Maynard F. Jordan Planetarium

THE X-TRA TERRESTRIAL FILES

Edited by Jenny Worster

Mission Statement:
The mission of the Maynard F. Jordan Planetarium of the University of Maine is to provide the University and the public with educational multi-media programs and observational activities in astronomy and related subjects.

Cosmic Classroom

Looking for fun and interesting space activities? The planetarium staff has prepared a collection of materials we call the Cosmic Classroom for you to use before and/or after your visit. These materials are entirely for use at your own discretion and are not intended to be required curricula or a prerequisite to any planetarium visit. The Cosmic Classroom is one more way that the Jordan Planetarium extends its resources to help the front line teacher and support the teaching of astronomy and space science in Maine schools.

The lessons in this Cosmic Classroom have been edited and selected for the range of ages/grades that might attend a showing of this program at the Jordan Planetarium. Those activities that are not focused at your students may be adapted up or down in level. Our staff has invested the time to key these materials to the State of Maine Learning Results in order to save you time.

The State of Maine Learning Results performance indicators have been identified and listed for the program, the Cosmic Classroom as a package, and each individual activity within the package. The guide also includes related vocabulary and a list of other available resources including links to the virtual universe. We intend to support educators, so if there are additions or changes that you think would improve, PLEASE let us know.

Thank you, and may the stars light your way.

The Maynard F. Jordan Planetarium Staff

The Program – The X-tra Terrestrial Files

"*The X-tra Terrestrial Files*" finds the most colorful - and humorous - ways to examine the question of extraterrestrial beings. Two investigators, Bolder and Gully, have staked out the Wisconsin countryside in search of a reported mysterious light. Their discussion of intelligent life on other planets takes us from here to the stars, a black hole, and even Great Britain where those funny crop circles first appeared. Space travel, and that relativity quirk called time dilation, as well as a noirthern lights and a host of other concepts are touched upon while our vigil continues. In an age rich with science fiction, this educational look at the possibilities will help answer some questions, but still leave enough doubt for an open mind.

We are very glad that you have chosen to visit our planetarium with your group. We hope that this guide either will help you prepare your group or help you review their experience at the University of Maine's sky theater.

State of Maine Learning Results Guiding Principles

The lessons in this guide, in combination with *The X-tra Terrestrial Files*, help students to work towards some of the Guiding Principles set forth by the State of Maine Learning Results. By the simple act of visiting the planetarium, students of all ages open an avenue for self-directed lifelong learning. A field trip encourages students to think about learning from all environments including those beyond the schoolyard. A Jordan Planetarium visit also introduces visitors to the campus of the largest post-9-D school in Maine and encourages them to think of this as a place which holds opportunities for their future education, enjoyment and success.

Other sites on the University campus, including three museums, explore a variety of subjects, and the Visitors Center is always willing to arrange tours of the campus. A field trip can contribute to many different disciplines of the school curriculum and demonstrate that science is not separate from art, from mathematics, from history, etc. The world is not segregated into neat little boxes with labels such as social studies and science. A field trip is an opportunity for learning in an interdisciplinary setting, to bring it all together and to start the process of thinking. For a more complete discussion of field trips, please visit the Jordan Planetarium web site at http://umainesky.com.

If used in its entirety and accompanied by the Planetarium visit this guide will help students to:

Become **a clear and effective communicator** through

A. oral expression such as class discussions, and written presentations
B. listening to classmates while doing group work, cooperation, and record keeping.

Become **a self-directed and life long learner** by

A. introducing students to career and educational opportunities at the University of Maine and the Maynard F. Jordan Planetarium.
B. encouraging students to go further into the study of the subject at hand, and explore the question of "what if?"
C. giving students a chance to use a variety of resources for gathering information

Become **a creative and practical problem solver** by

A. asking students to observe phenomena and problems, and present solutions
B. urging students to ask extending questions and find answers to those questions
C. developing and applying problem solving techniques
D. encouraging alternative outcomes and solutions to presented problems

Become **a collaborative and quality worker** through

A. an understanding of the teamwork necessary to complete tasks
B. applying that understanding and working effectively in assigned groups
C. demonstrating a concern for the quality and accuracy needed to complete an activity

Become **an integrative and informed thinker** by

A. applying concepts learned in one subject area to solve problems and answer questions in another
B. participating in class discussion

State of Maine Learning Results Performance Indicators

In conjunction with the Maynard F. Jordan Planetarium show The X-tra Terrestrial Files this guide will help you meet the following State of Maine Learning Results Performance Indicators in your classroom.

