Maynard F. Jordan Planetarium

IN THE MAINE SKY

Edited by Jennifer Ledenican

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 may not be focused at your students may be adapted for them. 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 – *In the Maine Sky*

During "*In the Maine Sky*" the audience explores celestial objects from the bright Moon, to nebulas so distant you need a telescope to bring them into focus. The universe unfolds with concepts and contents that help everyone understand it better and appreciate it from their own back yard. The program was built around the Maine State Learning Results. The show is in a 'live' format that brings together visitors and our planetarium host. Classes will discover what is out there and have the chance to ask those puzzling questions that keep us wondering.

We're 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 *In the Maine Sky*, 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-secondary 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. 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 *In the Maine Sky,* this guide will help you meet the following State of Maine Learning Results Performance Indicators in your classroom.

Grades 3-4

Science and Technology –

G. Universe

#1. Illustrate the relative positions of the Sun, moon, and planets.

#2. Trace the sources of Earth's heat and light energy to the Sun.

M. Implications of Science and Technology

#2. Investigate and describe the role of scientists and inventors.

English Language Arts –

B. Literature and Culture

#3. Respond to speakers in a variety of ways.

Grades 5-8

Science and Technology -

G. Universe

#1. Compare past and present knowledge about characteristics of stars and explain how people have learned about them.

#2. Describe the concept of galaxies, including size and number of stars.

#3. Compare and contrast distances and the time required to travel those distances on Earth, in the solar system, in the galaxy, and between galaxies.

#4. Describe scientists' exploration of space and the objects they have found.

5. Describe the motions of moons, planets, stars, solar systems, and galaxies.

J. Inquiry and Problem Solving

#1. Make accurate observations using appropriate tools and units of measure.

#2. Design and conduct scientific investigations which include controlled experiments and systematic observations. Collect and analyze data, and draw conclusions fairly.

K. Scientific Reasoning

#1. Examine the ways people form generalizations.

L. Communication

#4. Make and use scale drawings, maps, and three dimensional models to represent real objects, find locations, and describe relationships.

English Language Arts -

H. Research Related Writing

#1. Collect and synthesize data for research topics from interviews and field work, using note taking and other appropriate strategies.

#2. Separate information collected for research topics into major components based on relevant criteria.

Secondary

Science and Technology -

G. Universe

#1. Describe how scientists gather data about the universe.

J. Inquiry and Problem Solving

#1. Make accurate observations using appropriate tools and units of measure.

#2. Verify, evaluate, and use results in a purposeful way. This includes analyzing and interpreting data, making predictions based on observed patterns, testing solutions against the original problem conditions, and formulating additional questions.

K. Scientific Reasoning

#3. Develop generalizations based on observations.

Mathematics

F. Measurement

#1. Use measurement tools and units appropriately and recognize limitations in the precision of the measurement tools.

Performance Indicators Snapshot

The Show

<u>Grades 3-4</u>

Science and Technology
G. #1, #2, #4 M. #2
English Language Arts
B. #3

<u>Grades 5-8</u>

Science and Technology
G. #1, #2, #3, #4, # 5, K. #1
Social Studies – Geography
A. #1

The Guide

<u>Grades 3-4</u>

Science and Technology
G. #1

<u>Grades 5-8</u>

Science and Technology
G. #1, #2, #3, #4, J. #1, J. #2, L. #4,
Social Studies – Geography
A. #1
English Language Arts
H. #1, #2

A Month of Moons

Objectives and State of Maine Learning Results Performance Indicators:

1. Learners will be able to explain that the motion of the moon around the Earth causes the phases of the moon (3-4. Science and Technology. G. #1., G. #4.) (5-8. Science and Technology. G. #5.)
2. Learners will be able to make predictions of upcoming moon phases (3-4. Science and Technology. J. #3.)
3. Learners will be able to discuss the scientific and practical aspects of the activity (3-4. Science and Technology. L. #3.)

