

Smiley Radio Astronomy

Lab 3

Mapping a Radio Source



Lab 3- Mapping a Radio Source

This lab helps meet the following N.C. Competency Goals:

Earth/Environmental Science-

- *Goal 6:* The learner will acquire an understanding of the earth in the solar system and its position in the universe.
 - *Objective 6.05:* Evaluate astronomers' use of various technologies to extend their senses: Radio telescopes

Physical Science-

- *Goal 3:* The learner will analyze energy and its conservation.
 - *Objective 3.04:* Investigate and analyze the transfer of energy by waves: Electromagnetic waves (radiation).

Objective: Students will use Smiley to map an astronomical radio source at a frequency of 1.42 GHz.

Background:

Have you ever seen a contour map of a mountain like Mt. Everest shown here in Figure 1?



Figure 1. Mount Everest

Figure 2 is a 3-D image that shows a mountain-like feature:

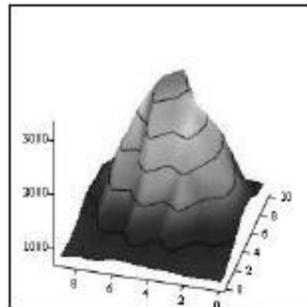


Figure 2. 3-D representation of a mountain

Figure 3 shows the same object from overhead:

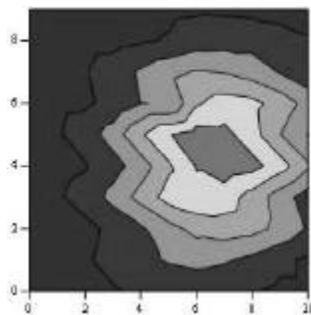


Figure 3. A shaded contour map

Figure 4 shows the same map without the shading. This is called a contour map.

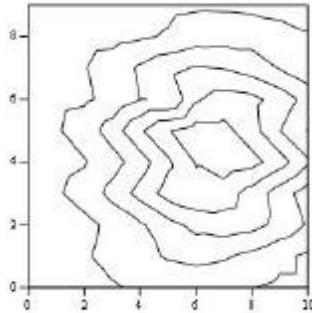


Figure 4. A traditional contour map.

The contour map in Figure 4 is nothing more than a grid of numbers, where numbers of the same value are connected together. The grid of numbers that make up the map in Figure 4 are:

```
782 791 792 833 834 868 900 824 846 797
782 830 799 942 853 944 873 849 826 797
848 949 880 1180 961 1234 930 973 810 746
957 1139 1103 1663 1286 1731 1121 1238 838 756
1069 1363 1426 2173 1758 2430 1498 1567 932 799
1177 1551 1825 2707 2415 2971 1505 1882 1045 890
1202 1632 2163 2872 3029 3223 2449 2040 1250 933
1148 1556 2277 2747 3291 3162 2701 1977 1308 920
1018 1372 2170 2302 3185 2694 2632 1768 1310 880
912 1109 1850 1736 2720 2007 2301 1470 1173 840
```

Prelab Activity: Print out and try drawing contouring lines on the array of numbers. Start with the highest number and draw a circle around it. That will be the peak value. Then draw a closed curve around the next highest set of numbers for the next contour. The contour lines show the peak and the valleys. In fact, the object above is actually the remnant of a supernova! The map was done at PARI at a frequency of 1.42 GHz. The map shows the intensity of the supernova remnant over an area on the sky of 1 degree x 1 degree - larger than the moon! (The moon covers about 1/2 degree diameter on the sky).

Procedure:

1. Login to [Smiley](#). For information on how to use Smiley see the [Smiley User's Manual](#).
2. In **Map** mode either click on the Sun or select the Sun from the **Control Panel Drop Down List**. Now click on **GO**.
3. In **Continuum** mode set your **IF GAIN** to around 17 and make sure your **Base Frequency** is set to 1.42 GHz.
4. Click on **Begin Scan**. While scanning use **Hand Paddle** to find the peak intensity. (Notice the box that displays the intensity for every point as it is plotted.). In general the **TARGET Coordinates** should be close to the **CURRENT Coordinates**. Keep moving Smiley until you find the peak intensity. Record the peak intensity in the table below along with the **CURRENT** azimuth and altitude at which it occurs. Allow Smiley to keep scanning.
5. Fill in the top row and left-hand column of the table below with the azimuth – 6 degrees, -4 degrees, etc. Do the same for the altitude.
6. Mapping the Sun means that you need to measure the brightness across the disk of the Sun. Using the **Hand Paddle** set Smiley to -6 degrees of your peak intensity in both Altitude and Azimuth. Record the intensity in the table below.
7. Now move Smiley -4 degrees in the Azimuth from the peak intensity and keep the Altitude the same (-6 degrees from peak intensity). Enter your results in the table below.
8. Next, move Smiley -2 degrees in the Azimuth from the peak intensity still keeping your Altitude the same. Enter your results in the table below.
9. Move Smiley +2 degrees in the Azimuth from the peak intensity still keeping your Altitude the same. Enter your results in the table below.
10. Move Smiley +4 degrees in the Azimuth from the peak intensity still keeping your Altitude the same. Enter your results in the table below.
11. Move Smiley +6 degrees in the Azimuth from the peak intensity still keeping your Altitude the same. Enter your results in the table below.
12. Continue moving Smiley using the **Hand Paddle** to adjust the altitude or azimuth and complete the table below.
13. From your set of measurements, construct a contour map.

Sun Intensities

	Current Az at peak intensity=	Az - 6 degrees =	Az - 4 degrees =	Az - 2 degrees =	Az +2 degrees =	Az +4 degrees =	Az + 6 degrees =
Current Alt at peak intensity=							
Alt-6 degrees=							
Alt-4 degrees=							
Alt-2 degrees=							
Alt+2 degrees=							
Alt+4 degrees=							
Alt+6 degrees=							

Discussion questions:

1. Does your map show a central peak and some structure? Why is the central peak off center?

Yes, there should be a peak with some decreasing intensities surrounding it. It is difficult to record the radio waves simultaneously from every point on the disk of the sun. Therefore, the central peak may be off center because the Earth is moving constantly, thus the measurements of radio waves coming from the sun are going to shift with the Earth.

2. What is the area on the sky, in degrees, that you have mapped?

12° x 12°

3. Will every object have the same structure? What might the map look like if you used more points more closely spaced?

No, each object will emit different intensities of radio waves. If you used more points more closely spaced, the differences in intensities would be less. The map would have more closely spaced lines.