Mission 10
The Search for Extraterrestrial Intelligence

Stellar Facts

Your SETI team has been given the opportunity to use the world's largest radio telescope at Arecibo, Puerto Rico and a microwave radio frequency computer analyzer to try to detect a radio signal from space. Many other people, working on different research projects, also use the telescope. Because of this, your time is limited. You may search only three stars for evidence of a radio signal. But which three? Which ones would be most likely to have planets with civilizations capable of communicating by radio? The following information will help you.

Astronomers understand the workings of stars. Stars come in a variety of brightness, colors, and sizes. But it turns out that these parameters are related, and a star cannot have arbitrarily combined values of color, brightness, or size. In fact, the life history and appearance of a star is dependent on only one thing: its birth weight, or mass.

Stars are formed from great clouds of gas and dust that collapse under their own weight. About half of all stars are born with nearby companions, forming multiple-star systems in which individual stars orbit one another. If there are planets around such multiple-star systems, they will have to be at very great distances from their stellar hosts. Otherwise, computer models show that the planets will be kicked out of the system by the interplay of the gravitational forces of the stars. But planets at such large distances will likely be too cold to support life, and so multiple-star systems may not be the best places to search for extraterrestrials. In most star catalogs, all the members of a multiple-star system have the same name, but with a letter appended (*e.g.*, Theta Orionis A, B, C, and D are the multiple star system known as the Trapezium at the heart of the Great Nebula in Orion).

Nature makes many more small stars than large ones. Most of the Milky Way's stellar population is made up of stars smaller than the Sun. These dwarf stars have surface temperatures of about 3,000 K, so they appear red–they are called red dwarfs. The small size and low surface temperature of these low-mass stars combine to make them dim. If we wish to find civilizations around red dwarfs, we will have to seek a planet orbiting close to the star. Otherwise, it will be much too cold for life. Unfortunately, planets that orbit very close to a star tend, after a while, to keep one side always facing the star (much as one side of the Moon always faces Earth). This would make for a planet that is quite warm in one hemisphere, and far too cold in the other. Consequently, small, cool stars are probably not favorable hosts for life.

Large stars, many times more massive than the Sun, compress their central regions to very high temperatures, and the result is that they burn their hydrogen fuel much faster than smaller stars. This means that they are both bright and hot (their colors are usually blue-white). Of course, a large star has more fuel to burn, but just as a Cadillac cannot go as far between fill-ups as a VW Beetle, despite having a larger fuel tank, a big star burns itself out far more quickly than a smaller one. Indeed, a massive star such as Sirius A or Deneb may last for only 100 million years before its fuel runs out. Because our experience on Earth tells us that intelligent life took billions of years to develop, these large, bright stars are probably not good candidates for hosting life either.

The way stars die is also determined by their mass at birth. When they begin to run out of fuel, most stars swell up for a while. The Sun will do this between 5 and 7 billion years from now, and when it does, it will swallow Mercury, Venus, and maybe Earth. These swollen stars are known as red giants. But the red giant phase is relatively brief: our Sun (and most average-sized stars) will blow off its outer shell and collapse into a tiny corpse no bigger than Earth. That's less than 1/100 of its original size. Such hot, tiny, glowing embers are called white dwarfs, and their fate is to slowly cool and fade from the heavens.

The largest stars, known as supergiants, won't die so calmly. Some will blow up in a catastrophic explosion called a supernova, and then collapse to a peculiar stellar corpse called a neutron star, or pulsar. Such corpses are only a few miles across and rotate hundreds of times per second. The very largest stars collapse into something far smaller. These stars become black holes.

Your Mission!

You will be given a "SETI Star-List" worksheet. Your mission is to choose the three stars from this list that you think might be the best ones to scan with a radio telescope to look for a signal from intelligent extraterrestrials who might live on a planet orbiting that star. Remember that each star system is a possible location for extraterrestrial intelligence, but we want to look at the most likely locations given our limited time on the radio telescope. Notice that our own Sun is at the top of the list. This is so that you can compare our Sun's characteristics to the characteristics of other stars. We are reasonably certain that there is intelligent life on Earth!

Write your three choices on your worksheet. Include the reasons for each of your choices. To receive printouts of the radio data for the three stars, write down the name of the star and the reasons why your team chose that star. Your teacher will initial each request to verify that you have used up one of your three choices. You may look at only one star at a time.

Do you think we know enough about the requirements for life to rule any stars out?

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SETI Star-List–Worksheet

Name: ______________________________________ Date: ________________________

Table 10.2–SETI Star-List.

Star	Mass (Sol = 1)	Radius (Sol = 1)	Temp (K)	Distance (Light Years)	Will You Scan It? (Give Your Reason)
Sol	1	1	5,500	8 light minutes	
Alpha Centauri A	1	1	6,000	4.3	
Epsilon Eridani	0.7	0.8	4,800	10.7	
Spica	17	7	26,000	220	
Betelgeuse	16	550	2,900	310	
Sirius B	1	0.2	Unknown	8.6	
Altair	3	1.6	7,400	17	
Aldebaran	5	25	3,700	68	
Alpha Centauri C	0.2	0.3	Cooling	4.3	
Antares	16	500	2,400	520	
Bd +50 1725	0.7	0.75	4,130	14	
Sirius A	3.5	2.5	9,800	8.6	
Arneb	12.5	63	7,300	950	
Alpha Centauri B	0.2	0.85	4,900	4.3	
Tau Ceti	0.8	0.9	5,100	11.9	
Saiph	18	7.4	27,000	68	
Beta Pictoris	3	2	7,800	59	

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Searching for a Signal–Worksheet

Name: ___________________________________ Date: ____________________________

1. Fill out the chart on your "SETI Star-List" worksheet.

2. What do you and your team members feel are the most important criteria in choosing to search one star over another?

3. From the stars listed on your worksheet, enter the three that best fit your search criteria into the table below.

Table 10.3-Stars to Search.