The General Idea:

Long ago people invented the word "MONETH" to describe the length of time it takes for the moon to show all of its different phases. By carefully watching the changing appearance of the moon, you are watching time pass. Some people know the moon so well, they can tell how many days have gone by since the last time they looked at the moon. You can begin to know the moon by keeping a record of the changing moon as the month goes by.

Getting Ready:

- Talk with your students before they begin their moon journals so that they understand the things that they need to look for and what they need to write down.

What You Need:

Notebooks for moon journals
Pictures of the moon for reference

What To Do:

1. On every clear night for one whole month, have students try to find the moon in the sky.
2. If it is there, make a drawing of the way that it looks. Use a pencil or crayons to draw the shape of the moon and color the markings that you see on the moon.
3. If it is a dark sky and they can see stars near the moon, put the stars in their drawing with larger dots for brighter stars, and smaller dots for dimmer ones.
4. Under each drawing, have them write the month and day and time when they saw the moon, how high up in the sky it was (a good way to have them measure this is by “stacking” their fists at arm length, so the moon would be “four fists” off the ground), and where it was in relation to sunset (it was close to where the sun sets, it was opposite where the sun sets, etc.).
5. If they see the moon in the daytime, they better draw it then. It may not be in the sky by the time it gets dark!
6. Compare students drawings of the Moon. Together, you can make a calendar of the moon and the way it looks for one entire month (or moneth). For this part of the activity, you can use the Moon Phases worksheet provided.

What To Discuss:

1. Is there a pattern to the changing moon?
2. Can you see the moon in the same place at the same time every night?
3. Based on your moon calendar, when is the next full moon?

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. (3-4. Science and Technology. G. #1.)
2. Learners will be able to demonstrate an understanding of the shape and position of our galaxy, the Milky Way. (5-8. Science and Technology. G. #2.)
3. Learners will be able to visualize their location in school, city, state, country, world, solar system, and galaxy. (5-8. Social Studies. Geography. A. #1.)

The General Idea:

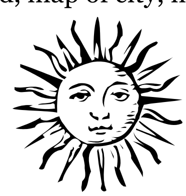
Usually you think of your address as only three or four lines long: your name, street, city, and state. But what if you were to address a letter to a friend in a distant galaxy? You would have to specify where you are to a much greater scale. How might you go beyond your town and state in order to complete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

Getting Ready:

- Get a map of your school and reduce or photocopy it (or have students sketch a map of your school).
- Reduce or photocopy a map of your neighborhood and a map of your city.
- Reduce or photocopy a map of your state.
- 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 in to the galaxy where they live.

What To Discuss:

1. After you have your students write down the following: Name, Classroom, School, City, State, Country, Planet, Planet System, Galaxy, and 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. At the planetarium our cosmic address is as follows:

- 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

Classifying Galaxies

Objectives and State of Maine Learning Results Performance Indicators:

1. Learners will be able to describe the different types of galaxies (5-8. Science and Technology. G. #2.)
2. Learners will be able to use scale drawings to appropriately represent galaxies (5-8. Science and Technology. L. #4.)
3. Learners will be able to place galaxies in their appropriate place on the tuning fork diagram (Sec. Grades. Science and Technology. J. #2.)

The General Idea:

Through this lesson students will become familiar with the Hubble Tuning Fork Diagram, a system of classification, still in use today, for galaxies invented in the 1920's by the noted astronomer Edwin Hubble. Students will practice the technique, useful in science, of engaging a scheme or plan to classify objects in a group. In this lesson you will be able to look at images of different kinds of galaxies, taken by the world's best telescopes. In most high school astronomy texts and in some Earth science texts, the Hubble Tuning Fork Diagram is presented as a way to classify, or put into groups, the various types of galaxies observed in space. This lesson also reinforces the idea that there are many "right" answers in science.

