

Unit 3 Lab 4

Mapping a Radio Source



Teacher Version

Unit 3 Lab 4:

Mapping a Radio Source

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

Teacher Notes:

***Note: It is recommended that you complete Lab 1 and Lab 2 before doing this lab.*



PARIPod 3.3 is still in development.

Background Knowledge

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

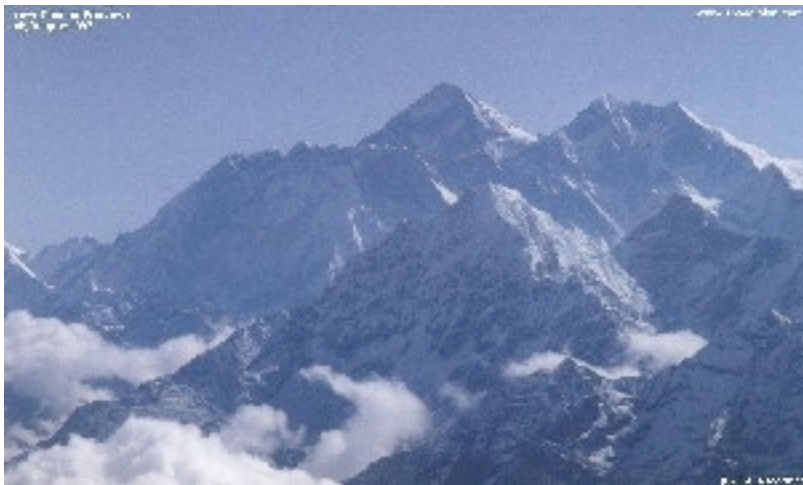


Figure 1. Mount Everest.

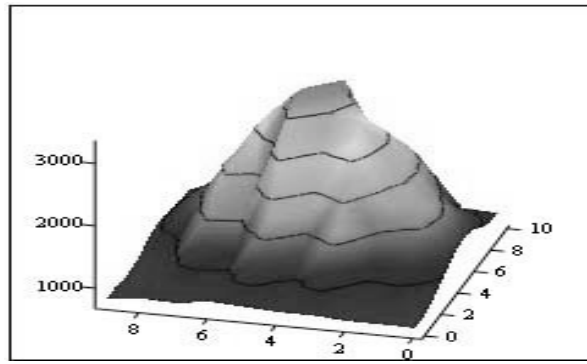


Figure 2 is a 3D image that shows a mountain like feature:

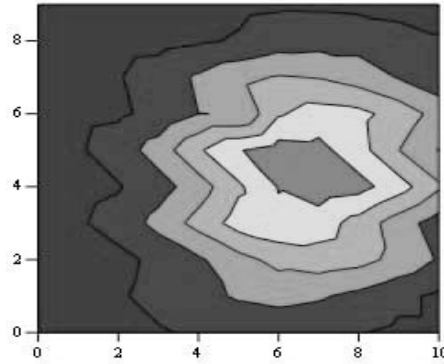


Figure 3 shows the same object from overhead:

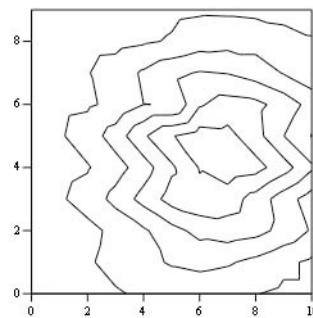


Figure 4 shows the same map without the shading.

This is called a traditional contour map.

Pre-lab Activity

Print out (larger 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).

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

Procedure:

1. Login to Smiley. For information on how to use Smiley refer to Unit 2 Smiley Basics.
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.
- 14.

Data Collection

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=							
Alt6 degrees=							
Alt4 degrees=							
Alt2 degrees=							
Alt+2 degrees=							
Alt+4 degrees=							
Alt+6 degrees=							

Analysis & Discussion

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

2. 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.

Pre-Lab Activity (Large Version)

Print out (larger 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).

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