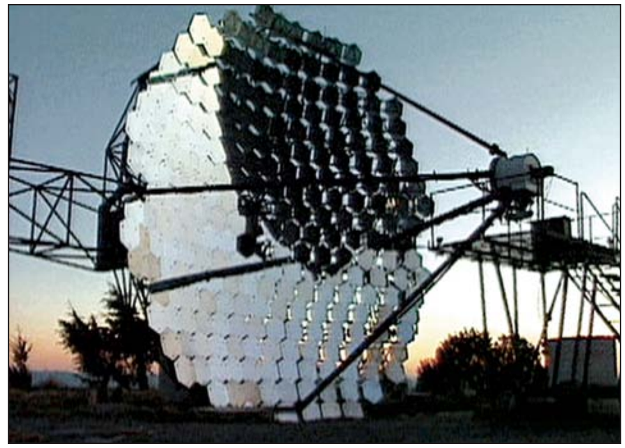
The FUTURES Channel®

MOVIE GUIDE

MOVIES NUMBER 3007-08

Eyes on the Universe Parts 3 & 4

The Movies:



Part 3: Telescope Mirrors—Building a large telescope mirror is a complex engineering task. *(Movie length: 3:16)*

Part 4: What's Next—When observatories move from Earth's mountaintops to above its atmosphere, astronomers will be able to look for signs of life on planets orbiting other stars. *(Movie length: 3:53)*

Featured: Don McCarthy, astronomer, Kitt Peak Observatory; Roger Angel, Astronomer, Kitt Peak Observatory

Background:

Astronomical observations have always been made difficult by the necessity of looking at the universe from the bottom of an ocean of turbulent atmosphere. All of that changed, however, with the launch of Earth's first space-based observatory, the Hubble telescope. New technologies have also been developed which can considerably improve the performance of the large ground-based telescopes which are based on mountaintops around the planet.

What is perhaps most fascinating about telescopes, however, is not just how they are built. Rather it is the fact that a telescope is a marriage of humankind's most practical engineering disciplines with what is possibly our most impractical ambition—to understand the nature of the universe.

Curriculum Connections:

Geometry (cylinders), Measurement (volume), Decimals 1

The mirror on Mount Wilson in California is 100 inches in diameter and 13 inches thick. Find its volume in cubic inches, and convert that to cubic feet. If the glass weighs 62.4 pounds per cubic foot, what is the weight of the mirror?

Ratios, Measurement (conversion) 2

Because of the Earth's rotation, a telescope must be moved by a motor so that it always points at the same point in the night sky. The rate of motion must be exactly the same as the rate at which the Earth spins: 1 rotation every 24 hours.

Suppose you have a motor which turns at the rate of 1,000 revolutions per minute. What gear ratio would you need to use between the motor and the telescope?

3

Algebra (solving equations)

The intensity of light that arrives at a telescope (I) coming from a point source (such as a star) is related to the distance (d) between the source and the telescope by this equation:

$$I = k/d^2 = k \cdot d^{-2}$$

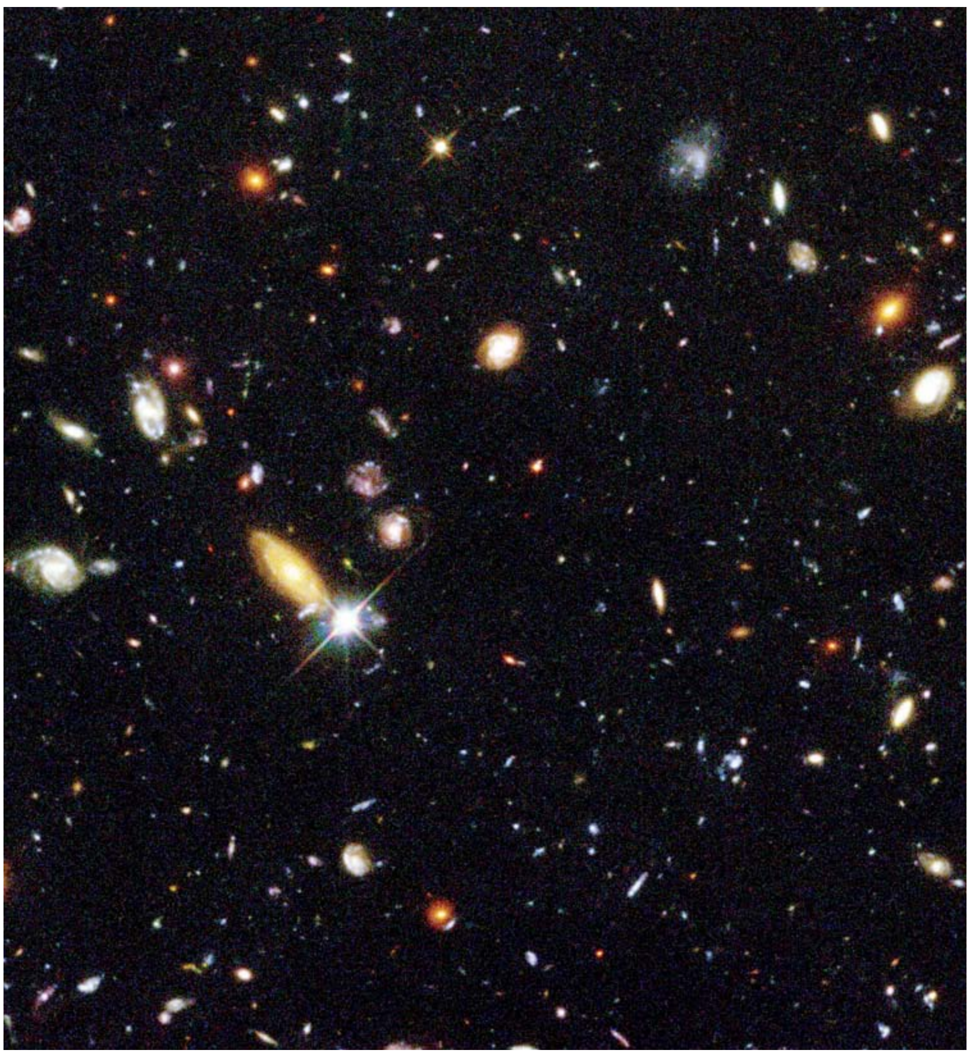
If one star is three times as far away from Earth as another, but both are of equal brightness, how will the intensity of their light compare by the time that light reaches Earth?