Getting Ready:

- For this lesson you will need nine pictures of galaxies selected for differences in observable characteristics (i.e. color, size, shape, etc.). We recommend photographs from one of these WWW sites http://www.astr.ua.edu/normal2.html OR http://www.astro.princeton.edu/~frei/Gcat_htm/cat_ims.htm Please note that it is helpful if you select one galaxy for each of those on the Tuning Fork Diagram below and all in color. You can also use the images provided at the end of this activity, however they eliminate the category of color when classifying them.

What You Need:

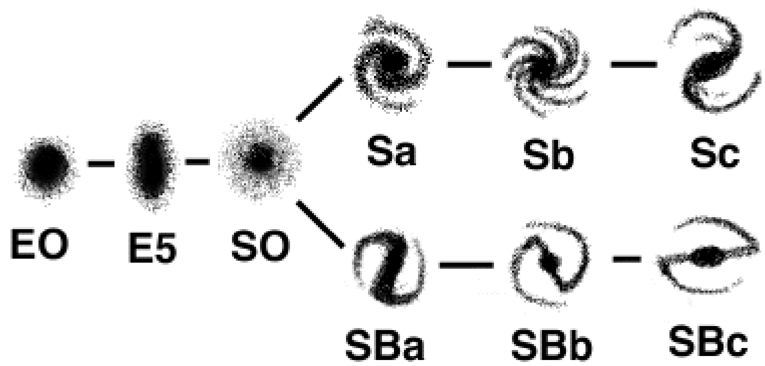
Nine pictures of galaxies
Chalkboard or overhead projector for recording class key.
Paper and pencils for student group recording.

What To Do:
Part I:
1. Display the pictures of galaxies and discuss their similarities and differences.
2. Ask a volunteer to divide the photographs into two groups using an observable characteristic (i.e. blue and not blue, round and not round, etc.).
3. Record results of first division.
4. Continue to divide groups of pictures, using a different characteristic each time, until only one photograph remains in each group. Continue recording results.
5. Using the class key, identify "unknown" pictures (optional).

Part II:
6. Divide class into groups of four to six students.
7. Provide each group with a sample set of photographs or display the first set (numbered) in a place where all the students can observe them.
8. Ask each group to devise and test a way of classifying galaxies that is different from the class key and have them record their results.

What To Discuss:

1. Tell students about how in the 1920's Edwin Hubble, an astronomer, gathered pictures of many galaxies. When he noticed that they were not all alike, he decided to group, or classify them. To group the galaxies in the photographs he studied, he could have used any of the ways that your students came up with, and perhaps he did. Hubble decided to classify galaxies by their shape or form. He created the following diagram, which is still used today, to classify the galaxy shapes.



The first type of galaxy is an "elliptical" galaxy. The word elliptical refers to its degree of "roundness". Hubble used the letter "E" to stand for elliptical galaxies.

The second type of galaxy Hubble called a "spiral" galaxy. It reminded him of a pinwheel or whirlpool. He used the letter "S" to stand for spiral galaxies.

The third type of galaxy reminded Hubble of a spiral with a solid bar across the center. He called it a "barred spiral" galaxy. He used the letters "SB" to stand for barred spirals.

2. Early photographic processes and small telescopes could not capture color very well, if at all. Especially the most distant galaxies were too faint to capture color. These may have been reasons that Hubble did not classify galaxies by color.

<u>Continuations/Extensions:</u>

1. Repeat activity with other objects such as potato chips, candy, shoes, etc.
2. Emphasize that the way Hubble chose is not the only way to classify galaxies.
3. After each group has devised and tested a way of classifying galaxies that is different from the class key, have the class discuss the differences and similarities in the systems that were designed.