Grades 3-5

Science and Technology –

B1. Skills and Traits of Scientific Reasoning – Students plan, conduct, analyze data from, and communicate results of investigations, including fair tests.

f. Pose investigable questions and seek answers from reliable sources of scientific information and from their own investigations.

D1. Universe and Solar System – Students explain the positions and apparent motions of different objects in and beyond our solar system and how these objects can be viewed from Earth.

a. Show the locations of the sun, Earth, moon, and planets and their orbits

English Language Arts –

E2. Speaking – Students use active speaking skills to communicate effectively in a variety of contexts.

a. Explain ideas clearly and respond to questions with appropriate information.

Grades 6-8

Science and Technology –

A1. Systems

a. Explain how individual parts working together in a system (including organisms, Earth systems, solar systems, or man-made structures) can do more than each part individually.

A2. Models

a. Compare different types of models that can be used to represent the same thing (including models of chemical reactions, motion, or cells) in order to match the purpose and complexity of a model to its use.

C4. History and Nature of Science

b. Describe a breakthrough from the history of science that contributes to our current understanding of science.
c. Describe and provide examples that illustrate that science is a human endeavor that generates explanations based on verifiable evidence that are subject to change when new evidence does not match existing explanations.

D1. Universe and Solar System

a. Describe the different kinds of objects in the solar system including planets, sun, moons, asteroids, and comets.
c. Describe the location of our solar system in its galaxy and explain that other galaxies exist and that they include stars and planets.

E1. Biodiversity

b. Explain how biologists use internal and external anatomical features to determine relatedness among organisms and to form the basis for classification systems.
d. Describe how external and internal structures of animals and plants contribute to the variety of ways organisms are able to find food and reproduce.

Social Studies –

D1. Geographic Knowledge, Concepts, Themes, and Patterns

b. Use the geographic grid and a variety of types of maps to gather geographic information.

9-D

Science and Technology –

B1. Skills and Traits of Scientific Inquiry

d. Formulate and revise scientific investigations and models using logic and evidence.
f. Recognize and analyze alternative explanations and models using scientific criteria
g. Communicate and defend scientific ideas.

D1. Universe and Solar System

a. Explain why the unit of light years can be used to describe distances to objects in the universe and use light years to describe distances.

b. Explain the role of gravity in forming and maintaining planets, stars, and the solar system.

c. Outline the age, origin, and process of formation of the universe as currently understood by science.

E1. Biodiversity

d. Analyze the effects of changes in biodiversity and predict possible consequences.

Performance Indicators Snapshot

The Show

Grades 3-5

Science and Technology
B1.a
English Language Arts
A4.a,b.

Grades 6-8

Science and Technology
C4.c

Grades 9-D

Science and Technology
D1.a,c

The Guide

Grades 3-5

Science and Technology
D1.a.

Grades 6-8

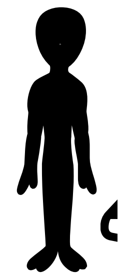
Science and Technology
A1.a; A2.a; C4.b; D1.a,c; E1.d.
Social Studies - Geography
D1.b.

9-D

Science and Technology
B1.d,f,g; D1.a,b; E1.d.

The Maynard F. Jordan Planetarium - Cosmic Classroom Activity

Invent an Alien



Objectives and State of Maine Learning Results Performance Indicators:

1. Learners will be able to analyze the characteristics that allow organisms to survive in the environment of a given planet (6-8. Science and Technology. E1.d.)
2. Learners will be able to discuss the basic characteristics of all living things (9-D. Science and Technology. E1.d.)
3. Learners will be able to create and use models of aliens to present the characteristics of the planets (6-8. Science and Technology. A2.a.) (9-D. Science and Technology. B1.d,f.)
4. Learners will be able to communicate and defend scientific ideas (9-D. Science and Technology. B1.g)

The General Idea:

This activity is ideal to enhance a unit concerning the Solar System. The students' goal is to construct a model of an Alien Being that could live on the planet they picked. These models can be made from any material they can find around the house, school, classroom, etc. and must be explained to the class as to why they have the features they do.

Getting Ready:

- Have students choose a planet or moon for the activity (it's up to you whether or not to include Earth as a choice).

