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How Do I Choose Which Part of Galactic Plane to Survey?

Overview: Our SETI project will survey the entire Galactic Plane, but we can only cover a small part of it during each class session. To collect SETI data, you will first need to choose which part of the Galactic Plane to observe. As part of a science team, this decision is entirely up to you and your class. Scientists sometimes make this sort of decision by writing and reviewing proposals. In this lesson, your students will write proposals (either individually or as teams), and then they will decide which proposal is most convincing. Some factors to consider might be:

- Which part of the Galactic Plane is above the horizon at the desired viewing time?
- Is it better to re-observe a patch of sky which contains promising candidates, or to collect data from a patch of sky which has not been observed at all?
- Should you look at the parts of the galactic plane that contains more stars than others or observe parts that are less dense?
- Should you observe the parts of the galactic plane are that closer or further away?

Note: After your students have finished their proposals, choose the top ones to read to the class. After the proposals have been read, a vote should be taken on which is most convincing. It is important that the students decide for themselves on which "skyframe" they wish to observe. They are the deciding authority.

Purpose:

1. To teach the students the steps to persuasive writing.
2. To help the class choose which "skyframe" to observe.
3. To teach them how scientists communicate with their fellow investigators

Required Background Knowledge: Students will need to understand about searching the galactic plane, looking for certain narrow band radio signals, and know about the difference between noise and possible signals.

Students will be able to: Write a persuasive proposal that explains their choice in which "skyframe" is to be observed.

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From the National Council of Teachers of English and International Reading Standards for the English Language Arts:

All students must have opportunities to:

- Adjust their use of spoken, written, and visual language (e.g., conventions, style, vocabulary) to communicate effectively with a variety of audiences and for different purposes.
- Employ a wide range of strategies as they write and use different writing process elements appropriately to communicate with different audiences for a variety of purposes.
- Use spoken, written, and visual language to accomplish their own purposes (e.g., for learning, enjoyment, persuasion, and the exchange of information)

From the National Science Standards:

All students should realize:

- As a result of this activity in grades 5-8 and 9-12, all students should develop an understanding of science as a human endeavor, nature of science, abilities of technological design, and understanding about science and technology.
- Scientists formulate and test their explanations of nature using observation, experiments, and theoretical and mathematical models. Although all scientific ideas are tentative and subject to change and improvement in principle, for most major ideas in science, there is much experimental and observational confirmation. Those ideas are not likely to change greatly in the future. Scientists do and have changed their ideas about nature when they encounter new experimental evidence that does not match their existing explanations.
- In areas where active research is being pursued and in which there is not a great deal of experimental or observational evidence and understanding, it is normal for scientists to differ with one another about the interpretation of the evidence or theory being considered. Different scientists might publish conflicting experimental results or might draw different conclusions from the same data. Ideally, scientists acknowledge such conflict and work towards finding evidence that will resolve their disagreement.

Web Links for Further Investigation These should open.

- GAVRT Looks for Life In Outer Space
- GAVRT/SETI Video
- Multi-wavelength Image

Resource/Materials Needed:

- Information sheets: Fast Facts about the Milky Way, Some Thoughts about Searching the Milky Way, and the Multi-wavelength Milky Way.
- Paper for a draft

- Paper for final persuasive proposal
- Pencils or pens
- Computer for the students to use so that they may investigate the listed URLs.

Teacher notes:

- Please read the information sheets (Fast Facts about the Milky Way, Some Thoughts about Searching the Galactic Plane, How Do I Write a Persuasive Essay) before you assign the activities.
- Look at the web links.
- Look over the Multi-wavelength Milky Way, making sure you have an image large enough for your students to read.

Student Activity:

GAVRT/SETI Viewing Proposal

Before you begin, make sure you have read Fast Facts about the Milky Way and Some Thoughts about Searching the Galactic Plane. Study the Multi-wavelength Milky Way until you understand what it is showing.

Astronomer/Student

After making careful considerations about the galactic bulge and reading Fast Facts about the Milky Way, Some Thoughts about Searching the Galactic Plane, the Multi-wavelength Milky Way, looking to see which areas have already been searched by the GAVRT SETI team, and researching any other information you think is important, write a clear proposal as to what part of the sky you wish to view.

Explain your decision and why your proposal would be the best to use for your observing session.

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Write a brief persuasive essay using the above information. It should explain to your class why your choice or your team's choice of location is the one that GAVRT should use to possibly detect an extraterrestrial signal.

Procedures:

1. Read Fast Facts about the Milky Way.
2. Read Some Thoughts about Searching the Galactic Plane. You may need to use the web links for further investigation before you start writing.
3. Carefully look over the Multi-wavelength Milky Way and investigate the "skyframe" you wish to use to listen for a signal. There are areas that would not be good to search for a signal. Make sure you choose carefully.
4. Read the information on How Do I Write A Persuasive Essay?
5. If you are working as a team, discuss the main points of your proposal. If you are working alone, organize your thoughts and then compose your proposal
6. Proof read what you have written.
7. Have a fellow student read your composition and make a few suggestions.
8. Make any changes you feel would improve your proposal.
9. Submit your proposal to your teacher to be considered as the one your class uses for its observing session.