Numbering the Stars

Objectives and State of Maine Learning Results Performance Indicators:

1. Learners will be able to demonstrate the size of our galaxy (5-8. Science and Technology. G. #2.)
2. Learners will be able to compare sizes and distances of scale stars to those of real stars (5-8. Science and Technology. G. #3.)
3. Learners will be able to conduct scientific investigations in order to comprehend the number of stars in our galaxy. (5-8. Science and Technology. J. #1., J. #2.)
4. Learners will be able to understand that using sand to represent stars is a practical use of a scale model. (5-8. Science and Technology. L. #4.)
5. Learners will be able to use note-taking effectively while gathering data, and separate that data appropriate. (5-8. English Language Arts. H. #1., H. #2.)
6. Learners will be able to use the appropriate unit of measure for the experiment they are conducting. (5-8. Science and Technology. J. #1.)
7. Learners will be able to form generalizations about other galaxies and make predictions about the number of stars in those galaxies (Sec. Grades. Science and Technology. K. #3., J. #2.)
8. Learners will be able to use measurement tools and units appropriately and recognize limitations in the precision of the measurement tools. (Sec. Grades. Mathematics. F. #1.)

The General Idea:

Comprehending the enormousness of 200 billion of anything is difficult for most people. Take the number itself for instance. How long do you think it would take to count to 200 billion? At one number a second, would you believe almost 6,400 years! Or consider height, a stack of 200 billion pennies would stretch 286,000 km, or three-fourths of the distance from the Earth to the Moon.

Astronomers often use 200 billion as the approximate number of stars in our galaxy, but most of us really cannot appreciate a number that large. This activity will help students develop a sense of number scale, understand the concept of volume, and develop scientific estimation, measurement and data analysis skills.

Getting Ready:

- The day before this activity, have your students make their own one-centimeter cube. You can photo copy the one at the end of this lesson for your students to cut out and glue together, or have them measure and make their own using a metric ruler. If you use the second option, make sure to tell the groups to use the metric rulers to draw the template accurately!
- Do the activity and calculations yourself before trying it with your class! You need to know how large a resultant volume to expect. This volume can vary drastically depending on the size of the sand grains you are using. The size of the sand grains also affects the length of time the activity takes to do, which needs to be determined in advance. Students may need anywhere from 5 to 30 minutes of counting time, depending on the size of the sand grains. (About 10 minutes is needed for one-millimeter diameter sand grains.)
- Make a set of three demonstration cubes: one each of 1cm, 10cm, and 1m on a side. You can make the cubic-centimeter cube using the template below. Make a similar template for the 10cm cube. You can tape meter sticks together to make a cubic-meter cube (but you will need 12 of them!) or pick up a box from a furniture store and cut it down to the right size.
- Filter the sand using a set of screen sieves to eliminate the finer grains. The sand does not need to be uniform, but all the grains need to be large enough to be easily counted (a diameter of one millimeter, on average). A sieve for flour or sugar works well.
- Introduce your students to galaxies before beginning the activity. This introduction may be handled in many different ways and may combine such elements as class discussion, homework reading selections, viewing and discussion of a video, viewing of slides and photographs, and so on. Your objective with this introduction is to

expose students to basic information such as: the description of a galaxy; the general structure of galaxies; and the name of our own Galaxy, the Milky Way.

What You Need:

Medium to coarse sand, about 200 ml, sifted to obtain fairly large grains
Paper cubes
Paper and pencils
1cm, 10 cm, 1m demonstration cubes

What To Do:

1. Explain to your students that our galaxy, the Milky Way, consists of approximately 200 billion stars. Ask if anyone can explain their concept of how big a number that is. Ask students how big a box they would need to store 200 billion bricks. (about 525 m on each side). The responses should make the point that students may know that 200 billion is 200 thousand million, but they are not likely to have any idea of the space that would be occupied by that many objects.
2. Tell the students that this activity will help them gain a better understanding of how many stars 200 billion really is. Ask them to imagine that they can take every star in our galaxy and scale it down until it is the size of a grain of sand. Sand grains vary in size and star sizes vary far more drastically, but tell them to imagine that the average star has been shrunk to the average size of a grain of sand which will be used during the following experiment as a model for a star.
3. Count out 10 grains of sand onto a sheet of paper and ask the students to imagine that they continue to count until all 200 billion of them have been piled into a cube. Ask your students to estimate how big a cube they would have in the end. Then show the class the 1cm cube and ask the students to estimate how many would be needed to hold 200 billion grains of sand in total. Do the same with the 10cm cube. Make sure that each student writes down the two estimates records her/his estimates for later reference.