Star Name and Number	Reasons for Your Choice	Teacher's Initials	Is There Evidence of Radio Signals?

4. If you had an unlimited amount of money and radio telescope time, would it be a good idea to look at every star in our galaxy for a signal? Explain your answer.

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Finding the Needle–Worksheet

Name: ______________________________________ Date: ___________________________

1. Did any of the stars your team chose show a signal through the background static during day one? Which ones?

2. Did any of the stars the class chose show a signal through the background static during day one? Which ones?

3. During day two, you will need to verify the apparent signals received by the class. Why do you think it is important for scientists to confirm and verify their data?

4. Did you find any stars that apparently had signals during day one but show no signal during day two? Which ones?

5. What may have happened to these signals?

6. Did you find a star that had a verified signal during day two? Which one?

7. Does this confirm that there is intelligent life somewhere else? (Remember, this is a simulation. But consider this: if one signal were verified once, would that confirm that there is intelligent life somewhere else?)

8. If the signal that came from that star was real, how many years did it take for the signal to get here? How many years would it take for us to send back a reply? How do you know?

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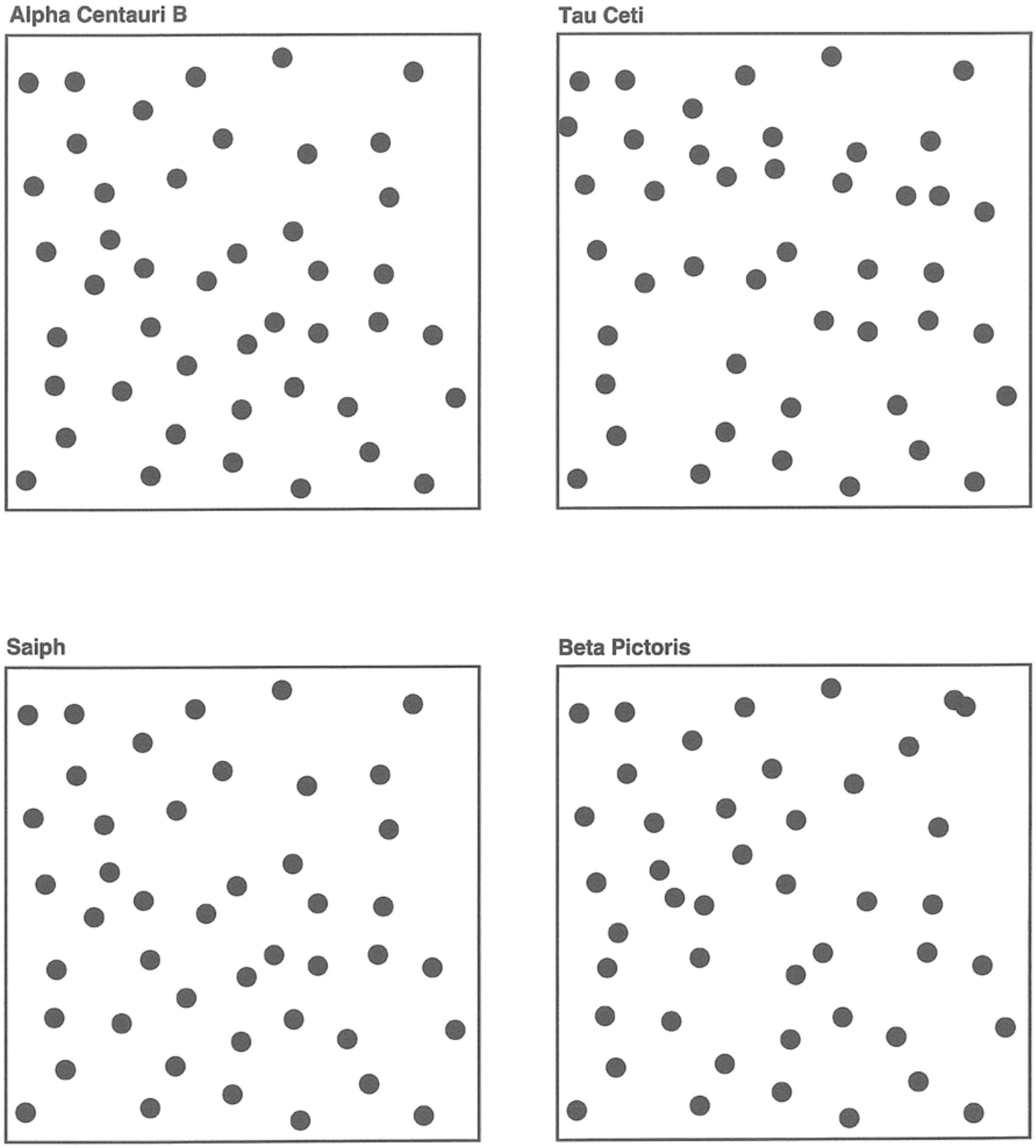
Radio Signal Search Data, Day One–Worksheet

Figure 10.2.

Figure 10.2 *(continued)*

Figure 10.2 *(continued)*

Figure 10.2 *(continued)*



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Radio Signal Search Data, Day Two–Worksheet

Figure 10.3.