What You Need:

Books on the planets
Access to the internet
Supplies for making the alien models

What To Do:

1. Tell the students that their goal is to construct a model of an Alien Being that could live on the planet they picked. (These could be 2 or 3 dimensional models made from any material they can find around the house, school, classroom, etc.)
2. Give the students adequate time to complete the task. Ask them also to write half-page to one-page descriptions of their Alien Beings, stating why they have the selected characteristics.
3. You may find this a good discussion to have again after they have researched the nature of their worlds, but before they actually start constructing their Alien Beings. Some of the requirements for a "Being" to exist on a given world should include:

   - A means to get food
   - A way to move around their world
   - A way to breathe
   - Other means to sense the environment, equivalent to our five senses
   - The effects of a gravitational pull larger or smaller than we experience.
4. On the day that the Alien Beings are due, they can be put on display around the room with the description in front of each one. The students should then have the opportunity to examine each other's Alien Beings to try to determine what planet or satellite they think each one comes from. This part of the activity can also be done as an oral presentation. (If the written descriptions are used during this part of the activity, students must be instructed to write them without naming their worlds.)

What To Discuss:

1. After the Alien Beings are reviewed, you might have the students talk about the difficulties they ran into designing life on other worlds and discuss with them the reasons our space probes have not found evidence of life elsewhere in the solar system.

Continuations/Extensions:

1. Read Extraterrestrials: A Field Guide For Earthlings by Terence Dickinson & Adolf Schaller.

Planetary Probe

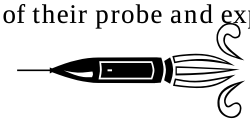
Objectives and State of Maine Learning Results Performance Indicators;

1. Learners will be able to describe how they would use a planetary probe to gather data about the planet visited (9-D. Science and Technology. D1.b.)
2. Learners will be able to explain that sending a planetary probe is a way of exploring space (6-8. Science and Technology. C4.b.)
3. Learners will be able to, when designing their planetary probe, take into account the features of a planet that would have an impact on the probe (6-8. Science and Technology. D1.a.)
4. Learners will be able to judge the practicality of including various items on a space probe. (6-8. Science and Technology. A1.a.)

The General Idea:

This activity is for students who are studying the characteristics of planets, moons, or other celestial bodies, and now want to imagine actually exploring the atmosphere or surface. The process of selecting appropriate tools for the situation is one all scientists follow. This activity also encourages collaboration and compromise among group members.

Groups of students choose, or are assigned, a particular planet and design a probe by selecting specific tools to be used on a mission to the planet. Encourage students to decide what the purpose of their probe is to be before selecting the tools. Groups can create models or "blueprints" of their probe and explain their choices to the class.



Getting Ready:

- A list of tools is provided, but teachers might want to bring in actual samples, and/or review the names and purposes of each tool. The list could easily be extended for later grades, and more complex issues including weight or size limitations, energy supplies, and even cost, can be incorporated. You will need to make these discussions before beginning the lesson.

What To Do:

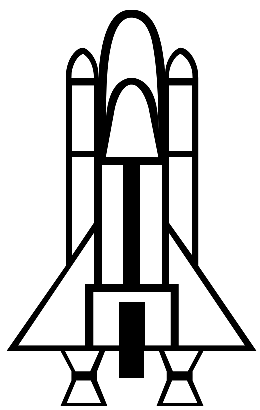
1. Divide your class into eight groups (nine groups if you wish to have students design a moon probe). Each group will be responsible for designing a manned or unmanned probe, especially designed for a particular planet.
2. Have each group choose a planet or assign a planet to each group
3. Students should be encouraged to do research in the library, on the internet, etc. for additional information on the planets and the Moon.
4. Have each group speculate on the type of space probe and devices that would be most appropriate for their planet.
5. Students should also be prepared to justify their decisions. For added realism, you might act as the Congress, and have each team submit a proposal with estimated costs and justifications for their space probes.
6. You may wish to impose certain restrictions on each group. For instance, you might give a weight limit, size limit, cost limit, etc.
7. After your students have decided on the items and design of their planetary probes, have each group make a blueprint or cross-section diagram of their probe. It is best to have each student in a group draw several components of the probe, and then cut and paste the whole thing together.
8. An alternative is to have members of each group gather 'found' objects in order to build a 3-dimensional model of their probe (fairly realistic space probes can be made with cardboard tubes, empty coffee cans, boxes, aluminum foil, and paint).

What To Discuss:

1. A representative of each group should describe the conditions on their planet and explain to the class why they designed their probe as they did.
2. The class can discuss the merits and shortcomings of each probe (remember to keep the criticism constructive!).
3. Would you send the same kind of space probe to different planets?
4. Encourage your students to consider factors such as the feasibility of sending an astronaut on the very long voyage to Pluto, etc.