Additional Information: Each one of the following (Fast Facts about the Milky Way, Some Thoughts on Searching the Galactic Plane, and How Do I Write a Persuasive Essay) need to be on a single sheet so that teachers can print them as mini lessons for their students to read. The Multi-wavelength Milky Way needs to have a URL or an additional page as it requires too many megabits to include here.

Fast Facts about the Milky Way (This needs to print on one page)

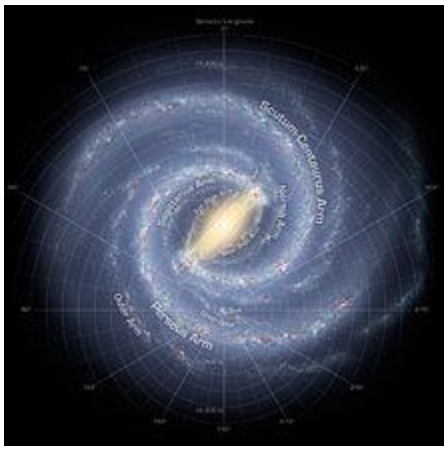
A brief astronomy lesson on objects that can be found in our Milky Way will leave pieces missing. But for you to make an intelligent choice about what part of the galaxy to observe, you must comprehend some of the important aspects about our galaxy.

Of course you understand that we live on a planet that has a moon, and that this whole planet-moon system orbits around a star, our sun. You also know that there are other planets in our solar system, eight at last count with assorted other objects including asteroids, meteors, Plutoids (dwarf planets in a belt found beyond Neptune), and an Oort

Cloud made up of ice bodies that may go half way to the nearest star. What you may not realize is that all of these pieces of the solar system collapsed down from a cloud of material about 4.5 billion years ago making our star and its planets. This is happening elsewhere in our galaxy where solar systems and stars condense out of clouds mainly composed of hydrogen and dust.

Our galaxy itself collapsed from a cloud of material about 13.2 billion years ago and may be nearly as old as the Universe itself. Nearby we have two smaller galaxies orbiting around us as we orbit in the Local Group of galaxies. Galaxies come in different sizes and shapes. Our Milky Way is a barred spiral, our nearest large neighbor, the Andromeda, Galaxy, is a spiral, and others are elliptical. The shape may have something to do with age, as the further back the Hubble Space Telescope looks; the more disorganized the galaxies become.

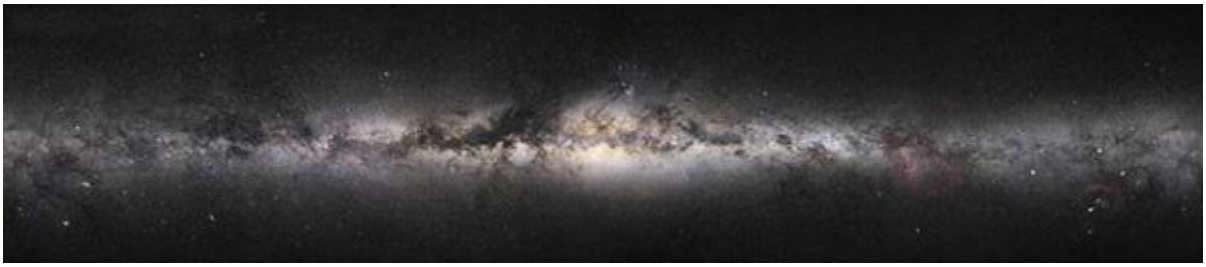
Just as galaxies have structure, our Milky Way has structure. We have a central bulge with a bar through it, arms that spiral outward from the center, and a halo of material surrounding the outer limits. The center of our galaxy has a supermassive black hole. We have between 200 to 400 billion stars which occupy an area that is between 100,000 to 120,000 light years across. (A light year is the distance light travels in a year at 186,000 miles per second, equaling about 6 trillion miles.) Most of the stars are in the central bulge, but many also reside in the spiral arms like our sun.



Age is a factor with galaxies and stars. Galaxies evolve. Stars are born and die. When new stars are born they collapse from clouds of hydrogen and dust and eventually obtain enough mass to start their nuclear furnace. How long they exist depends on their size and rate at which they are consuming their fuel (between a few 10,000 years to billions of years). Upon reaching the end of their life cycle, their nuclear furnace turns off, and depending on the star's size, the end results varies. If the star is huge, much larger than our sun, a supernova explosion results from the stars death, spreading left over star material back into space and possibly leaving a black hole. If a black hole is not produced by a supermassive star's death, a pulsar may result where the star use to reside. They are rotating neutron stars. They emit jets of particles from their poles and seem to blink on and

off at constant frequencies. Some even emit x-rays. When stars the size of our sun die, they create Planetary Nebula (these have nothing to do with planets) which also eject material back into space and leave behind small compact core spinning where the star use to live.