Now we will move on to the "meat" of the activity:

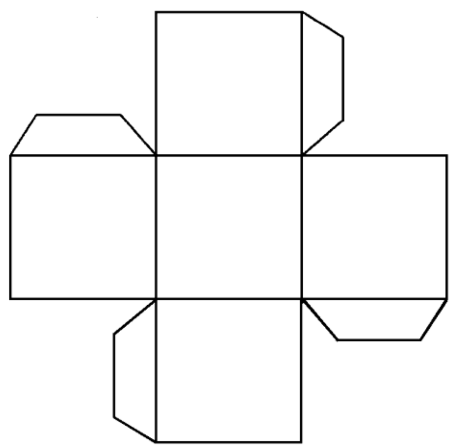
4. Combine your students into groups of two to three students each.
5. Have each group pick up one cubic centimeter of sand by using the cubic centimeter they made the day before.
6. Each group should dump their "stars" onto a piece of scratch paper.
7. Suggest that the groups *do not* count out loud.
8. Record the total count of sand grains from each group in the class, and together with the class calculate a class average for the number of stars in one cubic centimeter.
9. Divide the total number of stars, (200 billion) by the class-average. The number you get is the volume of the pile of stars in cubic centimeters. (i.e. it would take x number of cubic centimeters to hold 200 billion grains of sand). The equation looks like this: 200,000,000,000 / class average.
10. This number is still huge to the point of being meaningless. So a larger unit is needed to express this huge volume in a way that will be more meaningful to the students. The unit one cubic meter should bring the number down to understandable size for the students. To do this, first calculate the number of cubic centimeters in a cubic meter, (there are 100 centimeters in a meter, so the calculation would be 100 X 100 X 100 = number of cubic centimeters in a cubic meter) then use the answer to divide your total (your equation would be answer from first equation / answer from second equation = # of cubic meters needed to hold 200 billion grains of sand).
11. While the results depend entirely on the size of the sand grains being used, your students will generally find that all the stars in our galaxy would be represented by a pile of sand which has a volume of about 500 cubic meters, enough to fill a *very* large classroom to the ceiling!

What To Discuss/Extensions:

1. With the number of cubic meters in mind, ask your students if they think that the room would hold that much sand. Have your students measure the dimensions of your classroom and calculate the room's volume in cubic meters.

2. After the visual image of the room full of sand, or even overflowing, has had some time to sink in, remind students of the true sizes of stars (Most stars like the Sun have an equatorial diameter of about one million kilometers.) and that within our galaxy stars are many trillions of kilometers apart. With this information, your students may finally begin to have some sense of just how big our galaxy is.
3. If the stars were indeed the size of grains of sand, how far apart would they be? You may want to have students do this calculation as homework, using the same math skills developed in this lesson. For this activity students will need to find out how large an average star, such as the Sun, is and also how far apart the stars are, such as from the Sun to the next closest star, Proxima Centauri. (For grains about 1.3 mm on a side, the average spacing of stars in our solar neighborhood would place the grains about 40 miles apart!)
4. Discuss the relationship between the number of stars in our galaxy and the number of stars in the universe. Ask your students to contemplate the fact that there are about as many galaxies in the universe as there are stars in our galaxy. Have them calculate the approximate number of stars in the universe on the assumption that every galaxy has about the same number of stars.
5. Have your students change the scale for a star so that some larger object, such as a baseball, represents a star, and have them calculate the volume of the resulting cube of 200 billion baseballs.

Below is a template for the 1 cm cube. Please note that the size is approximate and that you will need to measure and make your own so that it is exactly 1 cm!



