table and expand the ‘Name’ column to show the full name. Also expand the ‘Distance (degrees)’ column. This distance refers to the difference between the coordinates of the star (i.e. where the star is located in the sky) and the coordinates of each spectrum (i.e. where the telescope was pointing when it took the spectrum).

17. Sort the distance column so that the lowest value is the first in the list.

Do you see the difference in the names of the first two spectra? One has HD128620 in the name and the other has HD128621. This is another name for a star (HD and then a number) and originates from the first large astronomical catalogue of stars, the Henry Draper (HD) Catalogue. HD128620 is another name for Alpha Centauri. HD128621 is another name for Alpha Centauri B, the companion star of Alpha Centauri.

18. Since we are concentrating on the spectra from Alpha Centauri (HD128620), click on the first spectrum in the list, as shown in the image above.

19. Click the ‘RETRIEVE’ button.

The spectrum will again be displayed in the main VOSpec window.
20. Load a spectrum of the Sun and the spectrum from Capella you saved earlier: Firstly download this spectrum of the sun called `solar_spectrum_900_1200.xml` and save it in the same folder as your Capella spectrum. This can be done by visiting: [http://www.rssd.esa.int/SD/ESAVO/docs/solar_spectrum_900_1200.xml](http://www.rssd.esa.int/SD/ESAVO/docs/solar_spectrum_900_1200.xml), right clicking and then selecting ‘Save Webpage As’. When the ‘Save As’ window opens, make sure to select ‘Webpage, XML only’ from the dropdown menu before clicking ‘Save’.


22. Browse to the folder you saved your Sun and Capella spectra in, select the spectrum of Capella and click the ‘Open’ button.

23. A window called ‘Edit Spectra’ opens. All that needs to be done here is to click the ‘Accept’ button.

Your loaded spectrum of Capella is now displayed along with the spectrum of Alpha Centauri.

24. To see which spectrum is which, click on one of them in your table, the spectral list.

When you do this, one of the coloured squares in the graphic mode region increases in size. Therefore, as shown above, the red spectrum is the Alpha Centauri spectrum, and the blue the Capella spectrum.

You can also press the coloured squares in the Graphic Mode region and display just that spectrum, plus the spectrum is highlighted in the table list. Or hover over the coloured squares and the name of the spectrum will appear.

25. Click the ‘View’ button, in the bottom left corner, to view all the spectra again.

26. Now open the spectrum you downloaded of the Sun by selecting File -> Open Spectrum in the main menu (or click on the ‘Open Spectrum’ icon).

27. When the Edit Spectra window opens, click the ‘Accept’ button.

All three spectra are now displayed in the main VOSpec window.

Note for astronomers and astronomy students: This solar spectrum is not actually in Flux (Janskys), but is uncalibrated and is in counts per detector pixel. It is displayed here with the flux calibrated spectra for easier identification of spectroscopic lines.

28. Change in the Graphic Mode the points to lines and then zoom into the central region with the three strong emission lines (between 0.100 and 0.105 microns).

The top spectrum is from the Sun, the middle from Capella and the bottom from Alpha Centauri. There are only emission lines present in this wavelength region. What differences and similarities do you see in the spectra from the three stars?

29. Now we are going to identify some lines. Select from the main menu Operations -> SLAP (or click on the SLAP icon).
30. Drag your mouse across the spectra so that the region turns yellow.

31. The Slap Viewer window will open. Open up the SLAP Services tree and select the NIST ATOMIC SPECTRA SLAP service.

32. Click the ‘Select’ button. A table then loads in the lower region of the window, in the Slap Services Output panel.

33. Go back to the main VOSpec window and move your mouse across the spectra. The line identifications, from the loaded database, are shown on the spectra.

34. See if you can identify any of the lines using this database and comparing with the image below, which contains the line identifications for the Sun. (1 micron = 10000 Angstroms, or Å).
Note: The NIST ATOMIC SPECTRA service comes from the National Institute of Standards and Technology (NIST), in the US, and contains data for radiative transitions and energy levels in atoms and atomic ions. Data are included for observed transitions of 99 elements and energy levels of 56 elements, as observed on Earth. This database contains many lines we would not expect to see from stars. Also, it does not contain lines from the highly ionized oxygen ion O VI.

FROM WHERE DO THE FAR INFRARED EMISSION LINES ORIGINATE?

These emission lines arise from the very hot solar corona. The corona is a region around the Sun, extending more than one million kilometres from its surface, where the temperature can reach two million degrees! In fact, the OVI lines that we looked at in this tutorial are formed at ~290,000 degrees!

For background on the Solar Atmosphere, see the ESA outreach page: [http://sci.esa.int/science-e/www/object/index.cfm?fobjectid=2546](http://sci.esa.int/science-e/www/object/index.cfm?fobjectid=2546)

For an introduction to the Solar Corona see the NASA outreach page: [http://imagine.gsfc.nasa.gov/docs/science/mysteries_l1/corona.html](http://imagine.gsfc.nasa.gov/docs/science/mysteries_l1/corona.html)
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