4

Statistics, Percents

The image below is a product of the Hubble Space Telescope. Every object that you can see in it, except the bright star below and left of the center of the image, is a galaxy.

This image is of a small section of the night sky that is just 0.002% of the entire sky. If the rest of the sky has a similar population of galaxies, estimate how many galaxies in the entire sky could be seen with the Hubble telescope. (Hint: Don't try to count every galaxy in the picture. Divide it up with a 2-inch grid, count the number of galaxies in 3 or 4 of those squares, and use an average of those numbers to estimate the number of stars in the whole image.)



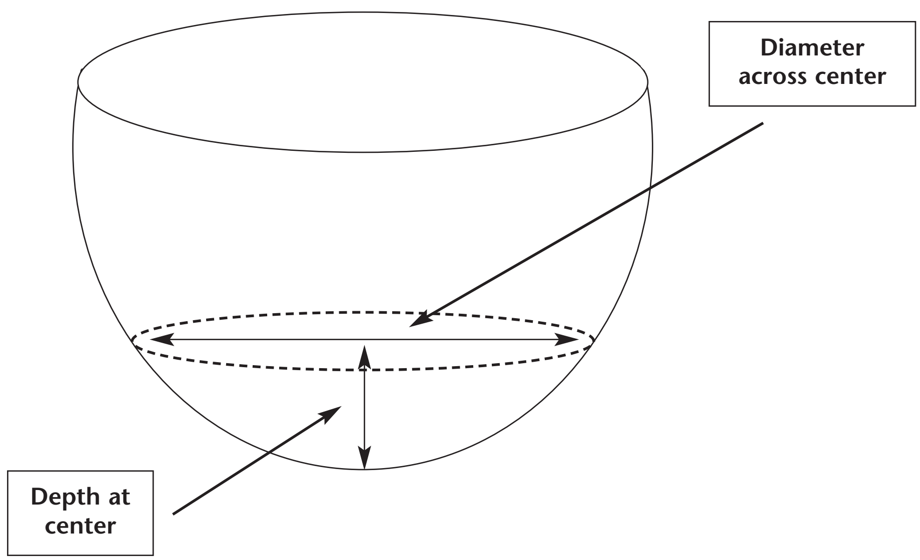
Kitchen Paraboloids

A "paraboloid" is a curved surface which, if cut through the center, would have a cross-section in the shape of a parabola. Telescope mirrors and headlights are both paraboloids.

In this investigation, you will find out if some common kitchen dishes are actually paraboloids.

Investigation steps:

1. Choose a glass or bowl which seems to have a paraboloid inner surface.
2. Put a little water into the object.
3. Measure the depth of the water and the diameter of the circular surface of the water.
   - To measure the depth of the water, insert a thin object, such as a toothpick or straw, into the water at the center point, and measure the length that became wet. Be sure that when you insert the object it is exactly vertical.
   - To measure the diameter, use a string to mark off the length.



4. Record your data in a chart.
5. Add a little more water.
6. Repeat steps #3 and #4 until you have data that spans the object from being nearly empty of water to being nearly full.
7. Graph the height of the water (on the y-axis) against the <u>radius</u> (not diameter) on the x-axis.
8. See if you can find an equation of the form $y = ax^2$ that matches the graph.
9. Repeat with another glass or dish.
10. Report on your results.

Teaching Guidelines: Kitchen Paraboloids
Math Topics: Algebra (quadratic functions)

Materials:

- Several bowls of different sizes and types
- Source of water
- Ruler
- String

Procedure:

This project should be done by students individually or in teams of two.

Distribute the handout and discuss it. Ensure that students understand the diagram. Review what they are being asked to do and ensure that they understand the assignment. Then have them begin.

Circulate as students work on the activity and assist as needed. Help them to determine just how they are going to investigate the questions asked, and help them work out how they are going to record their data.

Each student should prepare his or her own report on the procedure and results.

If you enjoyed this Futures Channel Movie, you will probably also like these:

Life Under the Ocean, #2004	A marine biologist studies the jellyfish-like animals living at 3,000 feet, where it is cold, dark and quiet.
The Bose Speaker, #1017	"You can never do anything better unless it is different," according to Dr. Amar Bose, who uses the rules of mathematics to achieve superior sound quality in his Bose radio and speakers.
Space Weather, #3004	With solar flares 200,000 miles across releasing the equivalent of all the energy ever produced on the Earth at one time, space weather forecasters will become an important feature on the future news.