All these events, black holes, neutron stars, pulsars, and areas of turbulent gas where new stars are forming emit radiation and make an area that will be too noisy for a signal to be seen from Earth.



So looking into the galactic bulge you will have an area with a black hole emitting radiation as it consumes material around it; you have supernova releasing great energies both during and after their stars end their lives; and other areas that are sources of noisy forms of radiation. So as you pick your coordinates to turn the radio telescope to search for a sign from an extraterrestrial source, you must be careful in your choice. You must search for a quiet area of our galaxy.

Here is a sheet about searching the galactic plane. Some Thoughts about Searching the Galactic Plane needs to be on a single page so teachers can print it for their students.

Some Thoughts about Searching the Galactic Plane

As discussed in Fast Facts about the Milky Way, we live in a barred spiral galaxy two thirds of the way out on one of the spiral arms. When we talk about searching the galactic plane, we mean that we are going to look toward area defined by the spiral arms of our galaxy.

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Spiral Galaxy NGC 1073 which is thought to be similar to the Milky Way (Hubble image)

We make several assumptions here.

1. Intelligent life is less common than planetary systems. Many planetary systems have been discovered by both ground and space based telescopes, and many more will be discovered in the near future.
2. In those planetary systems, intelligent life that can transmit a radio wave signal is even less common.
3. The assumption is that if we discover a radio signal from a distant planetary system, there is the possibility of intelligent life.

What are we going to look with? We will search for radio waves which turn out to be the most effective way to detect an extraterrestrial signal. They do not require a lot of energy to transmit over long distances, and they are distinguishable from other noise being emitted throughout the Milky Way.

There are many radio wavelengths from 300GHZ to 3KHz or from 1 millimeter to 100 kilometers. A GHz or gigahertz refers to the frequency that a wave cycles from crest to trough. A gigahertz cycles in billions of wavelengths per second. A radio wave that has a frequency of 1 GHz has a wavelength of 300 millimeters or about a foot. A radio wave that is 100 GHZ is about the size of 1/8 an inch. For our search we will use a frequency range from 0.5 GHz to 14 GHz. In this range there is less background noise for us to sift through.

Over the course of a four year period, with the help of your students, the galactic plane that is visible from Goldstone will be viewed completely, and we will do this multiple times. Your observations will be placed in a data base or catalog for further investigations. If after comparing the observations in this catalog, we determine that a signal was detected, it may well be one of the most important discoveries in the history of mankind. It will have profound implications. We will know that we are not alone in the Universe.

Multi-wavelength Milky Way URL or an image placed in their folder. It is just too large to add here!

Here is a fact sheet for persuasive writing:

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How Do I Write a Persuasive Essay? (needs to be on one page)

When you write to persuade someone to share your ideas, you have to make sure you have organized your thoughts and that you have facts to back up your ideas. It is kind of like winning an argument with a friend.

Your first paragraph…

You should start with an exciting sentence, something that makes the reader want to continue to read what you have written. This may be the most important line that you write because you will make someone want to read your essay or to put it down.

1. Write to grab their attention. You can open with an interesting thought, a cool fact, or a question.
2. State at least three major points to include in your essay. These points will be the paragraphs in the body of your writing.
3. You might want to find a good quote to include in this introduction.

The body of your essay…

This is the main part of your essay. Here is where you organize your thoughts into distinct paragraphs that support your main idea.

1. State the facts. Why is this thought important? An example might answer the question, "Will your discovery support or deny the nagging question of extraterrestrial life?"
2. Organize your arguments placing your strongest point place last.
3. Remember each paragraph supports only one idea.
4. Each paragraph is not just a list of ideas. You must develop them using facts, reasons, or arguments.

Finally your conclusion…

The final paragraph is the last one the reader will read so summarize your main points.

1. You might want to end making a prediction. "Our signal may be the most important one recorded because…"
2. You might end with a question. "Can you imagine how this signal will change how mankind looks at the universe?"
3. You might end with a solution. "This signal may solve the ancient question, "Is the life beyond Earth."
4. You might end with another quote.
5. The last line is the second most important line. It is the last thought your reader will see. You need to ask, "Will it make the reader agree or disagree with your essay?"

Remember…

Start your essay in an exciting way, write at least three main body paragraphs, and end with an interesting thought.

Questions:

As with all investigations, one question may give rise to another question. Keep a journal of your questions as you complete your investigation. If these questions have not been answered when you have finished your GAVRT/SETI scan, you may need to do further investigations using NASA websites. You are on the cutting edge of scientific research. Your journey may need to continue after your project is complete.