Possible items to include on the probes

1. Wide angle TV camera (for a clear view of a planet and its moons)
2. Seismograph (planetquake detector)
3. Thermometer
4. Microscope
5. Biological experiment (to detect life)
6. Radar (to examine surface below clouds)
7. Soil analyzer
8. Lightning rod
9. Wind velocity detector
10. Radio telescope ('sees" radio emissions)
11. Robot
12. Computer
13. Astronaut
14. Food
15. Air
16. Water
17. Bathroom
18. Entertainment
19. Magnetic compass
20. Telescope
21. Solar panels (for electric power)
22. Nuclear reactor (for electric power)
23. Rocket fuel
24. Attitude jets (small rockets for changing direction)
25. Geiger counter (for detecting radiation)
26. Air conditioner
27. Heater
28. Heat shield
29. Meteor shield (to protect ship from being punctured by small meteorites)
30. Spacesuit
31. Radio transmitter and receiver (for communications with Earth)
32. Landing gear (for landing on a hard surface)
33. Parachutes
34. Glider (for cruising through an atmosphere)
35. Flood lights
36. Gas analyzer
37. Weapons
38. Scientific experiment of students' choice
39. Other items of students' choice



Hello Out There!

Objectives and State of Maine Learning Results Performance Indicators:

1. Learners will be able to explain that light takes time to travel. (9-D Science and Technology. D1.a.)
2. Learners will be able to show that distances must be very great in order for the consequences of the speed of light to become apparent (9-D. Science and Technology. D1.a.)
3. Learners will be able to demonstrate that a fundamental consequence of the finite speed of light is that we always see a star's past, not its present. (6-8. Science and Technology. D1.c.)

The General Idea:

In common experience, it is assumed that light travels over any distance instantaneously. This is because the distances we normally encounter are relatively short and the speed of light is very great. However, light does take time to travel, and when the distances become great enough, this becomes apparent. An analogy can be made with sound, which travels more slowly than light. If the distance is great enough, there is a lag between seeing an event and hearing the sound that results from it. For example, when we see a bolt of lighting off in the distance, we see the flash of light before we hear the thunder. The light from the lightning reaches us before the sound does because sound travels much more slowly than light.

All forms of light travel at the same speed, 300.000 km/s. Radio waves, one form of light, are used to communicate with spacecraft. The signals now being received from a space probe take hours to reach Earth. The star Sirius (the brightest star as seen from Earth except for the Sun) is 9 light years away. This means that the light now reaching Earth from Sirius left the star nine years ago. If there were people on Sirius watching Earth, they would now be seeing what happened here nine years ago. All this is because light takes time to travel.

This activity is designed to help students understand that light does have a finite speed and that this has consequences for us. In order to grasp the meaning of the activity, it is important for students to understand that light acts as a messenger in the same way that a person can. Both transfer information from one point to another. How quickly the information is transferred depends on the speed of the messenger, whether the messenger is a person or light. This activity assumes that the students are familiar with a light year.

Getting Ready:

- Set up a scale model of the solar system

What You Need:

A scale model of the solar system
One piece of candy or other treat for each student

What To Do:

1. Select a volunteer or designate a student to be the "electromagnetic messenger."
2. Divide the class into three or four groups and position one group at each of the following planets in your scale model of the Solar System: Mars, Saturn, Uranus, and/or Pluto. Have the students face away from the Earth.
3. Tell the class that you (the instructor) will be on Earth sending out radio messages into the Solar System via the electromagnetic messenger.
4. The electromagnetic messenger must walk heel-to-toe. The students must also walk heel-to-toe when they travel. Since sound cannot travel in outer space, there must be ***no*** talking.
5. Send the messenger out into the Solar System with a card for each planet that is inhabited. Each card should read. 'Mr./Ms. ________ is on planet Earth handing out a limited amount of candy to hungry astronauts. Go to Earth if you want some candy. Remember, you must walk heel-to-toe, and NO TALKING!" Students must read the message silently.

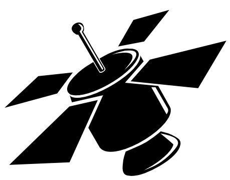
6. As students arrive, hand each one a piece of candy inconspicuously.