Vocabulary List

Axis	An imaginary straight line around which an object rotates.
Astronomical Unit - AU	The average distance from the Earth to the Sun, 93million miles.
Centimeter	A metric unit of length equal to 0.01 meter.
Classify	To arrange or put objects into categories.
Constellation	A grouping of stars, considered by humans to form a picture in the sky. Often related to mythology.
Data	Factual information (as in measurements, statistics, etc.) that can be used as a basis for reasoning, discussion, calculation, etc.
Day	The time it takes for a planet to make one full rotation (on Earth, 24 hours).
Diameter	The distance from one side of an object to another as measure through the center.
Elliptical	Shaped like an ellipse or oval.
Galactic cluster	Galaxies tend to cluster together, sometimes in small groups and sometimes in enormous complexes, these are often called galactic clusters.
Galaxy	A very large groups of stars and associated matter of which there are billions found throughout the universe.
Gravity	The force of attraction between two objects which is influenced by the mass of two objects and the distance between the two objects.
Meter	The base unit of length in the International System of Units that is equal to the distance traveled by light in a vacuum in 1/299,792,458 second or about 39.37 inches.
Moon	A natural satellite orbiting a planet.
Nebula	Any of the various clouds of gas and dust that occur in interstellar space.
Orbit	A specific path followed by a planet, satellite, etc.
Relative Distance	The distance between two objects as compared to something else.
Relative Size	The size of an object as compared to another object.
Revolution	The circling of a smaller object around a larger object.
Rotation	The spinning of an object on its axis.
Scale	Reducing all objects and distances by a percentage so that they are within a workable size.
Scale Model	A model of an object that is a percentage of its actual size.
Solar System	The system of planets, moons, and other objects revolving around a star (in our case, the Sun).

Space Probe	A vehicle designed to travel and explore remote locations in space and return information to astronomers and scientists.
Spiral	Winding around a center or pole and gradually receding from or approaching it.
Star	a massive, self-luminous celestial body of gas that shines by radiation derived from its internal energy sources.
Sun	Sol, the star that is closest to Earth and from which we get heat and light energy.
Telescope	A device used to form magnified images of distant objects.
Universe	The vast expanse of space which contains all of the matter and energy in existence.
Volume	The amount of space occupied by a three-dimensional object as measured in cubic units.
Year	The time it take for a planet to make one full revolution around a star, in our case, the Sun (on Earth, 365.25 days).

The Universe At Your Fingertips

In addition to the lesson plans included in this teacher guide, we recommend the following activities from The Universe at your Fingertips: An Astronomy Activity and Resource Notebook published by the Astronomical Society of the Pacific. This very comprehensive compendium of astronomy activities is an excellent resource that is available from the Maynard F. Jordan Planetarium. State of Maine Learning Results performance indicators are listed for each activity.

State of Maine Learning Results Performance Indicators	
"Fingertips" Activity Title	**Science and Technology Learning Results**
The Sun (B-1)	Gr.3-4. G. #2, H. #1 & Gr.5-8. G. #1
Observing a Planet (C-4)	Gr.3-4. G. #1. & Gr.5-8. G. #3., G. #5.
A Question of Scale (D-1)	Gr.5-8. G. #3.
Solar System Scale Model Sized to Your room (D-5)	Gr.3-4. G. #1. & Gr.5-8. G. #5.
Toilet Paper Solar System Scale Model (D-6)	Gr.3-4. G. #1 & Gr.5-8. G. #5.
The Thousand Yard Model (D-7)	Gr.3-4. G. #1. & Gr.5-8. G. #5.
Comparing the Sizes of Stars (G-1)	Gr.5-8. G. #1.
Among the Stars (G-2)	Gr.5-8. G. #1. & Secondary. G. #2. & #3.
Investigating Star Types (G-3)	Gr.5-8. G. #1.
How Many Stars? (H-3)	Gr.5-8. G. #1, G. #2., G. #3. Also, Math. Gr.5-8. F. #3.
A Ballooning Universe (H-4)	
The Expanding Universe (H-5)	
Visualizing the Expansion of Space (H-6)	
Parallax – How Far Is It? (J-2)	Gr.5-8. G. #1., #3. & #5. & Secondary. G. #3.