What To Discuss:

1. Why did it take longer for the students far away from "Earth" to get there?
2. How can we compare this activity to the travel of light?
3. Various forms of light provide astronomers with valuable information about the Universe. The idea behind the Hubble Space Telescope was to place a device to gather light (of both visible and ultraviolet wavelengths) above the atmosphere where it could get an unobstructed picture of these types of light from objects in space. When light travels through the atmosphere, it can be refracted, reflected, or absorbed making it difficult to get an accurate picture of the light from planets and stars with ground-based telescopes. In orbit around Earth, Hubble receives light that is unaffected by Earth's atmosphere.

Continuations/Extensions:

1. Light is electromagnetic radiation. It includes infrared, visible, ultraviolet, and all travel at exactly the same speed. The various forms of light have both harmful and helpful effects. X-rays revolutionized diagnostic medicine. Too much X-ray radiation, however, has been shown to be harmful. Students can investigate the uses of all the different forms of light and their effects on humans.
2. The idea of seeing a star's past brings up the topic of time travel. In a sense, we are going back in time when we observe any star because we see the star's past as though it were the present. Time travel is a popular theme in science fiction. Madeleine L'Engle's A Wrinkle in Time is an account of traveling through time between the planets. The poem "*Messages*" by Myra Cohn Livingston at the beginning of this activity describes some of the different messages we receive from space. Encourage students to investigate the phrases "pulsing beats from distant neutron stars" and "radio blackouts from a solar flare" from the poem.



Light Years

Objectives and State of Maine Learning Results Performance Indicators:

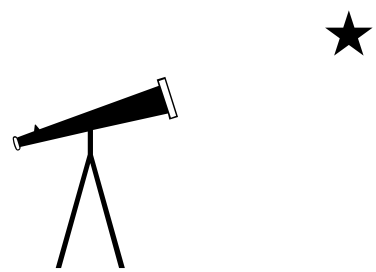
1. Learners will be able to define the term light year (6-8. Science and Technology. D1.a.)
2. Learners will be able to explain how astronomers measure distances in space by light years (9-D. Science and Technology. D1.a.)
3. Learners will be able to explain the distances of some stars close to our solar system (6-8. Science and Technology.D1.c.)

The General Idea:

Ever wonder why scientists felt the need to develop a new measure for distance? Last night, if it was clear, you might have seen the group of stars known as the Big Dipper. The closest of those stars is approximately 432 trillion miles away. Because of these vast distances, scientists created a new unit of measure called the light year.

Getting Ready:

- Have students review place value into the trillions



What You Need:

Copies of light years work sheet

What To Do:

1. Define the speed of light (180,000 miles per second)
2. Using multiplication, show how far light travels in one year
5. Given the mileage from the Earth to the Sun (93 million miles, also known as an Astronomical Unit or AU) have student compute the time light would need to travel from the Sun to Earth

What To Discuss:

1. If the Sun were to suddenly change color, how long until we would know?
2. If we look at objects deep in space tonight, what are we really observing? (the objects as they appeared in the past).
3. If a star is located 10 light years away from Earth, what is its distance from Earth in miles?

What To Do:

1. Hand out the Light Years worksheet for students to complete on their own, in groups, or as homework.

Light Years

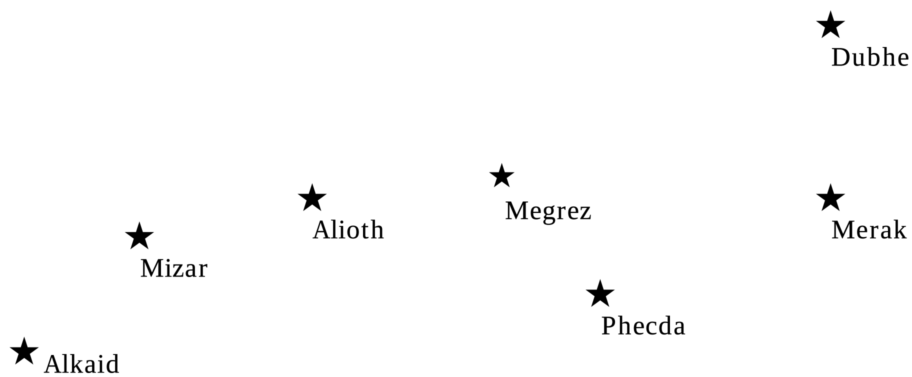
Light travels about 186,000 miles each second. Since there are 60 seconds in a minute, we multiply 186,000 by 60, therefore light travels about 11 million miles each minute.

How far will light travel in one hour?

How far will light travel in one day?

How far will light travel in one year?

Although the stars in the Big Dipper all appear to be the same distance away, actually they are not. Complete the following chart by converting light years (ly) to millions of miles.

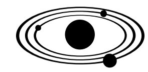


Star	Bayer Letter*	Distance (in light years)	Distance (in Miles)
Dubhe (Alpha)	α	107 ly	
Merak (Beta)	β	78 ly	
Phecda (Gamma)	γ	90 ly	
Megrez (Delta)	δ	74 ly	
Alioth (Epsilon)	ε	68 ly	
Mizar (Zeta)	ζ	76 ly	
Alkaid (Eta)	η	210 ly	

* An astronomer, Johann Bayer, in 1603 assigned Greek letters to all the brightest stars of the constellations. This remains the best labeling system for star charts, even today.

Your Universal Address

Objectives and State of Maine Learning Results Performance Indicators:



1. Learners will be able to describe our position in the universe, compared to the Sun, moon, stars, Milky Way, and other galaxies. (3-5. Science and Technology. D1.a.)
2. Learners will be able to demonstrate an understanding of the shape and position of our galaxy, the Milky Way. (6-8. Science and Technology. D1.c.)
3. Learners will be able to visualize their location in school, city, state, country, world, solar system, and galaxy. (6-8. Social Studies. Geography. D1.b.)

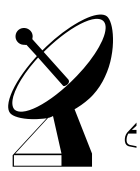
The General Idea:

Usually you think of your address as only three or four lines long: your name, street, city, and state. But what if you were to address a letter to a friend in a distant galaxy? You would have to specify where you are to a much greater scale. How might you go beyond your town and state in order to complete your address? This activity helps students understand where we are in relation to the other planets, stars, and galaxies.

Getting Ready:

1. Get a map of your school and reduce or photocopy it (or have students sketch a map of your school).
2. Reduce or photocopy a map of your neighborhood and a map of your city.
3. Reduce or photocopy a map of your state.
4. Reduce or photocopy a map of your country.

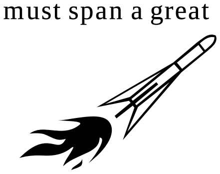
What You Need:



A copy of each of the following for each student: map of school, map of neighborhood, map of city, map of state, map of country.
A world map
A poster picture of the solar system
A picture of a spiral galaxy

What To Do:

1. Explain if you were to write a letter to an alien being from another planet, you would need a much more detailed address than the one that we use on our mail. A complete galactic address must span a great distance.
2. Hand out the maps of the school and have students find their classroom.
3. Hand out the maps of the neighborhood and have students find the school.
4. Repeat #3 with the city, state, and country maps.
5. As a class, find your country on the world map and mark it.
6. Find our planet, Earth, on the poster of the solar system and mark it.
7. Now show the students the picture of a spiral galaxy. Explain to students that no one has ever traveled outside our galaxy and as of yet no space probes have ever made it out of our solar system, let alone our galaxy. As a result we do not have any pictures of our galaxy to use for the next part of the activity. With that in mind, tell students that the picture you are using is not a picture of our galaxy, but one that scientists think looks like ours. Tell the class that our solar system is about 2/3 of the way from the center to the edge of the galaxy. Also, we are located on the outer edge of the "Orion spiral arm." The students can use those clues to mark where they think our solar system is on the picture of the galaxy.
8. Finally, ask the students to write their complete galactic address, all the way from the desk where they are sitting to the galaxy where the live.



What To Discuss:

1. After you have your students write down the following: Name, Classroom, School, City, State, Country, Planet, Planet System, Galaxy, Galactic Arm, ask the students questions about what they learned by putting their galactic address together.
2. Have students discuss other ways of remembering where we are in the universe.
3. An example of our cosmic address would be:

- Maynard F. Jordan Planetarium
- Wingate Hall
- University of Maine
- Orono
- Maine
- United States of America
- North America
- Earth
- Solar System
- Orion arm
- Milky Way Galaxy
- Local Group
- Virgo Supercluster
- Universe

Is Anyone Out There?

Objectives and State of Maine Learning Results Performance Indicators:

1. Learners will be able to determine the probability of the existence of extraterrestrial life.

The General Idea:

One of the most fascinating questions which could be asked is this: "What are the chances that life exists on another planet orbiting another star somewhere out there?" The attached worksheet will help students understand these chances by taking them step by step through the mathematics used to "guesstimate an answer.