Some good books to use with *In the Maine Sky*

Our Solar System
Simon, Seymour. 1992, Morrow Junior Books

The Planets in Our Solar System
Branley, F. 1986, Harper & Row.

Postcards from Pluto: A Tour of the Solar System
Leedy, Loreen. 1993, Holiday House.
Dr. Quasar gives a group of children a tour of the solar system

Mercury
Vogt, Gregory. 1994, The Millbrook Press

The Planet Venus
Hunt, G. & Moore, P. 1982, Faber & Faber.
An illustrated introduction.

The Home Planet
Kelley, K. . 1988, Addison-Wesley.
A picture album.

The Moon Observer's Handbook
Price, F. 1989, Cambridge University Press.

Mars
Vogt, Gregory. 1994, The Millbrook Press

Destination: Jupiter
Simon, Seymour. 1998, Morrow Junior Books

Saturn: A Spectacular Planet
Branley, F. 1983, Crowell.

A Distant Puzzle: The Planet Uranus
Asimov, Isaac, 1994, Milwaukee : Gareth Stevens Pub.,
Revised edition of "Uranus: The Sideways Planet"

Neptune : the farthest giant
Asimov, Isaac. 1990, G. Stevens Children's Books.
Describes the characteristics and movements of the planet Neptune.

Pluto
Vogt, Gregory. 1994, The Millbrook Press

Galaxies
Ferris, T. 1980 Stewart, Tabori & Chang.
Lavishly illustrated introduction to the large-scale cosmos by a noted science writer.

Galaxies
Hodge, P. 1986, Harvard U. Press.
A thorough introduction to our modern understanding of galaxies.

Galaxies
Simon, Seymour. 1988, Morrow Junior Books.
Identifies the nature, locations, movements, and different categories of galaxie.

Galaxies
Sipiera, Paul P. 1997, Children's Press.
Examines what a galaxy is, the different types that exist, and some facts learned from them.

Galaxies and Quasars
Kaufmann, W. 1979, Freeman.
Clear basic guide to what lies beyond our Milky Way Galaxy.

Our Vast Home: The Milky Way and Other Galaxies
Asimov, Isaac. 1995, G. Stevens Pub.
Provides an insider's view of our own Milky Way and discusses the nature and behavior of galaxies in general.

Some good web sites to use with *In the Maine Sky*

www.galaxies.com
An informative page put together by an amateur astronomer

space.jpl.nasa.gov
NASA's Jet Propulsion Laboratory web site

emma.la.asu.edu/dsn_solarsyst.html
An astronomy information page compiled by Ken Edgett, Arizona State University

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

seds.lpl.arizona.edu/nineplanets/nineplanets/nineplanets.html
A Multimedia Tour of the Solar System from the Students for the Exploration and Development of Space

www.dustbunny.com/afk
A web site about astronomy, designed for kids, with tons of information

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

www.eduref.org/Virtual/Lessons/index.shtml
Lesson plans written and submitted by teachers from all over the United States.

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

www.thursdaysclassroom.com
Lesson plans, activities, and teacher resources presented from Science@NASA

Astronomy Web Sites Worth a Visit

www.galaxymaine.com
The Maynard F. Jordan Planetarium and Observatory home page

www.galaxymaine.com/SA/SA.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

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

www.dustbunny.com/afk
A web site about astronomy, designed for kids, with tons of information

hawastsoc.org
The Hawaiian Astronomical Society's home page

spaceplace.jpl.nasa.gov/spacepl.htm
The Jet Propulsion Laboratory's web site for kids

www.calacademy.org/planetarium
Alexander F. Morrison Planetarium home page

www.nss.org
The National Space Society Home Page

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 that the information given on the above web sites to be accurate, accessible, or appropriate for students.