Getting Ready:

- Photocopy the "Is Anyone Out There" worksheet

What You Need:

A copy of "Is Anyone Out There" for each student

What To Do:

1. Hand out the worksheet as homework, just for fun, or to complement another activity that you are doing. This worksheet is very good for a cross-curriculum activity combining the study of astronomy in science and the study of probability in mathematics.

IS ANYONE OUT THERE?

One of the most fascinating questions which could be asked is this: "What are the chances that life exists one another planet orbiting another star somewhere out there?" Perhaps it would be best to put some limits on the size of 'out there'. For purposes of this activity, "Out There" will be limited to our own island of stars, the Milky Way Galaxy. The Milky Way Galaxy probably looks a huge turning pinwheel of stars. (The word 'probably' is used since no one has been outside the galaxy and no external photographs have ever been taken.)

While the exact number of stars in the Milky Way is not known, most astronomers will agree that there are probably several hundred billion stars. For purposes of this activity, the estimate to be used is two hundred billion. (That's the number 2 with 11 zeros behind it.) Most of these stars are congregated in a central bulge with the remaining strewn out in great spiral arms.

STEP ONE:

We mentioned before that our galaxy may contain as many as 200 billion stars. However, not all of these stars are good candidates. Easily half of all the stars in the galaxy are double stars (two stars going around each other) or triple stars. If life were to develop on planets going around stars, it would have a better chance if that star were a single star like our Sun. Thus, to find out how many total single stars there are in our galaxy, do the math step below.

1. 2OO,OOO,OOO,OOO X 1/2= _______________single stars

STEP TWO:

If life as we know it exists elsewhere, it probably is on a planet which goes around a sun like our own. Since not all the remaining single stars are like the Sun, some are hotter and blue in color (to hot for life) and others are cooler and red colored (too cold for life.), we will assume that only one star in ten is a star like our own. Thus, your next calculation is as follows:

2. (insert answer from step 1)_______________X 1/10___________single stars

STEP THREE

Not all of the remaining stars have the more complex elements from which life could develop. Some of these stars are what we call early stars, and they contain only hydrogen. Let us suppose that only one star is five has the elements required for life to develop. Perform the calculation below.

3. (insert answer from step 2) ________________X 1/5___________single stars

STEP FOUR:

These remaining stars might not have planets going around them which would be the right size for life. If the planet were too large, like Jupiter, it would hold in all the poison gases. If it were too small, like Mercury, there would not be enough gravity to hold onto an atmosphere. The next calculation is used if we assume that that only one in ten stars have an Earth-sized planet.

4. (insert answer from step 3) _______________ X 1/10 _____________Planets

STEP FIVE:

Next, the Earth-sized planets would have to be at the exact distance from their stars. If it were too close, there would be too much heat for life; too far away - too cold. Suppose that only one planet in ten is at the right distance. Do the calculation below.

5. (insert answer from step 4) _______________ X 1/10 _____________Planets

STEP SIX:

Of these remaining planets, not all of them may have developed an atmosphere which could sustain life. Let us assume that only one in ten has the proper blanket of air. Calculate the number of remaining planets below.

6. (insert answer from step 5) _______________ X 1/10 _____________Planets

STEP SEVEN:

Even though we have narrowed things down considerably, we still are not finished. The odds are fairly thin that life might actually develop on any of these planets. To be conservative, let us reduce the chances to one in a thousand.

7. (insert answer from step 6) _____________ X 1/1000 _____________Planets

STEP EIGHT:

One last reduction is necessary. The life which mathematically might exist on these planets may only be simple life (microscopic organisms, for example.) The chances that there might be planets with INTELLIGENT life are slim. To be on the safe side, reduce the number of remaining planets by a factor of 1000.

8. (insert answer from step 7) _____________ X 1/1000 _____________Planets

Vocabulary List

Astronomer	A person who studies and contributes to the science of astronomy.
Atmosphere	A layer of gases that surrounds a body such as a planet.
Axis	An imaginary straight line around which an object rotates.
Black Hole	A cosmic body of extremely intense gravity from which nothing, not even light, can escape.
Comet	Frozen masses of gas and dust which orbit through the solar system.
Constellation	A grouping of stars, considered by humans to form a picture in the sky. Often related to mythology.
Day	The time it takes for a planet to make one full rotation (on Earth, 24 hours).
Exobiology	A branch of biology concerned with the search for life outside the earth and possible effects of extraterrestrial environments on living organisms.
Galaxy	A cluster of stars, dust, and gas grouped together by gravity.
Gravity	The force of attraction between two objects. It is influenced both by the mass of the two objects and the distance between the two objects.
Light Year	The distance that light travels in one year, approximately 6 trillion miles.
Milky Way galaxy	A large spiral galaxy consisting of several billion stars, including our Sun.
Moon	A natural satellite orbiting a planet.
Orbit	A specific path followed by a planet, satellite, etc.
Planet	A massive object orbiting a star.
Revolution	The circling of a smaller object around a larger object.
Rotation	The spinning of an object on its axis.
SETI	A research program called the Search for Extra Terrestrial Intelligence.
Solar System	The system of planets, moons, and other objects revolving around a star called Sol (Sun).
Star	a massive, self-luminous celestial body of gas that shines by radiation derived from its internal energy sources.
Space Probe	A vehicle designed to travel and explore remote locations in space and return information to astronomers and scientists.
Sun	Sol, the star that is closest to Earth and from which we get heat and light energy.
Time Dilation	In the theory of special relativity, the "slowing down" of a clock as determined by an observer who is in relative motion with respect to that clock.
Universe	The vast expanse of space which contains all of the matter and energy in existence.

Year	The time period for a planet to make one full revolution around its parent star, the Sun (the Earth revolves around the Sun in 365.2422 days).

Some good books to use with The X-tra Terrestrial Files

Are We Alone?
Rood, R. and Trefil, J. 1981, Scribners.
Popular-level introduction to life out there and the search.

Cosmic Quest: Searching for Intelligent Life Among the Stars
Poynter, M. & Klein, M. 1984, Scribners & Atheneum.
A nice introduction to the search for life elsewhere in the universe for ages 13 and up.

Extraterrestrials: A Field Guide For Earthlings
Terence Dickinson, Adolf Schaller. 1994, School & Library Binding.

Extraterrestrials: Is There Life in Outer Space?
Davis, Amanda. 1997, PowerKids Press.
Briefly discusses the possibility of finding life on other planets.

The Search for Life in the Universe
Goldsmith, D. & Owen, T. 1980, Benjamin/Cummings.
A basic introductory text in this field.

The Search for Extraterrestrial Intelligence
McDonough, T. 1987, John Wiley.
Good-humored, basic book.

Some good web sites to use with The X-tra Terrestrial Files

www.seti-inst.edu
Home page for the Search for Extraterrestrial Intelligence (SETI) Institute

exobiology.arc.nasa.gov/
NASA's exobiology branch web site

www.naic.edu
Arecibo Observatory Home Page

www.seti.org/
SETI Institute site

Lessons From The World Wide Web

Also, a wide variety of lesson plans and activities can be found on the World Wide Web. These sites are dedicated to lesson planning in a variety of subjects.

btc.montana.edu/ceres
Maintained by the Burns Telecommunications Center, this page links to educational activities and classroom resources.

spaceplace.jpl.nasa.gov/spacepl.htm
This California Institute of Technology and NASA Jet Propulsion Laboratory site for kids offers information and activities .

school.discoveryeducation.com/

This Discovery Channel education site allows teachers to search for lesson plans by grade and subjects.

askeric.org/cgi-bin/lessons.cgi/Science/Astronomy

Lesson plans based of the popular PBS series, Newton's Apple

www.thegateway.org

Sponsored by The U.S. Department of Education's National Library of Education and ERIC Clearinghouse on Information & Technology, this site offers lesson plans for all subjects and all grades.

Astronomy Web Sites Worth a Visit

galaxymaine.com

The Maynard F. Jordan Planetarium and Observatory home page.

www.galaxymaine.com/SA/SA2.htm

The teacher resources and bibliography page on the Maynard F. Jordan Planetarium web site

space.jpl.nasa.gov

NASA's Jet Propulsion Laboratory web site

ssd.jpl.nasa.gov

A site about our solar system maintained by the Solar System Dynamics Group of the Jet Propulsion Laboratory.

www.nineplanets.org

A Multimedia Tour of the Solar System from the Students for the Exploration and Development of Space

www.clearsail.com/astronomy.htm

Astronomy links from the ClearSail student fun and research site

hawastsoc.org

The Hawaiian Astronomical Society's home page

www.nss.org

The National Space Society web site

stardate.org

Learn what's going on TODAY in astronomy on the "Star Date" web page, maintained by the University of Texas' McDonald Observatory

The Maynard F. Jordan Planetarium does not guarantee the information given on the above web sites to be accurate, accessible, or appropriate for students.